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Palynomorph Occurrence in Relation to Geochemistry, in the Amb Formation (Artinskian), Zaluch Gorge, Salt Range, Pakistan

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ABSTRACT

Vertical distribution of palynomorphs, in early Middle Permian strata (Amb Formation of Artinskian age), Salt Range, Pakistan was studied in relation to geochemistry. A total number of 24 rock samples were collected and processed for this purpose, from the outcrop of Amb Formation at Zaluch Gorge, Salt Range, Pakistan.

Geochemical analysis of rock samples consisted of thirteen (13) major oxides. Silica (SiO_2), Titanium (TiO_2), Aluminium (Al_2O_3), Ferric (Fe_2O_3), Ferrous (FeO), Maganese (MnO), Calcium (CaO), Magnesium (MgO), Sodium (Na_2O), Potassium (K_2O), Phosphorous (P_2O_5) and Carbon (organic + inorganic) in addition to water of crystallization (H_2O+) and adsorbed water (H_2O-).

Each sample of 20 grams was processed separately to determine the number of palynomorphs in order to assess the productivity level of each sample.

Of the 13 major elements studied, relative occurrence of Calcium Oxide, Magnesium oxide and carbon (organic and inorganic) was found to affect (control) the productivity level of samples.

A total of 56 palynomorph species belonging to 32 form genera were recorded, 11 genera and 19 species belonged to trilete, 6 genera and 10 species to monosaccates, 12 genera and 24 species to bisaccates. Two species of colpates and 1 species of acolpate pollen were also recorded.

In this paper we have attempted to introduce and indicate an important aspect of palynomorph availability and preservation in the sediments which remained totally unnoticed or ignored todate. Such trends if successfully confirmed and verified by further studies may revolutionize the entire field or paleopalynology.

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INTRODUCTION

During the past few decades the frontiers of Paleopalynology have been pushed into broader and broader realms. It has now become an important interdisciplinary science with lot of practical application, especially in oil and gas exploration (Traverse, 1988) providing basic information regarding correlation, age, thermal maturity and depositional environments of the sediments. Some workers have successfully used paleopalynological data to indicate oil source rocks (Teichumuller and Ottenjahn, 1977; Dexin and Huiqui 1980; Jiang, 1984;), whereas others have revised and worked out the exact age of the oil deposits (Dejersey, 1965).

Fossil palynomorphs are composed of extremely resistant and chemically stable organic molecules, viz. Sporopllenin, Chitin or Pseudochitin (Traverse, 1988). Fossil spores and pollen grains are hollow spheres or variously shaped compressed bodies devoid of cell membranes and other cytoplasmic contents, which are lost usually during fossilization.

It is mainly due to the durability and stability of sporopollenin against various physical (e.g. temperature, pressure) and chemical factors (e.g. pH, oxidation, other geochemical factors) that palynomorphs can also be preserved in older rocks. Transportation of these microfossils to the site of deposition (parent sediment) is governed by several factors. Some forms, e.g. Acritarchs, Dinoflagellates and Scolecodonts originate in water and their population and dispersal are controlled by factors, like temperature, availability of nutrients and pH (Farely, 1982; Melia, 1984). Other palynomorphs like embryophytic spores and pollen which are the main concern of the present paper may be deposited (preserved) in situ, or, brought to the depositional site from nearby or remote area(s) via various agencies like rivers (Chowdhury, 1982), streams (Stanley, 1965; Heusser, 1978), ocean currents (Chowdhury, 1982; Melia, 1984) and wind (Melia, 1984; Hooghiemstra and Agwu, 1986). Some sediments may contain reworked, i.e., recycled and redeposited palynomorphs (Cross et al., 1966; Stanley, 1969; Vincenes, 1984).

Palynomorphs are preserved in sediments under great variety of environments. They are not usually found in volcanic or metamorphic rocks. During sedimentation they behave as very small particles like silt and fine sand. Coarse sandstones, oxidised and weathered sediments, dolomites and sometime even carbonate sediments are poor containers of these microfossils. But some workers have reported well preserved palynomorphs in carbonate environments (Scott et al., 1985b) and limestones (Blome and Albert, 1985).

Such microfossils once deposited and preserved in sediments, later on, can be altered, partly or totally destroyed due to some post depositional hazards, mainly because sporopollenin and chitin despite being chemically highly stable are quite sensitive to oxidation (weathering and other factors e.g. crystallization and recrystallization. Sediments once containing well or moderately preserved palynomorphs may become poorly productive or totally non productive due to such post depositional alterations (Traverse, 1988).

The present work is a first preliminary attempt to investigate whether or not the chemical composition (or any change in it) of the parent sediment affects productivity (preservation) of palynomorphs. If a particular sediment is non productive i.e. containing no palynomorphs, no method is devised to-date to judge or check whether or not it originally contained palynomorphs or the microfossils disappeared later on. The authors have personally observed that if a silt or claystone of a particular Formation is highly productive at one level, it may become poorly productive or totally barren at another horizon(s). As indicated by several workers, it may be due to the changes in depositional environment (s) (Darrell and Hart, 1979; Darrell, 1973; Wang et al., 1982) thermal effects (Dow, 1977), or other post-depositional hazards, (Bonny, 1976; 1978).

