

STRATIGRAPHY OF THE AREA AROUND MATANOMADH IN NORTH-WESTERN KACHCHH WITH SPECIAL REFERENCE TO THE MATANOMADH FORMATION

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ABSTRACT

Four stratigraphic sections were measured in order to cover as much outcrop area as possible and to know the lateral persistence of various lithic units, their thickness and exact order of superposition in the area around Matanomadh, north-western Kachchh. The stratal units mapped in the area are Bhuj, Deccan Trap, Matanomadh and post-Matanomadh formations.

Frequency analysis and the variation pattern observed in the spore-pollen assemblage provide ample evidence for biostratigraphic zonation of the Matanomadh Formation. On the basis of the first appearance, maximum development and decline of the various palynomorphs four biozones have been recognized within this formation. These are (in ascending order): (i) Barren Zone, (ii) *Dandotiaspora dilata* Cenozoone, (iii) *Couperipollis brevispinosus* Cenozoone, and (iv) Sponge Zone.

Key-words — Lithostratigraphy, Biostratigraphic Zonation, Matanomadh Formation, Palaeocene, Kachchh (India).

सारांश

मातानोमढ़ शैल-समूह से विशेषतः संदर्भित उत्तर पश्चिमी कच्छ में मातानोमढ़ के आस-पास के क्षेत्र का स्तरविन्यास - रमेश कुमार सक्सेना

उत्तर पश्चिमी कच्छ में मातानोमढ़ के आस-पास के क्षेत्र में विभिन्न शिली एककों की पार्श्विक स्थिरता, इनकी मोटाई तथा अध्यारोपण के ठीक-ठीक क्रम को जानने के लिए तथा अधिकतम् संभव क्षेत्र को अध्ययन के अंतर्गत लाने हेतु चार स्तरिक खंड अनुमापित किये गये हैं। भुज, दक्खन ट्रैप, मातानोमढ़ एवं अन्तिम मातानोमढ़ शैल-समूह इस क्षेत्र के आलेखित स्तरीय एकक हैं।

बीजाणु-परागकण समुच्चय में प्रेक्षित बारंबारता विश्लेषण एवं विभिन्नता का ढंग मातानोमढ़ शैल-समूह के जीवस्तरविन्यासीय-अनुक्षेत्र-वर्गीकरण के लिए प्रचुर प्रमाण जुटाते हैं। विभिन्न परागणविकरूपकों के प्रथम प्रादुर्भाव, अधिकतम् विकास एवं पतन के आधार पर इस शैल-समूह में अधिरोहण क्रमानुसार चार जीव-मंडल (क) अनुत्पादक मंडल, (ख) डेन्डोटियास्पोरा डाइलेटा समुच्चय-मंडल, (ग) काउपेरिपोलिस ब्रेविस्पाइनोस समुच्चय-मंडल, तथा (घ) स्पंज मंडल हैं।

INTRODUCTION

THE commencement of Tertiary Period in Kachchh is marked by the Matanomadh Formation. It is characterized by laterite and kaolinitic clay in the lower part (Laterite Member) and ferruginous and gritty sandstones, carbonaceous shale, tuff, ash and mottled clay in the upper part (Clastic Member).

Wynne (1872) was the first to recognize this stratal succession as a full-fledged, stratigraphic unit. He named it a Subnummulitic Group and assigned an Early

Eocene age. This dating was subsequently supported by Oldham (1893), Tewari (1952, 1957), Nagappa (1959), Poddar (1959, 1963) and Wadia (1968). Pascoe (1964), for the first time, opined that the Subnummulitic Group (= Matanomadh Formation) might be Palaeocene in age. A Palaeocene age for this formation was also supported by Biswas (1965). He named it as the Madh Series and correlated it with the Ranikot Series (Palaeocene) of Sind-Baluchistan.

A lithostratigraphic classification of the Tertiary sediments of Kachchh has been

proposed by Biswas and Raju (1971, 1973). They formally instituted the name Matanomadh Formation. Saxena (1977), on the basis of lithological characteristics, divided this formation into a lower Laterite Member and an upper Clastic Member.

Records of palynological studies on the Matanomadh Formation are meagre. Mathur (1966) was the first to describe a spore-pollen assemblage from this formation. Recently, the author recovered a rich palynoflora from the various levels of the Matanomadh Formation (Kar & Saxena, 1976; Saxena 1978, 1979a).

