Ministry of Construction

No: 439/BXD - CSXD

REPUBLIC SOCIALIST OF VIETNAM
Independence - Freedom - Happiness

Hanoi, 25 September, 1997

DECISION OF MINISTER OF CONSTRUCTION
On Promulgating The Buiding Code Of Vietnam Volume II and Volume III

MINISTER OF CONSTRUCTION

- Pursuant to Decree N° 15/CP dated 4 March, 1994 of the Government regulating on Functions, Duties, Powers and Organization Structures of Ministry of Construction;

- Pursuant to Decree N° 42/CP dated 16 July, 1996 of the Government promulgating the Regulation on Investment and Construction Management and Decree N° 92/CP dated 28 August 1997 of the Government on amendment of and addition to some articles of Regulation on Investment and Construction Management promulgated in conjunction with Decree No 42/CP dated 16 July 1996 of the Government ;

- In consideration of requests on planning and construction management, on proposal from Head of Department for Construction Policy, Head of Department for Science and technology, Head of Department for state Inspection on Construction work Quality, Head of Department for Architecture and Planning Management, Director of Institute for architecture Researching ;

DECIDES

Article 1: To promulgate in attachment with this decision the Building Code of Vietnam - Volume II and Volume III

Article 2: This Decision takes effect from 1 November, 1997 and is applied in the Whole Country.

Article 3: Ministries, ministerial level Bodies, Bodies under Government, People's Committee of provinces and cities under direct Central Authority shall be responsible to organize the implementation of this Decision.

Ngo Xuan Loc
Minister of Construction
(Signed and Sealed)

Vietnam Building Code
(Natural Conditions)

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ANNEX 2.4
HYDROLOGY

This annex presented hydrological maps within "Set of hydrologic - meteorological Atlas of Vietnam" (1994), which is applied in construction

2.4.1 Hydrological map

"Set of hydrologic - meteorological Atlas of Vietnam" published by General Department of Meteorology and Hydrology - Programme for Science - technics progress of state 42A (Called "Meteorology and hydrology served the socio - economic devolopment) and programme for International hydrology - National Committee of Vietnam published in 1994, are hydrological maps as following:

a. River network and network of hydrological observatories

b. Year rain

c. Flowing stream

- Flowed stream of year
- Surface flowed stream
- Tacitly flowed stream to river
- Flowed stream of flood season:
- Flowed stream of continuously 3 months of greatest flood, flowed stream of greatest flood month
- Flowed stream of greatest flood top
- Flowed stream of dry season
- Flowed stream of continuously smallest 30 months, flowed stream of continously sallest 30 days
- Smallest flowed stream of day

d. Evaporating of basin,...

e. Zoning of river water regime

g. Turbidity of river water

h. Erosion module

i. Average water temperature:

- Average of year, of January, July
- Average highest, lowest water temperature of many years

k. Degree of mineralization and chemical components of river water, hardness of one

l. Hydrological zoning

Main map scale 1/4,000,000. Original map scale for establishing of which are 1/500,000 (for year rainfall and year flowed stream maps), 1/1,000,000 or 1/2,000,000.

2.4.2 Hydrological zoning

Map of hydrological zoning subject to Atlas is presented in figure 2.4.1. Following that, on hydrology, territory of Vietnam is divided into 3 regions with 13 zones and 37 areas on hydrological aspects, their characteristics are pointed out from table 2.4.1.

Table 2.4.1.

Essential characteristics of hydrological areas

Hydrological region, zone, area	Flowed stream of year v/s km^2	Rate % of under-ground stream in comparison with flowed stream of year	Flood season flowed stream		Minimum flowed stream of day v/s km^2	Water quality		Tide regime	Maximum risen unequal tide
			Rate % in comparison with whole year	Appeared month		Turbidity g/m^3	Degree of mine lization mg/l		
1. North Part region (A)									
1.1. Zone A-1: North-eastern North Part									
Area A-I-1	15-30	15-30	65-75	VI-IX	2,0-6,5	100-300	150-200		
Area A-I-2	15-40	10-35	65-75	VI-IX, X	2,0-5,0	100-300	100-150		
Area A-I-3	10-20	10-15	70-80	VI-IX	1,5-2,5	200-650	50-100		
Area A-I-4	15-25	10-15	75-80	VI-IX	1,0-1,5	50-450	200-250		
Area A-I-5	15-45	10-35	75-80	VI-IX	1,0-3,0	300-450	50-150		
Area A-I-6	30-110	10-15	80-85	VI-IX, X	2,5-20,0	50-100	50-100	equal day tide	449
1.2. Zone A-II: Viet Bac (Center of North Part)									
Area A-II-1	15-25	25-35	70-80	VI-IX,X	2,5-6,0	300-500	150-200		
Area A-II-2	15-100	15-50	65-80	VI-X	2,5-25,0	100-200			
Area A-II-3	35-75	15-45	65-75	VI-X	7,0-15,0	150-300			
1.3. Zone A-III: North-Western North Part									
Area A-III-1	40-85	15-45	60-75	VI-IX	6,0-15,0	200-400	150-200		
Area A-III-2	25-55	5-25	70-75	VI-IX	3,0-7,5	400-650			
Area A-III-3	10-30	35-45	65-80	VI-X	3,5-5,0	400-500			
Area A-III-4	10-25	30-35	65-70	VII-X	2,0-5,5	100-400			
Area A-III-5	25-50	20-35	70-80	VI-X	3,0-10,0	150-250			
1.4. Zone A-IV: Plain of Red river, Thai Binh									
Area A-IV-1	10-25		70-80	VI-X	<2,5		150-200		
Area A-IV-2	15-25		75-80					equal day tide	336

1.5. Zone A-V: Hoa Binh, Thanh Hoa									
Area A-V-1	20-45	10-25	70-80	VI-X	2,5-7,0	50-250	100-200	equal day tide	79
Area A-V-2	15-40	20-30	70-75		5,0-7,0	100-150	150-200		
1.6. Zone A-VI: Southern Thanh Hoa, Northern Nghe An									
Area A-VI-1	15-30		70-75	V,VI-XI	<2,5			equal and unequal day tide	275
Area A-VI-2	20-45	30-35	70-85	VI-IX	5,0-10,0	100-200	100-150		
Area A-VI-3	15-35	15-30	65-75	VII, VIII-XI	1,0-10,0			unequal day tide	264
2. *central* Part (B)									
2.1. Zone B-I: Southern Nghe Tinh - Binh Tri Thien									
Area B-I-1	20-75	15-40	55-70	IX-XI	2,5-16,0	50-200	50-150	equal day tide	210
Area B-I-2	20-40		55-70	IX-XI	<2,5			unequal day tide	252
Area B-I-3	45-75	15-25	65-75	IX-XII	2,5-13,0	50-150	50-100	equal and unequal half-day tide	145
2.2. Zone B-II: Quang Nam, Da Nang - Northern Nghia Binh									
Area B-II-1	35-75	30-35	65-70	IX-XII	5,3-13,0	100-150	<50	unequal half-day tide	126
Area B-II-2	35-75	35-40	70-75	X-XII	5,0-10,0	100-150		unequal day tide	
2.3. Zone B-III: Southern Nghia Binh - Northern Phu Khanh									
Area B-III-1	15-55	20-30	70-75	X-XII	2,5-7,5	50-150	<50	unequal day tide	170
Area B-III-2	10-55	10-20	60-70	X-XII	0,5-7,0	50-100			
3. Region of Highland and South Part region (C)									
3.1. Zone C-I: Northern and middle West Highland									
Area C-I-1	15-85	20-35	65-75	VII-X (VIII-XII)	1,5-8,0	100-200	<50		
Area C-I-2	10-40	20-35	65-75	IX-XII	1,0-3,0	50-250			
Area C-I-3	20-35	25-35	65-70	VII-XI,XII	1,5-5,0	50-150			

3.2. Zone C-II: Southern West Highland and South Part Aestern CII									
Area C-II-1	15-50	10-25	70-90	VII-XI	2,5-5,5	<100	<50		
Area C-II-2	25-25	20-35	70-80		0,5-5,5				
3.3. Zone C-III: Coast of extreme southern central Part									
Area C-III-1	2,5-25	10-20	65-75	VIII-XI (IX-XII)	0,0-5,5	100-250	50-100	unequal day tide	
Area C-III-2	2,5-25	10-15	75-85		0,0-2,5	100-250	<100	unequal half-day tide	183
3.4. Zone C-IV: Plain of South Part									
Area C-IV-1	5-20		70-80	VII-XI	<0,5			unequal half-day tide	229
Area C-IV-2	5-35		65-70	VII-X, XII				unequal day tide and unequal half-day tide	330

