Tonan Ajia Kenkyu (*The Southeast Asian Studies*) Vol. 10, No. 2 September, 1972

Some Properties of Recent Sediments in the Bangkok Plain of Thailand

by

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The author has been done stratigraphical studies of Quaternary sediments of the Chao Phraya drainage basin using chemical and mineralogical methods. The results for the uppermost streams (the Lampang basin)[1], the middle stream[2] and the near-apex area[3] of the deltaic part of the basin have already been published. The present paper deals with the near-gulf part of the delta.

In the areas reported in the preceding papers, it was the main target to make clear the relationship between weathering intensity and stratigraphical position. Whereas in this paper, the relation between the chemical properties of sediments and its depositional environment is tested as the main topics, since the area is dominated by recent sediments whose properties are more strongly controlled by depositional condition rather than the deteriolation by weathering.

I Sampling and Analytical Methods

The sampling sites are shown in a locality map of Fig. 1. The locality numbers shown here are identical to those shown on the locality map of Takaya.[4] Several specimens were collected horizon-wise at each locality, as their vertical positions are given in Fig. 2, with brief description. For the more detailed information about the field occurrence, should Takaya[4] be referred.

All the sampling sites are in an area which is supposed by Moormann and Rojanasoonthon[5] to be a teritory of either brackish or marine alluvial soil, except for four, i.e. Locs. 146, 153, 179 and 184, which locate on older surfaces in the marginal zones of the delta. The area concerned here is divided into A, B, C and D subareas, for the convenience for discussion.

Mineralogical composition of the clay fractions separated from the specimens were examined by X-ray diffraction method on oriented clay with various treatments. On air dried specimens, pH, water soluble cations and anions (such as Ca, Mg, Na, Cl and SO_4) and electric conductivity were determined based on the methods described by Kawaguchi and Kyuma.[6] Electric conductivity was measured at 20°C on water extracts or soil suspensions which have the soil water ratio of 1 : 5. For the detection of oxidizable sulphur,

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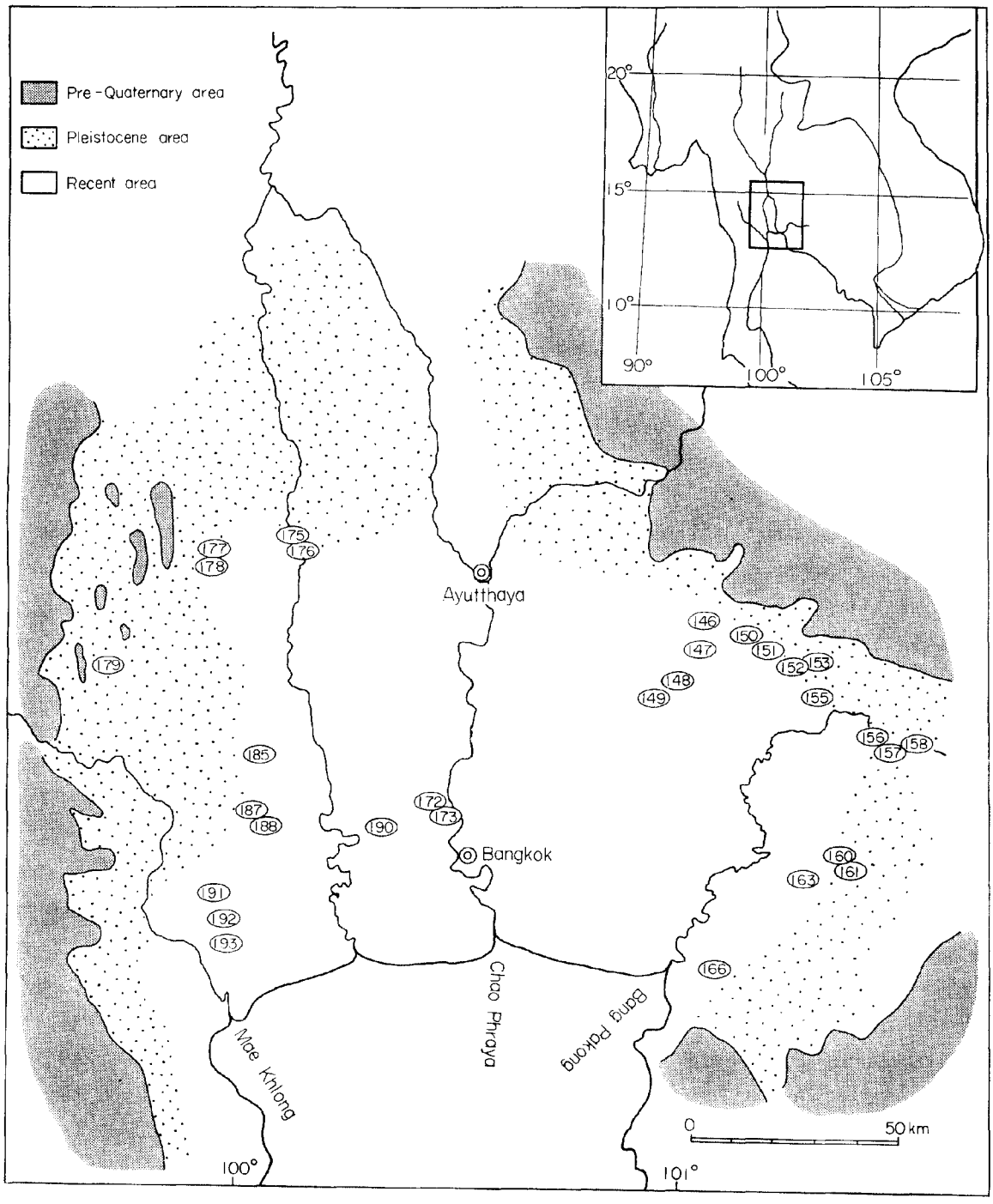