FIELD INVESTIGATION PROCEDURE

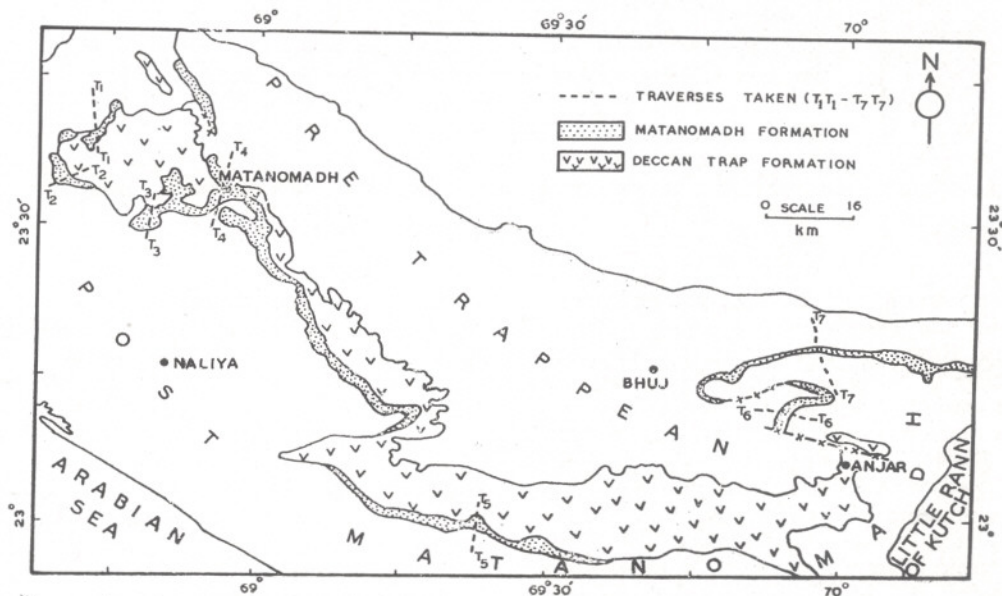
To select out a suitable section which may serve as a standard reference section for the correlation of the scattered outcrops of the Matanomadh Formation, a reconnaissance survey was carried out in Kachchh (Traverses-T₁T₁-T₇T₇, Text-fig. 1). From this survey it was found that Matanomadh area is best suited for the stratigraphic study of the Matanomadh Formation because—(i) this area represents the type area for the Matanomadh Formation

and also exposes the best sections for study, (ii) these sections are exposed in the nala cuttings along Bhuj-Lakhpatt Road and in Madhwali Nadi, hence easily accessible, and (iii) the entire thickness of the Matanomadh Formation as well as its lower and upper contacts are exposed in this area.

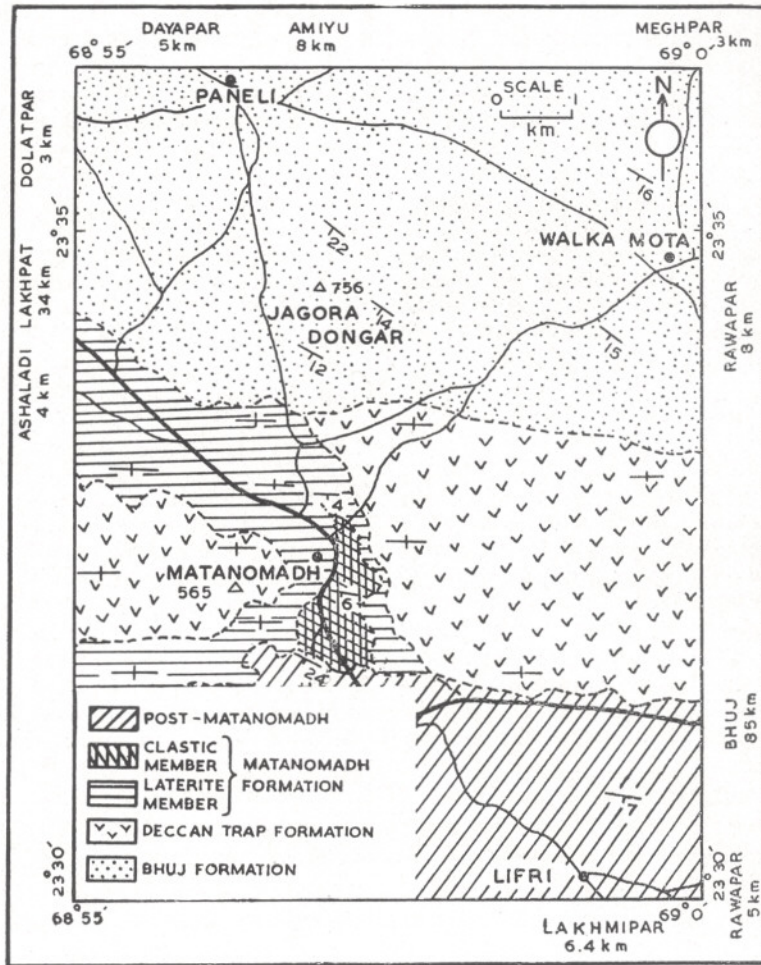
A number of traverses along different directions were undertaken in and around Matanomadh and thus the following succession was recorded in Matanomadh area:

