8 Summary and Conclusions

The present investigation comprises insights in the mineralogical and geochemical composition of carbonaceous shales from the different geological ages and areas of Egypt.

The study is concerned mainly with:

1- the black shale of Ataqa Formation of Carboniferous age in Abu Zinema southwest Sinai,
2- the black shale of Safa Formation of Jurassic age in Al Maghara coal mine North Sinai,
3- the black shale of Duwi Formation of Upper Cretaceous age in Abu Tartur phosphate mine, Western Desert,
4- the carbonaceous and black shales of Duwi Formation, Dakhla Shale and Esna Shale in the Nile Valley area,
5- and the black and carbonaceous shales of Duwi Formation and Dakhla Shale in Quseir phosphate mine at Red Sea coast

Mineralogically, the clay minerals of the Ataqa Formation are consisting predominantly of kaolinite with a minor part of illite while the Safa Formation clays consist mainly of detrital kaolinite. The clay minerals of the Duwi Formation in Abu Tartur consist mainly of smectite in addition to different proportions of kaolinite in Quseir ad Nile Valley. The Dakhla and Esna shales in Nile Valley consist predominately of smectite in addition to different proportions of kaolinite and chlorite.

The chemical composition of the studied shales shows generally enrichment of elements that are chemically immobile and associated with terrigenous influx, such as SiO_2, Al_2O_3, and TiO2 The Ataqa and Safa formations show enrichment of zirconium and depletion in CaO which reveals the proximity to the land. On the other hand the studied shales in Abu Tartur, Nile Valley and Quseir show enrichment of CaO.

The studied phosphate samples show enrichment in P_2O_5, CaO and flour, which reveal that flour apatite is the main phosphate mineral in Egyptian phosphate. The low content of detrital terrigenous influx SiO_2, Al_2O_3, TiO_2 and Rb, and the association of the phosphate beds with oyster limestone and diatom enrichment in Quseir and in the Nile Valley is indicating the deeper marine origin of the phosphates in the Eastern part of Egypt. The deposition of the phosphatic beds associated with black shales clearly demonstrates a diachronous transgression from the east to the west, starting in the Eastern desert during Lower campanian and culminating in Upper Campanian and Lower Maastrichtian, covering both, the East and the West, from Quseir, via the Nile Valley towards the Abu Tartur depositional centre.

The distribution of many trace elements has been affected by weathering. The studied shales in Abu Tartur, Quseir and Nile Valley show higher contents of the trace elements Sr, Ba, V, Ni, Cr, Zn, and Rb than shale samples from Abu Zinema and Al Maghara. The Dakhla Shale in Quseir mine shows the highest enrichment of V, Ni, Cr, Zn, and Cu due to the oxidation and weathering of organic matter and subsequent mobilization and concentration of these trace elements. The low trace elements enrichment in the studied phosphate samples indicates leaching processes outgoing from the overlain black shales.

Petrographically the study samples reveal the presence of four lithofacies namely;

1- Organic matter-rich black shale facies,
2- Foraminifera-rich shales facies,
3- Carbonate facies,
4- and phosphate facies.

The depletion of Ataqa Formation of Carboniferous age, Safa Formation of Jurassic age and Duwi Formation, in foraminifera and their dark colour as well as the presence of pyrite framboids in Duwi Formation reveal reducing environment of deposition.

The abundance of foraminifera in Dakhla Shale and Esna Shale in Quseir and the Nile Valley give evidence for an oxidation environment of deposition in middle to inner shelf positions. The phosphate samples in Abu Tartur show pelloids of P_2O_5 cemented by carbonate, while the phosphates in the Nile Valley are cemented by silica, an indication for more open marine conditions to the East.

The SEM micrographs show that the kaolinite in Ataqa and Safa formation is of swirly textures with face to face arrangement of coarse detrital kaolinite.
The smectite in Duwi Formation in Abu Tartur show papery structure. The most common forms of pyrite are framboidal and euhedral or masses. There are indications that the trace elements composition of these sediments is influenced by pyrite.

The total organic carbon (TOC) analysis shows high values in the black shales of Safa Formation of Jurassic in Al-Maghara, Ataqa Formation of Carboniferous in Abu Zinema and Duwi Formation of Cretaceous in Abu Tartur ad Quseir. The obtained values in Dakhla Shale and Esna Shale show very low values indicating the oxidation of organic matter in outcrop.

The Rock-Eval pyrolysis of the studied shales show that, most of the studied samples are of type III kerogen with low hydrogen index HI due to bad preservation of organic matter. The thermal maturity T_{max} values of the studied shales indicate immature organic matter for hydrocarbon generation.

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10 Appendix

Appendix A = Table 1 to Table 6b

Appendix B = XRD profiles

Appendix C = Plates of petrography and SEM

Notice:

N = Nile Valley (Esna-Idfu region)

Q = Quseir phosphate mine

AT = Abu Tartur phosphate mine

Mg = Al Maghara coal mine

b.d.l. = below detection limit

< = below

Table 1: Lithological description of the studied samples.

Sample No.	Description
N80	**Limestone**, white, compact, fossiliferous.
N79	**Limestone**, as above
N78	**Marl**, green to light brownish, moderately compact, fractured fossiliferous, evaporitic.
N77	**Marl**, as above
N76	**Limestone**, light yellowish, slightly argillaceous, fossiliferous, compact.
N75	**Shale**, , dark grey, calcareous compact, fractured with veins of evaporites
N74	**Argillaceous limestone**, yellowish, compact, silty in parts, fractured.
N73	**Shale**, dark grey, calcareous, moderately hard, ferrugineous.
N72	**Marl**, green to light brownish, moderately hard, ferrugineous, trace fossils.
N71	**Shale**,dark grey, calcareous, moderately hard, silty in parts, ferrugineous, with veins of evaporites
N70	**Claystone**, greenish to yellowish, calcareous,compact, ferrugineous spots, evaporitic.
N69	**Shale**, dark grey, grey to light brownish, calcareous, compact, silty in parts, veins of evaporites.
N68	**Shale**, as above.
N67	**Shale**, as above.
N66	**Shale**, as above.
N65	**Shale**, as above.
N64	**Shale**,. as above.
N63	**Shale**, as above.
N62	**Shale**, as above.
N61	**Shale**, as above.
N60	**Shale**, as above.
N59	**Shale, marly**, grey to yellowish, soft to moderate hardness, silty in parts, lamination, ferruginous.
N58	**Shale, marly**, as above.
N57	**Claystone**, grey to light brownish, calcareous, fractured, veins of evaporites
N56	**Argillaceous limestone**, moderately hard, silty in parts, fractured, evaporitic, ferrugineous spots
N55	**Claystone**, dark grey, calcareous, moderately hard, silty in parts, ferrugineous spots, evaporitic
N54	**Claystone**, grey, calcareous, moderately hard, silty in parts, ferrugineous spots, veins of evaporites
N53	**Chalky limestone**, white to yellowish, compact, fractured with veins of evaporites, silty in parts , fossiliferous.
N52	**Chalky limestone**, as above.
N51	**Argillaceous limestone**, grey to light grey, moderate to hard, veins of evaporites.
N50	**Argillaceous limestone**, as above.
N49	**Marl**, grey to dark grey, fossiliferous, ferrugineous spots, hard, evaporitic, Pecten shells.
N48	**Claystone**, reddish, ferrugineous, calcareous, compact, fractured evaporitic.
N47	**Shale**, black, dark grey, ferrugineous patches and spots between fissiles and through fractures, evaporites, organic remains and traces of shells well preserved, silty in parts..
N46	**Shale**, as above.
N45	**Shale**, as above.
N44	**Shale**, as above
N43	**Shale**, as above.
N42	**Shale**, dark grey, alternating with ferrugineous siltstone, brownish and reddish, fractured, evaporite lamination between fissiles.
N41	**Shale**, as above.
N40	**Shale**, as above.
N39	**Claystone**, grey to yellowish , calcareous, moderately hard, silty, in parts with gypsum laminae.
N38	**Shale**, dark grey to brownish, soft hardness, alternating with gypsum lamination, fractured
N37	**Shale**, black, dark grey to brownish, moderately hard, fractured filled with ferrugineous, silty.
N36	**Shale**, as above.
N35	**Claystone**, grey to light brownish, moderately hard, ferrugineous spots and patches, calcareous, large veins of evaporites.
N34	**Shale**, black to grey, compact, calcareous, veins of evaporite, patches of ferrugineous through fractures and between sheets.
N33	**Shale**, black, moderately hard, fractured, ferrugineous patches, few evaporite, calcareous.
N32	**Shale**, as above.
N31	**Shale**, grey to brownish, calcareous , moderate to soft, veins of evaporites, ferrugineous

Table 1: cont.

Sample No.	Description
N30	**Shale**, as above
N29	**Shale**, black to dark grey compact, ferrugineous patches evaporite, calcareous.
N28	**Shale**, dark grey to brownish, moderately hard, less orites,ferruginous patches ad spots embedded.
N27	**Shale**, as above.
N26	**Shale**, black to grey, medium hard, fractured, ferrugineous patches, reddish to brownish veins of evaporite,salts and calcareous.
N25	**Shale**, grey with red hematitic siltstone as lenses and tubes, moderately hard, evaporite embedded between shale, siltstone
N24	**Phosphat**, yellow to light brownish, highly fossiliferous,less hardness, organic matter and bones remains, cherty nodules.
N23	**Oyster limestone**, greyish, very compact, fractures filled with calcite and rock fragments
N22	**Argillaceous limestone**, yellow, very compact, patches of organic matter.
N21	**Dolomitic limestone**, grey, very compact.
N20	**Phosphate**, yellow to light brownish, highly fossiliferous, less hardness, organic remain, highly calcareous
N19	**Conglomerate bed**, light brownish , very compact, calcareous, phosphatic.
N18	**Sandstone**, grey to light brownish, moderately hard, lamination of sand, silt and claystone, fractured, evaporitic
N17	**Claystone**, grey, medium hard, silty, fissiles, fractured,veins of evaporite
N16	**Phosphate**, brownish, to yellowish, compact, fossiliferous, ferrugineous, with sandy and chert nodules.
N15	**Siltstone**, grey, brown to yellowish, alternating with claystone, fissil,medium hard , ferrugineous patches interbedded change the colour to yellowish, brownish
N14	**Sandstone**, yellow, moderately hard, ferrugineous.
N13	**Claystone**, yellowish to light brown, silty, compact, fissil fractured with black patches of organic matter and evaporites
N12	**Phosphate bodies**,with conglomerate and breccia, yellow to brownish, compact, ferrugineous.
N11	**Siltstone**, brown to reddish surrounding the phosphate nodules
N10	**Claystone/Siltstone**, brownish to grey, medium hard, rare evaporites, slightly fissil.
N9	**Claystone**, green,moderately hard, silty in parts, slightly fissiles with evaporites interclation
N8	**Siltstone**, grey, yellowish, brownish lamination, moderately hard, sandy in parts, iron concreation, ferrugineous,and few evaporites
N7	**Claystone**, green, moderately hard, fractured with rare evaporites.
N6	**Siltstone**, brownish, ferrugineous,calcareous, moderately hard, with embedded veinlets of sandstone ,cross lamenated,vew evaporite laminae are interbedded also
N5	**Siltstone**, green to brownish, moderately hard, slightly calcareous, sandy in parts, slightly fissiles.
N4	**Siltstone**, reddish brown, ferrugineous moderately hard and with rare evaporites
N3	**Claystone**, green to grey, silty in parts, with rare evaporites.
N2	**Siltstone**, brownish, ferrugineous, sandy in parts
N1	**Claystone**,dark grey, silty in parts ,rare evaporites and ferrugineous spots
Q1	**Shale**, black, subfissil, highly carbonaceous, pyritic.
Q2	**Marl**, yellowish brown ,compact.
Q3	**Phosphate**, yellow to light brownish, highly fossiliferous, less hardness, organic matter and bone remains, cherty nodules.
Q4	**Phosphate**, silicified, yellow brownish, compact, organic matter, bone remains, cherty nodules
Q5	**Oyster limestone**, greyish, very compact, fractured.
Q6	**Shale**, grey to yellowish, calcareous, micaceous, slightly fissiles.
Q7	**Shale**, brownish, micaceous, fissile, gypsiferous, slightly calcareous.
Q8	**Shale**, black to grey, compact, subfissile, alternated with gypsum laminae.
Q9	**Shale**, as above.
Q10	**Shale**, black, weathered.
Q11	**Shale**, pale browen, fossiliferous, highly calcareous, fissile
Q12	**Shale**, as above
Q13	**Shale**, pale brown, fossiliferous, highly calcareous, fissile, gypsiferous.
Q14	**Shale**, as above.
Q15	**Shale**, pale brown, grey, fossiliferous, highly calcareous

Table 1: cont.