Fig. 1 Locality Map Showing the Sampling Sites Reported in This Paper

the pH values were determined by glass electrode pH-meter on soil suspensions which were treated with hydrogen peroxide. When the pH values were below 3.8, the samples were considered to contain oxidizable sulphur, according to Murakami's experience.[7)]

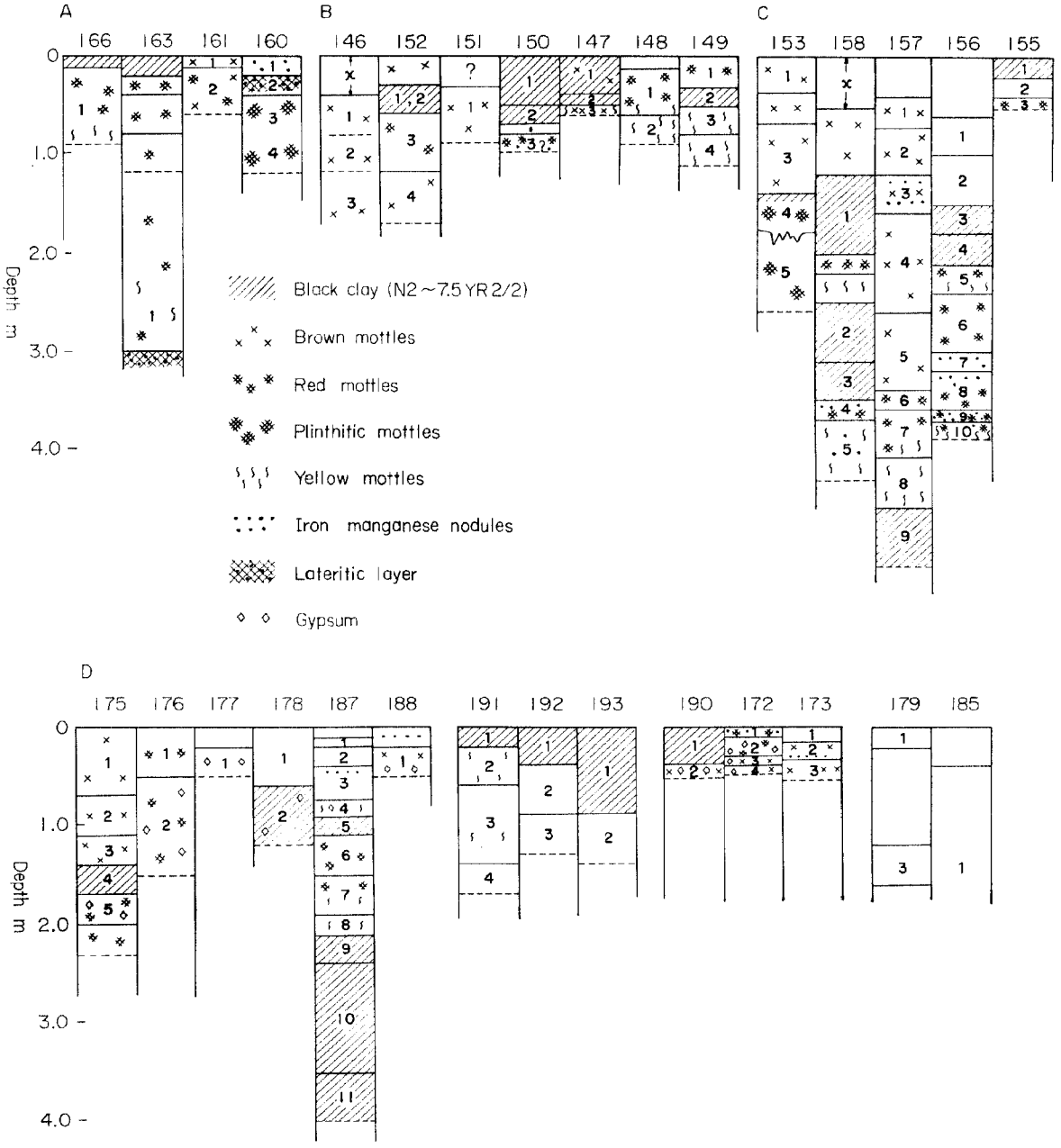

Fig. 2 Sampling Layers of Surveyed Profiles with Brief Description

II Results

The mineralogical characteristics of clay fractions and some chemical properties of specimens are tabulated in Table 1.