- | | |
|----------------------------------|---|
| 4. Naredi and younger formations | |
| 3. Matanomadh Formation | ... Clastic Member
... Unconformity ...
... Laterite Member |
| 2. Deccan Trap Formation | ... Unconformity ... |
| 1. Bhuj Formation | |

Besides, this area was geologically mapped (Text-fig. 2). Exposures of the various rock formations were plotted on a topographical map of 1:63360 scale. The mapped area lies between lat. 23°30'0"-23°36'15"N: long. 68°55'0"-69°0'0"E and falls in Survey of India toposheet no. 41A/14. While mapping the area, order



TEXT-FIG. 1—Geographical extent of the Matanomadh Formation in Kachchh (modified after Biswas & Deshpande, 1970).



TEXT-FIG. 2—Geological map of the Matanomadh area, north-western Kachchh, India.

of superposition, lithic characters, mega-fossils and depositional breaks were considered to be the basic criteria for the identification of various lithic units in the field. The contacts were marked on the base map by Compass Traverse method (Lahee, 1941, pp. 449-461). The amount of dip along with strike direction were recorded wherever possible, and plotted on the map to show the general trend of the rocks. The following lithic characters were considered important for the identification of the various formations in the field.

The Bhuj Formation is characterized by medium to fine-grained, compact sand-

stone unconformably underlying the traps. The overlying Deccan Traps are composed of aphanitic to porphyritic basalt. The lower, Laterite Member of the Matanomadh Formation conformably overlies the traps and is made up of laterite and kaolinitic clay. This member is unconformably overlain by the upper, Clastic Member of the Matanomadh Formation which is characterized by its colourful outcrops and is made up of carbonaceous and tuffaceous shales, ferruginous and gritty sandstones and mottled variegated clays containing plant impressions. The upper limit of the Matanomadh Formation seems

to be uniformly marked at the top of a red ferruginous sandstone. The Matanomadh Formation is conformably overlain by the Naredi Formation, which along with other younger formations has been mapped as post-Matanomadh.

STRATIGRAPHY OF THE AREA AROUND MATANOMADH

To understand the exact order of superposition, the thickness of various rock types, the lower and upper contacts of the Matanomadh Formation and finally to build up a local stratigraphic column, four sections were measured (Text-fig. 3). The complete thickness and lower and upper contacts of the Matanomadh Formation are not observable in any one section. The lower contact is exposed in section nos. 1 and 2, while the upper contact has been observed in section no. 4. Section no. 3 exposes only a part of the Matanomadh Formation. A composite section was prepared after compiling data from all the four sections. In all the sections the mottled clay bed is found to be consistent and was therefore taken as the datum line. Stratigraphically located samples were collected from all the sections for palynological studies. The description of the palynofossils recovered from this formation has already been published by Kar and Saxena (1976) and Saxena (1978, 1979a). The systematic description of the various stratigraphic sections is as follows:

Section No. 1 — Stratigraphic section exposed along the northern edge of the pond 1 km NNE of Matanomadh temple. The section exposes the following rock units in ascending order:

The rocks are almost horizontal to low dipping, up to 4° towards south. The greenish-grey shale (3) is poor in palynofossils while the grey arenaceous shale (5), grey sulphurous shale (6) and the shale partings within the red coarse grained sandstone (7) are very rich in calcareous sponge spicules.