Sample No.	Description
Q16	**Shale**, as above.
Q17	**Shale,** black, weathered.
Q18	**Phosphate,** silicified, yellow to light brownish, organic matter and bone remains, cherty nodules.
Q19	**Phosphate,** yellow to light brownish, compact, organic matter and bone remains.
Q20	**Marl,** yellowish brown ,compact.
Q21	**Oyster limestone** , greyish, very compact, fractured.
Q22	**Phosphate,** yellow to light brownish, highly fossiliferous.
Q23	**Shale,** pale brown, grey, fossiliferous (pecten), highly calcareous
Q24	**Shale**, as above.
Q25	**Shale**, as above.
Q26	**Shale**, as above.
Q27	**Shale**, black, weathered.
Q28	**Shale,** grey to greenish grey, fissile, gypsiferous, slightly compact.
Q29	**Shale**, as above.
Q30	**Shale**, as above
Q31	**Phosphate,** yellow, brownish, compact, organic matter and bones remains, highly calcareous
Q32	**Shale,** pale brown, grey, fossiliferous, highly calcareous.
Q33	**Shale**, as above
Q34	**Shale**, as above
Q35	**Shale**, black, weathered.
AT1	**Shale**, black, compact, subfissil, pyritic, slightly gypsiferous
AT2	**Shale**, as above
AT3	**Shale**, as above
AT4	**Phosphate,** black, calcareous, slightly compsct.
AT5	**Phosphate,** black, calcareous, slightly compsct.
AT6	**Shale**, as above
AT7	**Shale**, as above
AT8	**Phosphate,** black, calcareous, slightly compsct
AT9	**Phosphate,** black, calcareous, slightly compsct, fissile to sub fissile.
AT10	**Shale**, as above
AT11	**Shale**, as above
AT12	**Phosphate,** black, calcareous, slightly compsct.
Mg1	**Shale,** black, compact, highly carbonaceous, ferruginous
Mg2	**Shale**, as above
Mg3	**Shale**, as above
Mg4	**Shale**, as above
Mg5	**Shale**, as above
AZ1	**Shale,** black, gypsiferous, fissile, highly carbonaceous.
AZ2	**Shale**, as above
AZ3	**Shale**, as above
AZ4	**Shale,** black, gypsiferous, fissile, highly carbonaceous
AZ5	**Shale**, as above
AZ6	**Shale**, as above
AZ7	**Shale**, as above
AZ8	**Shale**, as above
AZ9	**Shale**, as above
AZ10	**Shale**, as above
AZ11	**Shale**, as above
AZ12	**Shale**, as above

Table (2): Semiquantitative mineralogical composition of clay fraction.

Age	Formation	Location	S.No	Smectite	Kaolinite	Chlorite	Illite
Late Maastrichtian – Early Eocene	Esna Shale	Nile Valley (Esna -Idfu) region	N79	95	5	0	0
			N78	90	0	10	0
			N75	98	2	0	0
			N73	95	0	5	0
			N72	97	0	3	0
			N71	95	5	0	0
			N69	71	0	29	0
			N66	70	0	30	0
			N64	93	7	0	0
			N60	62	Trace	38	0
			N55	100	0	0	0
			Avg.	**88**	**2**	**10.**	**0**
Late Maastrichtian-Middle Paleocene	Dakhla Shale		N47	93	7	0	0
			N43	58	0	42	0
			N41	55	0	45	0
			N37	83	17	0	0
			N35	35	0	65	0
			N33	86	14	0	0
			N31	68	Trace	32	0
			N29	88	12	0	0
			N27	78	22	Trace	0
			N26	86	14	0	0
			Avg.	**73**	**9**	**18.**	**0**
Campanian-Maastrichtian	Variegated, Duwi		N17	92	Trace	8	0
			N15	85	0	15	0
			N10	90	0	10	0
			N9	70	Trace	30	0
			N5	65	Trace	35	0
			N1	98	2	0	0
			Avg.	**83.**	**0**	**16.**	**0**
Maastrichtian	Duwi and Dakhla	Quseir Mines	Q.1	98	2	0	0
			Q.7	94	6	0	0
			Q.9	33	67	0	0
			Q 11	84	16	Trace	0
			Q.14	88	12	0	0
			Q16	92	8	0	0
			Q.20	85	15	0	0
			Q.23	94	6	0	0
			Q 26	97	3	0	0
			Q 32	80	20	0	0
			Q.34	34	66	0	0
			Avg.	**80**	**20.**	**0**	**0**
Maastrichtian	Duwi	Abu Tartur Mine	AT.2	99	1	0	0
			AT.5	100	0	0	0
			AT.7	100	Trace	0	0
			AT.9	100	Trace	0	0
			Avg.	**100**	**0**	**0**	**0**
Middle Jurassic	Safa	Maghra Mine	Mg 1	0	100	0	0
			Mg.3	Trace	100	0	0
			Mg 5	0	100	0	0
			Avg.	**0**	**100**	**0**	**0**
Carboniferous	Ataqa	Abu Zenima	AZ.1	0	100	Trace	Trace
			AZ.5	0	60	0	40
			AZ.8	0	100	0	0
			Avg.	**0**	**87**	**0**	**13**

Avg =average

Table (3): Semiquantitative mineralogical composition of bulk studied samples.

Age	Formation	Location	Sample No	Quartz	Feldspare	Calcite	Dolomite	Anhydrite	F-apatite	Iron oxides	Halite	Gypsum	Clay
Late Paleocene - Early Eocene	Esna Shale	Nile Valley (Esna- Idfu) region	N79	13	0	5	0	35	0	0	0	0	47
			N78	5	0	25	1	1	0	0	9	0	59
			N77	6	0	24	54	0	0	0	0	0	16
			N75	12	0	0	0	0	0	0	0	0	88
			N74	10	0	68	0	14	0	0	0	0	8
			N73	9	0	0	0	0	0	0	0	0	91
			N72	11	0	22	0	7	0	0	0	1	59
			N71	8	0	0	0	12	0	0	0	0	80
			N70	7	0	27	0	19	0	0	0	0	47
			N69	8	0	26	0	3	0	0	0	0	63
			N68	9	0	2	0	17	0	0	0	0	72
			N67	8	0	0	3	16	0	6	0	0	67
			N66	6	0	5	0	0	0	0	0	0	89
			N65	6	0	39	0	1	0	0	0	0	54
			N64	6	0	15	50	2	0	0	0	0	27
			N63	8	0	37	0	16	0	0	0	0	39
			N62	6	0	5	0	26	0	0	0	0	63
			N60	10	0	0	0	0	0	0	0	0	90
			N59	0	0	8	81	0	0	0	0	0	11
			N58	8	0	13	0	4	0	0	0	0	75
			N57	6	0	29	0	24	0	0	0	0	41
			N56	5	0	79	0	10	0	0	0	0	6
			N55	16	0	52	0	7	0	0	0	0	25
			Avg.	**8**		**21**	**8**	**9**	**0**	**0**	**0**	**0**	**53**
	Tarawan		N52	6	0	0	0	94	0	0	0	0	0
			N50	3	0	56	0	41	0	0	0	0	0
			Avg.	**4.5**	**0**	**28**	**0**	**68**	**0**	**0**	**0**	**0**	**0**
Middle Paleocene	Dakhla Shale		N49	7	0	88	0	0	0	0	0	0	5
			N47	30	0	0	0	0	0	10	0	0	60
			N46	23	0	0	0	7	0	0	0	0	70
			N45	28	3	0	0	0	0	0	0	0	69
			N44	17	0	0	0	29	0	0	13	0	41
			N43	19	0	0	0	0	0	29	0	0	52
			N42	22	0	0	0	0	0	0	0	0	78
Late Maastrichtian-			N41	20	5	3	0	0	0	0	0	0	72
			N39	47	9	0	0	4	0	0	0	0	40
			N37	7	0	0	0	44	0	5	0	0	44
			N36	17	6	6	0	16	0	7	0	0	48
			N35	0	0	0	0	84	0	0	0	0	16
			N34	19	0	0	0	0	0	7	0	0	74
			N33	23	3	0	0	0	0	0	0	0	74
			N32	21	3	0	0	0	0	0	0	0	76
			N31	14	1	0	0	0	0	0	0	0	85
			N30	24	1	0	0	0	0	0	0	0	75
			N29	16	3	0	0	0	0	39	0	0	42
			N28	10	4	0	0	0	0	0	0	0	86
			N27	17	0	42	3	0	0	2	0	3	33
			N26	20	4	0	0	0	0	0	0	0	76
			Avg.	**19**	**2**	**7**	**0**	**9**	**0**	**5**	**0**	**0**	**60**
Campanian -Maastrichtian	Variegated- Duwi		N24	40	0	13	0	0	47	0	0	0	0
			N21	5	0	95	0	0	0	0	0	0	0
			N20	18	0	4	0	0	78	0	0	0	0
			N17	4	0	0	76	0	0	0	0	2	18
			N15	17	0	0	46	0	0	0	0	0	37
			N13	33	4	0	0	10	0	16	0	1	36
			N12	45	10	0	0	11	0	0	0	0	34
			N10	53	31	0	0	0	0	0	0	0	16
			N9	42	15	0	0	0	0	0	0	0	43
			N7	64	5	0	0	13	0	0	0	0	18
			N5	64	19	0	0	0	0	0	0	0	17
			N1	75	15	0	0	0	0	0	0	0	10
			Avg.	**33**	**8**	**9**	**10**	**2**	**10**	**1**	**0**	**0**	**19**

Avg =average

Table (3): cont.

Age	Formation	Location	Sample No	Quartz	Feldspare	Calcite	Dolomite	Anhydrite	F-apatite	Iron oxides	Pyrite	Gypsum	Clay
Late Maastrichtian - Middle Paleocene	Duwi and Dakhla Shale	Quseir Mines	Q 1	33	0	0	0	0	0	0	2	1	64
			Q 2	19	0	0	51	0	30	0	0	0	0
			Q 4	47	0	0	12	0	14	0	0	0	0
			Q 6	0	0	0	0	0	53	0	0	47	0
			Q 9	14	0	52	0	0	0	0	0	34	0
			Q 10	43	0	0	0	0	0	0	4	4	49
			Q11	27	0	54	0	0	10	0	0	0	9
			Q 14	18	0	61	0	0	0	8	0	0	13
			Q 15	29	0	56	0	0	0	0	0	0	15
			Q 16	30	0	56	0	0	0	0	0	0	14
			Q 17	19	0	68	0	0	0	0	1	0	12
			Q 19	9	0	0	51	0	40	0	0	0	0
			Q 20	50	4	0	0	0	0	5	0	0	41
			Q 21	3	0	83	14	0	0	0	0	0	0
			Q22	6	0	54	0	0	40	0	0	0	0
			Q 23	40	0	0	0	0	32	0	0	0	28
			Q 26	20	0	38	0	0	0	0	0	0	42
			Q 27	14	0	48	0	0	21	0	3	2	12
			Q 31	8	0	40	0	0	52	0	0	0	0
			Q 32	74	0	0	0	0	0	0	0	6	20
			Avg.	**25**	**0**	**31**	**6**	**0**	**15**	**1**	**0**	**5**	**16**
Late Maastrichtian	Duwi	Abu Tartur Mine	AT 1	13	0	0	0	0	0	0	3	0	84
			AT 2	21	0	0	0	0	0	0	3	1	75
			AT 3	23	0	0	0	0	0	0	6	1	70
			AT 4	6	0	0	45	0	44	0	4	1	0
			AT 5	11	0	0	0	0	0	0	4	1	84
			AT 6	11	0	0	0	0	0	0	1	3	85
			AT 7	12	0	0	0	0	0	0	4	1	83
			AT 8	12	0	0	34	0	49	0	5	0	0
			AT 9	73	0	0	0	0	0	0	5	0	22
			AT 10	17	0	0	0	0	0	0	4	1	77
			AT 11	60	0	0	0	0	0	0	1	0	39
			AT 12	15	0	0	0	0	74	0	6	6	0
			Avg.	**23**	**0**	**0**	**7**	**0**	**14**	**0**	**4**	1	**52**
Middle Jurassic	Safa	Al Maghara Mine	Mg 1	35	0	0	0	0	0	4	1	0	60
			Mg 2	39	0	0	0	0	0	1	1	0	59
			Mg 3	49	0	0	0	0	0	0	4	0	47
			Mg 4	46	0	0	0	0	0	0	0	0	54
			Mg 5	43	0	0	0	0	0	0	0	0	57
			Avg.	**42**	**0**	**0**	**0**	**0**	**0**	1	**1**	**0**	**55**
Carboniferous	Ataqa	Abu Zinema	AZ 1	86	0	0	0	0	0	0	0	0	14
			AZ 3	75	0	0	0	0	0	0	0	0	25
			AZ 8	82	0	0	0	0	0	0	0	0	18
			AZ 9	83	0	0	0	0	0	0	0	0	17
			AZ 10	73	0	0	0	6	0	0	0	0	21
			AZ 11	*80*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*20*
			Avg.	**80**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**20**

Avg =average

Table(4): Major element composition(wt %) of the studied samples.