Some other sedimentological factors in combination with the associated vegetational pattern on nearby land and the differential rate of transportation of various palynomorph to the depositional site may affect occurrence and preservation of palynoflora in rocks (Smith, 1962; Chaloner and Muir, 1968; Phillips et al., 1974; Huges 1976; Scott and King 1981). But the possibility of the fact that any change (s) in the chemical composition of the parent sediment (Strata) may affect palynomorph productivity can not be ruled out totally.

Twenty four rock samples from an outcrop of Amb Formation of Artinskian age, at Zaluch Gorge, Salt Range, Pakistan (Figure 1) were collected to study such phenomenon. Nothing can finally be decided or authentically verified unless such studies are repeated or further expanded encompassing Formations of different ages covering wide range of lithological variations. Despite of the limited scope of this paper, we have provided a list consisting of some of the important palynomorphs recovered and few important photomicrographs of the specimens for the benefit of those who may be more concerned or interested in such findings (Plates I and II). However, the complete palynological data will soon be published separately.

GEOLOGY AND STRATIGRAPHY

The Permian system in Salt Range Pakistan is divisible into two groups (P.J. Group, 1985), viz. Zaluch and Nilawahan (Table 1) Amb Formation falls into the basal part of the Zaluch Group.

The Amb Formation at Zaluch Section (Figures 1 and 2) is about 46 metres thick and is divisible into two members (P.J. Group, 1985). The Lower member is about 30m thick consisting mainly of calcareous rocks. It conformably overlies pale greenish grey shale and sandstone alternations of Sardahi Formation. The lower part is mainly composed of calcareous and micaceous sandstone. Brachiopod shells are common throughout, and Fusilinid tests are contained in middle lower portions. Grey, muddy & light brown limestones predominate the middle part where Brachiopods are more common than Fusuline fossils. Further up, there is an alternation of calcareous sandstone and mudstone and mudstone with shale intercalation. Smaller foraminifers like Pachyphloia, Nodosaria, Hemigordius and Globivalvuline are found here.

The upper member is about 16.4m thick. White to light brown, fine to medium grained micaceous sandstone including greenish and black shales occupies lower portion. Sandstone also contains ripple marks & ripple and trough type cross laminations. Thallasinoides and Skolithos type of burrows including some Brachiopods are frequently encountered here. The upper portion is composed of greenish grey or black carbonaceous shales which are thin bedded. Fine grained sandstone with cross beddings, followed by brachiopod bearing sandstone beds predominate the top most part. Sedimentary structure and lithology of the upper member indicate a very shallow marine environment.

MATERIALS AND METHODS

Geochemical Analysis

The contents of SiO_2, H_2O^+, H_2O^- were determined gravimetrically. Al_2O_3, MnO, CaO and MgO were determined by Atomic absorption spectrophotometry.

Table 1. Stratigraphic classification of Permian formations (After P-J Group, 1985).

GROUP	FORMATION	AGE
ZALUCH GROUP	CHHIDRU FORMATION	LATE DZHULFIAN
	WARGAL FORMATION	LATE MURGHABIAN TO EARLY DZHULFIAN
	AMB FORMATION	ARTINSKIAN
NILAWAHN GROUP	SARDHAI FORMATION	SAKMARIAN
	WARCHHA FORMATION	
	DANDOT FORMATION	ASSELIAN
	TOBRA FORMATION	