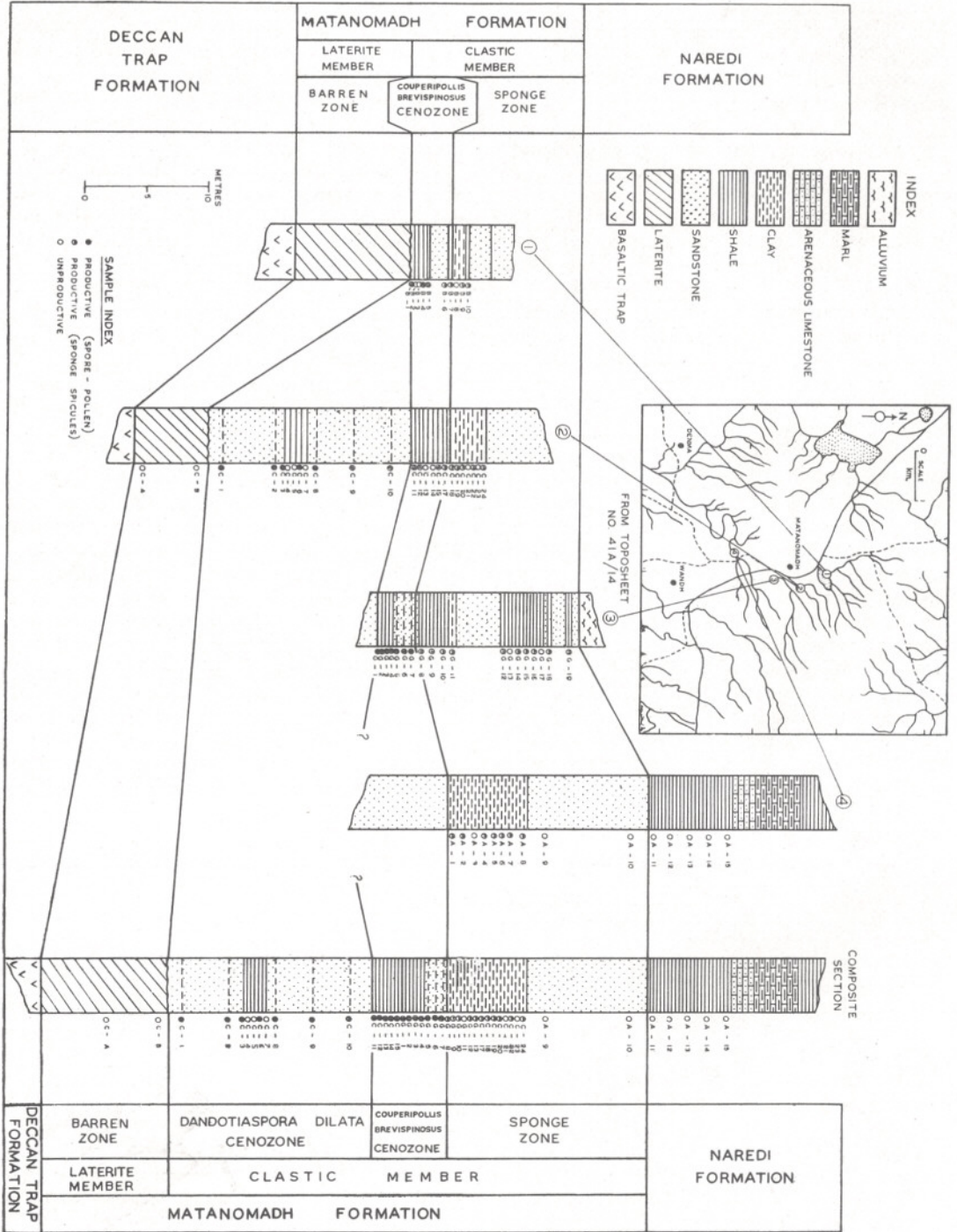
Section No. 2 — Stratigraphic section exposed along a nala cutting about 0.5 km ENE of Matanomadh, SSE of section No. 1. The following sequence is exposed in this section in ascending order:

The upper limit of the section, marked by a red ferruginous sandstone, is partly eroded and generally covered by Recent alluvial deposits. The dip of the rocks is 2°-5° towards south-west. This section yielded well-preserved and rich spore-pollen assemblage along with microplanktons and epiphyllous fungal remains in the tuffaceous bands of both the gritty sandstone beds (3, 5) and also in the carbonaceous tuffaceous shale (4). The mottled variegated clay bed (7) yielded sponge spicules in fair amount and in this very feature it corresponds with the grey shale beds of section no. 1.

Section No. 3 — Stratigraphic section exposed along a nala cutting along Bhuj Lakhpat Road, about 0.5 km SSW of section

SECTION NO. 1

FORMATION	MEMBER	LITHOLOGY	THICKNESS IN m
Matanomadh Formation	Clastic Member	9. Red ferruginous sandstone	1.68
		8. White coarse-grained gritty sandstone	1.83
		7. Red coarse-grained sandstone with shale partings	0.30
		6. Grey shale with streaks of sulphur	1.07
		5. Grey arenaceous shale	0.30
		4. Violet sandstone with embedded clay pebbles	1.52
		3. Greenish grey shale	1.52
..... Unconformity			
Deccan Trap Formation	Laterite Member	2. Laterite	9.15
	—	1. Basaltic Traps	—



TEXT-FIG. 3 — Palynostratigraphic correlation of the Matanomadh Formation in type area.