Location	Formation	Sample No	SiO_2 [%]	Al_2O_3 [%]	CaO [%]	MgO [%]	Fe_2O_3 [%]	TiO_2 [%]	P_2O_5 [%]	Na_2O [%]	K_2O [%]	SO_3 [%]	LOI [%]	Total[%]	CIA	SiO_2/Al_2O_3
Nile Valley (Esna-Idfu) region	Esna	N79	47 93	16 85	1 02	2 55	7 97	0 86	0 085	1 68	1 16	0 72	19 0	99 21	81	2,84
		N78	38 63	12 04	8 29	4 27	5 83	0 61	0 191	2 39	0 87	0 41	26 4	99 93	--	3,21
		N75	57 56	15 42	0 43	3 15	2 94	0 90	0 043	1 77	0 72	0 148	16 90	99 98	84	3,73
		N72	46 53	13 39	8 68	4 03	5 50	0 62	0 227	1 39	1 00	0 128	18 50	99 99	--	3,47
		N69	41 20	16 50	7.99	2 17	6 16	0 75	0 096	1 22	0 91	0 195	22 70	99 89	--	2,50
		N66	46 08	20 51	1 38	1 88	6 01	0 84	0 068	1 31	0 93	0 120	20 80	99 92	85	2.25
		N60	38 11	16 53	8 43	2 52	5 20	0 57	0 657	2 46	0 91	0 286	24 30	99 97	--	2,31
		N55	38 97	8 68	15 19	2 31	3 65	0 43	0 175	1 11	0 46	0 140	28 40	99 23	--	4,03
		N54	18 71	9 67	23 79	0 64	3 36	0 37	0 136	2 34	0 33	0 266	40 30	99 91	--	1,93
	Tarawan	N52	11 18	5 33	37 99	0 56	2 48	0 25	0 117	0 66	0 24	0 119	41 00	99 92	--	2,10
		N50	13 88	6 22	33 23	0 70	4 38	0 25	0 234	0 77	0 28	6 2	33 80	100	--	2,23
	Dakhla	N49	20 34	9 33	28 62	0 90	3 95	0 41	0 212	1 11	0 46	0 126	34 50	99 95	--	2,18
		N47	42 78	18.13	0 08	1 40	15 25	0 81	0 144	1 51	0 75	1 032	18 00	99 88	89	2,36
		N45	49 63	19 24	0 03	1 62	4 35	0 99	0 059	1 35	0 59	0 575	21 50	99 93	90	2,58
		N43	37 46	16 53	0 01	1 66	9 11	0 84	0 102	1 50	0 72	0 313	31 70	98 95	87	2,27
		N39	46 85	18 24	0 79	1 49	6 01	1 00	0 335	1 53	1 02	0 121	22 60	99 98	84	2,57
		N37	44 11	22 34	0 36	1 26	4.70	0 96	0 054	0 86	0 47	0 050	24 80	99 96	93	1,97
		N35	42 19	10 99	18 40	3 16	5 22	0 44	0 108	0 77	0 30	0 570	17 80	99 94	--	3,90
		N33	48 48	22 36	0 10	0 93	5 40	0 97	0 059	1 33	0 63	0 136	19 60	99 99	91	2,17
		N31	45 54	21 57	0 10	0 93	8 75	0 91	0 094	1 54	0 59	0 134	19 80	99 65	90	2.11
		N29	42 51	20 93	0 19	1 30	24 99	0 81	0 123	1 66	0 53	0 266	6 70	98 51	90	2,03
		N27	38 02	15 86	9 29	2 80	6 08	0 79	0 262	1 70	0 65	0 668	23 82	99 94	58	2,40
		N26	48 95	22 94	0.28	1 07	6 12	0 98	0 065	1 13	0 66	0 142	17 08	100	92	2,13
	Duwi	N24	19 21	0 20	29 34	0 30	1 05	0 03	16 78	0 86	0 05	2 173	30 00	99 99	--	96,05
		N21	18 37	0 49	45 39	0 51	0 86	0 04	0 290	0 18	0 05	0 050	33 77	100	--	37,49
		N17	48 59	16 17	1 48	1 60	4 93	0 91	0 244	3 15	0 91	1 544	20 47	99 77	74	3,00
		N15	53 75	11 44	0 60	1 31	3 71	0 83	0 453	1 68	1 09	0 075	25 00	99 93	77	4,70
		N10	57 94	12 67	0 94	1 11	7 88	0 96	0 673	1 24	1 05	0 296	15 24	99 99	79	4.57
		N9	49 85	18 44	0 24	1 22	4 56	1,28	0 202	1 38	1 55	0 137	21 10	99 95	85	2,70
		N5	55 09	15 25	0 19	1 04	3 42	1 34	0 494	1 38	1 56	0 266	19 95	99.98	83	3,61
		N1	52 66	17 42	0 13	1 71	7 09	1 27	0 041	1 81	2 98	0 394	14 49	99 99	78	3,02
Quseir phosphate mines	Duwi and Dakhla	Q 1	45 85	13 57	0 83	2 14	4 77	0 76	0 132	0 36	0 87	2 424	28 00	99 70	87	3.38
		Q.2	15 10	0 24	23 40	7 59	2 14	0 03	6 219	0 36	0 05	0 929	42 20	98 25	--	62,92
		Q 7	25 45	7 16	12 33	2 01	5 87	0 44	5 817	7 05	0 83	0 229	32 00	99 16	--	3,55
		Q 11	37 73	8 83	17 03	1 74	4 88	0 44	3 317	1 16	0 64	0 132	22 28	98 17	--	4,27
		Q 16	35 39	8 79	21 53	1 41	3 92	0 46	2 600	0 69	0 64	0 136	23 34	98 90	--	4,03
		Q 18	23 08	0 30	28 15	0 62	0 14	0,03	17 75	0 57	0 05	0 662	27 96	99 31	--	76,93
		Q 20	49 75	11 81	1 52	1 74	4 88	0 69	0 513	0 44	0 81	0.050	27 40	99 60	81	4,21
		Q 26	39 32	11 43	16 24	2 41	6 07	0 58	4 897	0 76	0 92	0 213	15 85	98 69	--	3,44
		Q 31	4 15	0 65	34 35	0 81	0 70	0 03	13 68	1 81	0 05	0 344	40 30	96 87	--	6,38
		Q 34	19 89	8.55	33 82	0 71	3 00	0 40	0 423	0 38	0 46	0 288	31 70	99 62	--	2,33
Abu Tartur	Duwi	AT 2	46 81	14 60	1 18	2 17	5 51	0 78	0 127	0 06	1 39	1 154	26 14	99 92	85	3,21
		AT 4	4 94	1 07	34 09	0 45	3 33	0 06	20 18	0 62	0 06	4 120	29 30	98 22	--	4,62
		AT 5	55 66	17 89	1 79	3 16	6 31	0 87	0 275	0 10	0 93	3 019	9 80	99 80	86	3,11
		AT 7	52 04	16 70	1 85	2 95	6 41	0 82	0 322	0 14	0 88	3 394	14 25	99 75	85	3,12
		AT 8	12 00	2 89	28 79	1 26	4 32	0 14	15 90	0 49	0 17	5 087	27 60	98 64	--	4,15
		AT 9	49 77	14 16	1 65	2 33	4 22	0 88	0 303	0 10	1 05	0 836	24 60	99 89	83	3,51
		AT 12	7 73	1.45	30 23	0 39	3 72	0 07	17 26	0 46	0 09	4 606	32 55	98 55	--	5,33
Al Maghra	Safa	Mg 1	47 01	25 88	0 37	0 90	8 70	1 97	0 093	0 11	0 93	0 543	13 25	99 75	95	1,82
		Mg 3	49 80	26.43	0.34	0 77	4 28	2 15	0 088	0 11	1.02	0 277	14 50	99 76	95	1,88
		Mg 5	49 77	26 34	0 35	0 67	6 30	2 25	0 089	0 11	0 86	0,599	12 44	99 77	95	1,89
Abu Zinema	Ataqa	AZ.1	51 12	18 86	0 29	0 30	0 49	1 14	0 067	0 31	0 94	0 207	26 00	99 72	92	2,71
		AZ 5	56 23	13 73	0 44	0 30	2 00	1 28	0 043	0,35	1 07	0,517	23 85	99 81	88	4,10
		AZ 7	57 98	15 37	0 79	0 30	0 23	0 44	0 028	0 11	0 24	0 414	24 20	99 90	93	3,77
		AZ 8	41 02	20 16	0 16	0 30	0 47	0 94	0 064	1 26	0 51	3 714	30 40	98 99	91	2,03

Table(5): Trace element composition(ppm) of the studied samples.

Location	Formation	Sample No.	Sr ppm	Ba ppm	V ppm	Ni ppm	Co ppm	Cr ppm	Zn ppm	Cu ppm	Zr ppm	Mn ppm
Nile Valley	Esna	N79	289	150	180	46	10<	181	119	24	114	46<
		N78	309	100	160	47	13	150	141	13	90	289
		N75	248	150	170	22	<10	171	58	22	133	<150
		N72	362	120	226	93	<10	180	244	21	84	499
		N69	331	150	196	65	10	197	160	28	110	185
		N66	211	180	170	48	15	181	154	21	130	<150
		N60	280	288	170	67	11	166	168	25	91	266
		N55	428	95	140	78	10	127	159	31	71	131<
		N54	719	70	110	44	<10	183	75	15	48	<150
	Tarawan	N52	990	48	83	32	<10	154	43	13	<40	<150
		N50	703	59	77	36	<10	144	<40	11	44	<150
	Dakhla	N49	784	62	140	45	<10	222	54	19	52	<150
		N47	113	60	180	46	25	108	116	21	91	608
		N45	109	69	190	33	9<	163	61	29	112	<150
		N43	43	110	170	51	22	111	127	14	97	831
		N39	158	140	250	46	12	265	90	25	173	<150
		N37	263	97	170	34	<10	156	68	22	109	<150
		N35	400	73	140	43	13	153	110	16	55	<150
		N33	197	73	190	46	11	197	73	27	95	<150
		N31	54	72	218	64	18	200	195	21	93	<150
		N29	40	73	202	87	25	192	138	<10	87	1040
		N27	299	74	197	52	<10	224	96	25	97	<150
		N26	82	77	210	45	13	215	101	29	97	<150
	Duwi	N24	1203	362	58	<12	<10	64	65	<10	<40	379
		N21	208	83	55	<12	<10	50	<40	<10	<40	1770
		N17	497	120	160	32	8<	174	82	34	99	<150
		N15	250	264	86	26	<10	77	68	26	297	<150
		N10	423	339	100	40	<10	100	96	32	336	359
		N9	562	134	150	19	<10	117	<40	20	236	<150
		N5	1703	219	100	14	<10	93	<40	22	372	<150
		N1	78	140	160	41	12	107	65	53	219	<150
Quseir Phosphate mines	Duwi and Dakhla	Q 1	76	92	110	41	20	81	69	27	138	195
		Q 2	301	34	45	<12	<10	<30	<40	<10	<40	732
		Q 7	470	72	1835	126	<10	379	1250	156	104	<150
		Q 11	486	79	3151	186	<10	631	1600	243	93	<150
		Q 16	513	93	2679	153	<10	414	1130	178	95	<150
		Q 18	951	110	20	<12	<10	35	<40	<10	<40	152
		Q 20	128	110	160	30	<10	123	135	25	146	<150
		Q 26	649	98	1455	177	12	540	1040	154	105	<150
		Q 31	895	53	20	18	<10	100	119	<10	<40	<150
		Q 34	1030	87	110	60	b.d l	240	61	31	55	<150
Abu Tartur	Duwi	AT 2	207	110	130	26	12	100	66	16	165	<150
		AT 4	1324	61	46	21	<10	<30	<40	<10	<40	556
		AT 5	226	69	150	31	13	112	41	15	100	<150
		AT 7	300	78	65	39	14	122	44	30	114	<150
		AT 8	1398	64	44	16	10	<30	<40	12	<40	738
		AT 9	296	79	130	36	10	124	53	30	106	<150
		AT12	1139	58	46	28	9<	58	<40	10	<40	660
Al Magahra	Safa	Mg 1	110	90	160	68	29	197	92	23	537	785
		Mg 3	113	100	160	67	25	194	84	30	575	272
		Mg 5	105	72	160	78	36	199	97	24	571	709
Abu Zinema	Ataqa	AZ 1	60	140	140	<12	<10	92	<40	37	239	b d l
		AZ 5	62	140	130	<12	<10	87	<40	22	237	b d l
		AZ 7	17	47	150	<12	<10	36	b d l.	12	215	b d l
		AZ 8	48	100	100	26	17	84	224	32	281	<150

Table(5): Cont.