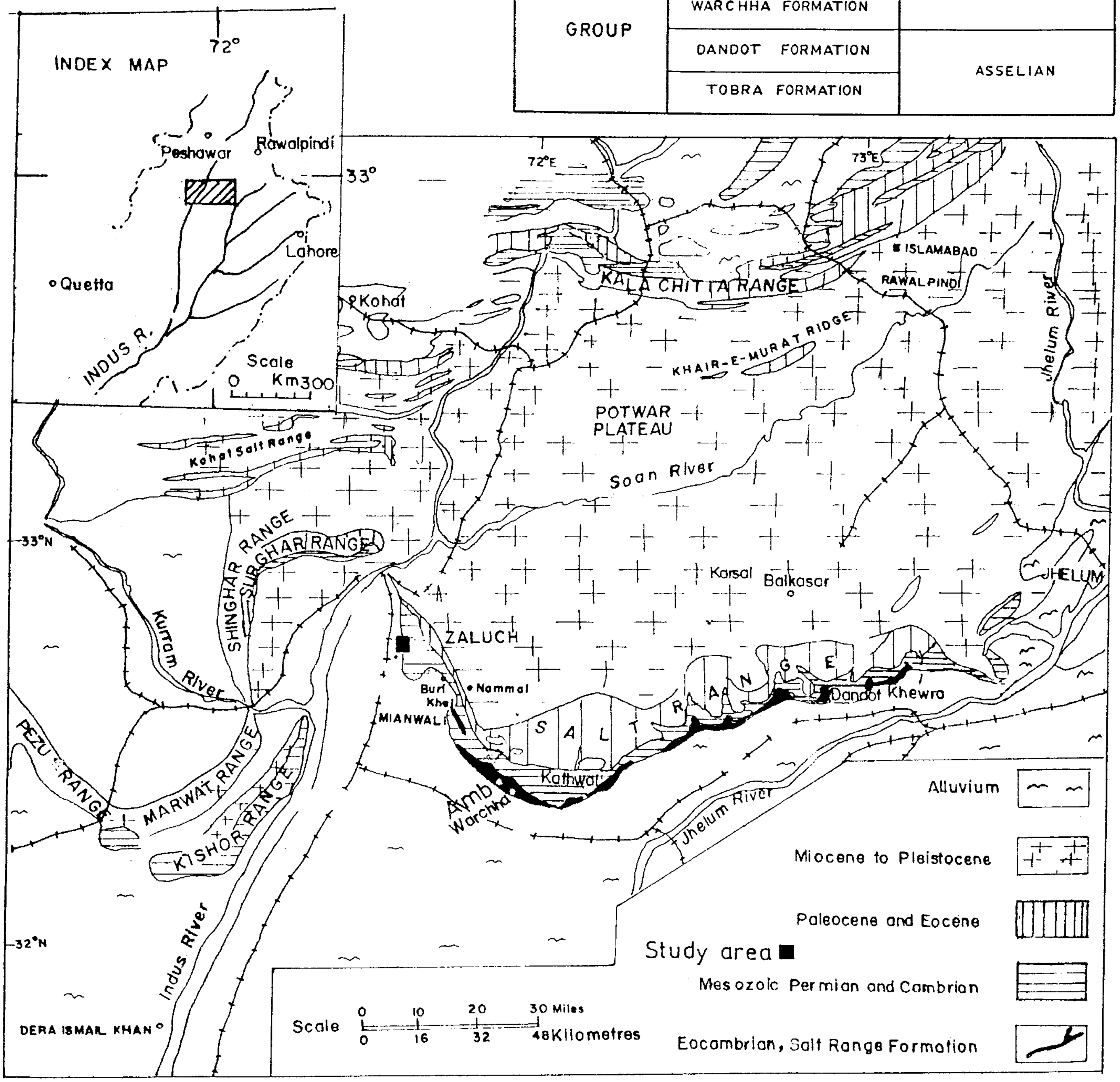

Figure 1-- Location map of the Salt Range and related areas.

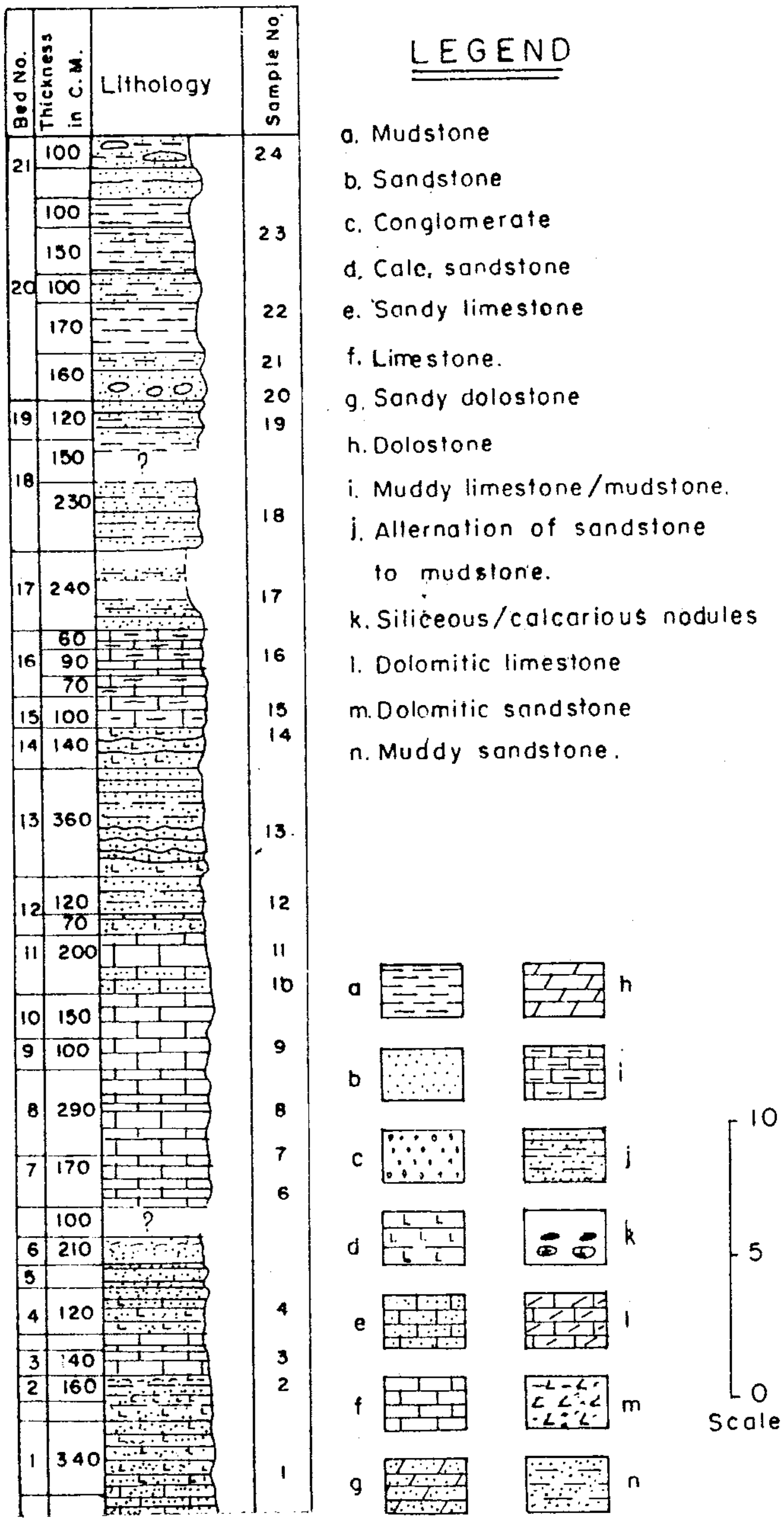

Figure 2-- Amb Formation along Zaluch Nala.