SECTION NO. 2

FORMATION	MEMBER	LITHOLOGY	THICKNESS IN m
Matanomadh Formation	Clastic Member	8. Red ferruginous sandstone	3.05
		7. Mottled variegated clay	3.05
		6. Carbonaceous shale	3.40
		5. Gritty sandstone with tuffaceous bands	8.54
		4. Carbonaceous-tuffaceous shale with plant impressions	1.83
		3. Gritty sandstone with tuffaceous shale bands	6.10
	 Unconformity	
	Laterite Member	2. Laterite	6.10
Deccan Trap Formation	—	1. Basaltic traps	—

SECTION NO. 3

FORMATION	MEMBER	LITHOLOGY	THICKNESS IN m
Matanomadh Formation	Clastic Member	14. Recent deposits	0.46
		13. Red ferruginous sandstone	0.85
		12. Grey shale	0.56
		11. Red sandstone with embedded clay pebbles	1.22
		10. Grey shale	0.15
		9. Violet sandstone with embedded clay pebbles	0.30
		8. Grey carbonaceous tuffaceous shale with sulphur	3.66
		7. Reddish-white sandstone	3.66
		6. Mottled clay	0.65
		5. Grey shale	2.44
		4. Red sandstone with streaks of grey shale	0.30
		3. Gritty sandstone with tuffaceous streaks	1.85
		2. Lignitic shale	1.22
		1. Gritty sandstone	0.61

no. 2. This section exposes the following sequence in ascending order:

The top of the section is marked by an eroded bed of red, ferruginous, lateritic sandstone covered by Recent alluvium. The lower part of the basal gritty sandstone is not exposed. The angle of dip is uniform, up to 5° towards south. This section, yielded well-preserved spores and pollen

grains along with microplanktons in the lignitic shale (2) and the tuffaceous shale bands of the gritty sandstone (3). The grey shale and mottled clay (5, 6) and the lower part of the tuffaceous shale bed (8) yielded numerous sponge spicules like the mottled clay beds of the other sections.

Section No. 4—Stratigraphic section exposed along a nala cutting about 1.5 km

SECTION NO. 4

FORMATION	MEMBER	LITHOLOGY	THICKNESS IN m
Naredi Formation		7. Gypseous claystone	1.30
		6. White fossiliferous marl	3.60
		5. Yellow limestone with fragmentary fossils	2.00
		4. Grey gypseous shale	6.10
Matanomadh Formation	Clastic Member	3. Red ferruginous sandstone with white clay pebbles	9.80
		2. Mottled tuffaceous clay	6.80
		1. Gritty sandstone	6.10
		Base covered by alluvium	

SSW of Matanomadh, across Matanomadh Denma Track. The following rock units are exposed in this section in ascending order.

The contact between the Matanomadh and Naredi Formation is conformable (Pl. 1, fig. 1). The dip is considerably steep, as compared to other sections, ranging between 20°-30° in the SSW direction (Pl. 1, fig. 2). This section is palynologically barren but

the samples collected from the basal part of the mottled tuffaceous clay (2) yielded sponge spicule-like structures. In this, it corresponds to the mottled clay bed of the other sections.

The following general succession has been compiled from the geological data collected from the measured sections and a number of traverses undertaken along different directions in this area:

FORMATION	MEMBER	LITHOLOGY
Naredi Formation		— Top not observed — Grey gypseous shale White fossiliferous marl Yellow compact limestone Grey gypseous shale
	Matanomadh Formation	Clastic Member Red ferruginous sandstone White sandstone with violet streaks Mottled variegated arenaceous clay Red sandstone with white clay pebbles Tuffaceous carbonaceous shale Gritty sandstone with thin tuffaceous bands Carbonaceous shale Gritty sandstone with tuffaceous bands
	 Unconformity
	Laterite Member	Laterite White kaolinitic clay
Deccan Trap Formation		Basaltic traps
	 Unconformity
Bhuj Formation		Medium to fine-grained feldspathic sandstone — base not seen —