Location	Formation	Sample No	Mo ppm,	Cd ppm	U ppm	Th ppm	Cs ppm	Pb ppm	Rb ppm	Cr/Ni	Rb/Sr	V/Cr
Nile Valley	Esna	N79	<5	b.d.l.	<5	<10	<8	<15	56	3,93	0,19	1,00
		N78	<5	<5	<5	<10	<8	<15	49	3,19	0,16	1,05
		N75	<5	<5	<5	<10	<8	<15	30	7,77	0,12	0,98
		N72	<5	<5	<5	<10	<8	<15	59	1,94	0,16	1,26
		N69	<5	<5	<5	<10	<8	<15	51	3,03	0,15	0,99
		N66	<5	<5	<5	13	<8	<15	59	3,77	0,28	0,93
		N60	<5	<5	7	<10	<8	<15	52	2,48	0,19	1,01
		N55	<5	b d l	<5	<10	<8	<15	29	1,63	0,07	1,09
		N54	b d l	<5	<5	<10	b d l	<15	16	4,16	0,02	0,62
	Tarawan	N52	b d l	b d l	6	<10	b d l	<15	12	4,81	0,01	0,54
		N50	<5	b d l	<5	<10	b.d l.	<15	12	4,00	0,02	0,53
	Dakhla	N49	b d l	<5	<5	<10	<8	<15	19	4,93	0,02	0,61
		N47	<5	<5	<5	<10	<8	16	24	2,35	0,21	1,70
		N45	<5	b.d l	<5	<10	<8	<15	26	4,94	0,24	1,16
		N43	<5	<5	<5	<10	b d l	<15	30	2,18	0,70	1,56
		N39	<5	<5	<5	<10	b d l	<15	41	5,76	0,26	0,93
		N37	<5	<5	<5	<10	b d l	16	19	4,59	0,07	1,07
		N35	b d l	<5	<5	<10	b d l	<15	16	3,56	0,04	0,92
		N33	<5	<5	<5	<10	<8	<15	25	4,28	0,13	0,98
		N31	<5	<5	<5	<10	b d l	<15	27	3,13	0,50	1,09
		N29	b.d l.	382	380	<10	b.d l	<15	27	2,21	0,68	1,05
		N27	<5	<5	<5	<10	<8	<15	25	4,31	0,08	0,88
		N26	<5	<5	<5	11	b d.l	<15	28	4,78	0,34	0,95
	Duwi	N24	<5	<5	51	b d l	b.d l	<15	10	5,33	0,01	0,91
		N21	b d l	<5	<5	<10	<8	<15	10	4,17	0,05	1,10
		N17	<5	b d l	<5	<10	<8	<15	35	5,44	0,07	0,90
		N15	<5	<5	<5	<10	b.d l	<15	29	2,96	0,12	1,12
		N10	<5	b d l	<5	<10	<8	66	29	2,50	0,07	1,04
		N9	<5	<5	<5	<10	<8	<15	48	6,16	0,09	1,26
		N5	b d l	7	<5	<10	<8	<15	41	6,64	0,02	1,11
		N1	<5	<5	b d l.	<10	<8	<15	96	2,61	1,23	1,49
Quseir phosphate mines	Duwi and Dakhla	Q 1	<5	b d l.	<5	<10	<8	<15	28	1,98	0,37	1,38
		Q 2	9	b d l	27	b d l	b d l	15	10	2,50	0,03	1,50
		Q.7	214	15	52	<10	<8	33	32	3,01	0,07	4,84
		Q 11	474 2	47	41	<10	<8	20	31	3,39	0,06	4,99
		Q.16	258	73	34	<10	<8	29	30	2,71	0,06	6,47
		Q 18	b.d l	b d l.	24	b d l.	b d l	<15	10	2,92	0,01	0,57
		Q 20	<5	<5	9	<10	b d.l.	<15	32	4,10	0,25	1,28
		Q 26	302	40	44	<10	b.d.l	30	40	3,05	0,06	2,69
		Q 31	<5	7	27	b d l	b.d l	<15	10	5,56	0,01	0,20
		Q 34	<5	b.d l.	11	<10	b d.l	<15	19	4,00	0,02	0,46
Abu Tartur	Duwi	AT 2	<5	<5	<5	<10	<8	<15	23	3,61	0,15	1,32
		AT 4	b d.l.	<5	21	<10	b d.l.	<15	<5	1,63	0,00	1,69
		AT 5	<5	b d l	<5	<10	<8	<15	34	3,13	0,09	1,80
		AT 7	<5	9	22	<10	b d l.	<15	<5	3,44	0,08	1,61
		AT 8	<5	b d l	<5	<10	<8	<15	27	2,07	0,01	1,12
		AT 9	<5	b d l	<5	<10	b d l	<15	25	3,85	0,11	1,30
		AT 12	12	7	27	<10	b d l	<15	6	1,14	0,00	1,92
Al Magh ara	Safa	Mg 1	<5	<5	<5	19	<8	<15	39	2,90	0,35	0,81
		Mg 3	<5	<5	5	16	<8	<15	44	2,90	0,39	0,83
		Mg 5	<5	<5	<5	13	<8	<15	37	2,55	0,35	0,78
Abu Znema	Ataqa	AZ 1	<5	<5	<5	19	9	124	51	7,67	0,85	1,49
		AZ 5	<5	b.d l.	<5	15	<8	95	30	7,25	0,48	1,46
		AZ 7	<5	b d l	<5	<10	<8	b d l	10	3,00	0,59	4,06
		AZ 8	<5	6	<5	14	<8	79	20	3,23	0,42	1,24

Table 6a: Pearsons correlation coefficient values of each pair of elements of the studied shale samples

	SiO_2	Al_2O_3	CaO	MgO	Fe_2O_3	TiO_2	P_2O_5	Na_2O	K_2O	SO_3	Sr	Ba	V	Ni	Cr	Zn	Cu	Zr	Rb	Cl	F
SiO_2	1.00																				
Al_2O_3	0.59	1.00																			
CaO	-0.89	-0.77	1.00																		
MgO	0.21	-0.07	-0.15	1.00																	
Fe_2O_3	0.09	0.33	-0.28	0.16	1.00																
TiO_2	0.57	0.79	-0.63	-0.19	0.13	1.00															
P_2O_5	-0.02	-0.36	0.14	-0.13	-0.03	-0.20	1.00														
Na_2O	-0.06	-0.03	-0.07	0.27	0.21	-0.20	0.11	1.00													
K_2O	0.52	0.28	-0.50	0.18	0.09	0.48	0.08	0.12	1.00												
SO_3	-0.14	-0.10	0.09	-0.03	-0.05	-0.12	0.00	-0.19	-0.11	1.00											
Sr	-0.41	-0.45	0.49	-0.07	-0.23	-0.24	0.39	0.13	-0.03	0.02	1.00										
Ba	0.36	0.00	-0.27	-0.08	-0.06	0.13	0.62	0.30	0.41	-0.23	0.12	1.00									
V	0.41	0.61	-0.53	0.440	0.46	0.24	-0.21	0.18	0.16	-0.16	-0.40	-0.02	1.00								
Ni	-0.13	0.29	0.00	0.28	0.54	0.15	-0.02	0.21	-0.05	-0.14	-0.12	-0.08	0.46	1.00							
Cr	-0.28	0.30	-0.09	0.11	0.27	0.14	-0.08	0.25	-0.13	-0.21	0.10	-0.17	0.52	0.61	1.00						
Zn	0.00	0.21	-0.16	0.34	0.30	-0.27	0.02	0.41	-0.05	-0.08	-0.24	0.14	0.37	0.64	0.28	1.00					
Cu	0.40	0.33	-0.36	0.00	-0.13	0.38	0.05	0.12	0.57	0.01	-0.13	0.29	0.18	0.03	0.05	0.06	1.00				
Zr	0.46	0.54	-0.43	-0.33	-0.06	0.87	0.00	-0.31	0.35	-0.08	-0.11	0.27	-0.10	0.04	-0.08	-0.08	0.27	1.00			
Rb	0.39	0.35	-0.41	0.31	0.12	0.41	-0.03	0.28	0.82	-0.24	-0.14	0.41	0.33	0.24	0.10	0.28	0.52	0.25	1.00		
Cl	-0.07	-0.21	-0.13	0.03	0.07	-0.11	0.00	0.59	0.01	-0.01	-0.03	0.21	-0.07	-0.10	-0.08	0.31	0.07	-0.10	0.07	1.00	
F	0.02	-0.36	0.13	0.26	-0.11	-0.35	0.35	0.12	0.01	-0.05	0.19	0.48	-0.18	-0.07	-0.23	0.20	-0.05	-0.19	0.12	0.07	1.00

Table 6b: Pearsons correlation coefficient of each pair of elements of the studied phosphate samples

	SiO_2	AL_2O_3	CaO	Mg	Fe_2O_3	TiO_2	P_2O_5	Na_2O	K_2O	SO_3	Sr	Ba	V	Ni	Cr	Zn	Cu	Zr	Rb	Cl	F
SiO_2	1.00																				
AL_2O_3		1.00																			
CaO			1.00																		
MgO				1.00																	
Fe_2O_3		0.81			1.00																
TiO_2		0.98			0.82	1.00															
P_2O_5			0.66				1.00														
Na_2O			0.63					1.00													
K_2O		0.96			0.74	0.98			1.00												
SO_3		0.81			0.91	0.82			0.74	1.00											
Sr			0.68				0.93			0.67	1.00										
Ba	0.50											1.00									
V		0.53				0.62			0.61	0.71			1.00								
Ni		0.96			0.69	0.91			0.91	0.71				1.00							
Cr					0.73			0.88							1.00						
Zn								0.93							0.86	1.00					
Cu			0.50														1.00				
Zr																0.67		1.00			
Rb																0.64		0.89	1.00		
Cl								0.79							0.70	0.87		0.55	0.58	1.00	
F							0.95				0.82						0.54			0.16	1.00

Appendix B

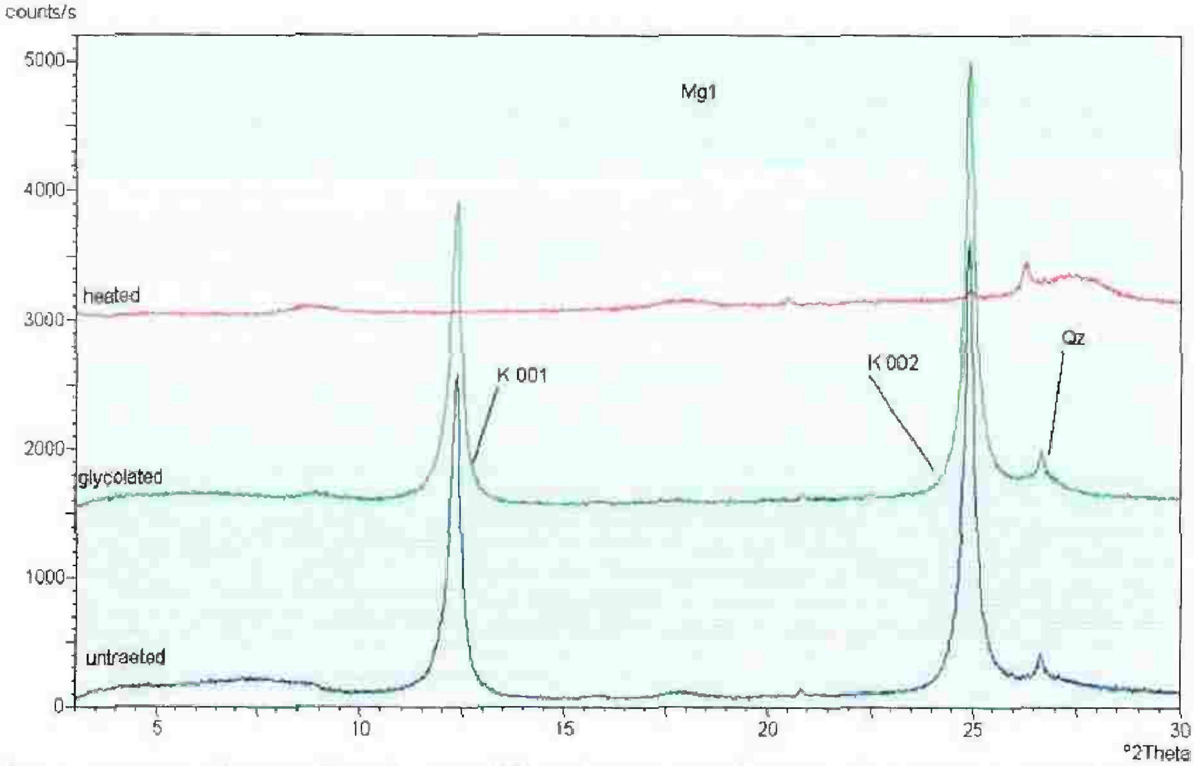


Fig.1: Representative profile of X-ray diffraction patterns for studied clays of Al Maghara coal mine