Results of mineralogical analysis

The X-ray diffraction diagrams of K-air dried oriented clays as shown in Fig. 3 revealed that the specimens could be grouped into four types; types A, B, C and D, each being char-

Table 1 Mineralogical Properties of Clay Fractions and Some Chemical Properties of Specimens

Locality	Sample Number	Mineralogical Characteristics of Clay Fraction 7Å	10Å	14Å	type of 14Å mineral	pH (H_2O) no treat	H_2O_2 treat	Water extract (me/100g soil) EC $\mu\Omega$	Cl'	SO_4''	Na	Ca+Mg	Remarks	Feldspar in fine sand
	166-1	50	17.5	32.5	A	3.3	2.7	343	##	##	8.27	2.20		
	163-1	60	10	30	C	2.4	1.9	285	—	##	0.07	3.62		
	161-1	60	10	30	C	4.6	3.8	17						
A	2	55	10	35	AC	4.4	3.9	6						
	160-1	57.5	12.5	30	C	5.0	3.5	4						
	2	67.5	10	22.5	C	4.9	4.0	3						
	3	60	10	30	A	4.9	3.9	2						
	4	70	5	25	A	4.9	4.2	3						
	149-1	35	25	40	AB	4.2	3.1	27						
	3	42.5	20	37.5	BA	3.9	3.1	28						
	4	42.5	20	37.5	BA	3.9	3.0	34						
	148-1	35	20	45	A	4.2	3.2	31					Black clay	
	2	42.5	17.5	40	A	4.1	3.3	38						
	147-1	67.5	17.5	15	D	4.3	3.1	27						
B	2	60	12.5	25.5	DA	3.8	2.7	36	—	±	0.24	0.54	Black clay	
	3	57.5	17.5	25	D	3.8	2.9	33	—	±	0.24	0.40		
	150-1	70	10	20	D	4.1	2.4	10					Black clay	—
	3	62.5	17.5	20	D	4.6	3.7	8						##
	151-1	62.5	20	17.5	D	4.6	3.8	7						
	155-1	60	10	30	A	4.1	3.3	13					Black clay	—
	2	55	15	30	AD	4.0	3.4	3						—
	3	50	15	35	AD	3.9	3.1	13						—
	146-1	55	15	30	D	4.0	3.1	11						
	2	55	17.5	27.5	D	4.9	3.6	2						
	3	55	10	35	D	5.0	3.7	1						
	4	62.5	5	32.5	D	4.9	4.3	2						
	152-1	70	15	15	D	4.9	4.2	6						
	2	72.5	17.5	10	D	4.4	4.0	17						
	3	75	15	10	D	5.0	4.2	3						
	156-1	50	15	35	DA	4.8	3.8	10						##
C	2	50	15	35	DA	4.4	3.4	19						±
	3	42.5	15	42 5	DA	4.1	3.0	31	—	±	0.96	0.44	Black clay	±
	4	42.5	17.5	40	AD	4.2	3.0	20						±
	5	40	20	40	AD	4.0	2.9	24						±
	6	67.5	7.5	25	AD	4.3	3.4	12						±
	7	65	12.5	22.5	DA	4.1	3.4	19						±
	8	70	10	20	DA	4.1	3.5	17						±
	9	67.5	10	22.5	DA	4.2	3.5	11						±
	157-1	42.5	15	42.5	AD	5.1	4.5	6						+

Locality	Sample Number	Mineralogical Characteristics of Clay Fraction 7Å	10Å	14Å	type of 14Å mineral	pH (H_2O) no treat	H_2O_2 treat	Watar extract (me/100g soil) EC $\mu\Omega$	Cl'	SO_4''	Na	Ca+Mg	Remarks	Feldspar in fine sand
	2	50	15	35	DA	5.8	5.2	6						+
	3	45	20	35	DA	6.3	5.2	6						++
	4	45	15	40	DA	7.0	7.2	8						++
	5	47.5	7.5	35	DA	6.9	6.5	27						+
	6	40	22.5	37.5	DA	3.9	3.4	116	−	++	1.83	1.30	Gypsum	+
	7	45	17.5	37.5	DA	3.9	3.4	64	+	+	0.76	0.72		±
	8	50	15	35	DA	4.1	2.9	55	±	+	1.04	0.44		−
C	9	52.5	12.5	35	DA	2.4	1.8	804	±	++	0.02	12.16	Black clay	−
	158–1	55	10	35	DA	4.0	3.2	42	−	±	0.22	0.80	Black clay	−
	2	65	10	25	AD	3.8	2.7	25	−	±	0.07	0.32		−
	3	70	15	15	DA	3.2	2.8	88	−	±	0.07	0.60		−
	4	65	20	15	D	3.8	3.4	41	−	±	0.11	0.72		−
	153–1	62.5	2.5	35	C									
	3	62.5	7.5	30	D									
	4	77.5	10	12.5	D								red mottled	
	5	72.5	12.5	15	D								red mottled	
	193–1	27.5	20	52.5	AC	8.0	7.4	35					Black clay	±
	2	37.5	25	37.5	AC	7.5	6.7	259	++	++	2.39	7.96	greenish grey clay	
	192–1	25	15	60	AC	7.3	6.5	94	++	+	1.74	1.58	Black clay	+
	2													
	3	27.5	20	52.5	A	9.0	8.5	63	+	±	1.87	0.30		++
	191–1	40	20	40	AD	7.3	4.4	193	+	±	3.04	3.10	Black clay	+
	2	42.5	25	32.5	D	8.1	4.8	103	++	+	1.83	1.46		+
	3	45	25	35	B	7.9	6.8	21						++
	4	35	20	45	BA	7.7	6.5	21						+
	187–1	42.5	40	17.5	B	6.4	4.7	84	++	±	3.81	0.54		++
	2	45	35	20	B	7.1	6.9	97	++	±	4.35	0.52		++
	3	42.5	37.5	20	B	7.2	7.5	198	++	+	8.69	1.70		+
D	4	55	35	10	B	7.7	7.7	212	++	++	9.35	3.22	Gypsum	+
	5	40	30	30	BD	7.7	7.5	180	++	++	9.13	0.64	Black clay	+
	6	40	25	35	BD	4.5	3.5	265	++	++	1.30	2.40		+
	187–7	42.5	35	22.5	B	4.5	3.5	265	++	++	13.0	2.40		±?
	8	45	27.5	27.5	B	4.6	2.9	260	++	++	12.6	2.06		+
	9	42.5	25	30	BD	4.5	2.9	371	++	++	16.0	5.42	Gypsum	++
	10	45	25	30	BDA	3.6	1.8	511	++	++	20.4	7.99		+
	11	40	30	30	BDA	2.7	1.8	595	++	++	10.4	17.56		++
	188–1	42.5	32.5	25	B	6.4	6.9	328	++	±	9.57	11.20	Gypsum	
	190–1	35	25	40	A	5.2	4.2	200	++	++	5.87	3.42	Black clay	++
	2	37.5	25	37.5	A	6.5	5.6	406	++	++	6.52	10.40	Gypsum	++
	172–1	40	20	40	A	5.2	3.7	34	+	+				
	2	37.5	22.5	40	A	4.7	3.6	119	++	++			Gypsum	