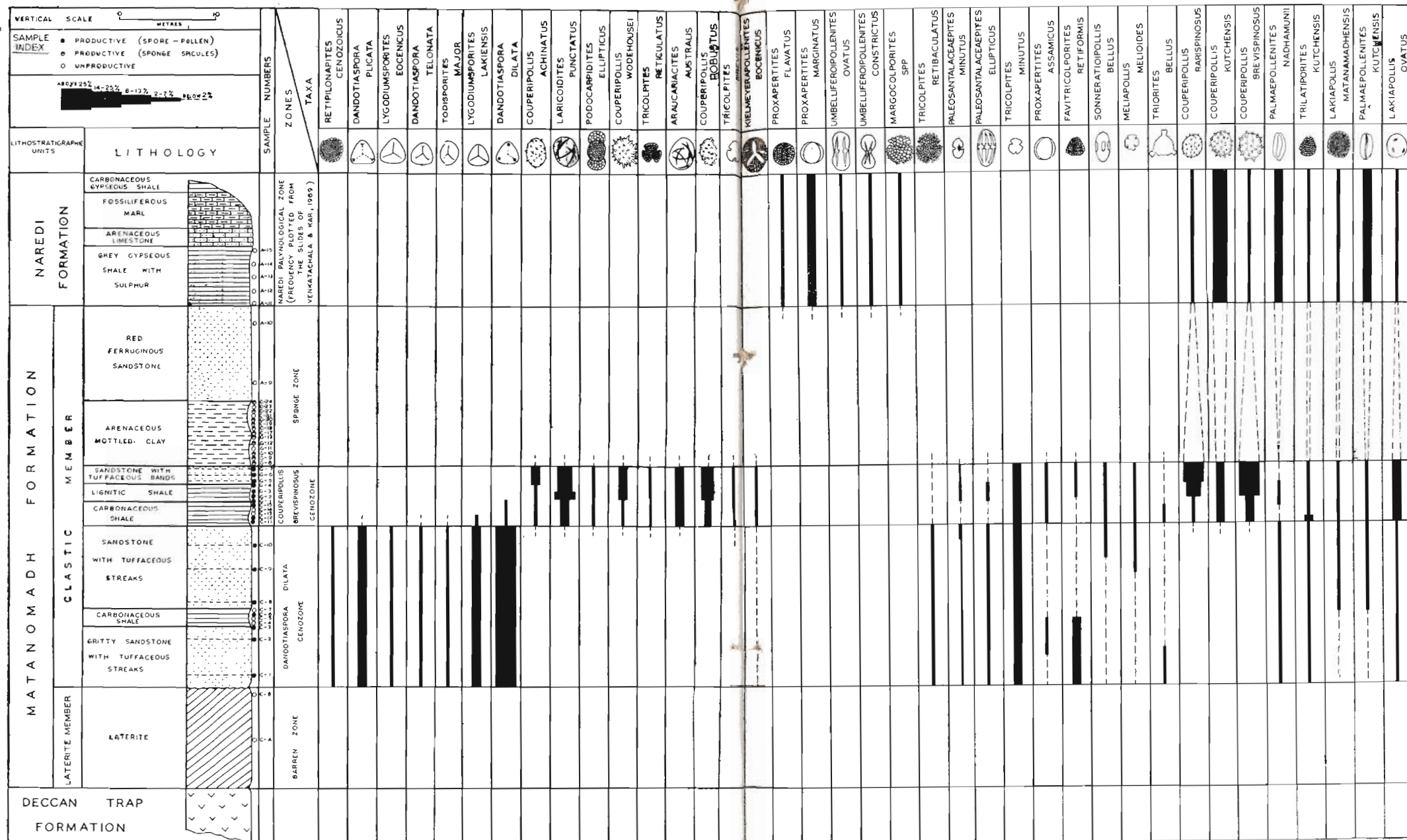
MATANOMADH FORMATION

Field evidences indicate that the depressions in the traps provided the depositional basin for the Matanomadh Formation. The irregular outcrop pattern of the Matanomadh Formation paralleling the post-trappean topography is the ample testimony for this contention.

Lithology—The materials composing this formation are mainly trap-wash, breccia, tuff, ash, etc. derived from traps and pyroclastics. The colourful and variegated nature of formation is attributed mainly to its derivation from volcanic material. This formation is thus easily distinguishable from other rock formations in the field. The occurrence of reworked Cretaceous

spores and pollen grains from the Clastic Member indicates that considerable amount of material of this formation was supplied by the Bhuj Formation (Saxena, 1979b). On the basis of lithology, this formation is divisible into two members, viz., Laterite Member and Clastic Member (Saxena 1977). Both these members are developed and exposed in Matanomadh area.

1. *Laterite Member*—This member is made up of chalky-white, kaolinitic, lithomargic clay and pink, grey and variegated bauxitic laterite and conformably overlies traps. The nature of its contact with the traps is suggestive of alteration of basaltic flows as well as of the pyroclastics ejected during the later phase of the Deccan Trap volcanicity. The laterite near Matanomadh



TEXT-FIG. 4 — Palynostratigraphic zonation of the Matanomadh Formation in north-western Kachchh

are ferruginous with few levels of high grade bauxite.

2. *Clastic Member* — The main rock types observed within this member are ferruginous and gritty sandstones, tuffaceous and carbonaceous shales, alum shales, bentonitic and ferruginous clays, volcanic ash and lignitic shales and mixture of two or more of these rock types.

Fossil Contents — Except the presence of *Venericardia beaumonti* d'Archaic & Haime and *Venericardia* sp. cf. *V. vredenburghi* Douville, reported by Tandon (1971) from the equivalent rocks exposed at Nareda, this formation appears to be devoid of megafauna. Angiospermous leaf and stem impressions were observed in carbonaceous shales, tuffaceous shales and mottled clay in the Matanomadh area. The palynofossils from this formation have been described by Mathur (1966), Kar and Saxena (1976) and Saxena (1978, 1979a).

Nature of Contacts — This formation conformably overlies the basalts of the Deccan Trap Formation (Text-fig. 3, Section nos. 1, 2). The upper contact, which is also conformable, has been marked at the top of the red ferruginous sandstone underlying the grey gypseous shale of the Naredi Formation (Text-fig. 3, section no. 4; Pl. 1, fig. 1). The contact between the Laterite and Clastic members of the Matanomadh Formation is unconformable and is marked at the top of the laterite.