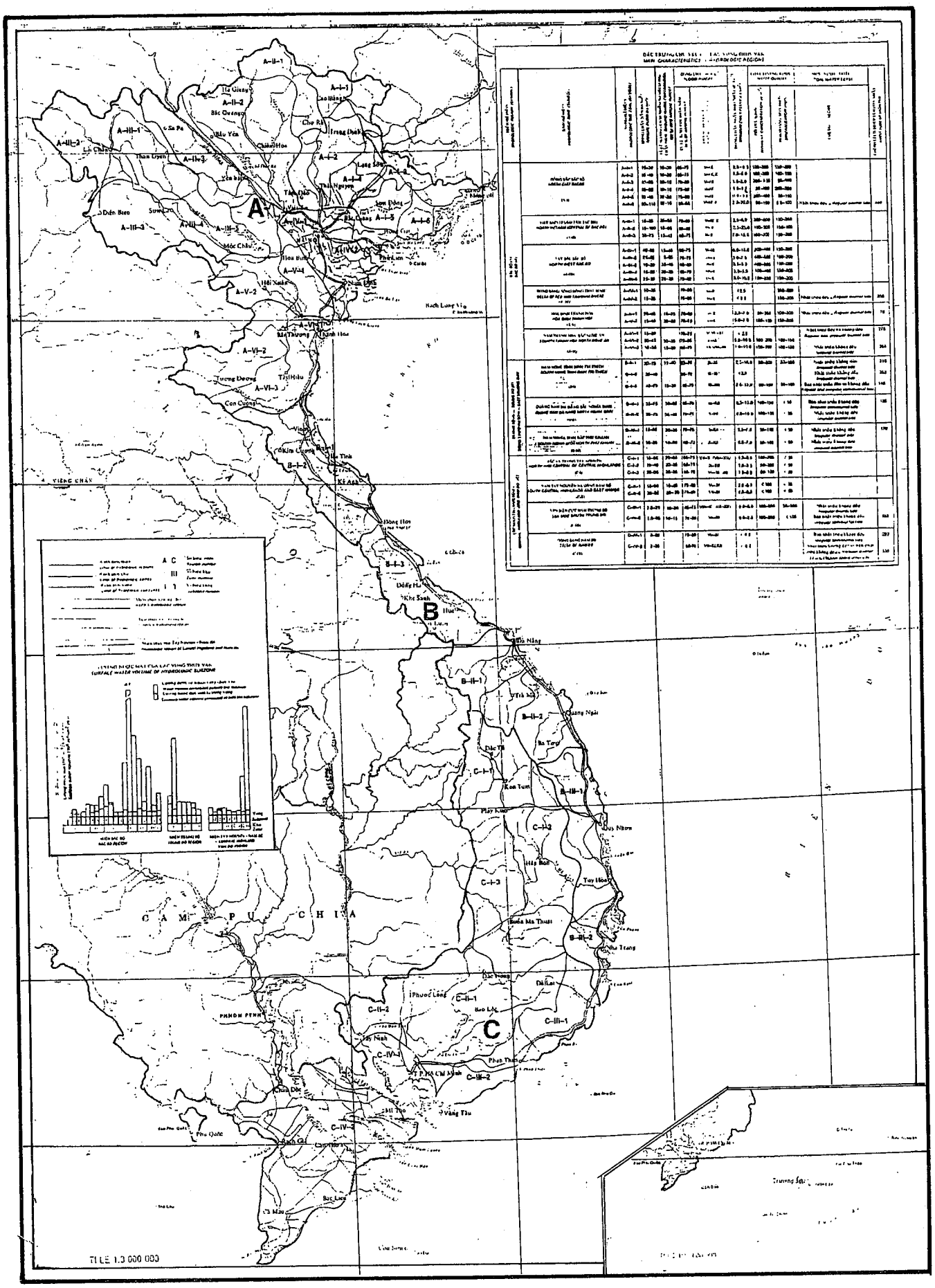

Fig. 2.4.1. Hydrological zoning map

ANNEX 2.5
METEOROLOGY AND HYDROLOGY OF SEA

This annex presented maps of sea meteorology - hydrology within "Set of Meteorological - Hydrologic Atlas" (1994) which is applied in construction.

"Set of hydrologic - meteorological Atlas of Vietnam" published by General Deparment of Meteorology - Hydrology - Progamme for Science-Technics progress of State 42A (Called "Meteorology and Hydrology served the socio - economical development) and Programme for International hydrology - National Committee of Vietnam 1994, there are Sea Hydrologic - Meteorological Maps as following:

a. Wind rose:

- Wind rose of months I, II, III, IV, V, VI (January, February, March, April, May, June)

- Wind rose of months VII, VIII, IX, X, XI, XII (July, August, September, October, November, December)

b. Average air temperature:

- Of months I, II, III, IV, V, VI (January, February, March, April, May, June)

- Of months VII, VIII, IX, X, XI, XII (July, August, September, October, November, December)

c. Average temperature of sea water surface layer:

- Of months I, II, III, IV, V, VI (January, February, March, April, May, June)

- Of months VII, VIII, IX, X, XI, XII (July, August, September, October, November, December)

d. Sea water saltiness of average surface layer:

- Of months I, II, III, IV, V, VI (January, February, March, April, May, June)

- Of months VII, VIII, IX, X, XI, XII (July, August, September, October, November, December)

e. Wave rose:

- Wave rose of months I, II, III, IV, V, VI (January, February, March, April, May, June)

- Wave rose of months VII, VIII, IX, X, XI, XII (July, August, September October, November, December)

g. Tide within East Sea:

- Isoamplitude and isophase of angle essential tide waves on East Sea.

h. Tide characterictics in Red River delta and Mekong delta

i. Depth distributed map of risen water by typhoon with 5% garantee rate of currence.

k. Flowed stream

- Tide maps in East Sea and depth of risen water within typhoon a presented on figures 2.5.1 and 2.5.2.

