18. PHYSICAL PROPERTIES

A. C. Pimm, Scripps Institution of Oceanography, La Jolla, California

This chapter has two limited objectives as follows:

1) To graphically summarize various physical and chemical properties for each site and show their relationship to other important parameters such as lithology, diagenesis, authigenesis and acoustic character.

2) To illustrate at the section (150 cm) level how some physical properties respond to important cyclical variations in lithology and also to some major stratigraphic boundaries. These variations in the physical properties were too subtle to be recorded in the data presentation for each site.

Figures 1 through 9 and downhole summaries of various physical and chemical properties. Tables 1 and 2 list the first occurrences of lithified sediments and some authigenic minerals, respectively. It must be emphasized here, that no firm conclusions should be drawn from these figures and tables because of the scarcity of data points due to spot coring. Furthermore, major hiatuses were detected at Sites 135, 136, and 140, and small hiatuses at Site 144; other hiatuses may also exist at other sites, but the cored data are

insufficient to detect them (see site reports and Chapter 27). The duration of the hiatuses cannot always be accurately determined and no reliable estimate can be made of the amount of sediment that may have been removed by erosion during the time represented in the hiatuses.

Despite the uncertainties mentioned above, it is hoped that the presentation of this data for Leg 14 will be useful for integration into future studies based on the results from many of the DSDP cruises.

Figures 10 through 17 show the natural gamma radiation (counts/7.6 cm/1.25 minutes) and porosity (%), and in some cases wet bulk density (gm/cc) on analog graphs adjacent to the section photographs. Where the composition of the sediment is listed under percent of components, these data were obtained from the visual smear slide estimates made on board. X-ray diffraction data were kindly provided by Ulrich von Rad (see Chapter 20); the occurrences of components under this category are listed by initials for abundant, common, rare, and trace.

TABLE 1 First Occurrence of Lithified Sediments

Site	San	dstone	Mu	dstone/Shale	Lim	estone		Chert
Number	Depth (m)	Aġe	Depth (m)	Age	Depth (m)	Age	Depth (m)	Age
135	435	Maestrichtian	565	Cretaceous	565	Cretaceous	565	Cretaceous
136	270	Senonian	-	1	-		 :	-
137		-	-	-			260	Cenomanian Turonian
138	-	-	260	Cretaceous/Tertiary	-		260	Cretaceous/Tertiary
139	610	Miocene	-	-	-	-	-	-
140	_	_	585	Paleocene		340	515	Paleocene?
144		2002	185	Senonian	185	Cenomanian	 .	

TABLE 2 First Occurrence of Authigenic Minerals

Site .	Р	yrite		Dolomite	Palyg	orskite ^a		Zeolite ^b
Number	Depth (m)	Age	Depth (m)	Age	Depth (m)	Age	Depth (m)	Age
135	565	Cretaceous	345 ^c	Lower Eocene	345	Lower Eocene	345	Lower Eocene
136	260	Senonian	240	Early Miocene	240	Early Miocene	260 ^d	Early Miocene
137	257	Turonian	300	Cenomanian	100	?	166	Upper Cretaceous
138	117	117 Upper 425 Oligocene 245		Cenomanian	185	Lower Tertiary?	55	Early Miocene
139	570	Lower Miocene	345	Middle Miocene		-		-
140	201	Early Miocene	315	Middle Eocene	240	Early Oligo- cene to Late Eocene	-	-
141	-			<u></u>	85	Early Pliocene		-
142			-		530	Miocene	455	Miocene
144	143	Upper Paleocene	165	Maestrichtian- Campanian	140	Paleocene	1	Oligocene

a palygorskite recovered on Leg 14 is considered to be of authigenic origin (see Chapters 20 and 27).

mostly clinoplitolite

^cdolomite may be reworked in part

phillipsite

	Porosity %	Water %	Penetro- meter 10 ⁻¹ mm	Drilling speed m/min	sand/silt /clay %	CaCO ₃	рН	Eh	Consolidation	Diagenetic Effects	Acoustic Character
	20 80	10 40	50 100	1.4	20 80	20 80	7.2.8.0	100 200	0oze		
20•				'.							
40 -											
60 -											
80 -	ï	~~~	<u>8</u> .5.7	T	64	÷		•	Ooze		
100 -	ž.										
120 -					-		8				
140 -				Ţ	-						
160 -				1			×.				Transparent zone - pelagic
180 -	•••	• ••	a •	1	· •	•.	s • 3	•	Ooze - firm		calcareous ooze
200 -											
220 -											
240 •											
260 -	•		, .		• •	•		•	Ooze		
280 ·											
300 ·											
320 -]							Major Reflector unconformity



Figure 1. (Continued).

