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APPENDIX A

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

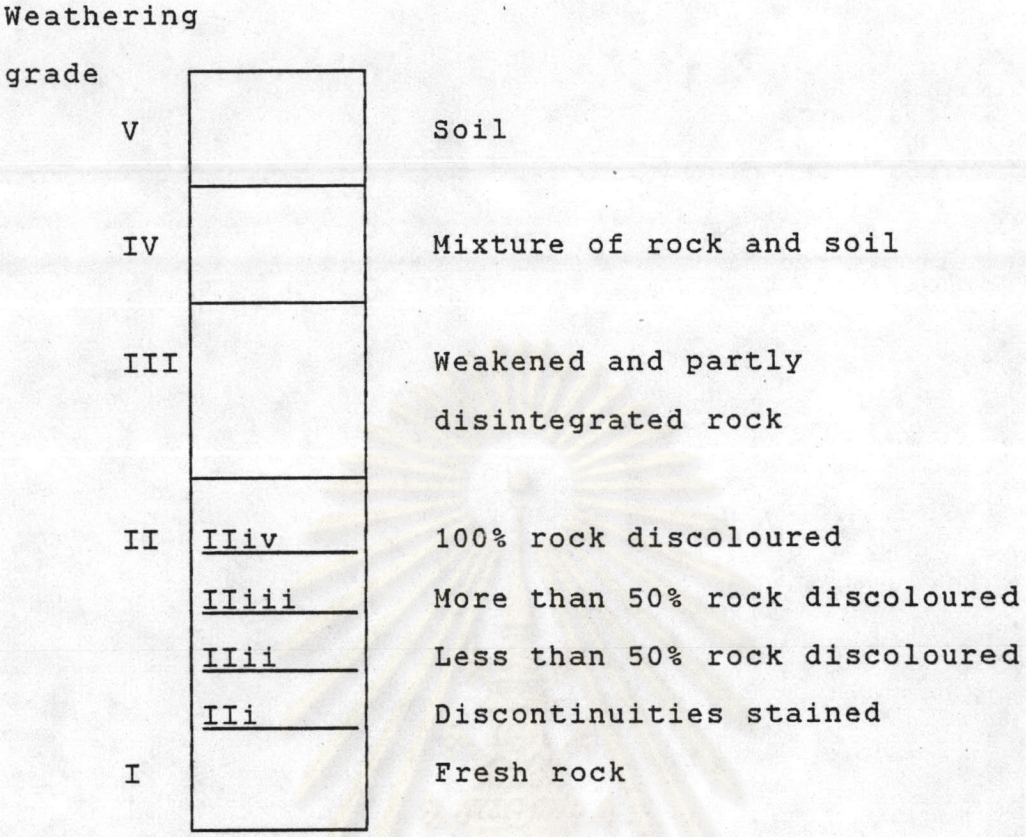

Figure 1A-1. The sequence of mass weathering grades used in field mapping (After Baynes et al., 1978).

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Table 1A-1. Diagnostic characters frequently used to define the various grades of granite (after Lee and de Freitas, 1989).

Weathering grade/zone		F	SW	MW	HW	CW	RS
Rock material	Visual recognition					Presence of original texture (11)	
		Degree of discolouration of rock material (9)					
		Degree of chemical decomposition of biotite and feldspar (8)				Presence of humus and roots (2)	
		Degree of physical disintegration (1)					
	Mechanical recognition				Disintegration of material in water (slakability) (6)		
		Relative rock material strength (6)					
					Breakability of NX core in the hand (5)		
		Friability (5)					
		Relative hardness by hammer blow (3)					
		Schmidt hammer value (3)					
					Method of hand excavation (3)		
		Degree of plucking of individual grains (2)					
						Degree of penetration of geological pick or knife (2)	
						Hand penetrometer value (2)	
Rock mass	Visual recognition	Degree of discolouration along joint plane (10)					
						Presence of original structure (7)	
		Rock to soil ratio (6)					
		Degree of weathering along joint plane (5)					
		Angularity of corestone (3)					
		Opening of joint (2)					
	Engineering recognition	NX core recovery (4)					
		Relative rock mass permeability (4)					
		RQD (1)					

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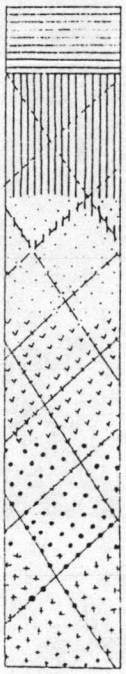
Table 1A-2. The weathering scheme for granitic masses (After Lee and de Freitas, 1989)