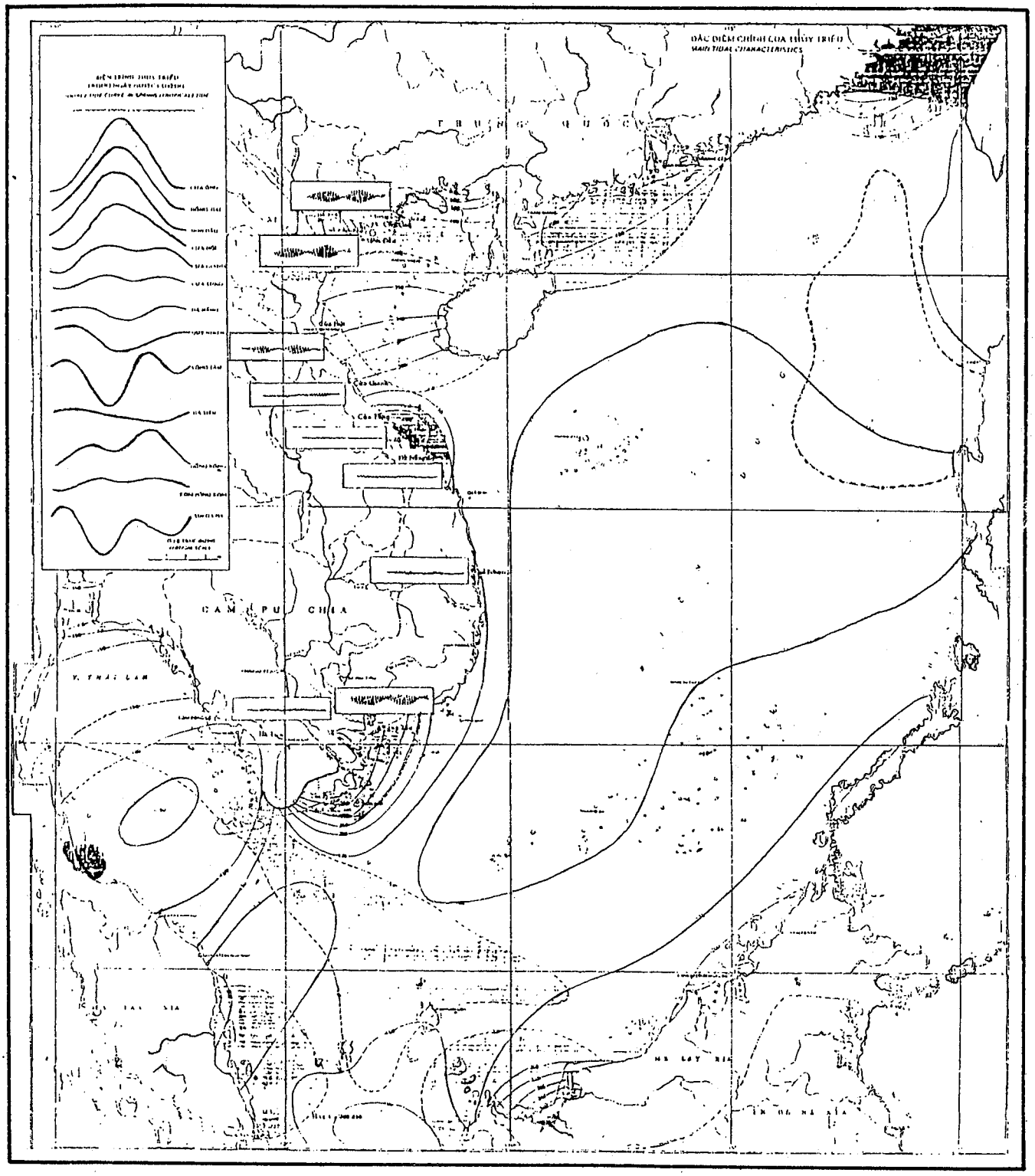

Fig. 2.5.1. Tide map in East Sea

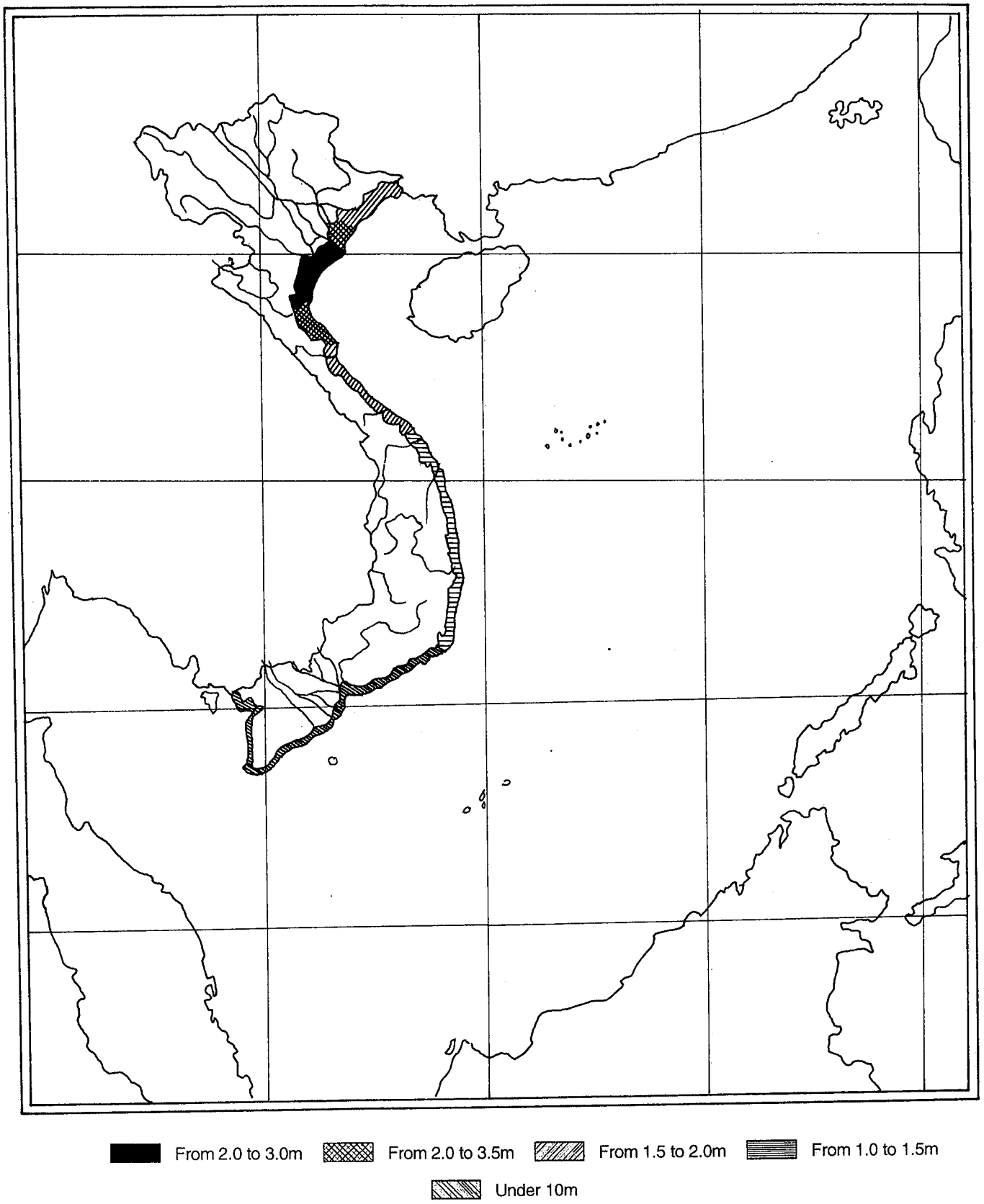

Fig. 2.5.2. Distributed map of risen water height caused by typhoon with garantee frequence 5%

ANNEX 2.7
RESISTIVITY OF EARTH

This annex applied some of comprehensive informations on resistivity of earth in Vietnam and which is used for reference document.

About resistivity of earth, there are:

Zoning map of apparent resistivity P_k, within length AB = 6m, scale 1/1,000,000 :figure 2.7.1 (reduced in size)

This map which is drawn out from reseached result of theme "Survey, measure of resistivity map on the whole territory of Vietnam with scale 1/1,000,000 and 1/2,000,000 by Committee for science - Technics of State implemented from 1997 to 1998 and has been checked and taken over. Data on apparent resistivity and real risistivity of soil layers at different depths from AB = 0,5m to AB = 500m are being surveyed correctly in according with process of deep measure by symmetric deep measure methode.

Document sources:

[1] "Constructed technical conditions for works with foreign investment capital in SR Vietnam" (drafted)

Annex 10: Lightning protection

Map established by: Institute for Postal Science - Technics,

Presided by: Tran Nang Binh

[2] Researched result of theme "Survey, measure of resistivity map on whole territory of Vietnam which scale 1/1,000 and 1/2,000,000 - by Committe for Science and Technology of State implemented 1977 - 1988 and which is been checked and taken over.

Presided by: Tran Nho Lam (General Department of Geology) and Head Board of theme.

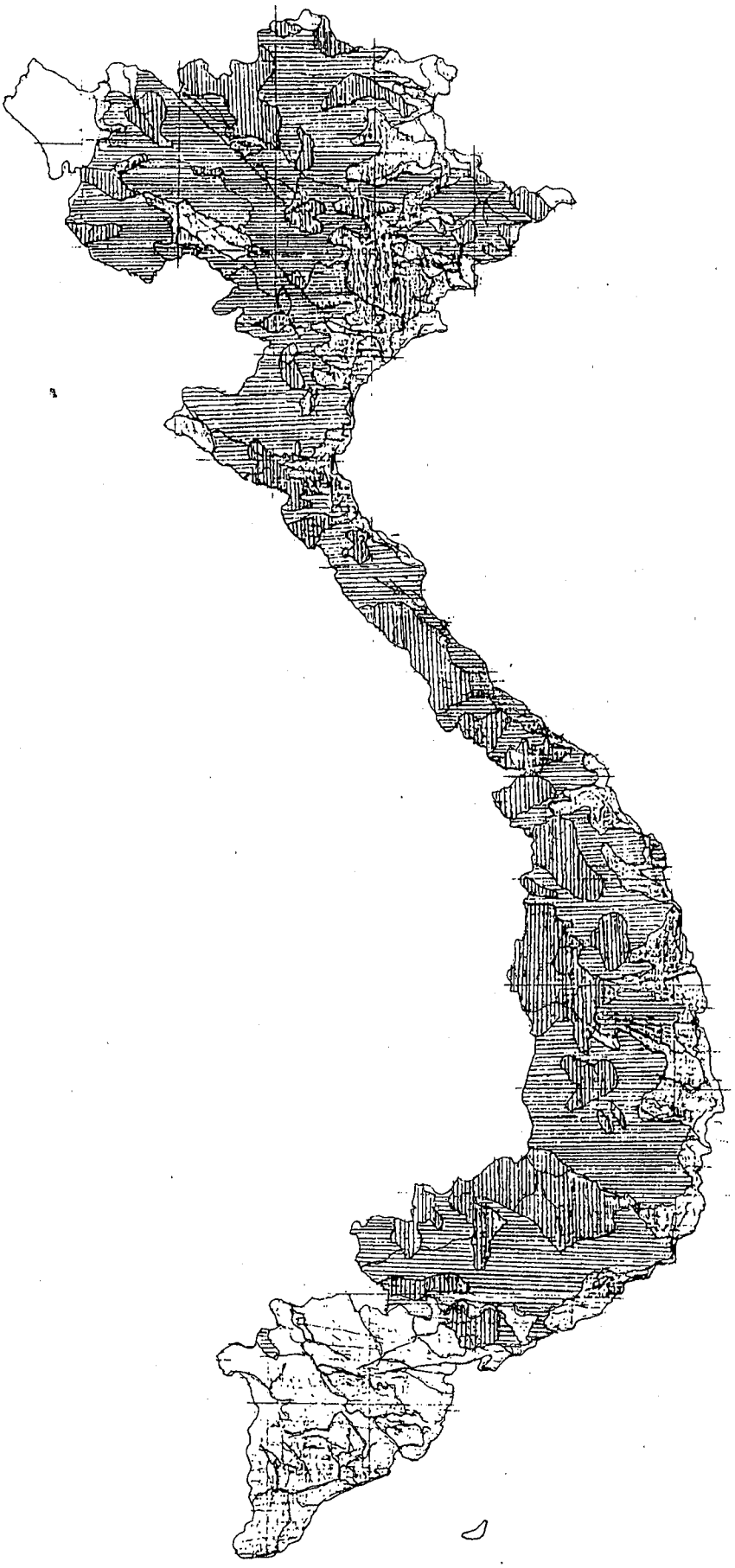

Fig. 2.7.1. Zoning map of apparent resistivity ρ_K AB × 6m

ANNEX 2.9
ENGINEERING GEOLOGY

This annex supplied some of comprehensive informations on engineering geology in Vietnam and which is used for reference document.

2.9.1 Engineering geological map

1. Map of engineering geological zoning

   Engineering geological zoning of territory Vietnam is showed by engineering geological map, scale 1/2,000,000 (Figure 2.9.1, reduced in size)

2. Contents and methods for establishing of map:

   a. Vietnam's engineering geological map with scale 1/2,000,000 which showed general lines of engineering geological conditions of the whole territory, important conditions for evaluating of area on work constructed aspect in order to more detailedly determine the content, volume and researched method of engineering geology.

      On the map it displayed essential factors of engineering geological conditions as type of earth and rock, ages and their origins, great tectonic factors (great tectonic faults), characteristic of relief and geomorphology, hydrologic-geological conditions processes and phenomena of dynamic geology

   b. Classiflying of soil and rock:

      Soil and rock types on territory which are divided into 2 estates that are stratums and groups.

      Based on characteristics of architectural structure (Connection between minerals and earth, rock that created grain) all earth and rock are divided into 2 stratums: layer has hard connection (hard rock) and layer has no hard connection (sotf, incoherent soil).

      Based on formed origins and conditions, earth and rock within a stratum is divided in to different groups. Earth and rock within a

stratum is being formed in tectonic conditions and likely ancient geography therefore the engineering geological which are nearly resembled.

Ages and origins of earth and rock, tectonic faults and geological limits are showed by internationalization signs.

c. Relief characteristics are showed by relief ground levels as represented disposition.

d. Hydrologic - geological conditions is showed on map with essential contents which are underground water level depth and ability of their corrosions, Evaluations of eroded property of water are subject to following norms:

Acid corrosion:	as pH of water are smaller than 5
Delayed washing corrosion:	as content of HCO_3 are smaller than 2 mEq/l
Sulfate corrosion:	as content of SO_4 are greater than 250 mEq/l
Carbonic corrosion:	as content of CO_2 are greater than 3 mEq/l

e Processes and features of construction dynamic geology are showed by signs. Specially earthquakes on surface which are subject to scale of 12 levels MSK - 64 that are showed by Latin numbers.

g. Physico - mechanical characteristics of each earth and rock group which are collected and classified and presented in description of map.

3. Groups of earth and rock

Based on divided principle of earth and rock as about mentioned, all form of earth and rock on Vietnam territory are divided into 2 stratums and 15 groups

a. Rock stratum has rigid connection which included following groups:

- Group 1: Group of acid penetrated, neutral and alkaline rocks That group included the magma complexes as following:

Song Ba (AR), Song Re, Ca Vinh (PR_1), Chu Lai - Ba To, Po Sen, Xom Giay, Muong Hum (PR_2), Chieng Khuon ($\in$), Dai Loc, Song Chay, Pia Ma (D_1), Truong Son, Muong Lat, Ngan Son

(D_3), Ben Giang, Que Son, Dien Bien (P_2), Van Canh, Song Ma, Nui Dieng (T_2), Hai Van, Pia Biooc (T_3), An Koet - Dinh Quan, Deo Ca, Pu Sa Phin, Pia Oac (K_2), Ban Chieng, E Yen Sun, Pu Sam Cap, Cho Don (P_3).