Environment of Deposition — The occurrence of pteridophytic and angiospermous palynofossils along with the microplanktons, fungal remains, angiospermous leaf impressions and the presence of sponge spicules suggests continental to estuarine environment of deposition (Saxena, 1980).

Age — A detailed discussion on the age of this formation has been given by Saxena (1980) suggesting a Palaeocene age.

BIOSTRATIGRAPHIC ZONATION OF THE MATANOMADH FORMATION

A perusal of the published work on the Matanomadh Formation shows that palynostratigraphic work on stratigraphically located samples from measured sections has not so far been done. An attempt is therefore made here to find out the marker

palynotaxa for delimiting the various stratigraphic levels within this formation.

A composite assemblage has been obtained by taking the mean value of the palynological data from various stratigraphic sections of the formation. The palynological data, thus obtained, have been plotted according to their vertical distribution (Text-fig. 4). The frequencies of the significant spore-pollen taxa have been shown under 5 slabs, viz., very rare (below 2%), rare (2-7%), common (8-13%), abundant (14-25%) and predominant (above 25%).

On the basis of the frequency analysis and variation pattern of the spore-pollen assemblage from the different levels it seems possible to divide the formation into 4 biozones. The first appearance, the maximum development and the decline of the spore-pollen taxa have been taken as parameters for the recognition of the biozones. These features have also been found suitable in the delimitation of the zonal boundaries.

4. Sponge Zone

3. *Couperipollis brevispinosus* Cenozoone

2. *Dandotiaspora dilata* Cenozoone

1. Barren Zone.

The Laterite Member of the formation is devoid of any type of fossils and therefore biostratigraphically constitutes a 'Barren Zone'. The upper contact of this zone with the overlying *Dandotiaspora dilata* Cenozoone is unconformable. Both these contacts are observable in section no. 1 and 2 (Text-fig. 3).

Several levels of the Clastic Member yielded a rich palynological assemblage. The overall composition of the palynoflora from different levels, especially the dominance of a few species and presence or absence of others, permits the division of this member into 3 biozones. A formal description of each biozone is given below:

Dandotiaspora dilata CENOZONE

Type Section — Section no. 2 (Text-fig. 3), Lat. 23°32'33"N; Long. 68°57'12"E, Matanomadh area, north-western Kachchh, India.

Lithology — This zone is mainly composed of sandstone with alternations of carbonaceous and tuffaceous shales. The average thickness of this zone is about 16.0 m.

Lower Contact — This zone constitutes the lowest biostratigraphic unit of the Clastic

Member of Matanomadh Formation and rests unconformably over the Barren Zone (= Laterite Member). This contact is observable in section nos. 2 and 3 (Text-fig. 3).

Upper Contact—The upper contact has been marked between the sandstone of this zone and the carbonaceous shale of the overlying *Couperipollis brevispinosus* Cenozoone. This contact is conformable and is exposed in section nos. 2 and 3 (Text-fig. 3).

Significant species of this cenozoone—*Dandotiaspora dilata* (Mathur) Sah, Kar & Singh, *D. plicata* (Sah & Kar) Sah, Kar & Singh, *D. telonata* Sah, Kar & Singh, *Lygodiumsporites lakiensis* Sah & Kar, *L. eocenicus* Dutta & Sah, *Todisporites major* Couper, *Retipilonapites cenozoicus* Sah, *Palmaepollenites nadhamunii* Venkatachala & Kar, *Tricolpites minutus* Sah & Kar, *Lakiapollis ovatus* Venkatachala & Kar and *Trilatiporites kutchensis* Venkatachala & Kar.

Species restricted to this Cenozoone—*Dandotiaspora dilata*, *D. plicata*, *D. telonata*, *Lygodiumsporites lakiensis*, *L. eocenicus*, *Todisporites major* and *Retipilonapites cenozoicus*.

Remarks—The significant feature of this zone is the predominance of the pteridophytic spores and negligible representation of gymnospermous pollen grains (see Saxena, 1980, text-fig. 1). Spores referable to *Dandotiaspora* constitute about 35 per cent of the total assemblage, in some samples up to 60 per cent or even more. The dominance of this taxon is, therefore, very remarkable and helps in distinguishing this Cenozoone from the overlying *Couperipollis brevispinosus* Cenozoone.

Couperipollis brevispinosus CENOZONE

Type Section—Section no. 3 (Text-fig. 3), Lat. 23°32'15"N: Long. 68°57'12"E, Matanomadh area, north-western Kachchh, India.

Lithology—This zone is predominantly characterized by shales with a sandstone bed at the top. The shales are carbonaceous and tuffaceous while the sandstone contains thin lenses or streaks (5-15 cm in thickness) of tuffaceous shales. The average thickness of this zone is about 6.5 m.