1. Typical weathering profile of Korean granites	2. Classification: Zone	Term	Abbreviation	3. Description: Distribution of rock material within joint-bounded block and its grade	Simplified expression[1]
	VI	Residual soil	RS	Most material is RS grade	RS^{Cr}_{Pu} (HP 0.3) (SL 4)
	V	Completely Weathered	CW	Most material is CW grade	CW^{Cc}_{Pc} (SL 2)
	IV	Highly Weathered	HW	Inner material is HW grade; outer material is HW or CW grade, occasionally RS grade	$HW^{Ch}_{Ps}90$ $CW^{Cc}_{Pc}10$ (Sh 18) (SL 1)
	III	Moderately Weathered	MW	Inner material is MW grade; outer material is MW or HW grade, occasionally CW grade	$MW^{Cm}_{Ps}90$ $HW^{Ch}_{Pm}10$ (SH 42) (SH 22)
	II	Slightly Weathered	SW	Inner material is SW grade; outer material is SW or MW grade.	$SW^{Cs}_{Ps}95$ $MW^{Cm}_{Pm}5$ (SH 55) (SH 45)
	I	Fresh	F	Inner material is F grade; outer material is F or SW grade.	$F^{Cf}_{Pf}95$ $SW^{Cs}_{Pf}5$ (SH 60)(SH 57)

Legend
RS granite
CW granite
HW granite
MW granite
SW granite
F granite

Note, the description shown in column 3 relates to the vertical profile shown in column 1 and the simplified expression of the description shown in column 3 also relates to the vertical profile shown in column 1. Column 3 is only a description of column 1 and does not specify the criteria for defining the zones I to VI.

[1] SH: Schmidt hammer rebound value; SL: Slaking class; HP: Hand penetrometer value (MPa).

Table 1A-3. The simple classification schemes of weathering state and decomposition grade equivalent (modified after Irfan and Powell. 1985, BSI, 1981 and GCO, 1984).

weathering state of rock material (After BS5930)		Decomposition grade equivalent(GCO manual 1984)	
Fresh	Fresh	Fresh	I
Discoloured	Partially discoloured	Slightly decomposed	II
	Completely discoloured	Moderately decomposed	III
Decomposed	Highly decomposed	Highly decomposed	IV
	completely decomposed	Completely decomposed	V
	Residual soil	Soil	VI

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Table 1A-4. The weathering scheme for granitic material (After Lee and de Freitas, 1989).

1. Classification				2. Description			
				Visual description			
Grade	*Term*	*Abbre-viation*	*Type of material*	*Degree of chemical decomposition*	*Log. symbol*	*Degree of physical disintegration*	*Log. symbol*
I	Fresh	F	Rock	All mineral constituents are sound.	CF	No evident microfracturing[1] (using ×10 magnification at most).	PF
II	Slightly weathered	SW	Rock	Plagioclases are occasionally slightly decomposed (gritty). Biotites are slightly decomposed and beginning to stain some of the surrounding minerals.	CS	Slightly microfractured (over 10 mm spacing). All microfractures and grain boundaries are tight.	PS
III	Moderately weathered	MW	Rock	Most of plagioclases and some potash feldspars are moderately decomposed (gritty). Biotites are moderately decomposed staining many of the surrounding minerals.	CM	Moderately microfractured (5–10 mm spacing). Most microfractures and grain boundaries are tight, but some of them may be slightly open.	PM
IV	Highly weathered	HW	Rock/ Soil	All plagioclases and some potash feldspars are highly decomposed (gritty to clayey) and most potash feldspars are moderately decomposed (gritty). Biotites are highly decomposed staining most rock minerals.	CH	Highly microfractured (2–5 mm spacing). Microfractures which are mainly grain boundaries tend to be slightly open.	PH
V	Completely weathered	CW	Soil	All plagioclases and most potash feldspars and biotites are completely decomposed (clayey), some potash feldspars are highly decomposed (gritty to clayey). Original texture is present.	CC	All microfractures and grain boundaries tend to be open. Original texture is present.	PC
VI	Residual soil	RS	Soil	All feldspars, biotites are completely decomposed (clayey). Original texture is absent.	CR	The existence of microfractures and grain boundaries are hardly distinguishable due to the absence of original texture	PR

[1] *Note*: not describing fracture and cleavage of minerals.

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Table 1A-5. British Standard and other acceptance values for test results on roadstone and concrete aggregates.