- Group 2: Group of penetrated mafic, super mafic rocks included complexes as following:

Konkbang (AR), Bao Ha (PR_1), Hiep Duc, Nui Nua, Bo Xinh (E_1), Ba Vi (P_2), Cao Bang (T_1), Nui Chua (T_3) and Phuoc Thien (N_2).

- Group 3: Group of eruptive, acid, neutral, alkaline rocks that included stratum systems Ngoi Phia (Kut) and Pu Tra (Ppt)

- Group 4: Group of Mafic eruptive rocks that included bazalts of N_2 - Q_I and Q_{II-IV} ages.

- Group 5: Group of metamorphosed rocks that included stratum system Kan Nac (AR), stratum system Suoi Chieng, Song Tranh (PR1), Song Hong, Sinh Quyen, Dak Min, Kham Duc, Song Chay, SaPa, Bu Khang, Po Ko (PR1 and PR2), Nam Co (PR_2-$\in_1$).

- Group 6: Group of triflestone sedimentary rocks that included stratum systems and layers:

Mo Dong, Ha Giang, Song Ma ($\in$), Suoi Nai, Than La ($\in_3$-Q_1), Dong Son (O_1), Tan Mai, Song Ca, Long Dai (O-S), Huoi Nhi (S_2-D_1), Do Son, Bac Bun, Song Mua, Nam Pa, Rao Chan (D_1), Duong Dong, Ta Khoa (D_{1-2}), Ban Giang (D_2), Yen Duyet (P_2-T_1), Lang Son, Sai Gon (T_1), Nam Tham, Quy Lang (T_2), Mau Son, Nam Mu (T_3), Lai Chau (T_{2-3}), Hon Gai, Van Lang, Suoi Bang, Dong Do, Nong Son, Suoi Bang (T_3), Ha Coi (J_{1-2}), Phu Quoc (J_3-K_1), Yen Chau (K_2), Mu Gia (K), Phu Tien - Dinh Cao, Cu Lao Duong (P_2), Hang Mon, Khe Bo, Dong Hoi, Song Ba, Phong Chau, Phu Cu, Tien Hung, Na Duong, Vinh Bao, Rinh Chua (N).

- Group 7: Group of triflestone sedimentary - neutral, acid eruptive rocks, that included stratum systems and layers

Long Dai (PZ_{1-2}), Tan Mai, Phu Ngu and Long Dai (O-S)), Song Hien, Dong Trieu, Mang Giang (TZ), Tam Lang, Muong Hinh and Bao Loc Narrow (J_3-K), Don Duong (K).

- Group 8: Group of triflestone sedimentary - biochemical - eruptive rocks that included systems and layers:

Cam Duong ($\in$), Ben Khe, A Vuong ($\in$ - O_1), Lu Xia (O_1), Na Mo (O), Phu Ngu (O-S), Sinh Vinh, Pa Ham (O_3-D_1), Xuan Son, Pinh Phuong (S_2 - D_1), Bo Hieng(S - D_1), Dai Giang (S_2 - D_1), Mia Ke, Dai Thi, Ban Nguon (D_1), Huoi Loi, Tan Lam (D_{1-2}), Ban Pap, Muc Bai (D_2), Toc Tat, Dong Tho (D_3), La Khe (C_1), Ta Thiet, Can Loc (P_2), Na Khuat, Hon Nghe (T_2), Tho Lam (J_{1-2}), Ban, Don (J_{1-2}), Song Ca (O-S), Nam Cuoi (PZ_{1-2}), Ban Diet (C_3-P_1), Song Da (C_3-P_1), Cam Thuy, Dong Dang (P_2), Co Noi (T_1), Muong Trai (T_{2-3}), Van Chan (J_3-K).

Group 9: Group of biochemical sedimentary rocks that included layers:

Chang Pung, Ham Rong ($\in_3$), Lo Son, Nam Can (D_2), Co Bai (D_{2-3}), Cat Ba (C_1), Luong Ki, Da Mai (C), Bai Son, Muong Long (C-P), Ha Tien (P), Dong Giao, Dong Trau (T_2).

b. Rock stratum is no hard connection that included following groups:

- Group 10: River sediments;

- Group 11: Group of sediments which originated from sea, sea wind of fourth age;

- Group 12: Group of marshy sediments of Holocene age;

- Group 13: Group of multi - original sediments: river - flood and river - flood - accumulated side of fourth age;

- Group 14: Group of multi - original sediments: river - Sea of fourth age and Neogen (N_2)

- Group 15: Group of marsh - original sediments: Sea - marsh, river - sea - marsh, river - marsh, river - lake of fourth age.

4. Physico - mechanical characteristics of soil and rock groups

Value of essential physico - mechanical characteristics norms earth and rock types which are showed following tables:

- Current hard rock types: table 2.9.1;

- Soft and cohesive soil that originated from delay - accumulated side: table 2.9.2;

- Soft and cohesive soil within plain of North Part: table 2.9.3;
- Cohesive soil of plain of South Part: table 2.9.4;

2.9.2 Engineering geological zoning

On engineering geology which could divide the continental territory of Vietnam into 7 regions:

1. Eastern foldied mountainous region of North Part

   - This region is the northern border lines as China - Vietnam frontier, western side is Chay river fault, Western - South side is Red rive rift-zone, eastern side is East Sea.

   - On the whole, that is the low mountain with inserted hill region, the greatest part of area which has average heigth of 600 - 700 m, ranges of mountain disposed in form of radiant ray and arc shape with convex part that oriented to eastern, south - eastern directions, which rather accorded with direction lines of folded structures.

   Within widely distributed area of forms of continental crude - carbonnat-eruptive forms of Paleosoic age which are being weakly metamorphosed by themself and medium from carbonat sediments. That characteristics are fixed physical - mechanical properties of soil and rock and development of geological processes. Cart process are expanted very strong, formed great mountainous blocks with specific trait of landscape. It expanded processes of withered, slope side eroded and slided development.

2. Western folded mountainous region of North Part

   - Northern limit of region is China - Vietnam frontier, eartern side is Chay river fault, western - south side is Ma river fault.

   - Region characteristics which are expander of ranges of high and medium high mountains, slopped side, that parallelly gone each others and prolonged to north eastern - south western direction which coincided with geological structure direction. Inserting with mountainous ranges are depth valleys.

   Structure, tectonics and components of soil and rock within region which very complicated. Activity of new tectonics and strong seism,

slided cart processes, collaped rock,... that strongly expanded. That one there is activity level of strongest geodynamics. Cart Limestone range which prolonged to north western - south eastern direction from northern frontier to south eastern coast. On this direction, relief is step -by -step lower and degree of cart expander that is increasing.

3. Northern folded mountainous region on Central Part

- This region is separated with the western folded mountainous region of North Part becaused by Ma river fault and with Kontum earth mass region by Binh Son - Phuoc Son fault.

- Ranges of mountain which prolonged to north western - south eastern direction. Relief altitude reduced fastly from ranges of medium high and low mountains at Laos - Viet frontier to low plains of coastal eastern side.

Within widely distributed region of eruptive - continental crude, continental crude - carbonat - eruptive and carbonat froms. Activity of new tectonics and seism which are rather strong. It expanded strongly the slided, rock collaped, erosion, sloped side and cart processes. Typical is the cart limestone mountainous mass of Ke Bang. Coastal plains which are narrow, relativily sloped, on which devoloped accumulating relief by wind.

4. Earth mass region of Kontum

- Northern limit of region is Binh Son - Phuoc Son fault, southern side is Tuy Hoa - Kontum fault.

- It is medium high mountainous region with many tops with heigt over 2,000 m which step - by - step changed to low mountainous and coastal plain on western direction to eastern one. Characteristics on region is activity which lifted new tectonics that is uneven. Ngoc Linh area there is the moved manifestation that formed relativily strong mountain.

Within region which distributed very spaciously strong metamorphosed forms and infiltrated magma forms. Cainozoic basalt cover layer which occupied unlarge area and usually being segmented. Withered processes is expanded which presented type of completely hydrolitic different

crust on cainozoic basalt. In addition it is still devoloped the slided, rock collaped, erosion, sloped side processes.

5. Southern folded mountainous region of Central Part

- Southern folded mountainous region of Central Part which separated to Kontum earth mass region by Tuy Hoa - Kontum fault and to the moast form sagging region of south Part by Ba Ria - Loc Ninh fault.

- Characteristics of region is development of volcano highlands at middle part and western side, and mountains with inserted hills on northern, north - western, south - western and eartern side. Highlands with different altitudes from 300 - 500m to 1,400 - 1,600m which form relief terraces.

- Cainozoic basalt forms which spaciously distributed and formed cover layer with various thickness on surface of highlands.

Withered process expanded strongly, specially within basalt forms, thickly withered crust with specifics which are attending both types of complete hydrolitic withered and uncomplete hydrolitic crusts. Vestiges which expanded on basalt that have very big hollow coeffient but shearing strength is relativily great.

6. Red river rift form sagging region

- Plain of North Part under to Red river rift form sagging region is area of about 17,000 km^2 which is the accumulated plain, its surface is rather even and plat with altitudes from 1 to 12m, medium with 6 - 8m, uneffectivily tilt to south - eastern side and separated by densely rivers and streams network.

Constructing of plain which are the soft and incoherent fourth sediments. Underground water is distant from earth surface 0 - 5m, usually it is 1-2m. In coastal area, sea water components changed completely. Within depth sphere from 0 to 10 - 15m that usually met weak soil which generated difficulty for building of works. Plain skirt is more favourable engineering geological conditions. Within region there are manifestations of tectonic earth crack.