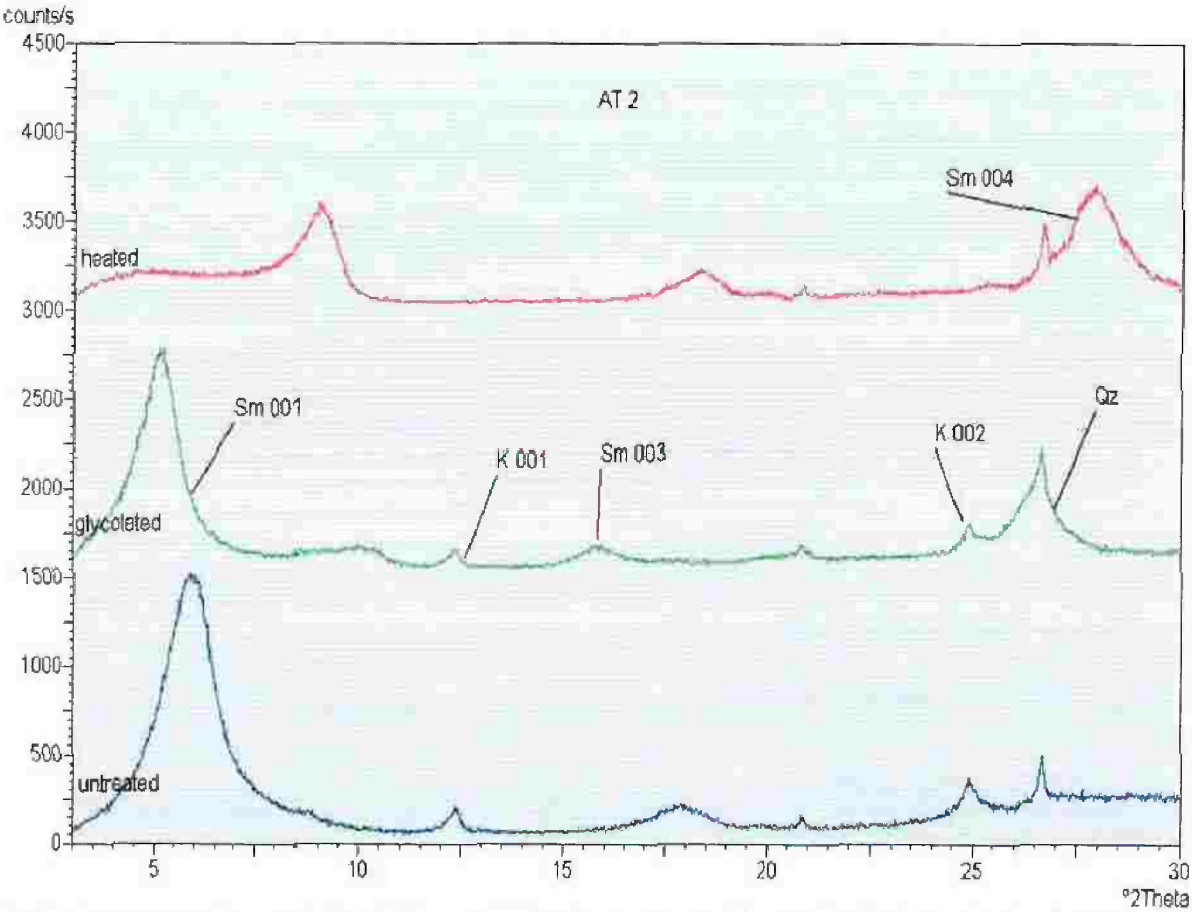


Fig.2: Representative profile of X-ray diffraction patterns for studied clays of Abu Tartur phosphate mine

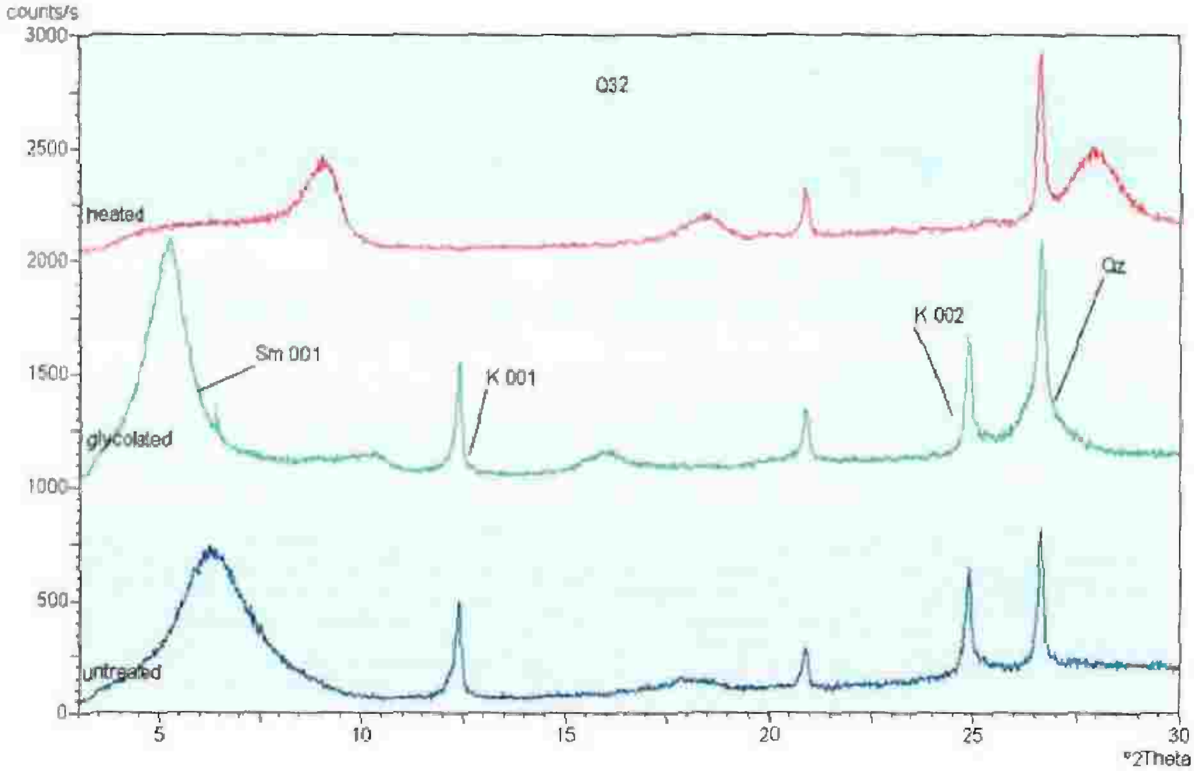


Fig.3: Representative profile of X-ray diffraction patterns for the studied clays of Quseir phosphate mine

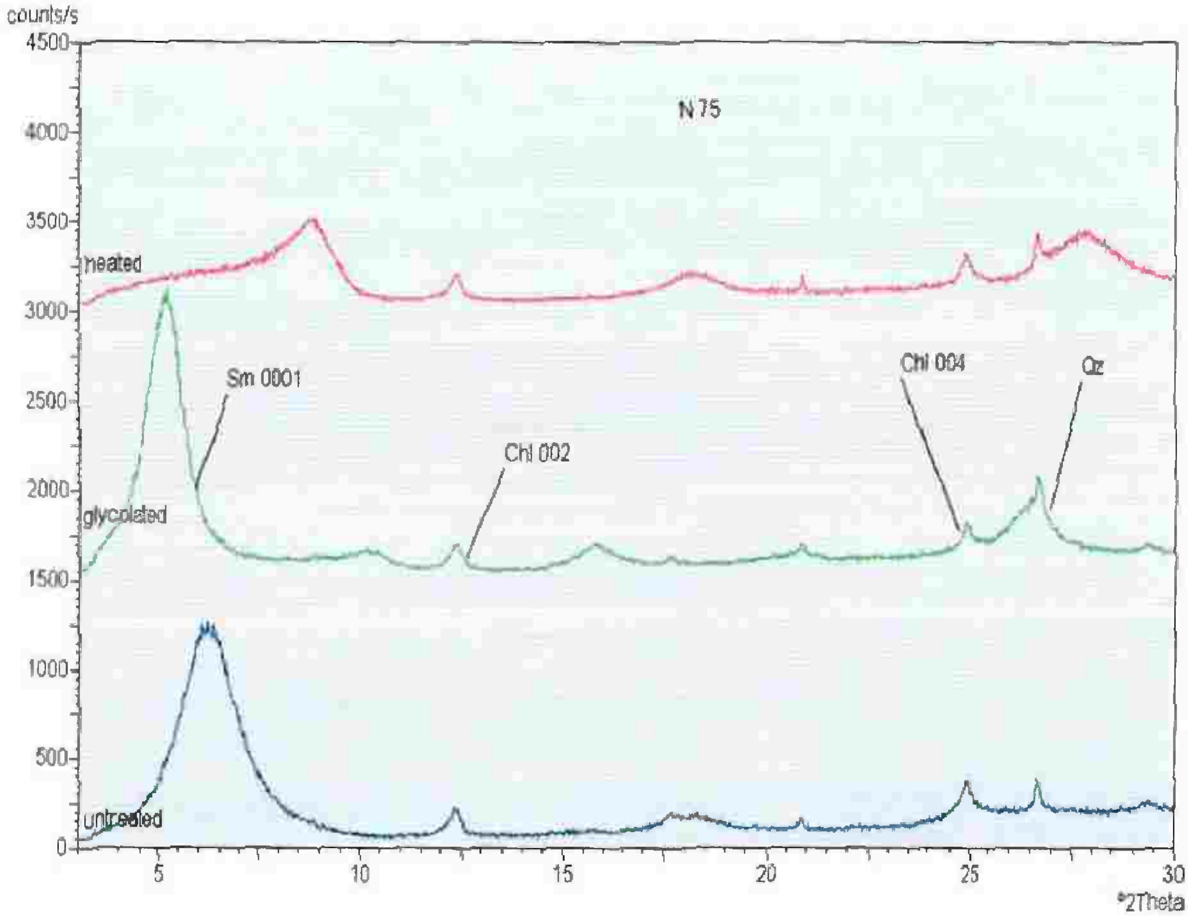


Fig.4: Representative profile of X-ray diffraction patterns for studied clays of Esna-Idfu, Nile Valley.

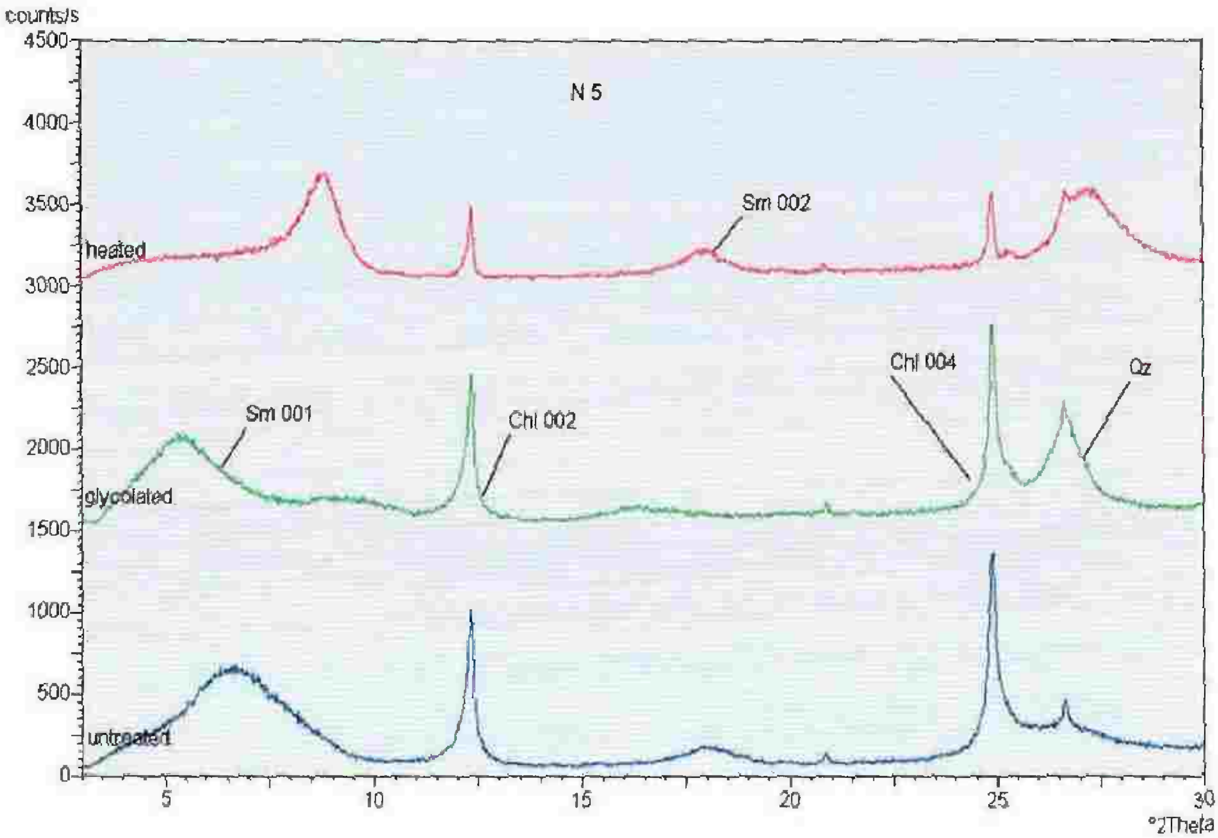


Fig.5: Representative profile of X-ray diffraction patterns for studied clays of Esna-Idfu, Nile Valley.