Locality	Sample Number	Mineralogical Characteristics of Clay Fraction 7Å	10Å	14Å	type of 14Å mineral	Hp (H_2O) no treat	H_2O_2 treat	Watar extract (me/100g soil) EC $\mu\Omega$	Cl′	SO_4''	Na	Ca+Mg	Remarks	Feldspar in fine sand
	3	32.5	20	47.5	A	4.9	3.9	128	++	++			Gypsum	
	4	35	25	40	A	5.2	4.5	148	++	++			Gypsum	
	173–1	35	15	50	A	4.8	3.6	45	±	+				
	2	37.5	17.5	45	A	5.5	5.9	70	+	+				
	3	32.5	20	47.5		6.9	6.1	80	+	+				
	177–1	47.5	20	32.5	BD	4.2	3.2	152	−	++	3.59	5.16	Black clay	
	178–1	45	25	30	BD	6.6	5.8	113	+	+	3.81	1.70		
	2	50	20	30	D	4.6	4.2	274	+++	++	10.6	4.56		
D	175–1	50	25	25	BA	6.9	6.7	6						
	2	45	30	25	BD	6.6	6.9	38	+	−	1.52	0.38		
	3	45	30	25	BD	5.1	3.8	79	++	+	3.45	0.72		
	4	50	20	30	C	4.6	3.2	77	−	+	3.45	0.74		
	5	52.5	27.5	20	D	4.3	3.2	123	+++	++	4.57	1.46		
	176–1	50	25	25	DB	6.1	5.7	4						
	2	45	30	25	BD	4.4	4.1	119	−	++	1.30	6.68		
	179–1	37.5	47.5	15	B									
	3	42.5	15	42.5	B									
	185–1	42.5	35	22.5	B									

acterized by dominant montmorillonite, vermiculite or beidellite (vermiculitic montmorillonite), Al-interlayered mineral and by partially chloritized 14 Å mineral.

When the areal distribution of the four types is examined, such general trend as shown in Table 2 is made clear. Kaolin mineral content seems to fructuate much even among specimens taken from similar topographic positions.

Results of Chemical Analyses

Sediments found in depressional parts of the area are either dark brownish grey clay with varing colored mottles or dark greenish grey clay having brown mottles accompanied with or without gypsum crystals. These are both fresh sediments, and the former is supposed to be of brackish origin and the latter of marine origin. Judging from field occurrences and laboratory data, it is most likely that once the clays suffer from leaching and oxidation, the original mottles convert to another ones in accordance with a rule shown as in Table 3.

The so called acid sulphate soil is supposed to be a soil developed from brackish sediments and usually bears red, yellow and occasionally pale yellow mottled. X-ray diffraction diagrams of mottles demonstrated that the three mottles of different colors have their own diffraction patterns suggesting compositions of different iron compounds as shown in Fig. 4. The figure shows that the red mottle is associated with haematite and geothite, the yellow one with geothite and the pale yellow one with jarosite respectively.