The amounts of TiO_2 and P_2O_5 were determined by spectrophotometry. FeO and inorganic carbon were determined volumetrically. The alkalies and organic carbon were determined by C+S analyzer.

Palynological Analysis

Samples were prepared according to the standard procedure (Dohar, 1980; Phipps and Playford, 1984; Masood and Qureshi, 1993). Samples were first thoroughly washed under running tap water and then with distilled water to remove any external contamination. Fifty grams of each sample was subjected to bulk maceration and was subsequently treated in the following order (with at least five decantations with distilled water between each treatment): (1) HCl 40%:24 hours, (2) HCl conc: 24 hours, (3) HF: 24 hours, (4) Schulz solution (Formula From Dahar 1980):half an hour, (5) KOH 2%: five minutes and (6) Heavy liquid separation by $ZnCl_2$. Centrifugation was not employed at any stage.

A drop of macerated material was placed in a mixture of Okcol (Wilson, 1968; 1974) that was spread on cover glass (No.1), dried, subsequently inverted on slides with Glycerine jelly (formula from Dohar, 1980) or Canada Balsm as mounting medium, per gram of the sediment were also calculated (Traverse, 1988). Rock samples and palynological slides are stored in the Micropaleontology (Paleopalynology) Laboratory, Department of Botany, University of the Punjab, Lahore, Pakistan. Specimens were photographed on Kyowa Medilux microscope using 35mm Forte 200 ASA (24 Din) Panchromatic film.

RESULTS AND DISCUSSION

The presence or absence of one or more elements (s) in different combinations was found to affect the productivity (palynomorph per gram of the sediment) of palynomorphs in the rock samples of the Amb Formation (Tables 2 and 3). Of the thirteen oxides studied geochemically (TiO_2, Al_2O_3, FeO, MnO, CaO, MgO, Na_2O, K_2O, P_2O_5, "C" inorganic, H_2O^+ and H_2O^-) only four, viz. CaO, "C" inorganic showed weak correlation with the palynomorph productivity. The results of only these four oxides are presented in this paper.

It has been observed that when calcium oxide (CaO) and inorganic carbon are present together (Table 3) they have a negative effect on palynomorph occurrence, although the coefficient of correlation ($r = -0.1823$) is not significant at 0.05 level of significance (Table 2).

It was further observed that low organic carbon in the sediments has a positive effect (Table 3) on palynomorph occurrence. The coefficient of correlation between organic carbon content and palynomorph occurrence being -0.0954. Although the r value is not significant at 0.05 level of significance (Table 2) yet it shows a definite trend.

An important correlation seems possible between relative occurrence of calcium oxide (CaO) and Magnesium oxide (MgO) and the palynomorph occurrence (Table 3). The r value of -0.2518 (although not significant at 0.05 level of significance) indicates a trend that palynomorphs do not occur very frequently in limestones & dolomite rocks. This is in accordance with the findings of Traverse (1988).

Palynological findings consisted of fifty six (56) species belonging to thirty two (32) form genera, eleven genera and nine species belonging to trilete, six genera and ten species to monosaccate, twelve genera and twenty four species to bisaccates. Two species of colpate and one specie of acolpate pollen were also recovered (Table 4).

Palynoflora is generally dominated by bisaccates especially haploxylonoid forms, taeniate and striatid forms being rare. Monosaccates were also moderately represented and included forms with paracondition of saccus attachment and alete corpus representing Cordaitales (Bharadwaj, 1966). Recovered microfossils exhibit close similarities with the earlier findings (Balme, 1970; Masood et al., 1988; Masood et al., 1992). Poor preservation of evenvesiculate miospores, which are more suitable for long distance transport (due to inflated air sacs) may indicate a slight delay in transportation of palynomorphs to the depositional site, during which time they were damaged by decaying microorganisms or reflected reworking, recycling, repositioning or reshuffling or these microfossils due to post depositional hazards. Since the Amb Formation represents shallow marine environment (P.J. Group, 1985), the sediments may have been periodically exposed because of regressive phases, and thus affected palynomorph preservability.

Keeping in view the limited scope of this paper, we have not incorporated or highlighted technical aspects of the recovered palynoflora like systematics, biostratigraphy, and other relevant information. This will soon be published separately with a different objective. Palynoflora has been listed here under two major categories, viz. pollen and spores as adopted by several authors (Farabee et al., 1991). Although, a systematic treatment under "Turmal system of classification" (Backhouse, 1991) seems more appropriate and valid, yet this is intentionally avoided to keep this part brief.

CONCLUSIONS

Higher amounts of calcium oxide (CaO) and inorganic carbon when present together imparts low productivity to the sediments.