For abbreviations; Sm: smectite, K: kaolinite. Chl: chlorite, Qz: quartz.

Appendix C

Plate 1

Fig. A: Photomicrograph of black shale of Duwi Formation in Abu Tartur phosphate mine shows quartz grains, monocrystalline, moderately to well sorted grains.

Fig. B: Photomicrograph of black shale of Safa Formation in Al Maghara coal mine shows wisps of organic matter.

Plate 2

Fig. A: SEM micrograph shows swirl texture with face to face arrangement of coarse detrital kaolinite in black shale of Safa Formation in Al Maghara coal mine.

Fig. B: SEM micrograph shows swirl texture with face to face arrangement of coarse detrital kaolinite and detrital platelets of kaolinite with irregular edges in black shale of Ataqa Formation in Abu Zinema.

Plate 3

Fig. A: Photomicrograph of black shale of Duwi Formation in Abu Tartur phosphate mine shows silty claystone.

Fig. B: SEM micrograph shows smectite particles, have expanded, flored "cornflak" or "Okal leaf" like structure, in Duwi Formation in Abu Tartur phosphate mine.

Plate 4

Fig. A: SEM micrograph showing the agreggates of euhedral pyritic grains in Duwi Formation in Abu Tartur phosphate mine.

Fig. B: SEM micrograph showing agreggates of framboids of pyrite.

Plate 5

Fig. A: Photomicrograph showing highly foraminiferal shale in Dakhla Shale in Esna –Idfu, Nile Valley.

Fig. B: Photomicrograph showing highly foraminiferal shale in Dakhla Shale in Quseir mines.

Plate 6

Fig. A: Photomicrograph showing a micritic, microsparitic or sparitic matrix of the oyster limestone bed in Quseir mine.

Fig. B: Photomicrograph showing micritic, microsparitic or sparitic, fossiliferous limestone of Tarawan Chalk in Esna-Idfu Nile Valley.

Plate 7

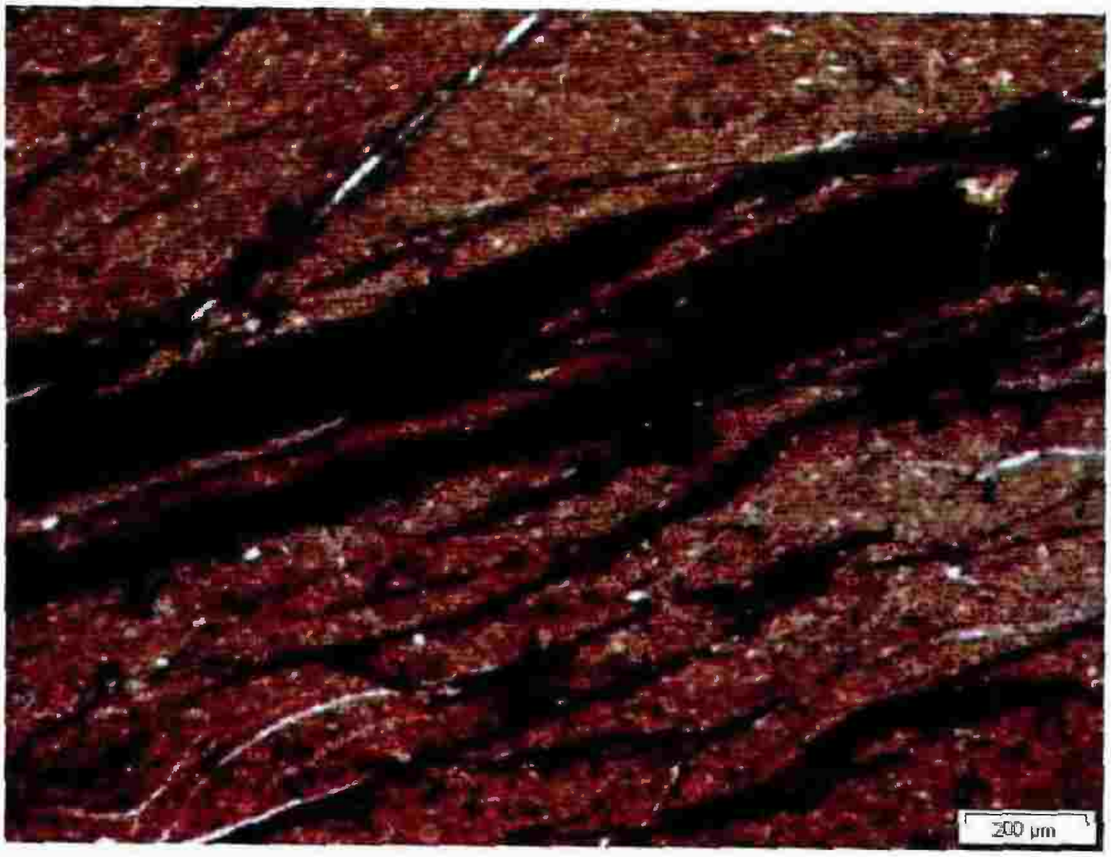
Fig. A. Photomicrograph showing uncoated phosphate grains in Quseir phosphate mine

Fig.B: SEM micrograph showing phosphate grains cemented by silica in Duwi Formation Esna –Idfu Nile Valley.

Fig.C: SEM micrograph showing coated and uncoated phosphate grains cemented by calcite in Duwi Formation in Abu Tartur.

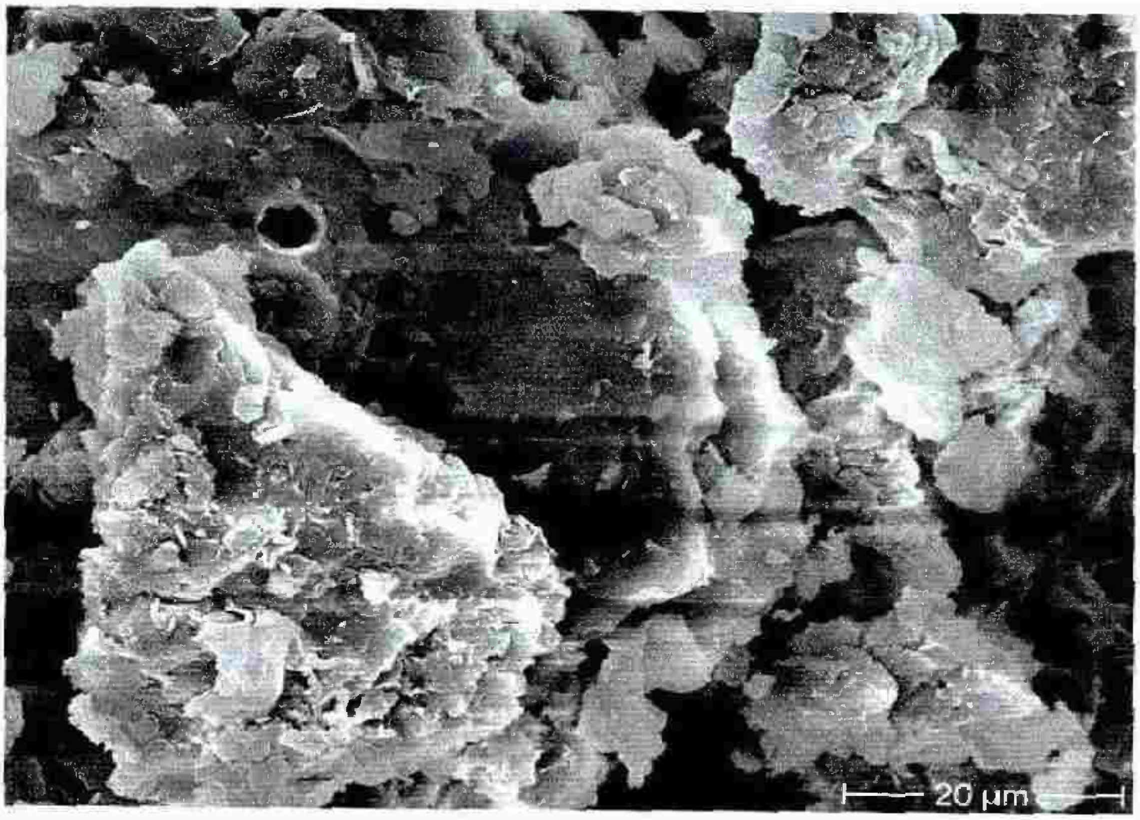
PLATE 1

A



B

PLATE 2



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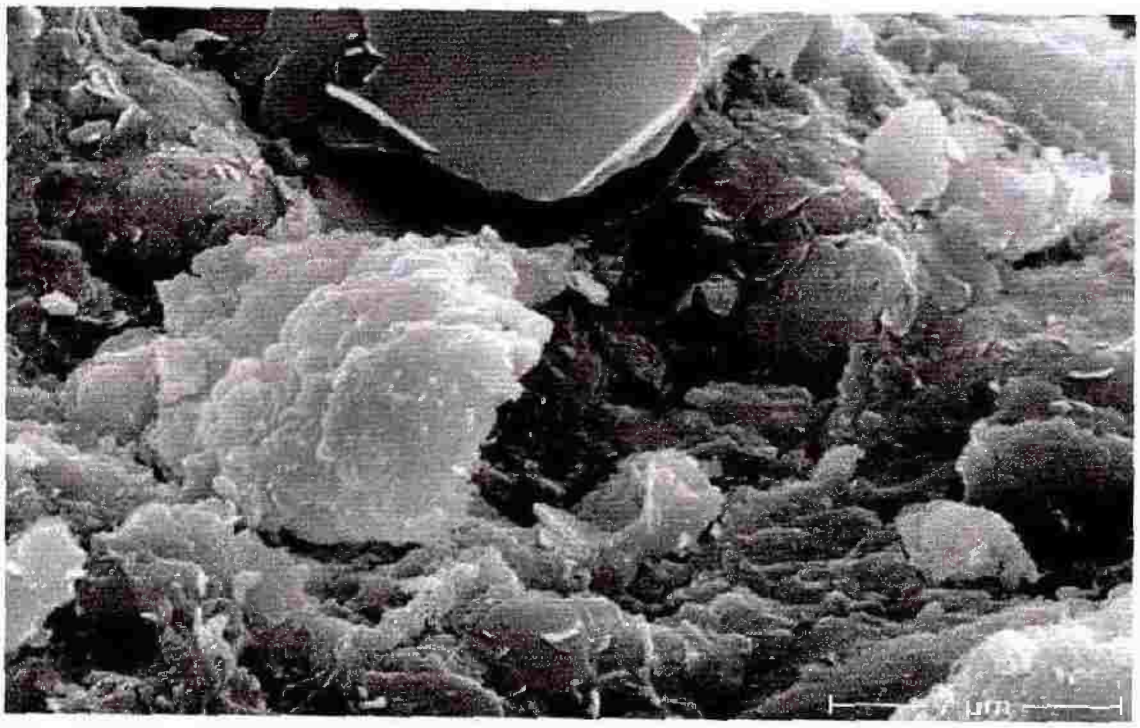