Lower Contact—The lowermost shale bed of this zone conformably overlies the sandstone bed of the underlying *Dandotia-*

spora dilata Cenozoone. This contact has been observed in section nos. 2 and 3 (Text-fig. 3).

Upper Contact—The upper contact of this zone with the overlying Sponge Zone is conformable and is marked between the sandstone bed of this zone and mottled, arenaceous clay bed of the overlying Sponge Zone. This contact is observable in all the four sections (Text-fig. 3).

Significant species of this Cenozoone—*Podocarpidites ellipticus* (Cookson) Potonié, *Laricoidites punctatus* Saxena, *Araucariacites australis* Cookson, *Couperipollis wodehousei* (Biswas) Venkatachala & Kar, *C. brevispinosus* (Biswas) Venkatachala & Kar, *C. rarispinosus* (Sah & Dutta) Venkatachala & Kar, *C. kutchensis* Venkatachala & Kar, *C. achinatus* Sah & Kar, *C. robustus* Saxena, *Palmaepollenites kutchensis* Venkatachala & Kar, *Tricolpites reticulatus* Cookson, *T. minutus* Sah & Kar, *Lakiapollis ovatus* Venkatachala & Kar, *L. Matanomadhensis* Venkatachala & Kar, *Meliapollis melioides* (Ramanujam) Sah & Kar, *Trilatiporites kutchensis* Venkatachala & Kar, *Sonneratioipollis bellus* Venkatachala & Kar and *Kielmeyerapollenites eocenicus* Sah & Kar.

Species restricted to this Cenozoone—*Podocarpidites ellipticus*, *Laricoidites punctatus*, *Araucariacites australis*, *Couperipollis wodehousei*, *C. brevispinosus*, *C. rarispinosus*, *C. achinatus*, *C. robustus* and *Tricolpites reticulatus*.

Remarks—In contrast to the underlying *Dandotiaspora dilata* Cenozoone, this zone is marked by the dominance of gymnospermous and angiospermous pollen grains and decrease of pteridophytic spores. The genera *Laricoidites* (13 per cent) and *Couperipollis* (32 per cent) predominantly occur in this zone, while in the underlying zone they are almost negligible. Such high frequency of these genera is a reliable feature for identification of this zone.

Sponge Zone

Type Section—Section no. 4 (Text-fig. 3), Lat. 23°31'46"N: Long. 68°56'48"E, Matanomadh area, north-western Kachchh, India.

Lithology—This zone is mainly composed of shale and mottled clays, overlain by a

red ferruginous sandstone. The average thickness of this zone is about 16.0 m.

Lower Contact—The lower bed of this zone, i.e. mottled arenaceous clay, rests conformably over the sandstone bed of the underlying *Couperipollis brevispinosus* Cenozoene. This contact has been observed in all the 4 sections (Text-fig. 3).

Upper Contact—The red ferruginous sandstone forming the top of this zone is conformably overlain by gypseous shale and claystone of the Naredi Formation. This contact is exposed in section no. 4 (Text-fig. 3).

Remarks—This zone is devoid of a distinct palynoflora but the abundance of sponge spicules in this zone, encountered in all the sections studied here, makes it an important stratigraphic level marking the top of the Matanomadh Formation.

CONCLUSIONS

The stratigraphic study of the Matanomadh area shows the development of Bhuj, Deccan Trap, Matanomadh and post-Matanomadh (Naredi and younger formations) formations in ascending order. The Bhuj Formation is unconformably overlain by Deccan Trap Formation consisting of stratified basaltic traps. The next unit in succession, conformably overlying the Deccan Trap Formation, is the Matanomadh Formation which is made up of lower Laterite Member and an upper Clastic Member. The contact

between the Laterite and Clastic members is unconformable. The Matanomadh Formation is overlain by the Naredi Formation.

The range and relative frequency of the various taxa show that there are striking differences between *Dandotiaspora dilata* Cenozoene and *Couperipollis brevispinosus* Cenozoene.

Based on the observations on the slides of Venkatachala and Kar (1969) and as shown in Text-fig. 4 it is apparent that some new taxa appear in the Naredi Formation which are altogether absent in the Matanomadh Formation. Further, there are a few taxa common to both the formations but their frequencies are different, sufficient to distinguish them from each other.

The 4 biozones proposed here within the Matanomadh Formation extend laterally in all the 4 sections measured in the type area (Text-fig. 3). Their lateral persistence may permit the recognition and correlation of equivalent horizons outside the area under present investigation.

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EXPLANATION OF PLATE

PLATE 1

1. Stratigraphic section exposing the contact of Matanomadh Formation with the overlying Naredi Formation.
2. Rocks of Matanomadh Formation exhibiting high angle of dip.



PLATE 1