Low organic carbon has a positive effect on palynomorph occurrence.

Calcium oxide (CaO) and Magnesium oxide (MgO) together in higher amounts impart lower productivity to the sediments.

Although the "r" values are not significant in each of the three cases or correlations, yet this tendency definitely foreshadows a trend, though not very strong, between the chemical factors and palynomorph occurrence.

Table 2. "r" values between different chemcial components (%) and number of palynomorphs/g of the sample (sediment)

Relationship between different chemical components (%) and number of palynomorphs	"r" Values
% of CaO & inorganic C (X_1) and number if oaktbinirogs/g of the sampe (sediment) (Y).	-0.1823*
% of organic carbon (X_2) and number of palynomorphs/g of the sample (sediment) (Y).	-0.0954*
% of CaO and Mgo (X_3) and number of palynomorphs/g of the sample (sediment) (Y).	-0.2158*

* Not significant at 0.05 level of significance.

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Table 3. Rrelationship between various chemical compounds and palynomorph occurrence.

Sample no.	No. of Palyn-omorphs/g	% of CaO	% of CO_2	Combined % of CaO & CO_2	% of O Carbon	% of MgO	Combined % of MgO & CaO
A 02	NIL	18.15	15.82	33.97	1.51	3.94	22.09
A 03	NIL	26.50	23.60	50.10	0.67	1.81	28.31
A 06	NIL	50.00	42.41	92.41	<0.10	0.78	50.78
A 09	NIL	50.72	40.76	91.48	1.41	0.97	50.69
A 011	NIL	33.00	30.00	63.00	<0.10	2.33	35.33
A 16	NIL	22.74	22.94	45.68	2.21	2.49	25.23
A 17	NIL	12.94	16.35	29.29	<0.10	5.91	18.85
A 10	51	53.00	31.00	66.00	1.03	3.05	38.01
A 05	150	16.59	15.14	31.73	<0.10	8.45	25.04
A 04	202	22.00	14.09	36.09	<0.10	0.85	22.85
A 12	210	21.86	17.77	39.63	<0.10	1.81	23.67
A 15B	300	19.89	16.26	36.15	<0.10	1.81	21.70
A 15	351	28.00	27.10	55.10	<0.10	5.60	33.60
A 13	556	17.01	11.70	28.71	<0.10	0.31	17.32
A 20	1012	0.87	0.86	1.73	<0.10	1.22	2.07
A 14	2229	30.44	17.26	47.17	<0.10	5.35	35.79
A 21	4000	0.44	0.43	0.87	<0.10	0.95	1.35
A 19	9000	2.43	2.16	4.59	<0.10	2.28	4.71
A 01	11100	20.15	14.82	34.97	1.51	2.94	23.09
A 18	20000	4.13	2.38	6.51	1.30	3.63	7.76
A 07	35200	51.31	40.41	91.72	<0.10	0.35	51.66
A 22	56000	16.62	14.09	30.71	<0.10	4.45	21.07
A 08	56700	46.26	39.81	86.07	1.30	0.87	47.13
A 23	80202	2.47	2.17	4.44	<0.10	0.62	3.09
A 24	85000	2.63	2.36	4.99	<0.10	0.54	3.17

Table 4. List of some important palynomorphs recovered from Amb Formation, Zaluch Gorge, Salt Range, Pakistan.