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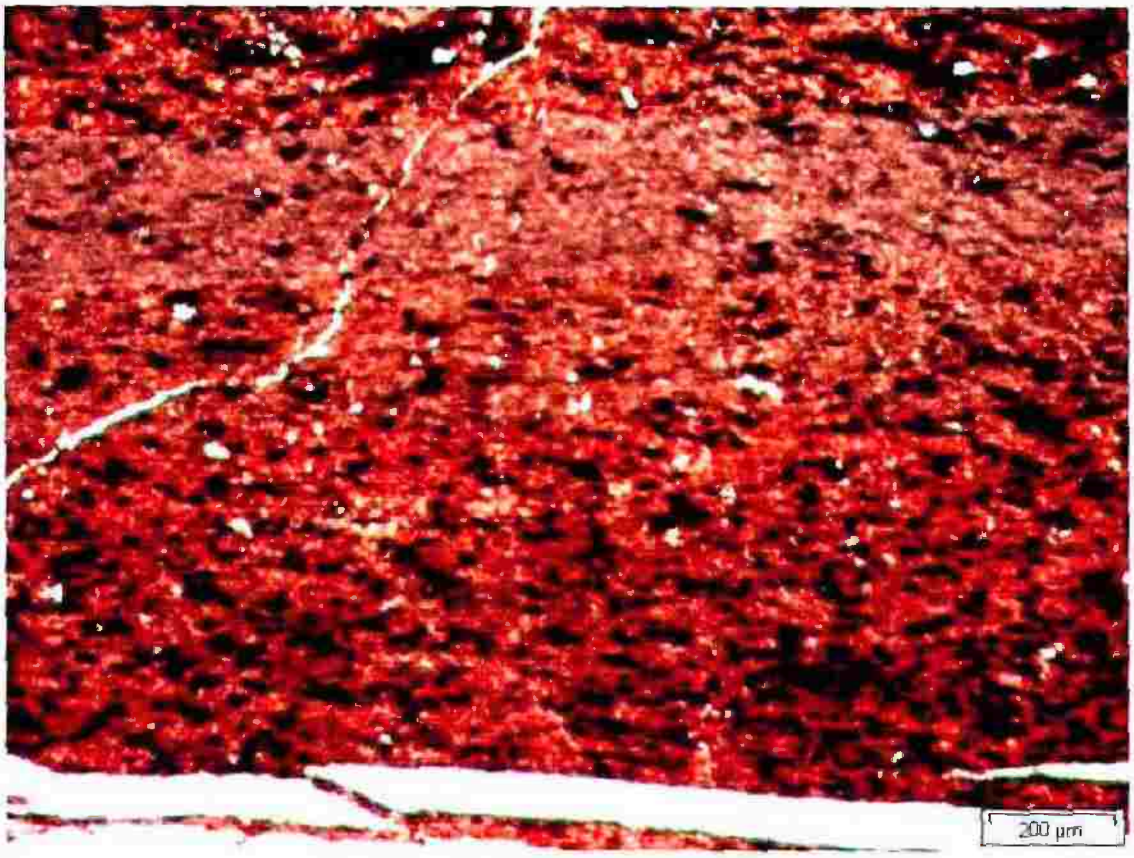
PLATE 3



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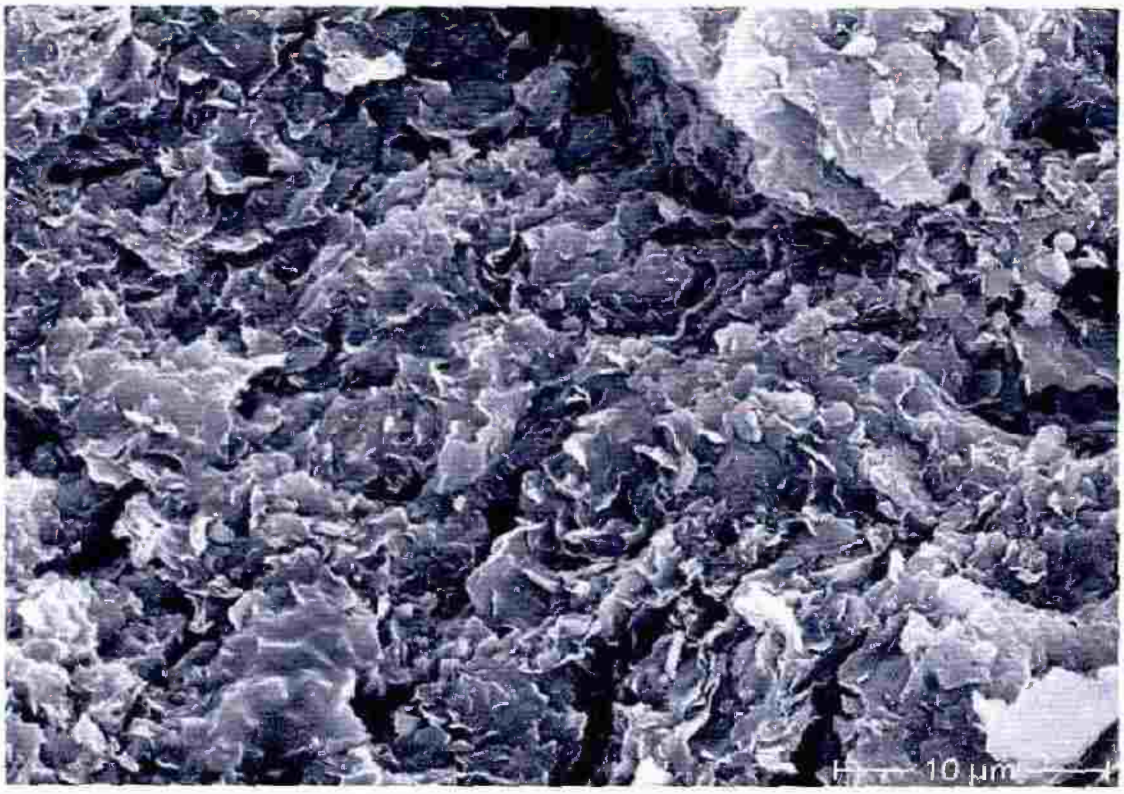

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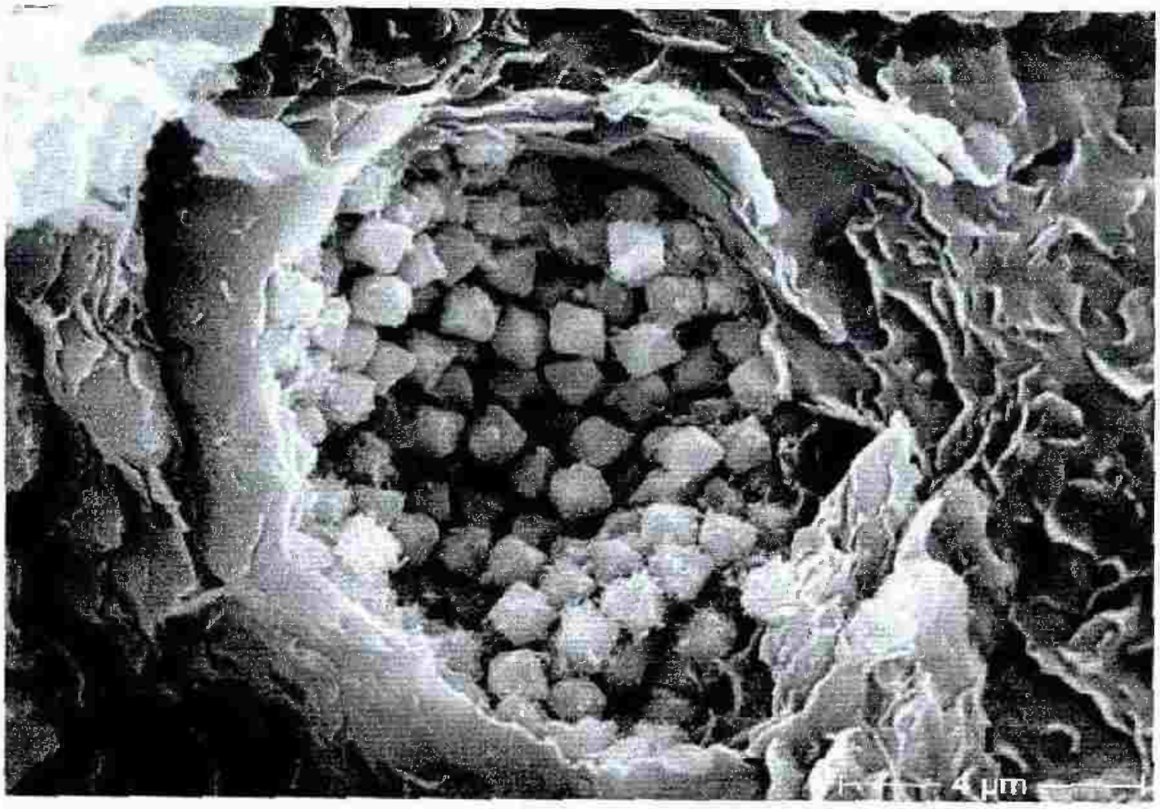
PLATE 4



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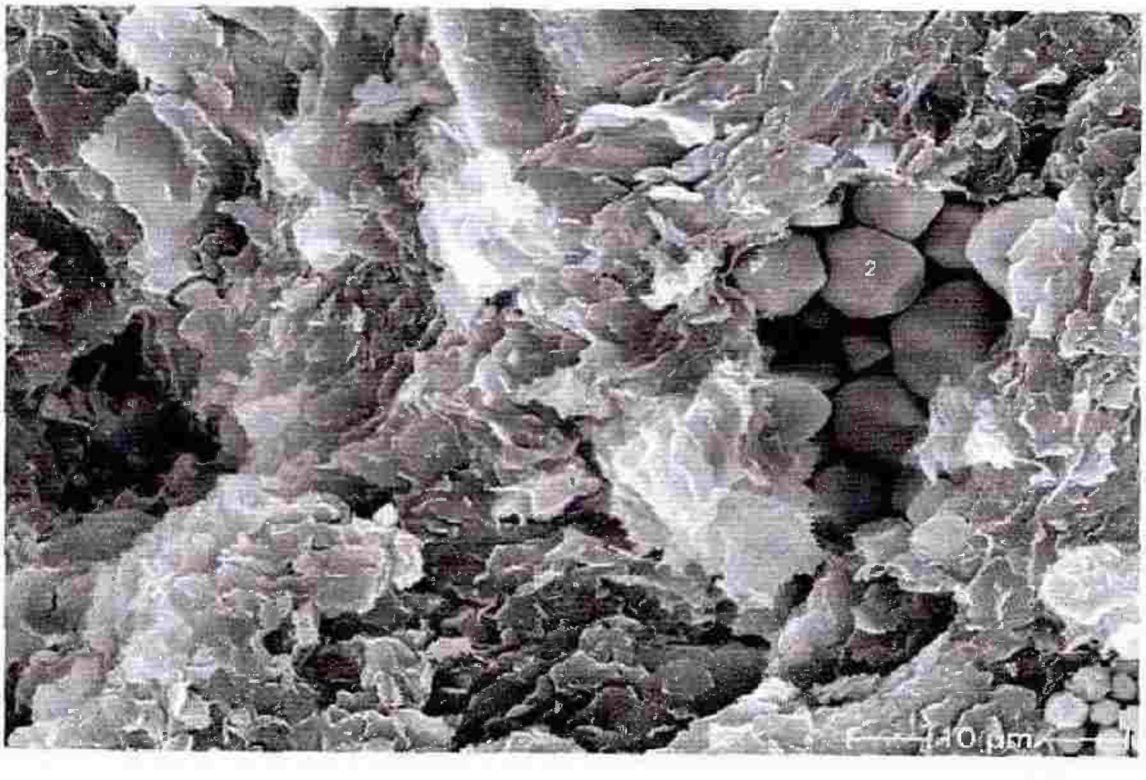

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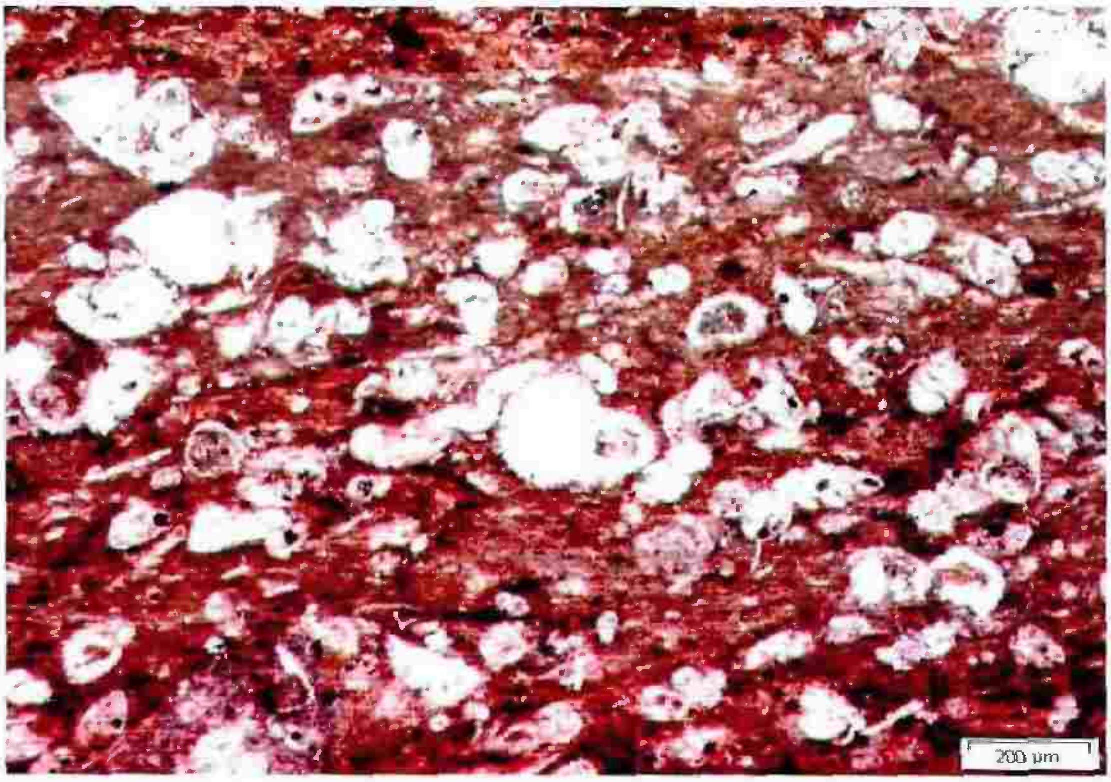
PLATE 5