USE	TEST	TEST VALUE	AUTHORITY
C.R.	Bulk density	>2.6 g/cm³	Higginbottom in Anon. 1976
C.R.	Water absorption	<3%	Higginbottom in Anon. 1976
C.	Unconfined compressive strength	>34.5 MN/m²	Reynolds 1950
C.R.	Aggregate impact value	≯45%	British Standard 882:1973
		≯30%+	British Standard 882:1973
R.	Modified aggregate impact value	40% maximum*	Hosking & Tubey 1969
R.	Aggregate abrasion value	10% max. for difficult conditions	Anon. 1976c
		12% max.for average conditions	Anon. 1976c
R.C.	10% fines aggregate crushing value	50 kN min.	Hosking & Tubey 1969
		≮100 kN for wearing surfaces	British Standard 882:1973

C. concrete aggregates. R. road aggregates

* used in the assessment of low-grade aggregates

\+ for wearing surfaces

APPENDIX B

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Table 2B-1. Summary of tectonic and paleogeographic events of Thailand and continental Southeast Asia. (after Bunopas and Vella, 1992).

GEOLOGIC TIME SCALE			TECTONIC MOVEMENTS	SEDIMENTATION AND IGNEOUS ACTIVITY	STRUCTURAL DEVELOPMENT	TECTONIC EVENTS AND HISTORY
CENOZOIC		HOLOCENE	Latest crustal compression; First anticlockwise rotation (?)	Alluvials Young gravels Young basalts	Uplift, bending of NS faults, westward thrust on old flts	St.II NEOTECTONICS
		PLEISTOCENE	East-west extension, slight clockwise rotation.	Basalts & old Gravels Local marine transgression (Gulf).	Deep seated north-south fractures.	St.I
	2.5					
	NEOGENE	PLIOCENE				
	7					
		MIOCENE				
	26					
	PALEOGENE	OLIGOCENE	12 degrees clockwise rotation. Opening of Gulf. Subsidence of Gulf and intermontaine valleys.	Continental facies: fine grained clastics and organic deposits in the intermontaine basins. Paralic facies in the Gulf. Granites 50-70 Ma.	Extensional faults. Horsts & Grabens but little uplift. Moderate uplift of Khorat Plateau.	Stage II MESOTECTONICS
	38					
		EOCENE				
	54					
		PALEOCENE				
	65					
MESOZOIC		CRETACEOUS	Progressive clockwise rotation. Post-collision westward underthrusting of Shan-Thai by Indochina	Granites 70-93 Ma. Khorat evaporites	Westward overthrusts west of former Sukhothai arc. Westward underthrust east side of Nan Geosuture. NW trending sinistral faults	Stage I
	136			Molasse (Khorat redbeds) east of Western Mountains. Triassic-Jurassic marine beds to west. Granites 120-190 Ma & associated TJ volcs.		
		JURASSIC				
	190					
		TRIASSIC	Collision of Shan-Thai and Indochina	WEST sh. lm. / CENTRAL lm.sh. gwk. ss. / EAST gwk. cgl.	West dipping isoclinal folds; eastward overthrust in Sukhothai Fold Belt.	StageIV
	225		Spreading bet. S-T and Ind. paired subduction	Granites and P-T volcs.		
PALEOZOIC		PERMIAN	Mainly passive margins on Shan-Thai and Indochina; wide ocean between both.	Mainly limestone some tuff. ss. / lst. sh. ss.	Moderate deformation, distinct fold cleavage common west dipping isoclinal folds.	Stage III
	280		Start of clockwise rotation of Shan-Thai immediately after rifting from Gondwana.	Diamictites / Flysch, volc. and redbeds / Shelf facies		Stage II PALEOTECTONICS
		CARBONIFEROUS		Carbonate shelf facies cont. to lower Perm. / Sukhothai volcanic arc assemblages / Passive continental margins of Indochina (?)		
	345					
		DEVONIAN	Sukhothai margin active		Severe deformation; metamorphosed to schist and phyllite in Central belt.	Stage I
	395		Sukhothai volcanic arc forms on edge of Gondwana.			
		SILURIAN	Part of Gondwana west (now east) of Shan-Thai rifts away.		Fold-thrust belt at edge of Western Mountains	
	430					
		ORDOVICIAN	Peneplained area of Gondwana flooded by early Paleozoic transgression.	Carbonate and Orthoquartzite	Open asymmetric folds, axial planes dipping east.	Stage II ARCHEOTECTONICS
	500					
		CAMBRIAN		Orthoquartzite	Common mesoscopic folds. Minor metamorphism	
	570					
PROTEROZOIC		PRECAMBRIAN	Shan-Thai peneplained while part of the Gondwana interior.	Amphibolite facies gneiss, schist, calcsilicate and marble.	Eastward dipping isoclinal folds. Common mesoscopic and microscopic folds.	Stage I ARCHEOTECTONICS