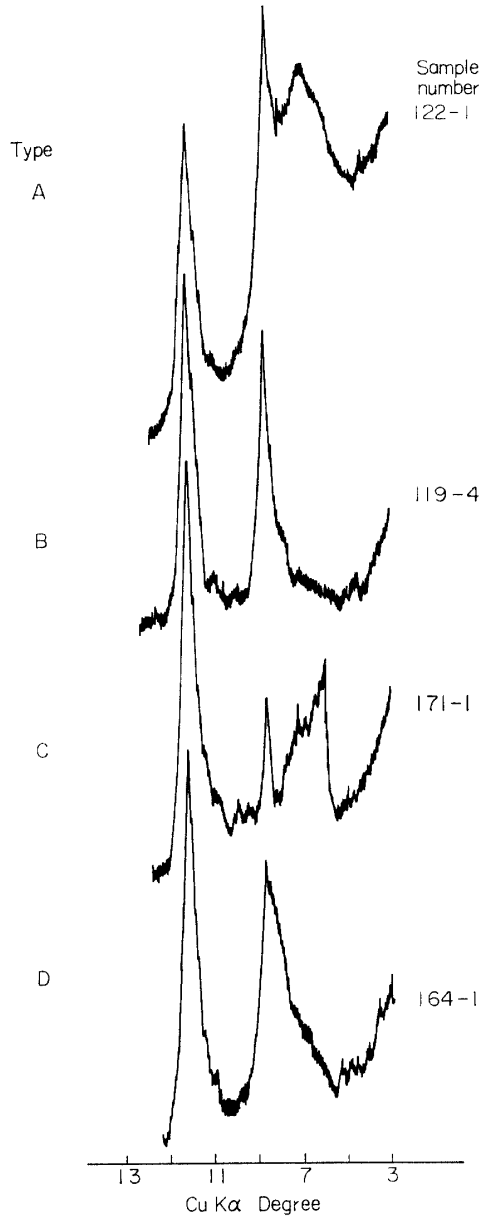

Fig. 3 Types of X-ray Diffraction Diagrams of K-air Dried Oriented Clays

Some of brackish sediments in the Prachinburi-Kabinburi (C) area yields iron nodules and/or plinthitic mottles, which are very resemble to those fond in Pleistocene terrace along the margin of the delta. This field appearance reminds the author of the Pleistocene brackish sediments which were found in the old deltaic area and were reported in a preceding paper.[3] But it is still premature to conclude them to be identical because of the lack of the evidence to decide the stratigraphical positions of the sediments.

Based on the above-mentioned criteria, all the specimens examined are grouped and listed as in Table 4. Profile presentations of some of the representative columns are also given in Fig. 5.

Table 2 Relation between Topography and Clay Mineralogical Characteristics of Sediments

Topography*	Clay mineralogical characteristics	
Natural levee and/or Fan	Illite, 14 Å mineral	Vermiculitic montmorillonite is dominant.
Delta flat	Illite, 14 Å mineral	14 Å mineral tends to show partial chloritization.
Deltaic high and Coastal flat**	Illite, 14 Å mineral	Montmorillonite is dominant.

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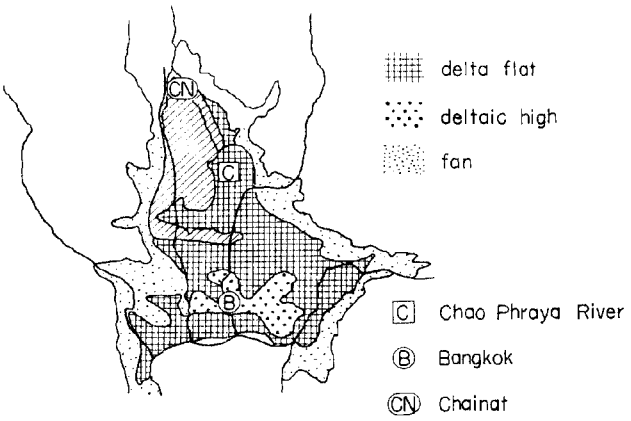


after Takaya[10]

** The low strips sandwiched between the "deltaic high" and the coast-line is termed by the present author, though Takaya[10] did not separate them from the "deltaic flat".

Table 3 Relation between Two Recent Sediments and Their Chemical Nature

	Chemical nature: oxidizable sulphur	Chemical nature: water extracts EC	Chemical nature: water extracts SO''_4	Chemical nature: water extracts Cl'	Leaching status	Field appearance
Brackish sediments (Acid marine sediments)	+	high	+	+	unleached and slightly oxidized	no mottled organic matter rich layer, yellow mottled layer
				−		
		low	+	−	leached and oxidized	black surface layer, red mottled layer
			−	−		
Marine sediments	−	high	+	+	slightly leached or unleached	no mottled greenish grey layer brown mottled layer with gypsum
		low	−～±	−	leached	brown mottled layer, black surface layer