	P	orosity %	Water %	Penetro- meter 10 ⁻¹ mm	Drilling speed m/min	sand/silt /clay %	CaCO ₃	рН	Eh	Consolidation	Diagenetic Effects	Acoustic Character
	20	0. 80	10 40	100 200	1.4	20 80	20 80	6.0 6.6	100 200			
20 -					1							
40 -					I I							
60 -		i B										
80 -												
100-												? Reflector
120												
140 -		Ċ	<"·	10		17	1		•	Ooze-firm		
160 -												
180 -												
200 -												
220		2	÷.,	~		: :	·. ·			Ooze		
240 -		:	÷	۰ ۰	1		·.			Ooze Silty clay-firm	Palygorskite Auth. Carbonate Zeolite R Dolomite	Transparent Zone -
260			· .	·. ·		·· ·	·			Semi-consol. clay & ash beds (some	Lussatite Palygor. Smectite	calcareous ooze, brown clay, ash beds
280		÷		4.		. ·	• .		•	calcite cemented) Semi-consol. clay	Dolomite Recryst. CaCO ₃	
300 ·]									Ooze	Smectite, Palygor.	
320												Basement Reflector - basalt



	Porosity %	Water %	Penetro- meter 10 ⁻¹ mm	Drilling speed m/min	sand/silt /clay %	CaCO ₃	рН	Eh	Consolidation	Diagenetic Effects	Acoustic Character
	20 80	10 40	100 200	1.4	20 80	20 80	6.4 7.0	100 200			
- 60 -	2	•	v ^t ·)			•	Disturbed by coring Firm clay		Transparent Zone - pelagic brown clav
80 -				1							
100 -	1.00 11.00		•	ſ	e e			:		Palygor.	
120-											Reflector -?
140 -	1	Ņ	ŧ	1	2.		÷	•		Palygorskite	
160 -	··		a.	{	•			.•:		Palygor. Clinoptilolite Hectorite	
180 -				רי ז						Sepiolite	Transparent - pelagic brown
200 -			i.	1		••••	•	•		Palygor., Lussatit Clinoptilolite Smectite, Zeolite	clay
240 -				1							
260 -	•	•	۷.	1	 r .	· .	•	•	Chert, but unconsol. clay ooze interbeds	Large pyrite 6 cm diam. Recryst. Rads Smectite, Palygor.	Reflective Zone
280 -		<i>U</i>			8	<u>```\``</u>			Semi_consol	Smectite, Palygor.	
300 -		. }	8		.; ;;	÷	•		Thin mudstones	Zeolite & Dolomite-Tr	
320 -	Ę.	ą.	A.	1	.,	· .			Indurated zones		
340 -											
360 -		·									
- 380 -	۰.	•••	8		4	•.		•	Semi and indurate Zeolite zones	d	

Figure 3. Site 137.

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	Porosity %	Water %	Penetro- meter	Drilling speed m/min	sand/silt /clay %	CaCO3	рН	Eh	Consolidation	Diagenetic Effects	Acoustic Character
	20 80	10 40	100 200	14	20 80	20 80	7.3.7.9	100 200			
60 -	4	•3	*.	1	98. P		•		Disturbed by coring	Zeolite	Zone of Reflectors - clay with sand interbeds
80 -				1							
100-	<		a ¹	1						Zeolite-R	Transparent Zone - clay, silty clay
120 -	•		а,	1		•	•				
140											
160-				Ť							
180 -				ľ					Semi-consol. Shaly partings	Palygorskite,	Zone of Reflectors-
200 -										Sheetre	mostly clay, reflections due
220 -				1							layers?
240 -											
260				t ÷					Indurated shale		
260 -				.1					mudstone, chert	Tridymite	
280 -	-										
300 ·				I,							
320 ·				ļ.							
340		•	•	!					Firm clay	Zeolite casts after Rads. Palygor.	
											Transparent Zone - pelagic clav
360 -											
380											
400											
420 -				l.					Indurated &		
440		·							cherty black mud, dolostone, some semi-indurated dolomitic silty clay	Dolomite Smectite Ankerite Palygorskite	Reflective Zone - dolomite, chert, basalt