PALEOTETHYS I ? PALEOTETHYS ? TETHYS ? INDEAN OCEAN

SHAN-THAI and Indochina united as S.E Asian Peninsula, and joined to South China

SHAN-THAI and Indochina separate microcontinents

SHAN-THAI on active margin of Gondwana

SHAN-THAI a part of Gondwana interior

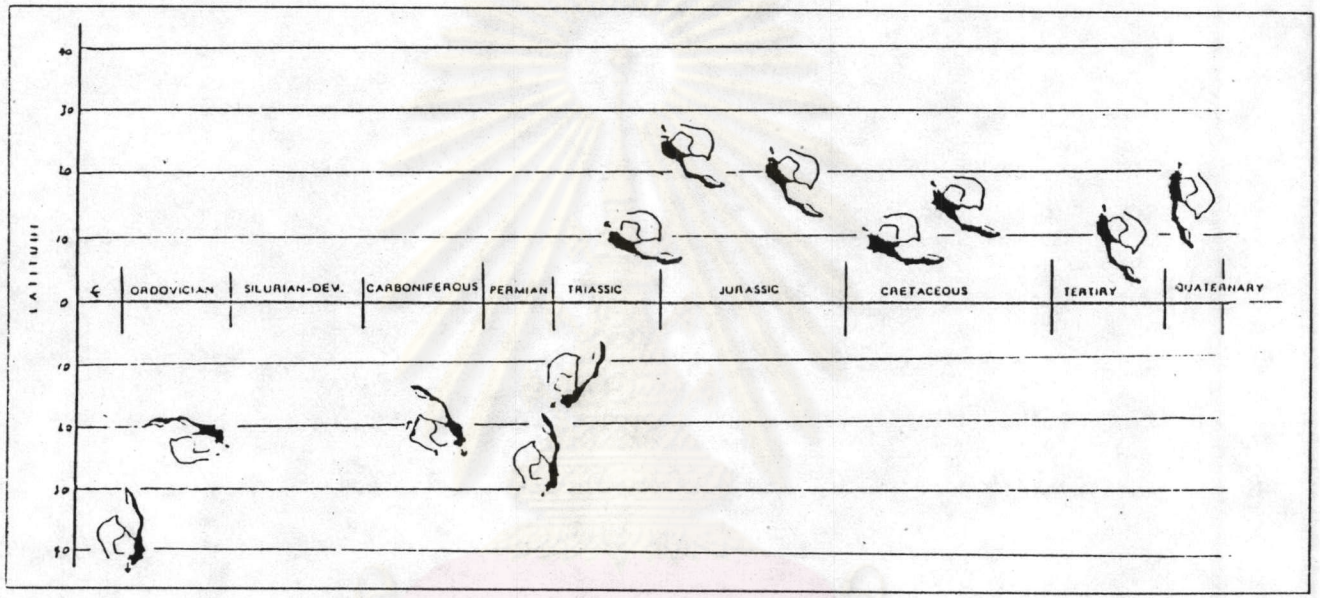
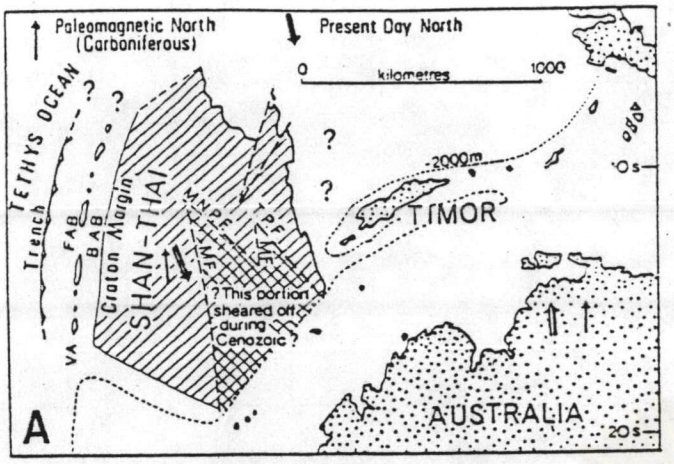
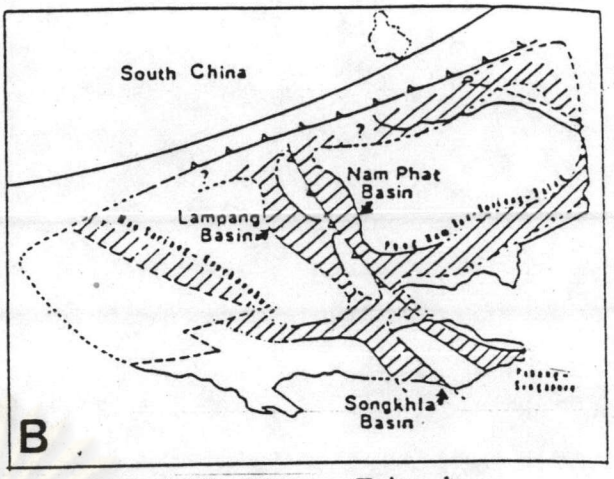