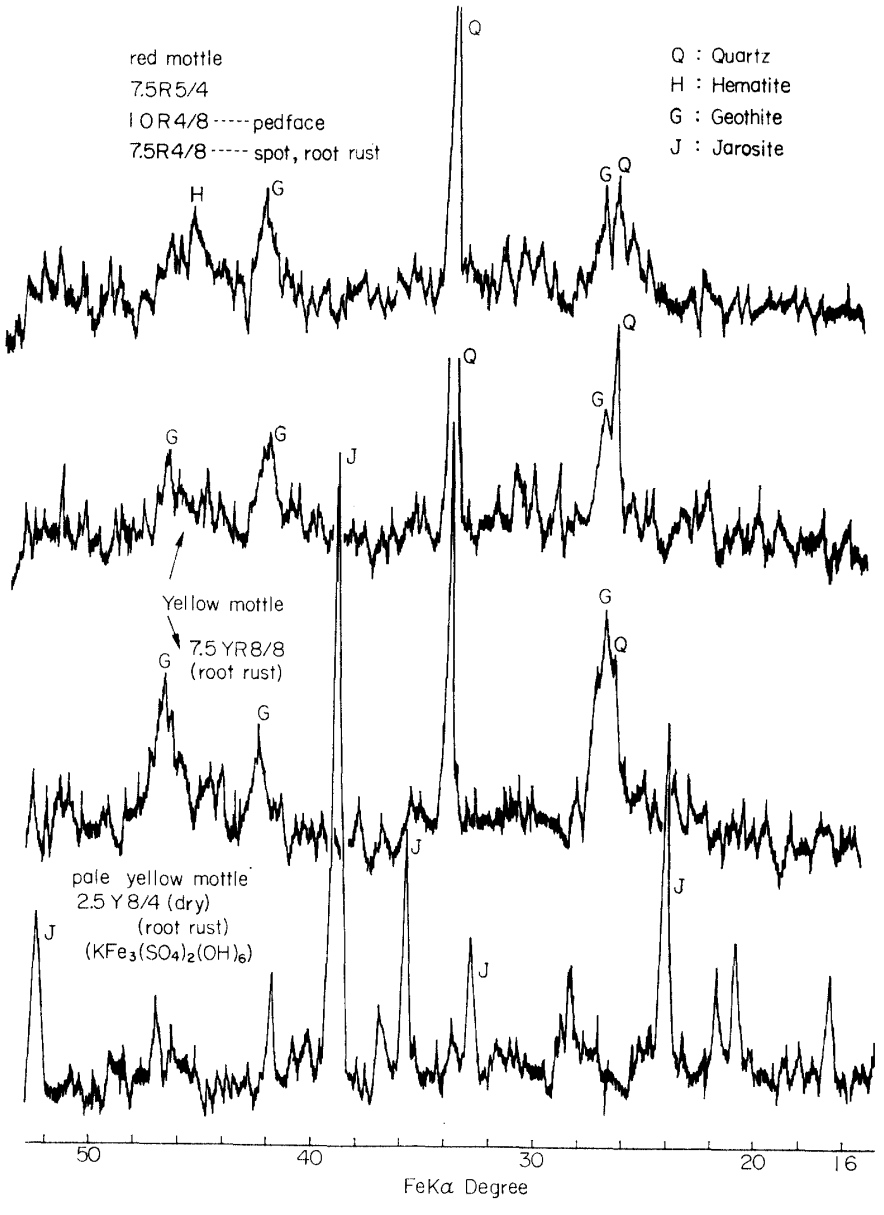


Fig. 4 X-ray Diagrams of Various Mottles Separated from Acid Sulphate Soil

III Correlation with Other Information

To summarize the results of the studies, a tentative correlation chart among the Takaya's topographical division, soil condition outlined by Moormann[5], Pons and Van der Kevie[8], Paul Vlek[9] and the author's results is shown in Table 5.

Table 4 Grouping of Specimens Based on Chemical and Mineralogical Nature of Sediments

Locality	Group	Sample Number	Nature of sediment	Characteristics of Clay Mineral Composition			remarks
				Kaolin %	Type of 14 Å mineral	Quantitative relation of 2:1 type clay	
A	iii	160–3 4	Plinthitic mottled sediments	60～70	A	Ill＜other	older terrace deposit
	ii c	160–1, 2	Many iron nodule bearing sediments				
	ii b	161–1, 2	Fresh water sediments?	50～60	C～AC	Ill＜other	fan deposits
	ii a	163–1	Acid marine sediments (Brackish sediments)				
	i	166–1	Acid marine sediments (Brackish sediments)	50	A	Ill＜other	alluvial deposits
B	ii	146–1, 2, 3	Fresh water sediments	62.5～70	D	Ill＞other	older terrace or fan deposit
	ii	152–4				Ill＜other	
	i b	150–1 147–2, 3 147–1 151–1 152–1, 2, 3	Leached acid marine sediments (acid sulphate soil)	55～70	D～DA	Ill＞other Ill＜other	alluvium affected with fan depoist
	i a	149–1, 3, 4 148–1, 2	Leached acid marine sediments (acid sulphate soil)	35～42.5	A～AB or BA	Ill＜other	alluvium
C	iii b	153–4 5	Plinthitic mottled sediments	65～77.5	D～DA or AD	Ill＜other	older terrace deposit or basement plain
	iii a	156–6, 7 8, 9 158–2, 3, 4	Leached acid marine sediments (acid sulphate soil)				
	ii	155–1, 2, 3 156–3, 4, 5 (1, 2) 157–6, 7, 8, 9 158–1	Leached acid marine sediments (acid sulphate soil)	40～60	DA～AD (A)	Ill＜other	alluvial plain