	Porosity %	Water %	Penetro- meter 10 ⁻¹ mm	Drilling speed m/min	sand/silt /clay %	CaCO3	рН	Eh	Consolidation	Diagenetic Effects	Acoustic Character
	20 80	10 40	100 200	14	20 80	20 80	6.7.7.3.	<u>0</u> 100			
20 - 40 -	×»,~	*******	 			1	:	; ; ,	Ooze		Possible reflective
60 -	×	:	<u>х •</u> •	1		6					zone - pelagic calcareous ooze
80 - - 100 -	ż	ά	Ł		18	·			Firm clay	Palygorskite Zeolite (?)	
120		٠	•••	1 1 '	••		-	•		Palygorskite	
140											
160-											
180 -											
200	1	<i></i>	2		14	ļ			Firm Clay	Palygorskite	Non- reflective zone – clay
220											
240 •				l							
260											
300									Firm sand		
Fig	ure 5. <i>Site</i>	l e 141.	I	I	Į.	I		I	I		

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	Poros	ity	Wate %	er	Penetro- meter 10 ⁻¹ mm	Drillin speed m/min	ng	sand /cl	/silt ay %	Ca	^{CO} 3	рH	Eh	Consolidation	Diagenetic Effects	Acoustic Character
	20	80	10	40	100 200	1	4	20	80	20	80	6.8 7.4	0 100			
20•																
40 -																
60-	ľ.															
80 -																
100																
120-		•		••								•	·	Ooze		
140 -																
160														-0		Transparent Zone – pelagic
180 -																ooze
200																
220 -				;	.a.						×.			Ooze		
240 -												577.52				
260 •					5											Weak
280																zone?
300																
320																
1.	1		1		1	11		l		L		1		ł		

Figure 6. Site 139.

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Figure 6. (Continued).

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	Porosi %	ty	Wate %	er	Pene met 10 ⁻¹	tro- er mm	Drill spee m/mi	ling ed in	san /c	d/silt lay %	Ca	2 ^{CO} 3		рH		Eh	9	Consolidation	Diagenetic Effects	Acoustic Character
0	20	80	10	40	, 100	200	1.	4	20	80	20	. 80	,7,	3	7,9,	100	200			
20 •											8									
40																				
60 -																				
80 -									;	.:										
100 -	:			;	·`;:	••	1			•••		•		•				Ooze		Mostly transparent pelagic calcareous
120 -					Ì		1,1													002e
140																				
160 •																				
180 ·																				Reflective Zone - Siliceous ooze and silty clay
200 -	;			ŗ	· .				1	÷	!							Firm mud/ooze & silty clay	Smectite	
220																				
240 -	4		•	۶.	3				14			'n					·	Firm sand & clay	Palygorskite	
260 -							1													
280 -							1													
300 ·							1													

Figure 7. Site 140.

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320	:	· ·		ŀ	I	.	•	Semi-consol. silty clay	Palygorskite Smectite Sepiolite Dolomite	
340]							Indistinct reflective zones occur
360			1					Sami sousol		throughout
380 -	·	•				•		Semi-consol.		
400										
420										
440								Firm clay & chert	Palygorskite Lussatite	
460			Ļ							
480										
500										
520-	•			•	•	•	·	Very firm clay, silty clay & chert	Palygorskite Lussatite Dolomite	Reflective Zone - chert
540										do lomite claystone
560 ·										
580								Shale & chert	Lussatite	
600-			1						Smectite	
620										
640.	•	× e.						Semi-consol. clay Firm sand	Smectite Palygor. Lussatite	

Figure 7. (Continued).