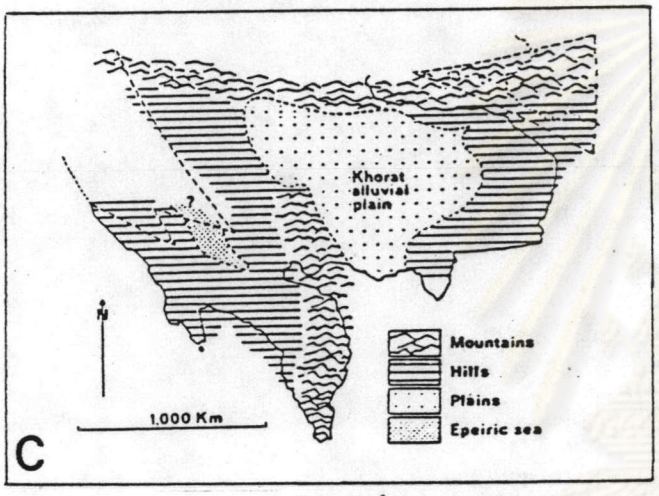
Figure 2B-1. Showing approximate positions and the rotation of Shan-Thai from early Ordovician to Quaternary. Configurations of Shan-Thai (black) and Indochina (unshaded are used only for comparison to present day, where both got into the same picture in Late Triassic. (after Bunopas and Vella, 1992).