SPORES:-

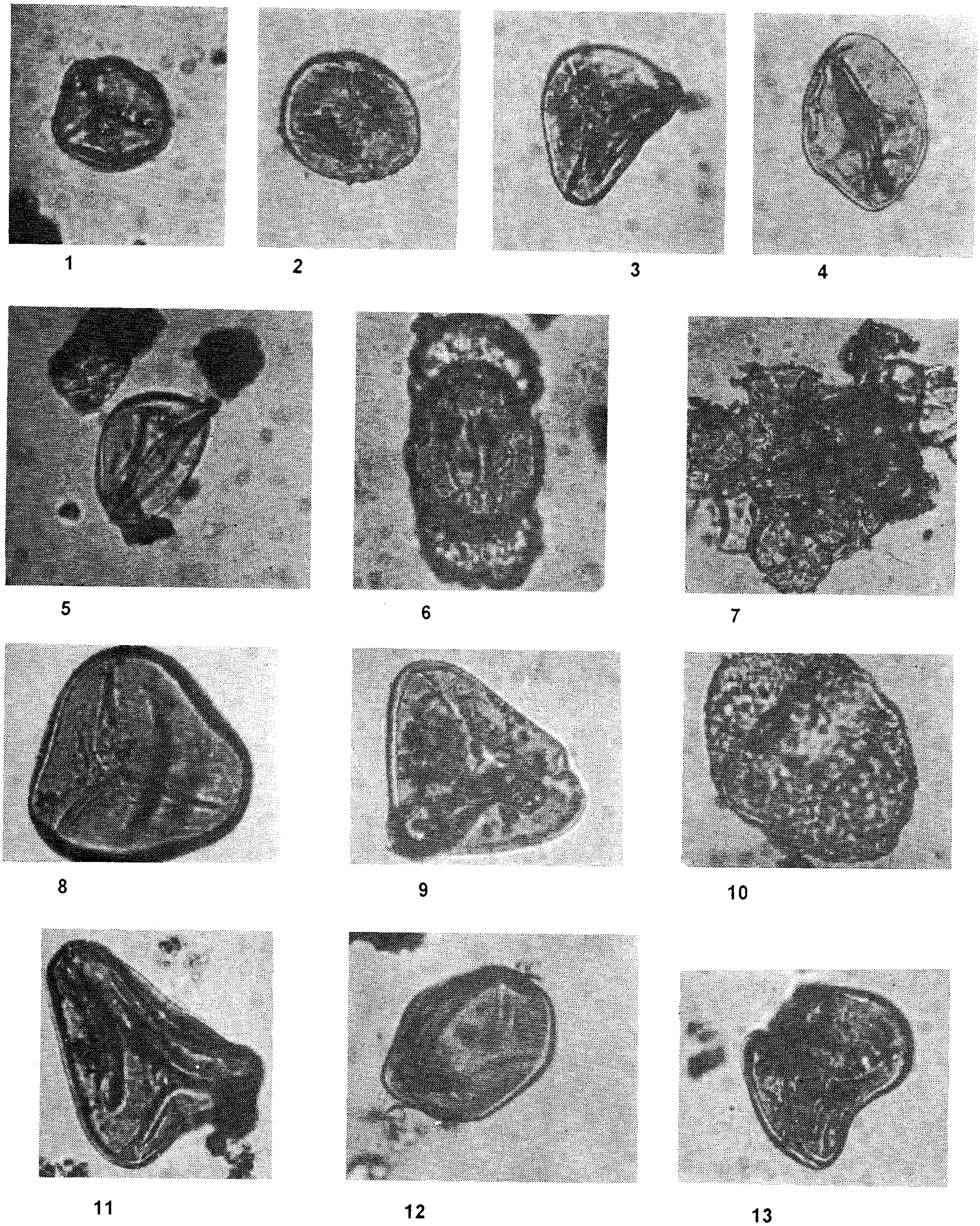
Calamospore hartungiana	Schoph, 1944
Leiotriletes tripartitus	Stone, 1969
Leiotriletes adnatus	Potonie & Kremp 1955
Leiotriletes Notatus	Hacquebard, 1957
Granulatisporites punctatus	Stone, 1969
Granulatisporites parvus	Potonie & Kremp, 1955
Punctatisporites punctatus	Ibrahim, 1953

POLLEN:-

Plicatipollenites malabarensis	(Potonie & Sah) Foster
Plicatipollenites densus	Srivastava, 1970
Plicatipollenites gondwansis	Lele, 1964
Parasaccites indistinctus	Masood, 1983
Lueckisporites virrkiae	Potonie & Klaus, 1963
Alisporites tenuicorpus	Balme, 1970
Falcisporites nuthallensis	Balm, 1970
Protohaploxpinus goraiensis	Potonie & Lele, 1964
Sulcatisporites ovatus	Balme & Hennelly, 1955

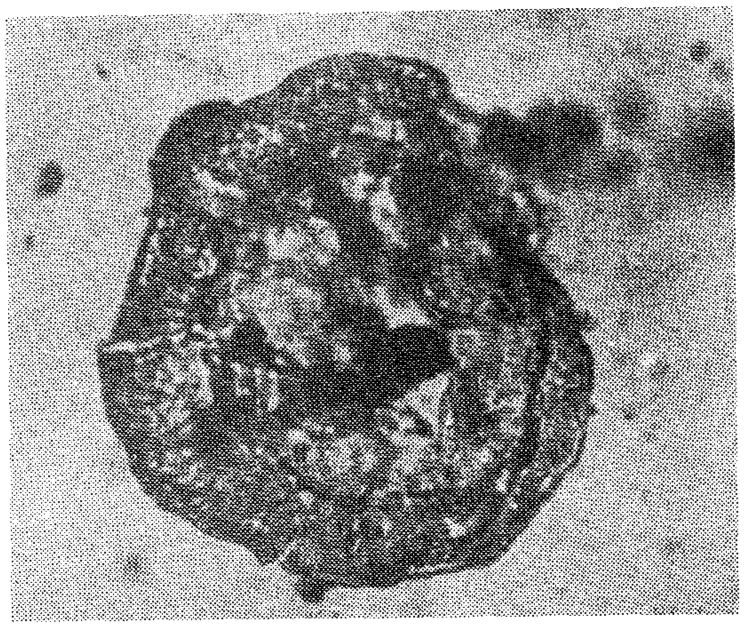
PALTE I

(See page 69 for explanations)



PALTE II

(See page 69 for explanations)