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	Porosity %	Water %	Penetro- meter	Drilling speed m/min	sand/silt /clay %	CaCO3	pН	Eh	Consolidation	Diagenetic Effects	Acoustic Character
	20 80	10 40	20 80	1.4	20 80	20 80	7.0 7.6	100 200			
20 -											
40-			-								
60 -	e e			I'I							
80 -		÷									Reflective zone-
100	•	· ;	: `		:: <i>:</i>			·	Unconsol.	Siderite	interbedded sands, calcareous mud, and calcareous ooze
120											
140											
160 -				1 1				G			
180											
200 -			5.	1		• •			Ooze and unconsol. to	Siderite	
220•				1					semi-consol. sand		
- 240 -											
260-				']							
280 -											



300 -	•	٠	•	1	• •	•		•	Ooze and semi-consol. marl mud	Carbonate rhombs- some redeposited	
320											
340 -											
360 -	j	ś	y :	11	* ?	.*			Consol. to semi-consol.	Zeolite? Authigenic	Transparent
380 -										carbonate-Tr.	calcareous ooze, calcareous clay, foram sand
400 -											
420 -				1		•	•	3 .	Consol.	Authigenic carbonate-Tr	Prominent Reflector
440 -							8	5	Concel		
460-	•	•	ſ	1					consol.	Zeolite	
480-	j	3	Ç.		15	\$			Consol.		Reflective zone- silty calcareous mud marl, foram sand,
500-											Chalk
520				1					Teducated	D-1	ی
540	••		ſ	1				·	Induraced	Palygorskille	Rise Reflector
560											Calcareous marl
580	•••	•.	1	h	s	· ·		•			
600 -											

Figure 8. (Continued).

PHYSICAL PROPERTIES

	Porosity %	Water %	Penetro- meter 10 ⁻¹ mm	Drilling speed m/min	sand/silt /clay %	CaCO ₃	pН	Eh	Consolidation	Diagenetic Effects	Acoustic Character
0	20 80	10 40	100 200	1.4	20 80	20 80	7,0, 7,6	100 200			
		:	¥.		·· · ·	÷.		•	Ooze with soft and firm layers, few		
20 -	(<i>,</i> •	A		1.1	• .	•		thin semi-consol. marl beds	Rads partly	
		, i	5							pyritized	
40 -	•	•.	··· .		·. ·.	ž			Ooze-mostly soft	Pyritized Rads	
60 -	с. С			1	N: N:	14			Firm clasts in soupy matrix (drilling)		
80											
100-				l	. i, '				Soupy - due to		
120 -						10 85			arilling		
140	* <u>*</u>	<i>:</i> :			$i \leq i_{1}$	·	•		Indurated chalk	Calcitized Rads Smectite Clinoptil	olite
160 -				1			-		Marl mudstone	Palygorskite, luss Authigenic Carbona	atite te
	·			1			·		Marl & marly	Barite-Tr. Clinoptilolite, lu	ssatite
180 -						•	÷	•	claystone Shale and Limestone	cement in claystor Smectite, Clinopti	lolite
200 -									Semi-consol. clay		
220 ·				1		• •	·	•	and limestone	Clinoptilolite, au carbonate, lussati siderite, pyrite	uthigenic ite,
240										sparry calcite ce in limestone calcitized Rads	ment
260						۰.			Semi-indurated	Clinoptilolite, authigenic carbonate	
280										0.000 (0.000 (0.000)) (0.000 (0.000)	
300						. ·			Indurated marlstone limestone, claystone	Smectite, Palygor Sepiolite, Chalce Sparry & micriti calcite cement i	skite, dony-Tr. c n
320					523 B					Pyritized Rads.	
	•					· ·			and claystone		



Figure 10.

135-7-2

Quartzose feldspathic sandy silt, becomes more indurated downwards

Qtz	60%	Feldspar	15%
Mica	10%	Carbonate	10%
C1 ay	4%	Heavies	1%

Porosity increase due to drilling deformation
Quartzose sandstone cemented carbonate - low porosity Lower gamma than elsewhere as feldspar, micas, and clay lower
Sand as above, but not cemented
Silt
Sand
Silt
Calcite cemented quartz siltstone -(Carb. 70%, Qtz. 20%)

Silt

Clay ball Slightly graded sand

Quartzose	silt	t	
Qtz	60%	Feld.	.10%
Clay	15%	Mica	5%
Authige	enic	Carb.	10%



136-5-1

Pelagic brown silty clay with common MnO streaks and blebs. Clay (Montmorillonite, Quartz, Palygorskite) 80% Feldspar, mica, kaolinite, dolomite 20%. This interval represents hiatus of 50 m.y. Only lithology break occurs at 49 cm on scale - note increase in porosity

_Mostly brown clay with irregular _____ white layers of palygorskite, some ash

Ash - sand size



136-5-5

Ash - probably originally contiguous with above

Clay (Montmorillonite & Silty clay Quartz) 75% Carbonate 15% Fe0 10%

Ash beds with discrete coarse ash layers. Clay (Mont. & Qtz.)40-70% Opaques 5-25%. Glass 1-20%, Feldspar and Heavies 1-10%

Clayey ash

Ash

Figure 11.