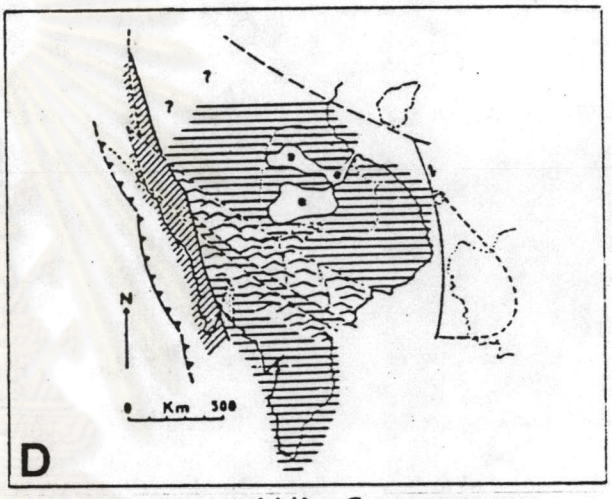
Early Carboniferous



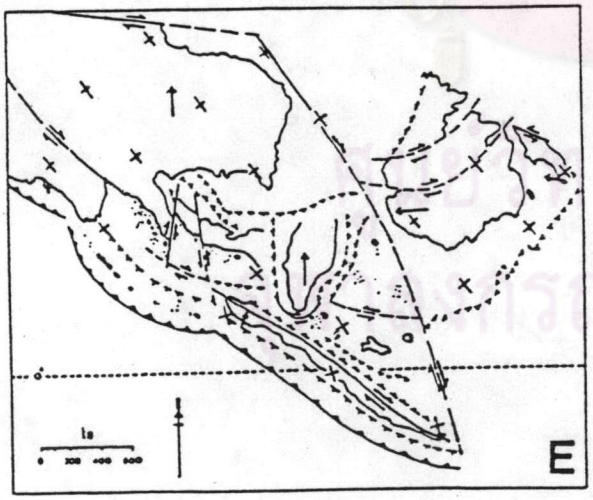
Middle-Upper Triassic



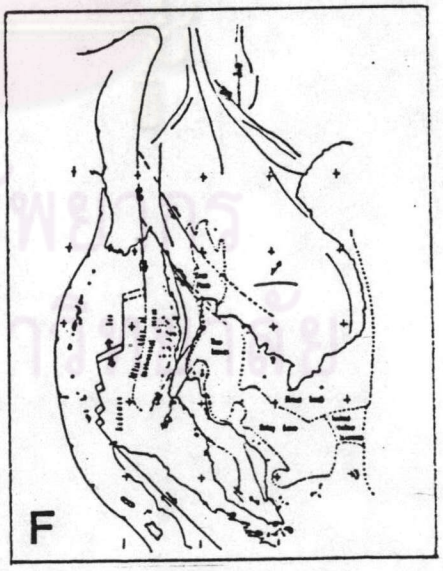
Jurassic



Early - Middle Cretaceous



Late Cretaceous to Early Tertiary



Present

Figure 2B-2. Reconstruction of Thailand during : A.Early Carboniferous ; B. Middle to Upper Triassic ; C.Jurassic ; D.Early to Middle Cretaceous ; E.Late Cretaceous to Early Tertiary ; F.Present paleogeographic sketch map. (after Bunopas and Vella, 1992).