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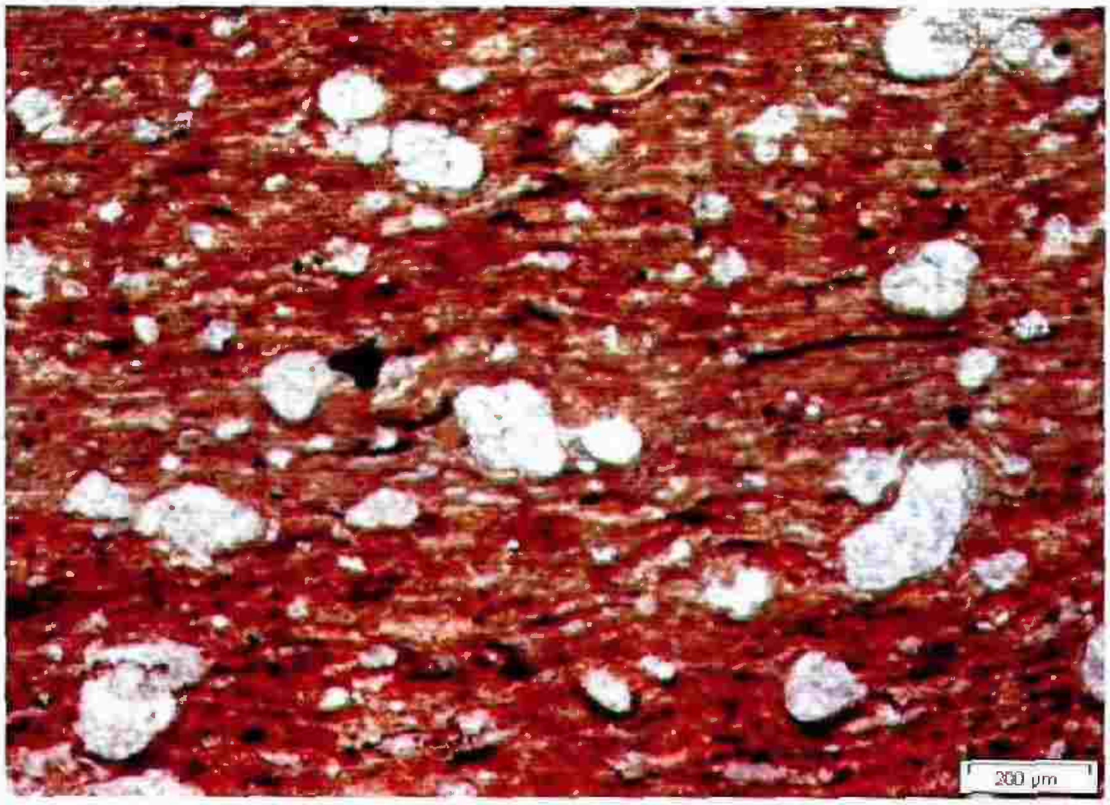

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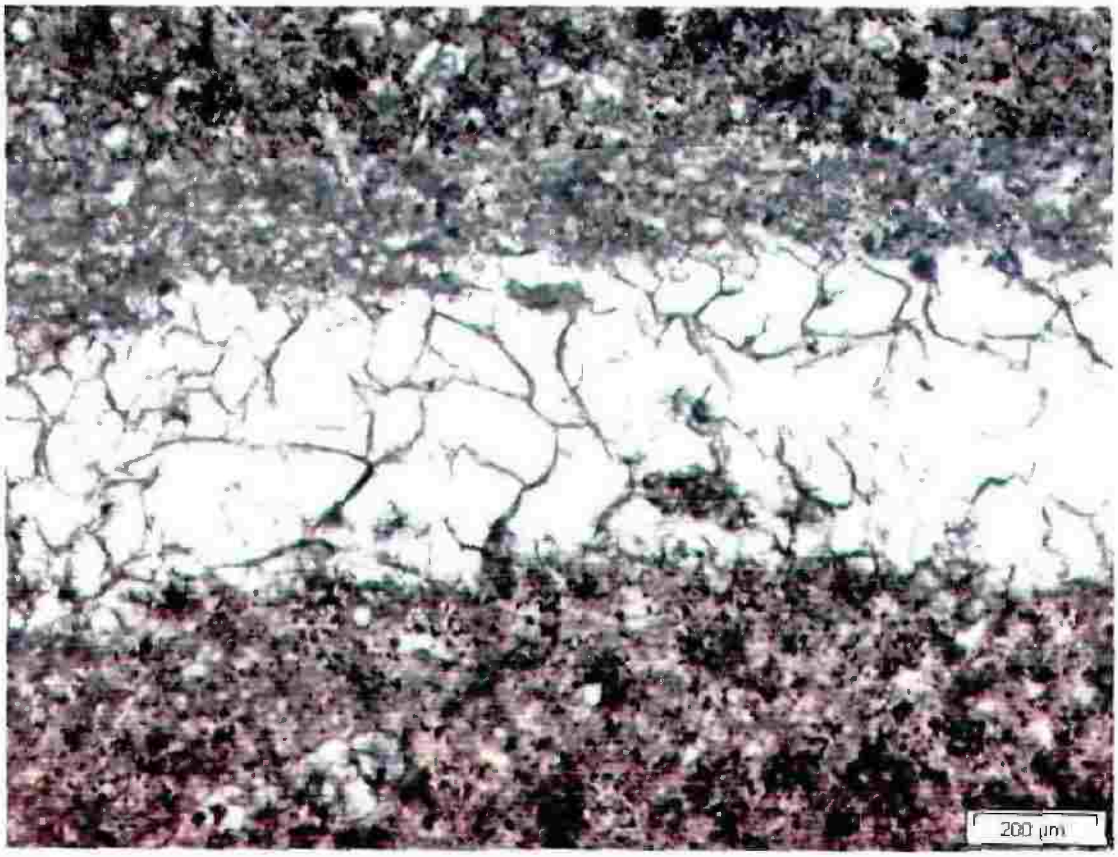
PLATE 6



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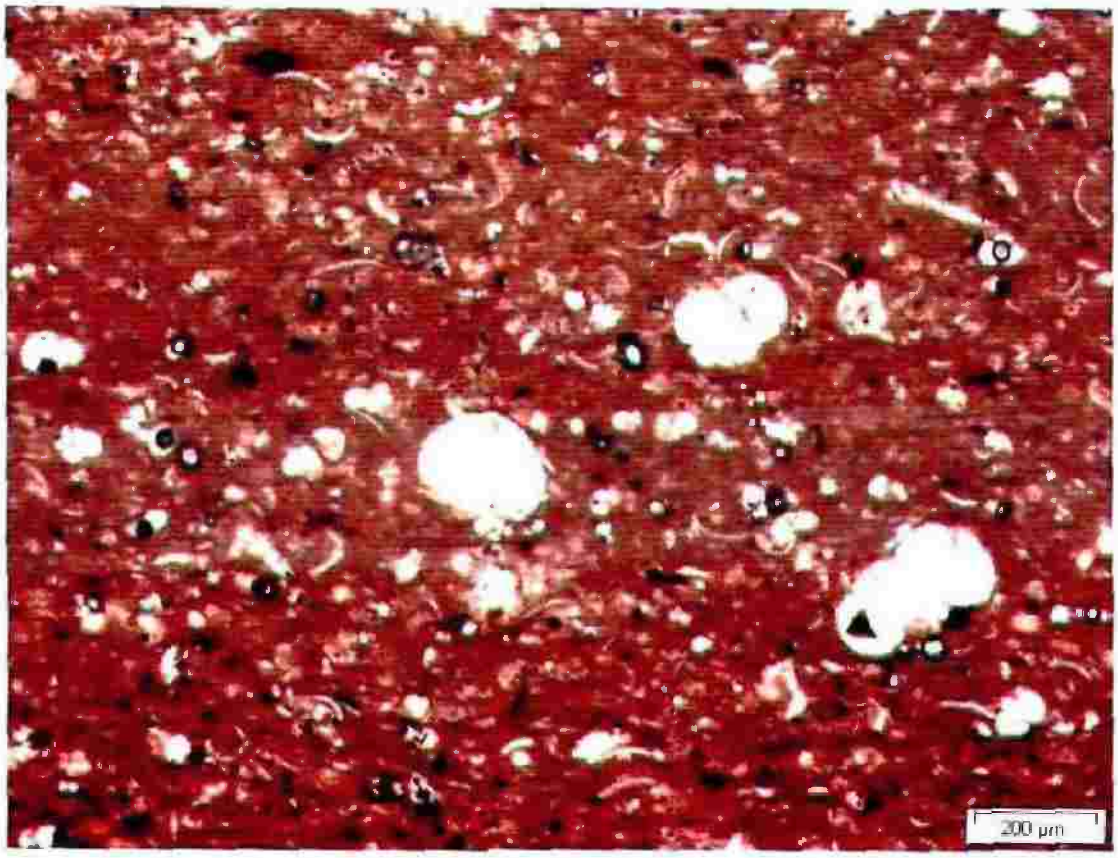
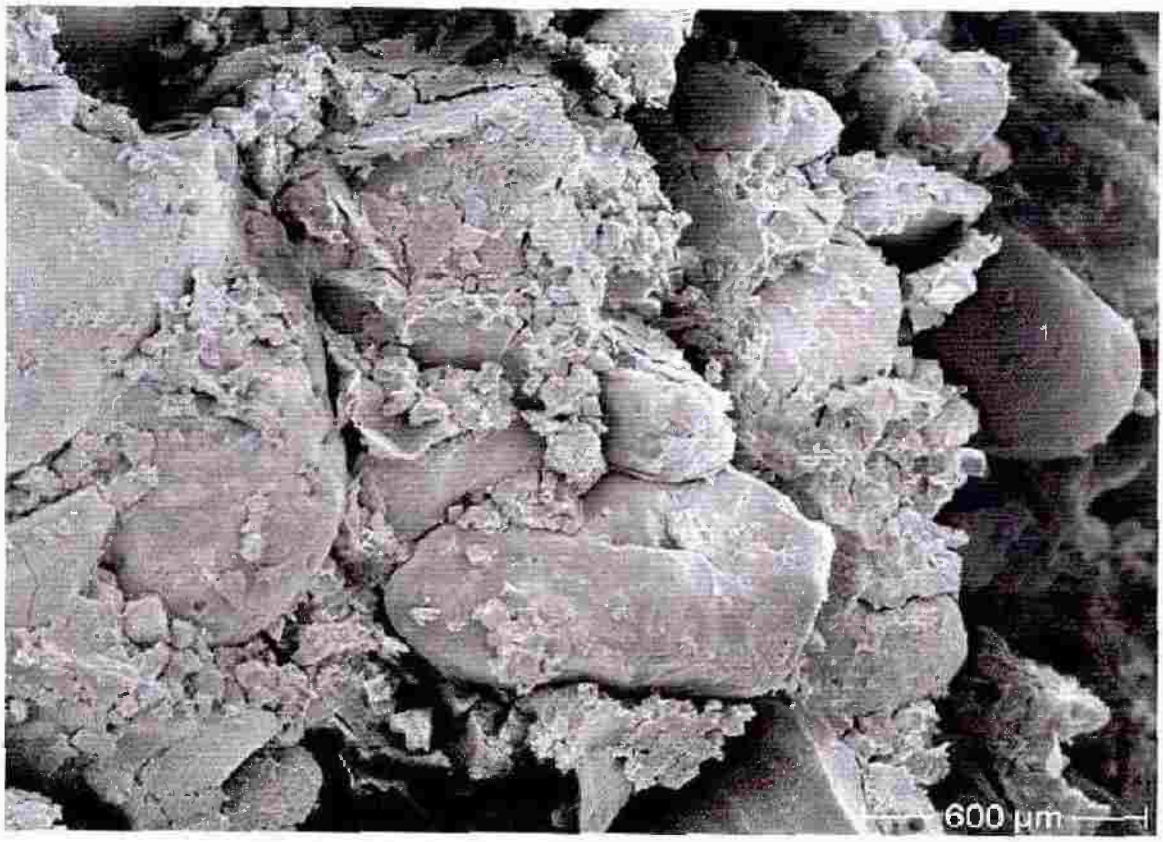


B

PLATE 7

A



B

PLATE 7

C