Locality	Group	Sample Number	Nature of sediment	Characteristics of Clay Mineral Composition			remarks
				Kaolin %	Type of 14 Å mineral	Quantitative relation of 2:1 type clay	
	i	153-1, 3 157-1, 2, 3, 4, 5	Fresh water sediments	42.5～62.5	DA～AD(C)	Ill<other	Fresh sediment on weathered old terrace or basement natural levee
	iii b	175-4, 5 176-1, 2 177-1 178-1, 2 187-5, 6, 7, 8, 9, 10, 11	Acid marine sediments (brackish sediments) (acid sulphate soil)	40～52.5	BD～DB (C, D, B)	Ill≦other	
	a	191-3 4	Fresh water? sediments	35～45	B～BA	Ill<other	alluvium
	ii b	191-1 2	Marine sediments	40～42.5	D～AD	Ill<other	
D	a	193-1, 2 192-1, 2	Marine sediments	25～37.5	AC～A	Ill<other	
	b	175-1 2	Fresh water sediments	45～50	BA～BD	Ill≧other	natural levee deposit
	i a	187-1, 2 3, 4 188-1	Marine sediments	37.5～55	B	Ill≫other	fan deposit
	a′	179-1 185-1	Fresh water sediments				
	i′	190-1, 2 172-1, 2 3, 4 173-1, 2, 3	Marine sediments	32.5～40	A	Ill<other	alluvium

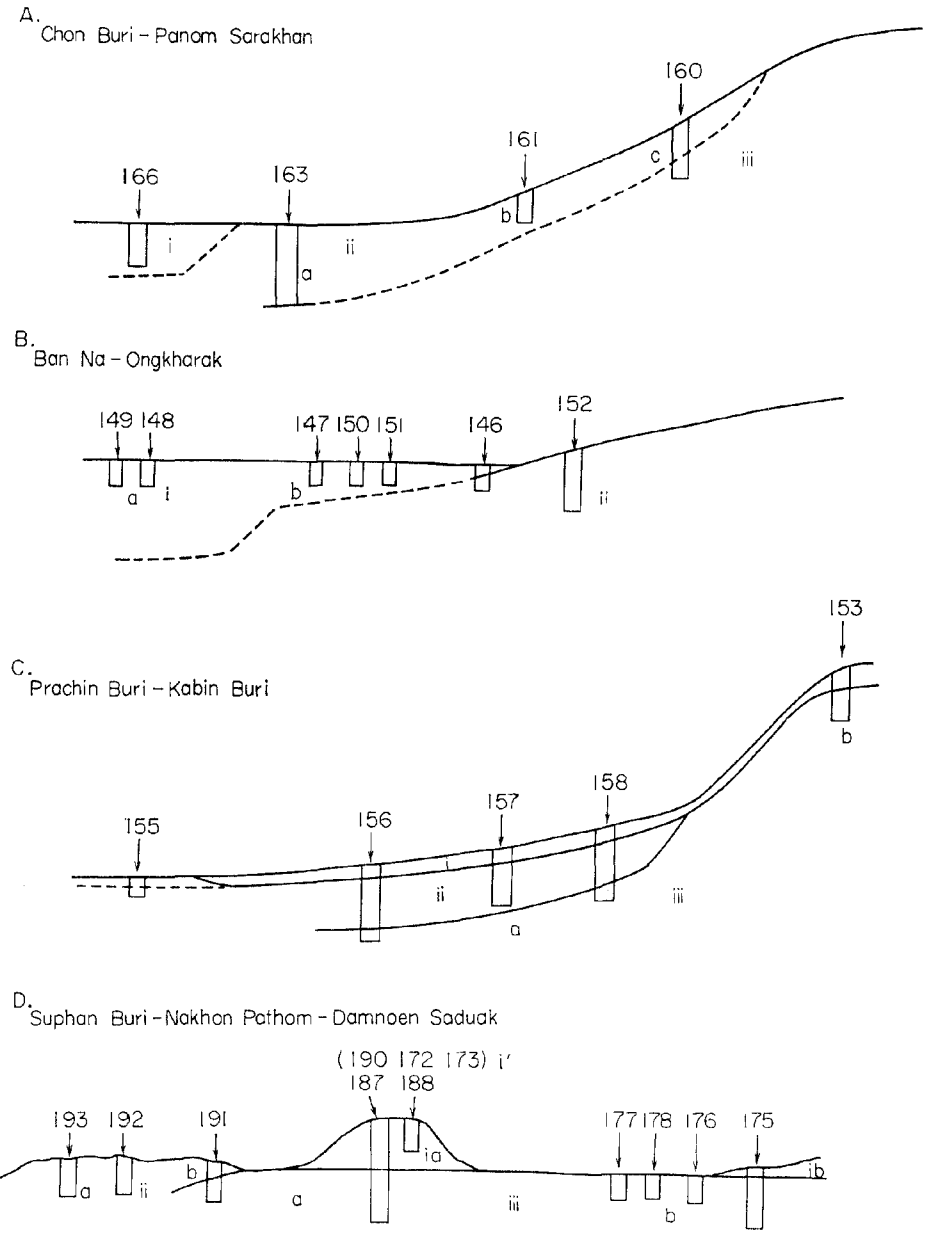
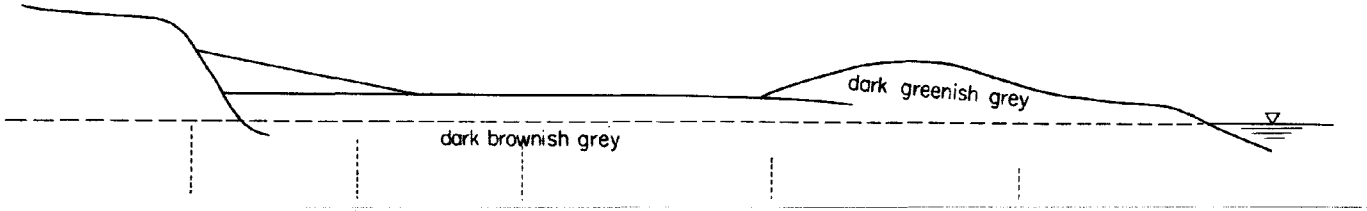