138-6-2

Dolomitic silty clay Feldspar & Montmorillonite A Mica C Dolomite C-A

Highest density correlates with maximum dolomite - note occurs at base of unit compared with center of other units

Carbonaceous	Clay
--------------	------

Dolomitic silty clay

Altered tholeiitic basalt. As rock fractured density curve interrupted; however, high densities are indicated. Note high gamma emissions.

Believed that actual basalt/ sediment contact lost during coring operation. Note only about 11 cm of sediment cycle (between 42 and 106 cm) present compared with minimum unit size of 30 cm in 138-6-3

Carbonaceous clay

Density peaks correspond to lighter dolomite-rich layers; four alternations indicated between 106 and 142 cm.

Ash layers Carbonaceous clay



Figure 13.



142	-5-	1
1 76		

Calca	areous	clay displaced by
drill	ing	
Sand%	Silt%	
66	16	Foram sand-note low
		gamma counts
81	5	Forams 35% Nannos 20%
0.		Combonate funce 25%
		Carbonate trags. 25%
74	10	Mica, quartz, FeO,
		Opaques 20%
Calca	reous	clay with Mn laminae
Drill	ing br	eak
Silty	clav	- note high gamma in-
cross	ing do	unwards porosity do-
creas	any do	wilwards, porosity de-
creas	es dow	nwards: this due to
incre	ase of	Lacu ₃ upwards, color
also	lighte	ns
	C	lay minerals 50-60%
	N	annos 10-20%
	C	arbonate frags. 5-10%
	P	vrite, Mica, Ouartz
	5	-10%
17% 0	aCO.	1075
1770 0	3	
Sand%	Silt%	
8	74	Graded clavey silt/
	1.1.	sandy silt Note higher
		damma than foram cand
		Journa then stiltu slou
2.2		lower than silly clay.
43	44	Porosity increases
		slightly downwards.
		Quartz 30%, Clay
10		minerals 20%, Foram
40	47	nanno. & carb. frags.
		25% Rest - chlorite
		feldsnar Fel onaques
		heavier & biotito
		neavies a Diouice

Clay grading down to silty clay



144A-3-1

Foraminiferal nannoplankton chalk ooze Gamma curve indicates fairly uniform composition - slight variations due to minor components such as zeolite, chlorite-mica.

Nanno 60%, Foram 30%, Zeolite 5%

Chlorite-mica, pyrite, quartz, Rads. 5%

Rapid changes in porosity due to varying consolidation. Possibly this is related to activity of burrowing organisms which are restricted to definite zones; the burrows are mostly horizontal and contain disseminated pyrite grains.

Figure 15.



144A-3-2

Foraminiferal nannoplankton marl/chalk ooze Minor variations in clay and zeolite content indicated by gamma curve. Porosity values are low because sediment highly indurated (<5x10^{-1mm} penetrometer) except from 113-148 cm where unconsolidated. Note few pronounced spikes indicating very low porosity - at depth of 40 cm spike coincides with lense of small (0.1-0.2 mm) pyrite cubes grown together. Similar composition to 144A-3-1 but mottling and burrowing less pronounced

Note: in several places porosity curve goes below zero - the grain density here is greater than section average of 1.852 used for calculating porosity.

Figure 16.



144A-3-5

Zeolite foraminiferal nannoplankton chalk/marl ooze Faintly mottled, also darker horizontal burrows Nanno 30%, Foram and Carbonate fragments 25%, Zeolite 15%, Rest - clay minerals, some pyrite, quartz, chlorite

Time hiatus of 8-9 m.y.

At Tertiary/Cretaceous boundary Thanetian stage of Paleocene rests on M. Maestrichtian Interval 86-102 cm beneath hiatus shows increase in gamma emission and decrease in porosity