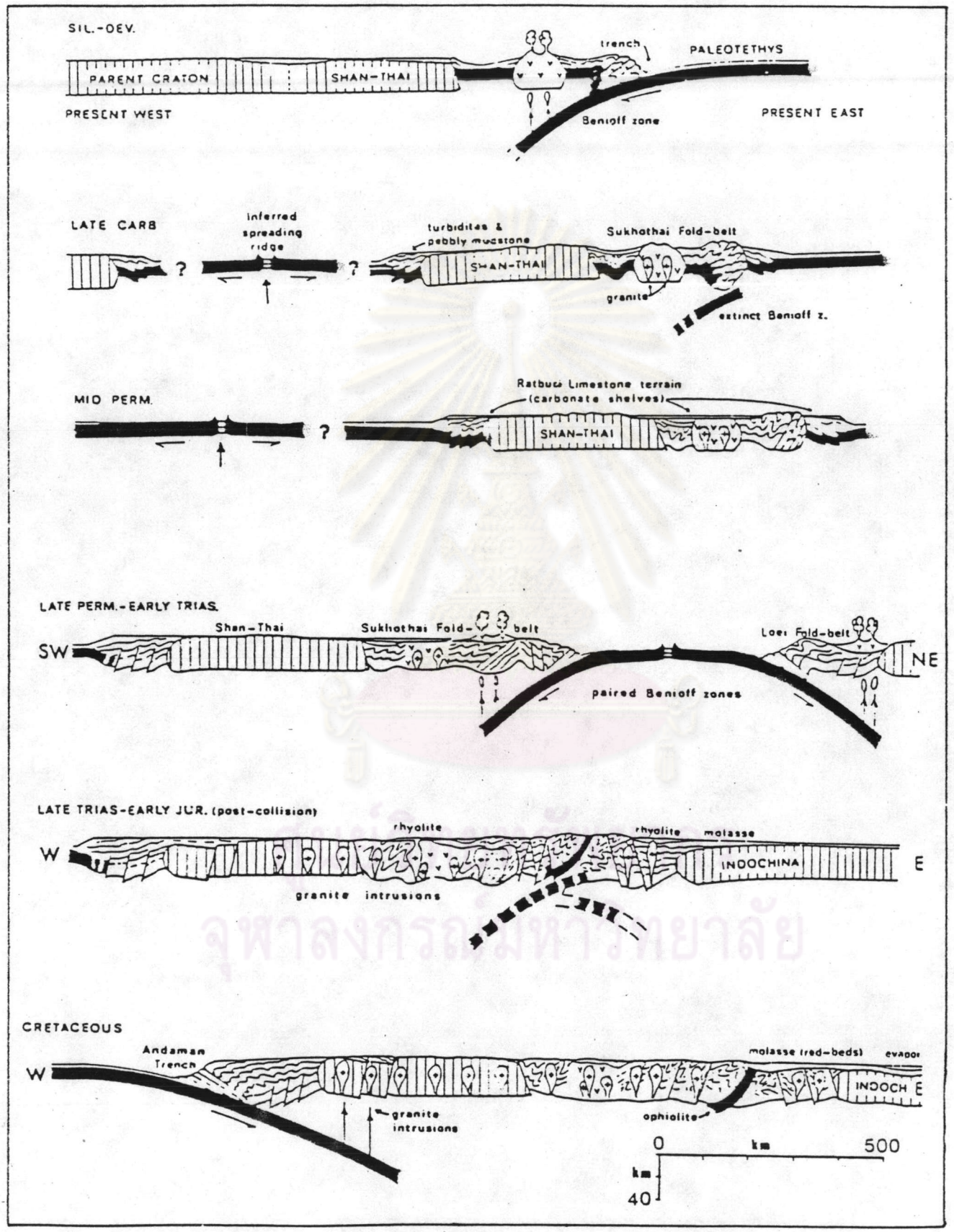


Figure 2B-3. Plate tectonic history of Thailand, consisting of Shan-Thai (west) and Indochina (east) (after Bunopas and Vella, 1992).

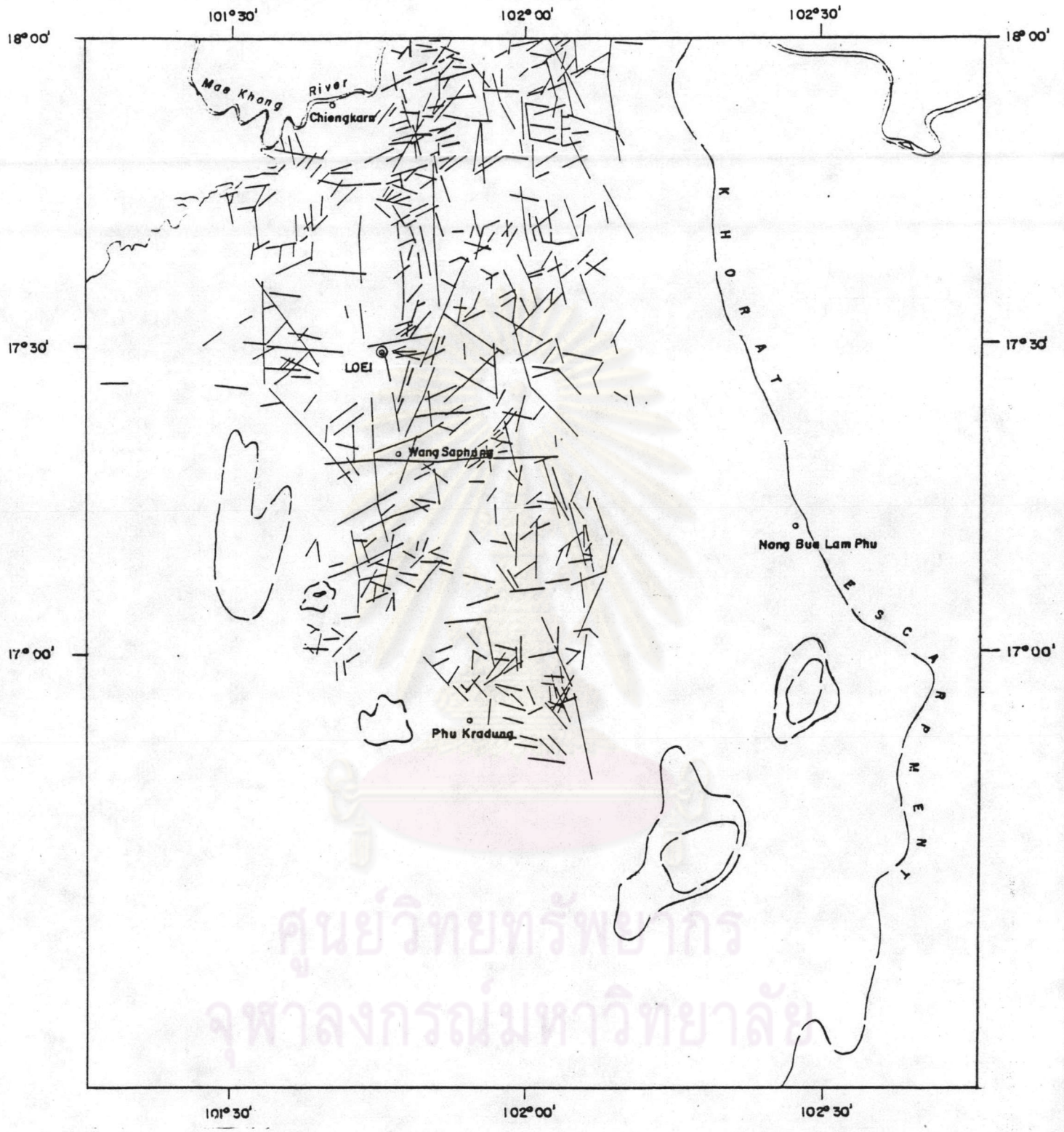


Figure 2B-4. All direction lineaments map of Loei Province (interpreted from - enhanced landsat imagery).