7. Sagging region with ditch of form South Part

- Plain of South Part under to ragging region with ditch form of South Part is area of about 61,300 Km^2 which is the even and flat

alluvial one. Its terrain with worn out and scraped off - accumulated high plain of terrace with altitudes from 3 - 5 to 80 - 100 m which expanded in eastern area and the accumulated low plain terrain with altitudes from 0.5 - 1m to 5 - 8m that expanded in western one.

- Characteristics of eastern plain which is wave shape terrain; constructing of its upper part is pleistocene sediment that is good faculty for building, underground water level which is usually distant from earth surface from 2 - 5m and greater. Here is strongly expanded the eroded and seraped off surface and withered processes. Constructed condition is favorable.

- Western area is the even and flat terrain, very thick fourth sediment. Holosene forms that are almost covered the surface. Underground water is usually distant from earth surface from 0 - 2m. Weak soil is great thickness and distributed spaciously. Marshy processes are very developing. These conditions that generated difficultly for building of works and economic exploitation of territory.

Document sources:

"Constructed technical conditions of works with foreign investment capital in SR Vietnam" (Drafted)

Annex 2: Engineering geology

Compiled by: Association of Geology of Vietnam

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Fig. 2.9.1. Engineering geological map

Table 2.9.1

Physico-mechanical properties

Rock type	γ g/cm^3	γ_s g/cm^3	n %	σ_n kG/cm^2
Granite	2.51-2.69	2.65-2.76	0.1-3	970-2370
Syenite	2.50-2.62	2.63-2.72	0.1-4.5	1000-2200
Diorite	2.53-2.75	2.67-2.86	0.1-5	1050-2560
Gabbro	2.65-3.04	2.85-3.30	0.05-6	1340-3170
Diabase	2.64-2.98	2.78-3.1	0.1-7.4	1100-3300
Basalt	2.45-2.83	2.77-2.96	0.6-20	815-2700
Riolite	2.35-2.60	2.62-2.71	1.3-9	980-2560
Dacide	2.43-2.64	2.65-2.76	0.8-7	913-2617
Andesite	2.46-2.68	2.65-2.79	0.6-77	1220-2776
Tuff	2.38-2.54	2.66-2.81	4.2-22	
Gneiss	2.48-2.66	2.65-2.77	0.3-5.7	767-2100
Quartzite	2.54-2.80	2.64-2.93	0.5-3.6	1613-3950
Pebblestone	2.44-2.56	2.62-2.70	4.2-10.9	350-1200
Sandstone	2.31-2.65	2.64-2.73	1.6-15	470-1760
Soft sandstone	2.0-2.40	2.65-2.76	13-26	12-150
Powderstone	2.30-2.62	2.65-2.71	2-17	240-1500
Slite clay	2.43-2.58	2.69-2.80	2.4-11	274-1500
Claystone	2.28-2.50	2.68-2.74	5-20	50-900
Limestone	2.50-2.66	2.69-2.75	2.5-12.6	58-1920
Marl	2.36-2.47	2.67-2.80	5.3-18.2	

of hard rock on Vietnam territory

σ_c kG/cm^2	σ_k kG/cm^2	$E_{đh}$ 10^4 kG/cm^2	E_o 10^4 kG/cm^2	μ
570-790	35-60	25-70	1-20	0.12-0.70
550-810	31-53	43-84	2-28	0.10-0.28
520-913	40-60	36-78	0.5-40	0.11-0.34
705-2380	50-77	63-117	8.5-75	0.2-0.41
624-2100	55-76	70-112	10-50	0.22-0.38
392-957	27-65	20-100	0.2-61	0.15-0.29
591-750	41-65	34-72	0.7-19	0.1-0.33
580-796		43-93	2.7-4.3	0.13-0.30
		50-110	3.2-60	0.15-0.32
310-815	34-48	15-55	0.4-27	0.17-0.35
420-2080	43-86	40-90	15-48	0.10-0.28
190-685	17-62	26-73	15-26	0.12-0.26
198-1250	53-72	40-75	14-60	0.14-0.35

Table 2.9.2.

Average Value of physico-mechanical properties of soil :

Originated rock group		Soil type	Norms of physico-mechanical property					
Number sign	Group name		<0.005m m%	W_{tn} %	γ g/cm^3	γ_s g/cm^3	γ_n g/cm^3	n %
1	Acid penetability	Mixed clay	27	25	1.78	1.42	2.70	48
		Mixed sand	8	10	1.45	1.32	2.66	50
4	Mafic eruption	Mixed clay	38	33	1.52	1.14	2.84	60
		Clay	55	38	1.55	1.12	2.86	61
		Black sand	50	41	1.76	1.25	2.73	54
5	Metamorphosis	Mixed clay	26	23	1.78	1.45	2.72	47
		Clay	39	31	1.78	1.36	2.75	51
7	Sediment of triflestone	Mixed clay	26	21	1.88	1.55	2.72	43
		Clay	41	29	1.80	1.40	2.74	49
8	Sediment of eruptive triflestone	Mixed clay	24	24	1.76	1.42	2.71	48
		Clay	45	33	1.76	1.32	2.74	51
11	Biochemical sediment	Clay	43	39	1.70	1.22	2.79	56
		Laterite		9	2.35	2.16	3.03	24

type of accumulated side clay- decay

Norms of physico-mechanical property								
G %	W_c %	I_d %	B	C kG/cm^2	ψ degree	E_o kG/cm^2	a_{1-2} cm^2/kg	k_t cm/s
37	25	12	-0.02	0.18	26	66	0.023	$1.2.40^{-5}$
20	16	4	0.25	0.09	30	59	0.018	$4.3.10^{-4}$
54	40	14	-0.50	0.20	26	41	0.053	$3.7.10^{-4}$
63	43	20	-0.15	0.31	24	37	0.062	$3.0.10^{-4}$
57	32	25	0.30	0.46	10	45	0.047	$2.5.10^{-7}$
40	27	13	-0.30	0.28	24	65	0.022	
56	35	21	-0.10	0.41	22	60	0.032	$1.6.10^{-6}$
39	25	14	-0.28	0.26	23	64	0.019	$3.1.10^{-6}$
53	30	23	-0.04	0.45	19	60	0.024	$1.2.10^{-6}$
39	26	13	-0.15	0.33	25	56	0.028	$4.7.10^{-6}$
55	34	21	-0.04	0.47	20	54	0.032	$4.9.10^{-6}$
58	38	20	0.05	0.38	23	47	0.045	$8.3.10^{-5}$

Table 2.9.3

Average value of norms of Physico-mechanical

Earth and rock group	Earth and rock subgroup	Soil type	Claygrain <0.005mm (%)	Humidity W_{tn} (%)	Bulk volume γ (g/cm^3)	Dry bulk volume γ_c (g/cm^3)	Specific volume γ_r (g/cm^3)	Hollow coefficient ε_o
River sediment	a IV_3	Clay	46	35	1.84	1.37	2.71	0.98
		Mixed clay	25	30	1.90	1.46	2.70	0.85
		Mixed sand	9	26	1.90	1.50	2.68	0.79
Sedi-ment of sea, river	am IV_3	Clay	40	34	1.84	1.37	2.71	0.97
		Mixed clay Mixed	18	31	1.88	1.43	2.70	0.89
		sand	7	24	1.90	1.53	2.68	0.75
Sea sediment	m $IV_{2\text{-}dd}$	Clay	45	36	1.85	1.36	2.70	0.98
	m IV^c_{2vp}	Clay	41	29	1.92	1.49	2.72	0.85
		Mixed clay	20	26	1.95	1.54	2.70	0.75
		Mixed sand	8	22	1.97	1.61	2.68	0.66
Sea sediment	bm IV_3	Clay mud	38	57	1.65	1.05	2.68	1.55
		Mixed clay mud	19	43	1.76	1.23	2.69	1.18
		Mixed sand mud	6	36	1.80	1.32	2.67	1.02
Sea sediment	bm IV_{2dd}	Clay mud	41	62	1.62	1.00	2.66	1.66
		Mixed clay mud	21	47	1.73	1.18	2.67	1.26
		Mixed sand mud	7	37	1.08	1.31	2.67	1.03
Marsh	bm III^c_{2vp}	Clay mud	40	58	1.64	1.04	2.66	1.55
		Mixed clay mud	22	51	1.68	1.11	2.65	1.39
		Mixed sand mud	9	38	1.75	1.27	2.67	1.10
Marshy sediment	b IV_3	Mixed clay mud	19	50	1.65	1.10	2.67	1.42
		Mixed sand mud	8	38	1.74	1.26	2.68	1.12
Accumu-lated side decay	Metamorph osed - stone	Clay	35	31	1.78	1.36	2.74	1.03
		Mixed clay	26	25	1.82	1.45	2.72	0.88
	Trifle - stone	Clay	38	24	1.91	1.54	2.72	0.77
		Mixed clay	21	21	1.92	1.58	2.71	0.72
	Lime - stone	Clay	43	39	1.70	1.22	2.79	1.27