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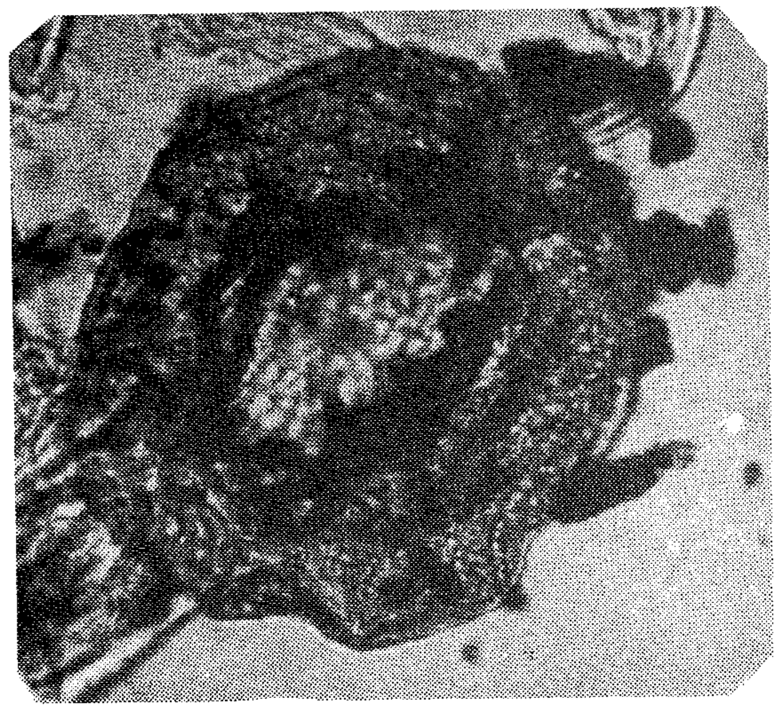

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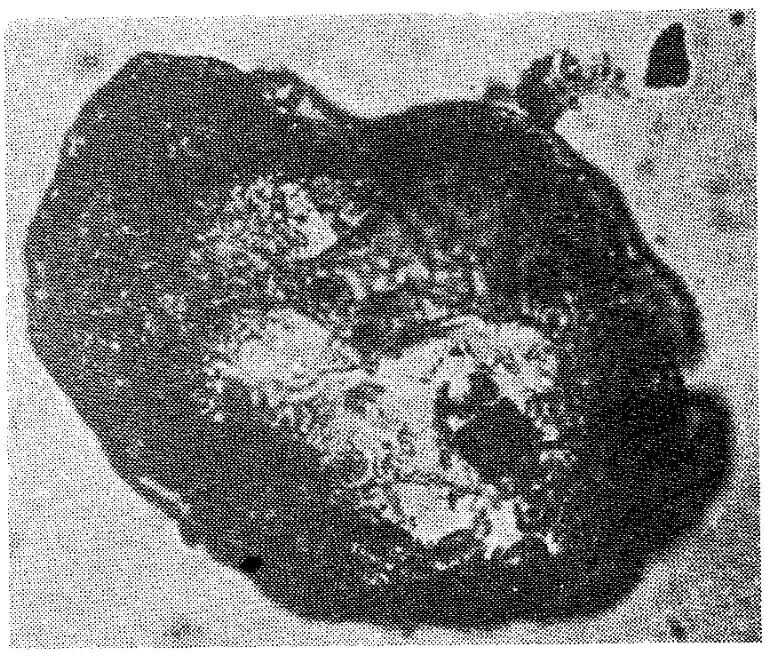

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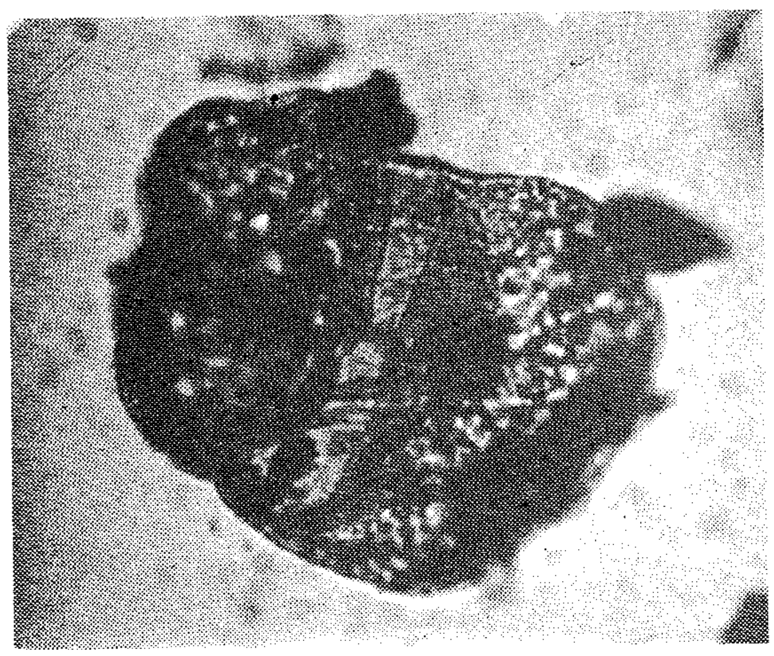