Fig. 5 Schematic Cross Sections Linking Representative Columns

Acknowledgement

The author is deeply indebted to the staff of Geology Department of the Chulalongkorn University of Thailand for their kind assistance in supplying valuable information. Thanks is also due to Dr. Takaya who assisted the author during field survey and gave him helpfull advice for making this manuscript.

Table 5 A Correlation Chart of the Properties of Young Quaternary Sediments in and Around the Bangkok Plain



Topography	Old Delta or Terrace	Fan	Delta flat		Deltaic High		Coastal flat	According to Takaya[10]
great soil group	Low humic grey soil etc.	Non calcic brown soil	Brackish alluvial soil		Marine alluvial soil			According to Moormann *et al*,[5] Pons & van der Kevie[8] and Paul Vlek[9]
subgroup			old acid sulphate soil	typical acid sulphate soil	intermediate type	non acid marine alluvial soil	young acid sulphate soil or non acid marine alluvial soil	
soil series	Manorom Saraburi Nakhon Pathom		Ayutthaya	Rangsit Ongkharak	Bang Nam Prio Bangkhen	Bang Len Bangkok	Tha Chin Cha Am Samut Prakan	
horizon sequence			black surface horizon —brown mottled horizon	black surface horizon —cat clay —mud clay	black surface horizon —brown mottled horizon with gypsum		black surface horizon —mud clay or brown mottled horizon	Author's interpretation
chemical characteristics: oxidizable sulphur			−	−～+	−		+ or −	
chemical characteristics: water ext. EC			low	low	high		high	
chemical characteristics: Cl'			−	−	+		+	+
chemical characteristics: OS''			−	−～+	+		+	+
clay mineralogical characteristics		Illite dominate	Chloritization of 2:1 type clays occurs		Vermiculitic montmorillonite and montmorillonite dominate			

References

1) Hattori, T. 1970. "Some Properties of Soils and Substrata in the Lampang Basin," *Tonan Asia Kenkyu* (*The Southeast Asian Studies*), Vol. 7, No. 4, pp. 527–545.
2) Hattori, T. 1971. "The Quaternary Stratigraphy in the Northern Basin of the Central Plain, Thailand," *Tonan Asia Kenkyu* (*The Southeast Asian Studies*), Vol. 9, No. 3, pp. 398–419.
3) ———. 1972. "Some Properties of Brackish Sediments along the Chao Phraya River of Thailand," *Tonan Asia Kenkyu* (*The Southeast Asian Studies*), Vol. 9, No. 4, 522–532.
4) Takaya, Y. 1972. "Quaternary Outcrops of the Southern Part of the Central Plain of Thailand," *Tonan Ajia Kenkyu* (*The Southeast Asian Studies*), Vol. 10, No. 2, pp. 298–319.
5) Moormann, F. R. and S. Rajanasoonthon. 1967. *General Soil Map of Thailand,* scale 1:1, 250, 000
6) Kawaguchi, K. and K. Kyuma. 1968. *Lowland Rice Soils in Thailand.* Reports on Research in Southeast Asia, Natural Science Series No. 4 of the Center for Southeast Asian Studies, Kyoto University, pp. 150–153.
7) Murakami, H. 1961. "Qualitative and Semi-quantitative Determination of Oxidizable Sulphur in Polder Soils by the Treatment of Hydrogen Peroxides, "*Nihon Dojohiryogaku Zashii* (*Journal of Soil Science and Manure, Japan*), Vol. 32, pp. 276–279. (in Japanese)
8) Pons, L. J. and Van der Kevie, W. 1969. "Acid Sulphate Soils in Thailand: Studies on the Morphology, Genesis and Agricultural Potential of Soils with Cat-clay," *Soil Survey Report,* No. 81, Land Development Department of Thailand. (Refer from 9)
9) Vlek, Paul. 1971. "Some Morphological, physical and Chemical Aspect of Acid Sulphate Soils in Thailand," *Soil Survey Report,* No. 84, Land Development Department of Thailand.
10) Takaya, Y. 1971. "Physiography of Rice Land in the Chao Phraya Basin," *Tonan Ajia Kenkyu* (*The Southeast Asian Studies*), Vol. 9, No. 3, pp. 375–397.