properties of soil: Cohesive soil of North Part delta

Degree of satera-tion G (%)	Yield point Wc (%)	Plastic limit Wd (%)	Index of plasticity (%)	Consiste-ncy B	Angle of internal friction φ (degree)	Cohesive force C (kG/cm^2)	Coeffi-cient of Subsided compres-sion a_{1-2} (cm^2/kG)	Deforma-tion modulus E_o (kG/cm^2)	Coeffi-cient of permiabi-lity K (cm/s)
97	47	26	21	0.43	12	0.38	0.033	47	$1.9.10^{-7}$
95	35	22	13	0.61	14	0.25	0.028	52	$6.4.10^{-7}$
88	26	20	6	1.00	22	0.18	0.018	68	$1.5.10^{-6}$
95	42	23	19	0.33	10	0.33	0.037	42	$3.7.10^{-7}$
94	32	21	11	0.90	15	0.17	0.021	61	$5.3.10^{-7}$
86	25	20	5	0.80	21	0.09	0.017	70	$1.3.10^{-6}$
99	47	25	22	0.50	11	0.37	0.030	52	$3.2.10^{-7}$
95	46	25	21	0.19	16	0.50	0.023	64	$1.2.10^{-7}$
93	33	20	13	0.46	19	0.32	0.019	70	$2.8.10^{-7}$
89	23	18	5	0.80	23	0.14	0.015	85	
99	53	32	21	1.19	5	0.10	0.110	15	$1.5.10^{-7}$
98	39	26	13	1.30	7	0.07	0.074	22	$4.5.10^{-6}$
94	29	24	5	2.40	24	0.02	0.037	39	$4.8.10^{-4}$
99	57	34	23	1.22	5	0.10	0.123	13	$1.3.10^{-7}$
99	43	29	14	1.28	7	0.07	0.076	21	$2.3.10^{-6}$
96	30	24	6	2.17	22	0.02	0.035	42	$2.5.10^{-5}$
99	55	33	22	1.14	6	0.10	0.103	16	$1.3.10^{-7}$
97	47	32	15	1.27	7	0.07	0.082	19	$2.2.10^{-6}$
92	30	24	6	2.33	19	0.02	0.038	37	$3.0.10^{-5}$
94	49	35	14	1.07	7	0.06	0.077	20	
91	32	26	6	2.00	20	0.02	0.037	40	$8.0.10^{-5}$
82	54	33	21	-0.09	20	0.38	0.026	60	
77	41	26	15	-0.07	22	0.21			
85	46	24	22	-0.02	19	0.44	0.019	64	$1.9.10^{-7}$
79	38	23	15	-0.13	21	0.32	0.017	66	$5.1.10^{-7}$
85	58	40	18	-0.05	23	0.38	0.045	48	

Table 2.9.4

Average value of norms of physico-mechanical

Area (province)		Eastern region of south part (Tay Ninh,. Song Be., Dong Nai)				
Layer (Engineering geological factor)		1b	1c	13	14	15
Granulometric composition %	> 2mm	-	1	16	13	4
	0-0.05mm	41	56	45	26	61
	0.05-0.005mm	35	35	20	41	28
	< 0.005mm	24	8	19	25	7
Natural humidity W_{tn}%		26	25	18	22	17
Bulk volume g/cm^3	Natural γ_o	1.87	1.91	2.06	2.05	2.07
	Dry γ_c	1.48	1.53	1.73	1.68	1.76
Specific volume γ_r, g/cm^3		2.68	2.68	2.70	2.72	2.67
Hollow coefficient ε		0.8	0.73	0.56	0.62	0.57
Degree of sateration G,%		87	91	87	96	89
Yield point W_c, %		36	26	33	44	20
Elastic limit W_d, %		23	19	21	25	16
Index of elasticity I_d, %		13	7	12	19	4
Consistency B		0.24	0.85	-0.25	-0.16	0.25
Angle of internal friction φ, degree		17	23	24	21	26
Cohesive force C, kG/cm^2		0.25	0.11	0.35	0.66	0.09
Coefficient of subsides compression a_{1-2}, cm^2/kG		0.032	0.026	0.012	0.015	
Modulus of total defomation E, kG/cm^2		37	50	100	95	
Power of compressed resistance σ_n, kG/cm^2				1.20	2.70	
Number of drived tamper N_{30}				45	42	40
Coefficient of permiability K_t, cm/s						
Coefficient of infiltrated coalescence C_v, cm^2/s						

properties of soil: Cohesive soil of South Part delta

Ho Chi Minh City									
5	5a	11a	11b	2a	2b	13	14	14a	15
					1	7	6		
14	13	24	59	68	48	30	21	63	
31	27	32	44	20	25	24	25	29	
60	58	55	32	21	6	21	39	50	
39	82	70	55	13	14	17	19	64	18
1.72	1.50	1.58	1.70	2.07	2.10	2.07	0.05	1.60	
1.21	0.82	0.93	1.09	1.83	1.84	1.76	1.72	0.97	
2.69	2.64	2.67	2.65	2.67	2.66	2.69	2.72	2.65	2.67
1.07	2.23	1.86	1.41	0.46	0.44	0.53	0.57	1.72	0.53
98	98	100	99	76	84	86	90	98	90
54	73	63	41	27	20	32	46	61	22
30	45	39	26	16	16	15	27	37	17
24	28	24	15	11	4	13	19	24	5
0.38	1.33	1.35	1.93	-0.28	-0.50	0.14	0.42	1.18	0.20
10	5	6	8	25	27	20	20	5	25
0.40	0.07	0.12	0.07	0.18	0.10	0.37	0.57	0.10	0.11
0.057	0.197	0.159	0.081	0.008	-	0.012	-.0014	0.024	0.010
35	10	15	17	124		100	86	15	92
0.50	0.17	0.23	0.09	0.48	0.23	1.25	1.69		0.37
6						43	40		29
1.10	4.4.10	7.2.10	6.9.10			$7.6.10^{-8}$	$4.8.10^{-8}$		$6.1.10^{-7}$

Table 2.9.4

Average value of norms of physico-mechanical

Area (province)		Dong Thap province							
Layer (Engineering geological factor)		1a	1b	5a	6a	11a	11b	13	14
Granulometric composition %	> 2mm							2	3
	2-0.05mm	10	33	12	26	15	29	37	26
	0.05-0.005mm	33	39	25	40	34	40	35	28
	< 0.005mm	57	28	63	34	51	21	26	43
Natural humidity W_{tn} %-		-	-	-	56	58	4	22	25
Bulk volume g/cm^3	Natural γ_o	1.79	1.85	-	1.69	1.64	1.69	2.01	2.00
	Dry γ_c	1.33	1.42	0.91	1.07	1.03	1.15	1.60	1.75
Specific volume γ_r, g/cm^3		2.69	2.68	2.65	2.66	2.67	2.77	2.70	2.72
Hollow coefficient ε		1.02	0.90	1.91	1.49	1.58	1.32	0.63	0.09
Degree of sateration G.%		92	92	99	99	97	95	94	98
Yield point Wc, %		53	38	68	42	54	39	33	47
Elastic limit W_d, %		31	24	42	26	32	25	20	26
Index of elasticity I_d, %		22	14	26	16	22	14	13	21
Consistency B		0.18	0.50	1.16	1.87	1.20	1.57	0.16	-0.03
Angle of internal friction φ, degree		11	15	5	8	5	7	20	18
Cohesive force C, kG/cm^2		0.41	0.30	0.09	0.06	0.1	0.08	0.42	0.56
Coefficient of subsides compression a_{1-2} cm^2/kG		-	-	0.164	0.074	0.105	0.067	0.014	0.015
Modulus of total deformation E, kG/cm^2		-	-	13	16	16	17	80	82
Power of compressed resistance σ_n, kG/cm^2		1.21	0.68	0.18		0.21			
Number of drived tamper N_{30}		7	7						
Coefficient of permiability K_t, cm/s		-	-	2.9.10			1.9.10		
Coefficient of infiltrated coalescence C_v, cm^2/s				4.2.10			3.8.10		

properties of soil: Cohesive soil of South Part delta *(Continued)*

Long An province					Tien Giang province				
5	11a	11b	13	14	8	9	11b	13	14
			2						
19	22	37	40	16	21	40	43	47	31
32	34	36	34	36	36	38	37	30	28
49	44	27	27	48	43	22	20	22	41
35	67	45	23	26	34	30	41	22	24
1.82	1.57	1.77	1.98	1.96	1.83	1.88	1.80	2.02	1.99
0.94	1.21	1.21	1.61	1.55	1.36	1.45	1.28	1.66	1.62
2.71	2.66	2.67	2.70	2.70	2.71	2.70	2.70	2.70	2.71
1.05	1.80	1.21	0.67	0.74	0.99	0.85	1.11	0.62	0.67
94	99	99	93	95	98	95	100	96	97
48	64	35	34	49	47	31	32	32	45
26	41	22	20	27	26	21	21	20	25
22	23	13	14	22	21	10	11	12	20
0.41	1.13	1.76	0.21	-0.07	0.38	0.80	1.81	0.17	0.05
9	5	9	19	18	15	-	9	21	20
0.25	0.12	0.04	0.46	0.53	0.26	-	0.10	0.30	0.50
0.038	0.136	0.056	0.019	-	0.031	-	0.054	0.014	0.017
46	14	18	75	-	50	-	20	83	75
			1.36	1.24					
				26					
2.3.10									

Table 2.9.4

Average value of norms of physico-mechanical

Area (province)		An Giang province				
Layer (Engineering geological factor)		1a	1b	11a	11b	13
Granulometric composition %	> 2mm	-	-	-	-	-
	2-0.05mm	8	27	14	31	43
	0.05-0.005mm	36	41	37	42	31
	< 0.005mm	56	32	49	27	26
Natural humidity W_{tn} %		27	27	25	61	43
Bulk volume g/cm^3	Natural γ_o	1.86	1.91	1.90	1.73	2.04
	Dry γ_c	1.47	1.53	0.99	1.21	1.63
Specific volume γ_r, g/cm^3		2.70	2.69	2.68	2.68	2.70
Hollow coefficient ε		0.83	0.74	1.76	1.21	0.66
Degree of sateration G, %		94	90	93	95	98
Yield point Wc, %		54	41	57	38	36
Elastic limit W_d., %		32	25	33	24	21
Index of elasticity I_d, %		22	16	24	14	15
Consistency B		-0.23	-0.07	1.22	1.37	0.20
Angle of internal friction φ, degree		16	19	6	8	22
Cohesive force C, kG/cm^2		0.50	0.36	0.13	1.07	0.43
Coefficient 0f subsides compression a_{1-2} cm^2/kG		-	-	0.010	0.062	0.015
Modulus of total deformation E, kG/cm^2		-	-	23	25	83
Power of compressed resistance α_n, kG/cm^2		1.71	1.65	0.33	0.28	0.67
Number of drived tamper N_{30}						
Coefficient of permiability K_t, cm/s				4.4.10	6.9.10	
Coefficient of infiltrated coalescence C_v, cm^2/s				5.3.10	1.3.10^{-3}	