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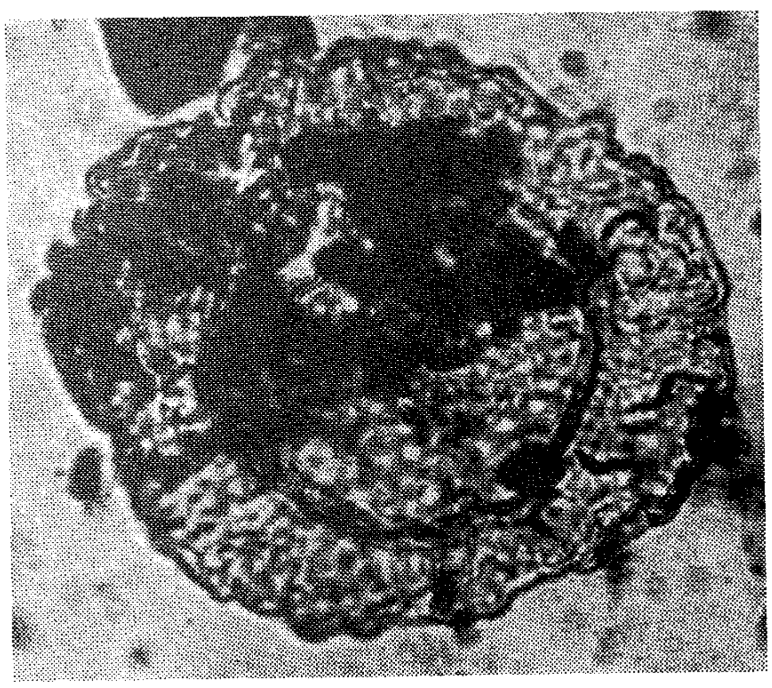

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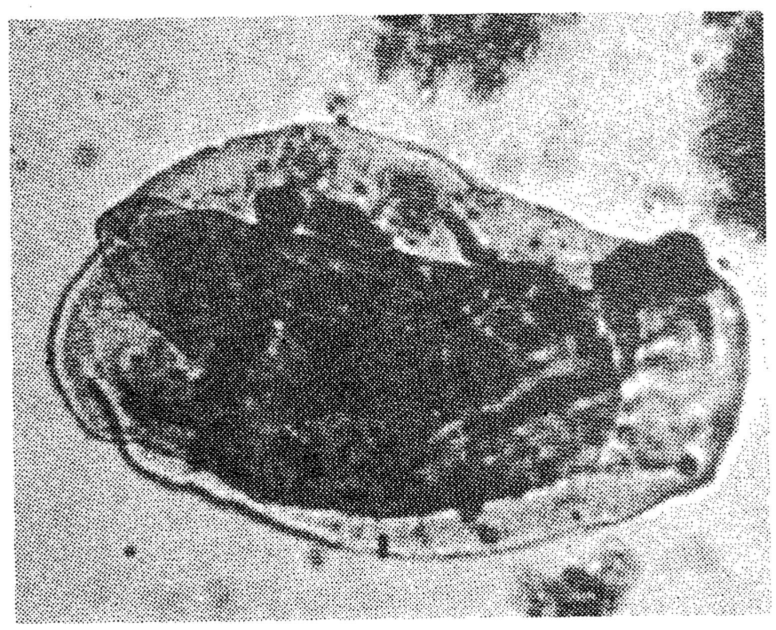

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EXPLANATION OF PLATES

(All figures magnified x 600 unless otherwise stated)

PLATE I

1. Leiotriletes tripartitus Stone 1969
   Sample No.8, Slide No. A08-C
   Flim No. Mo2/19/20
2. Punctatisporites punctatus Ibrahim 1933
   Sample No. A21, Slide No. A21-A
   Flim No. Mo2/35/36

3 & 13. Leiotriletes notatus Hacquebard 1975
   Sample No. A21, Slide No. A21-A
   Flim No. Mo2/41/42, Mo1/65/66

4. Leiotriletes sp. (unidentified)
   Sample No. A23, Slide No. A 18-C
   Flim No. Mo1/21/22
5. Leiotriletes adnatus Potonie & Kremp 1955
   Sample No. A 18, Slide No. A 18-A
   Flim No. Mo4/2/3
6. Lueckisporites virrkiae Potonie & Klaus 1954
   Sample No. A1, Slide No. A 1-B
   Flim No. Mo1/47/48
7. Group of Trilete spores of the genus Leiotriletes Naumova ex Potonie & Kremp
   Sample No. A 17, Slide No. A 7-A (x 300)
   Flim Mo2/29/30
8. Granulatisporites parvus (Ibrahim) Potonie & Kremp 1955
   Sample No. A 21, Slide A 21-C
   Flim No. Mo3/33/34

9 & 11. Granulatisporites punctatus Stone 1969
   Sample No. A 21, Slide A 29-D
   Flim No. Mo3/51/52 and Mo3/37/38

10. Alisporites tnuicorpus Blame 1970
   Sample No. A 17, Slide No. A 1-D
   Flim No. Mo2 85/8
12. Loiotriletes sp. (unidentified)
   Sample No. A 16, Slide No. A 1-C
   Flim No. Mo1/5/66

PLATE II

1. Plicatipolleni malabarensis (Potonie & Sah) Foster
   Sample No. A 24, Slide No. A 11-B
   Flim No. Mo135/36
2. Plicatipollenites indicus Lele 1964
   Sample No. A 23, Slide No. A 17-C
   Flim No. Mo2 71/72
3. Parasaccites indistinictus Masood 1983
   Sample No. A 1, Slide No. A1-B
   Flim No. Mo1/59/60
4. Protohaploxypinus goraiensis Potonie & lele 1964
   Sample No. A 22, Slide No. A1-B
   Flim No. Mo1/51/52
5. Plicatipollenites gondwansis (Blame & Hennely) Lele 1964
   Sample No. A 17, Slide A 17-D
   Flim No. Mo2/83/84
6. Calamospora hartungiana Schopf 1944
   (2 identical over lapping specimens)
   Sample No. A 21, Slide No. A21-C
   Flim No. M03/35/36

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