properties of soil: Cohesive soil of South Part delta *(Continued)*

Ben Tre province						Cuu Long province					
5a	6	6a	11a	13	14	5	6	11a	11b	13	14
-	-	-	-	-	-	-	-	-	-	-	-
21	57	44	16	26	15	25	59	20	48	31	16
32	24	30	36	34	42	32	26	31	29	37	38
47	19	25	48	30	48	43	15	49	23	32	46
60	28	45	57	25	27	25	24	60	43	25	48
1.63	1.89	1.74	1.66	1.95	1.91	1.87	1.93	1.63	1.76	1.98	1.96
1.02	1.47	1.20	1.05	1.56	1.51	1.50	1.50	1.55	1.02	1.23	1.53
2.69	2.69	2.69	2.70	2.69	2.71	2.70	2.68	2.68	2.68	2.70	2.72
1.63	0.83	1.25	1.56	0.72	0.79	0.80	0.73	1.62	1.78	0.71	0.77
99	91	97	98	93	93	84	85	97	97	95	98
56	33	35	54	35	47	50	29	57	233	38	48
35	22	21	34	21	25	27	20	35	20	22	26
21	11	14	20	15	22	23	9	22	13	16	22
1.20	0.55	1.67	1.15	0.26	0.10	-0.10	0.45	1.15	1.77	0.19	0.08
5	18	67	5	22	20	16	20	5	7	23	20
0.08	0.12	0.05	0.10	0.30	0.50	0.32	0.17	0.12	0.07	0.42	0.24
0.10	0.029	0.063	0.102	0.108	0.021	0.029	0.034	0.103	0.070	0.017	0.020
21	50	27	20	75	72	68	57	20	23	76	73
0.28		0.22	0.19	1.12	2.34	0.63	0.28	0.25	0.20	-	-
				21	26						

Table 2.9.4

Average value of norms of physico- mechanical

Area (province)		Hau Giang province						
Layer (Engineering geological factor)		5	5a	6a	11a	11b	13	14
Granulometric composition %	> 2mm							1
	2-0.05mm	17	13	29	13	40	38	18
	0.05-0.005mm	41	35	48	46	40	43	40
	< 0.005mm	42	52	23	41	20	19	41
Natural humidity W_{tn}, %		35	63	47	58	42	26	27
Bulk volume g/cm^3	Natural γ_o	1.78	1.62	1.70	1.65	1.77	1.97	1.93
	Dry γ_c	1.31	0.99	1.17	1.04	1.25	1.56	1.53
Specific volume γ_r, g/cm^3		2.70	2.67	2.68	2.67	2.68	2.69	2.71
Hollow coefficient ε		1.06	1.71	1.28	1.56	1.15	0.72	0.77
Degree of sateration G, %		90	99	98	99	98	97	95
Yield point Wc, .%		51	59	38	55	33	35	47
Elastic limit W_d, %		28	35	24	33	22	22	26
Index of elasticity I_d, %		23	24	14	22	11	13	21
Consistency B		0.30	1.18	1.65	1.14	1.81	0.30	0.07
Angle of internal friction φ, degree		15	6	6	6	8	20	19
Cohesive force C, kG/cm^2		0.28	0.13	0.10	0.10	0.06	0.21	0.48
Coefficient of subsides compression a_{1-2} cm^2/kG		0.054	0.135	0.077	0.098			0.023
Modulus of total deformation E, kG/cm^2		34	14	23	21			70
Power of compressed resistance α_n, kG/cm^2		0.54	0.21	0.30	0.31		1.68	2.16
Number of drived tamper N_{30}		-	0		2		39	34
Coefficient of permiability K_t, cm/s			$3.5.10^{-8}$	$1.3.10^{-3}$	4.10-8			
Coefficient of infiltrated coalescence C_v, cm^2/s			$1.8.10^{-3}$	$3.1.10^{-3}$	6.10-4			

properties of soil: Cohesive soil of South Part delta *(Continued)*

Minh Hai province						Kien Giang province					
5a	6a	11a	11b	13	14	5a	6a	11a	11b	13	14
12	31	15	34	34	16	12	30	14	29	44	15
29	40	30	39	40	36	45	46	49	48	36	44
59	29	55	27	26	48	43	24	37	23	20	41
67	49	65	47	26	29	71	45	66	45	26	26
1.59	1.70	1.60	1.73	1.99	1.95	1.56	1.73	1.60	1.72	1.96	1.97
0.94	1.14	0.95	1.18	1.59	1.51	0.91	1.20	0.96	1.19	1.56	1.57
2.66	2.66	2.67	2.67	2.70	2.72	2.66	2.66	2.67	2.68	2.68	2.70
1.80	1.33	1.74	1.26	0.72	0.79	1.92	1.21	1.78	1.26	0.71	0.72
99	98	99	99	98	98	98	98	96	96	98	86
63	41	60	38	37	49	66	39	56	57	33	46
38	26	36	25	23	26	40	25	33	24	21	25
25	15	24	13	14	23	26	14	23	13	12	21
1.16	1.55	1.21	1.70	0.21	1.13	1.20	1.50	1.43	1.61	0.40	0.56
5	6	5	5	21	18	5	8	6	8	18	17
0.12	0.08	0.10	0.06	0.34	0.62	0.12	0.10	0.09	0.30	0.56	0.56
0.158	0.092	1.149			0.025	0.186		0.165			
13	17	14			69	11		12			
0.17		0.18	0.11	1.40	1.88	0.18	0.23	0.20	0.22	0.52	1.61
					33					21	30
								$1.6.10^{-8}$			
								$1.8.10^{-4}$			

ANNEX 2.10
HYDROLOGYCAL GEOLOGY

This annex supplied some of comprehensive informations on hydrologycal geology in Vietnam and which is used for reference document.

2.10.1. Hydrologic - geological characteristics

1. Hydrologic - geological condition, specially that are water level depth and corrosive property of underground water which effected to engineering geological condition, that are connected to engineering geology, essentially it should be considered the first underground water layers and complex systems from ground suface downwards.
2. Underground water level
   a. On territory of Vietnam, underground water level depth mainly depends on exitsted terrain as following:

Area	Underground water level depth
- Mountainous region	Often over 10m
- Hilly region	5 - 10m and over
- Concentrated and taken off plain	2 - 5m
- Low plain	0.2m

   b. Sea water level changed to seasons, first and almost within hilly regions and highlands. In plain, ocsillation of water level reduced step - by - step as that is far from river. In coastal area, underground water level changed to dynamics of day (in northern) and half - day (in southern) under tide influence.
3. Chemical components, degree of minerallization and corrosive property of underground water.

   Chemical componets.....of underground that changed direction from mountain to plain.

a. Mountainous zone:

In mountainous zone there commonly are types of hydrocarbonate - calcium - magnesium water or calcium - natrium - hydrocarbonate - chloride and chloride - hydrocarbonate mixed one with total degree of mineralization that usually is M 0.05 - 0.15 g/l, that one is usually the decomposed and delayed - eroded property

b. Hilly zone:

In hilly zone commonly there are hydrocarbonate and hydrocarbonate chloride - calcium - natrium water with total degree of mineralization that usually is M 0.05 - 0.50 g/l. Water within carbonate forms which usually is hydrocartbonate calcium magnesium one with total degree of mineralization that is 0.2 - 0.6 g/l, having carbonic eroded property

c. Coastal low zone:

In coastal low zone, chemical components of underground water which changed completely, total degree of mineralization changed from smaller than 1 to 10 - 20 g/l, that usually is 1.5 g/l.

d. Marshy zone:

In marshy zones it usually met water with sulfate, acid eroded property.

2.10.2 Hydrological geology zoning

1. "Set of hydrologic - geological Atlas of Vietnam" published by General Department of Meteorology and Hydrology - Programme for Science - tecnics progressive of State 42A and Programme for International Hydrology - National Committee Vietnam, 1994, with hydrologic - geological zoning map (see figure 2.10.1).

After that on hydrological geology it could divide continental territory of Vietnam into 6 zones:

a. Zone I: Eastern North Part, including 2 subzones:

1a: Cao Bang - Lang Son
1b: Ha giang - Tuyen Quang

b. Zone II: Western North Part, including 3 subzones:

IIa: Lao Cai - Hoa Binh
IIb: Phong Tho - Tan Lac
IIc: Lai Chau - Thanh Hoa

c. Zone III: Plain of North Part, including 3 subzones:

IIIa: Vinh Yen - Do Son
IIIb: Ha Noi - Thai Binh
IIIc: Son Tay - Ninh Binh

d. Zone IV: northern of Central Part, including 3 subzones:

IVa: Muong Te
IVb: Dien Bien - Ha Tinh
IVc: Huong Son - Binh Son

e. Zone V: middle and southern of Central Part, including 3 subzones:

Va: Kon Tum - Tay Son
Vb: Srepok
Vc: Da Lat

g. Zone VI: Plain of South Part, including 3 subzones:

VIa: Tay Ninh - Bien Hoa
VIb: Moc Hoa - Tra Vinh
VIc: Long Xuyen - Bac Lieu

2. Hydrologic - geological map

Hydrologic geological map of Vietnam with scale 1/2,000,000 is showed on figure 2.10.2 (reduced in size)

Document sources:

[1] "Set of hydrologic geological Atlas of Vietnam" published by General Department of Meteorology and Hydrology - programme for Science - Technics progress of state 42A (named "Meteorology and Hydrology served socio - economic development") and Programme for International Hydrology - National Committee of Vietnam, 1994.

[2] "Constructed technical condition for works with foreign investment capital in SR Vietnam" (Drafted) by Institute for Building Standardization, 1991

Annex 2: Engineering geology

Compiled by: Association of Geology of Vietnam

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Opponents: Dr. Pham Van Co, Institute for Science under National water Conservancy, Dr. Vu Cao Minh, Institute for Geology under General Institute of Sciences Vietnam.

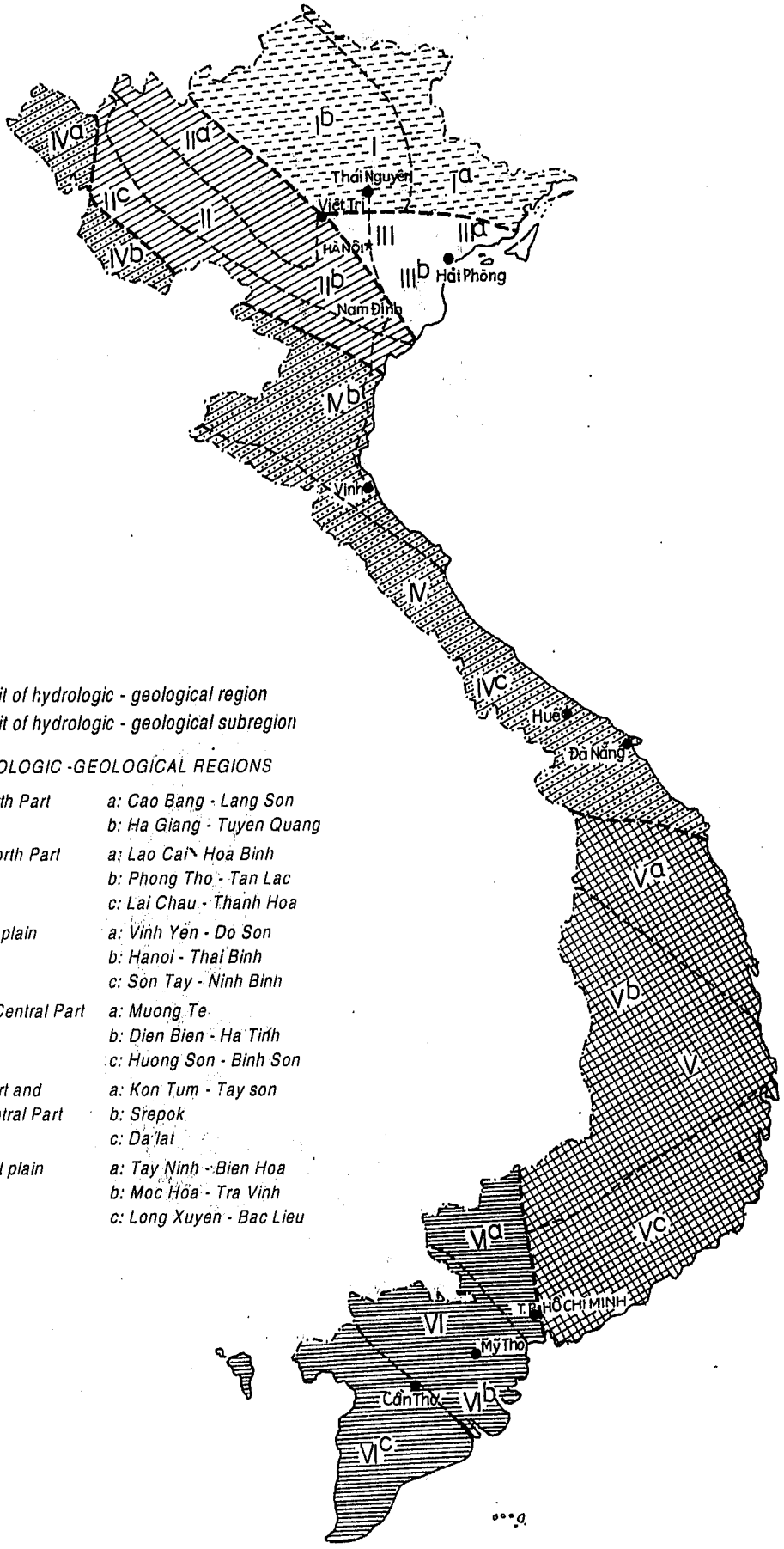

Fig. 2.10.1. Hydrologic - geological zoning map

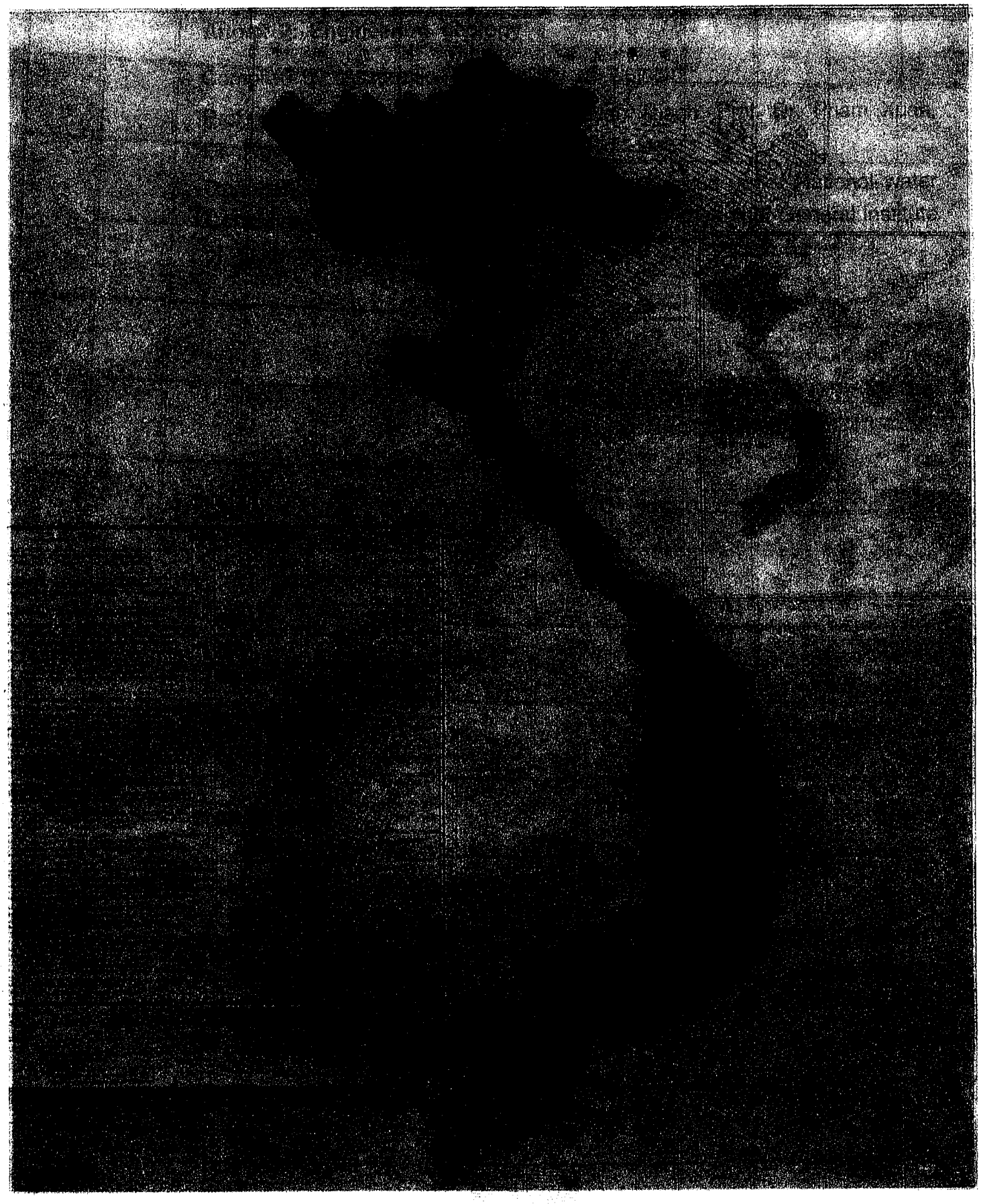

Fig. 2.10.2. Hydrologic - geological map

ANNEX 2.11
MINERALIZATION OF EARTH

This annex supplied some of comprehensive informations on mineralization of earth in Vietnam and which is used for reference document.

2.11.1 Characteristics of earth mineralization

1. Vietnam is under the humid tropic zone. Dry season is very evident in South Part but in North Part which is almost not one. Withered processe and earth creativity in both part, therefore they are also diferent: North Part is in humid condition, South Part is in inserted dry and humid one.
2. On terrain, territory Vietnam is 3 types:
   a. Low - lying region and plain: are deltas and coastal low - lying regions which occupied a considerable area.
   b. Hilly midland region: which only occupied a small part of territory area.
   c. Mountainous region: occupied almost area of territory which is mountainous terrain.

2.11.2 Classification of earth

As the other humid tropic zones, earth and rock on territory Vietnam are very various, there are many different classificated manners.

As following that is classification based on collection and clasification on zoning materials of earth with scale 1/1,000,000 and 1/50,000 and studies on formed process and features of earth.

1. Soil on mountain and highland
   a. Types of alite soil
      - Alite dust soil on high mountain
      - Bauxite contained within alite soil on basaltic rock
   b. Types of ferrolite soil

- Red yellow ferrolite dust soil on mountain
- Red brown ferrolite soil on neutral and base rock
- Red brown ferrolite soil on limestone (tera - rosa)
- Yellow red ferrolite soil on metamorphosed rock
- Red yellow ferrolite soil on acid magma rock
- Light yellow ferrolite - sialite soil on sandstone

c. Limestone mountain

2. Soil on hill and sloped side

a. Types of exhauted degraded ferrolite soil

- Exhauted, less expanded ferrolite soil
- Turned Gley exhauted, grey ferrolite soil
- Brown on ancient alluvial ferrolite soil
- Exhauted ferrolite soil on raw chipping rock

b. Types of margalite - ferrolite soil

- Grey margalite - ferrolite soil on carbonate rocks
- Black margalite - ferrolite soil on tuff

c. Gravel denuded-eroded soil.

3. Soil in plain and low - lying zone

- Coastal sand
- Alluvial soil
- Mangrove and salt soil
- Salt contacted soil
- Alluvial soil
- Slushy soil
- Peat soil

The description of soil types which is presented on ducument /1/, given as following.

2.11.3 Earth mineralization map

Earth mineralization map with scale 1/2,000,000 is showed in figure 2.11.1 (reduced in size)

Document sources

[1] "Constructed technical conditions for works with foreign investment capital in SR Vietnam" (Drafted) - by Institute for building standardization, 1991
Annex 4: Mineralization of earth

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