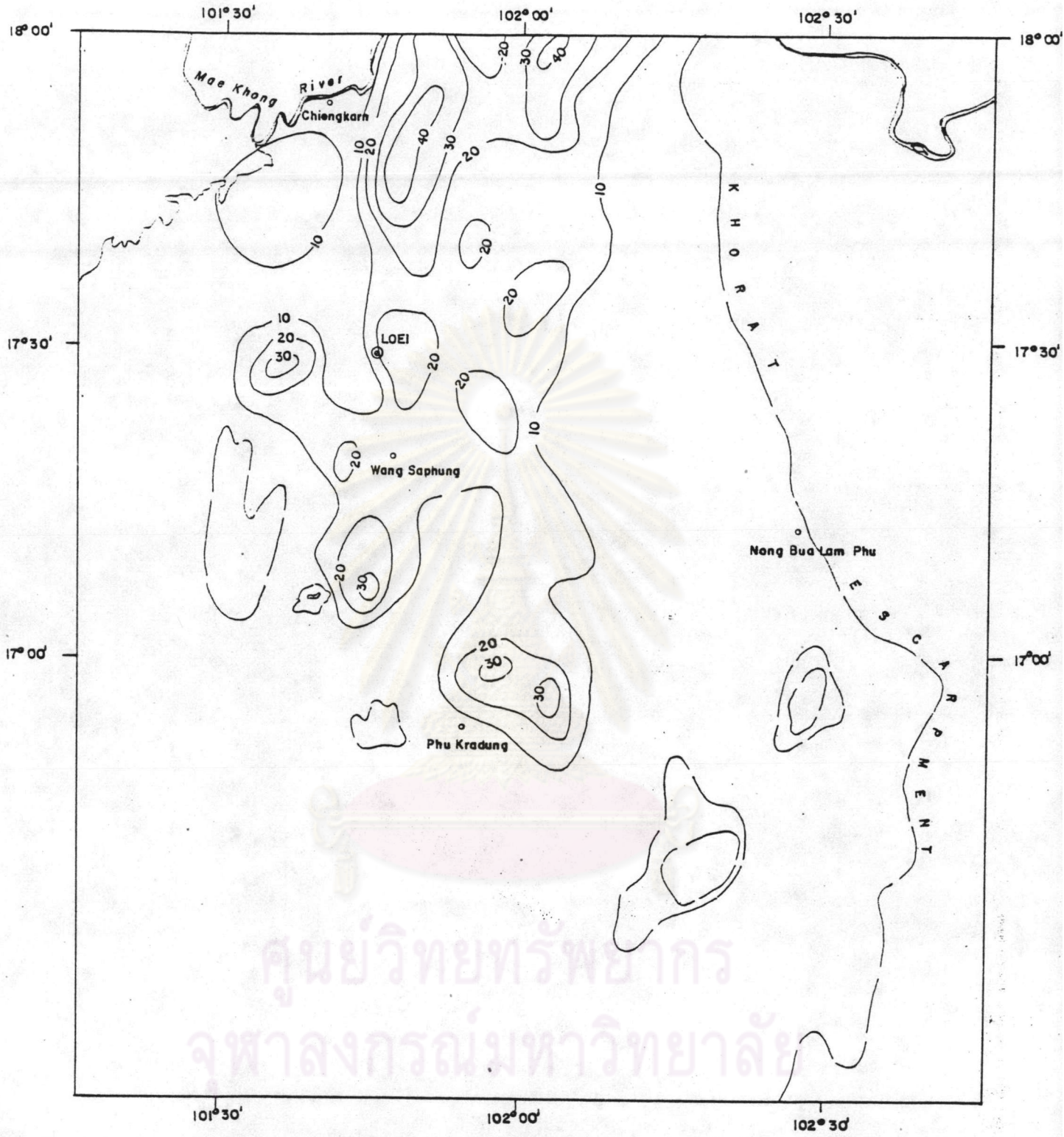


Figure 2B-5. All direction lineaments density contour map of Loei Province (interpreted from enhanced landsat imagery).

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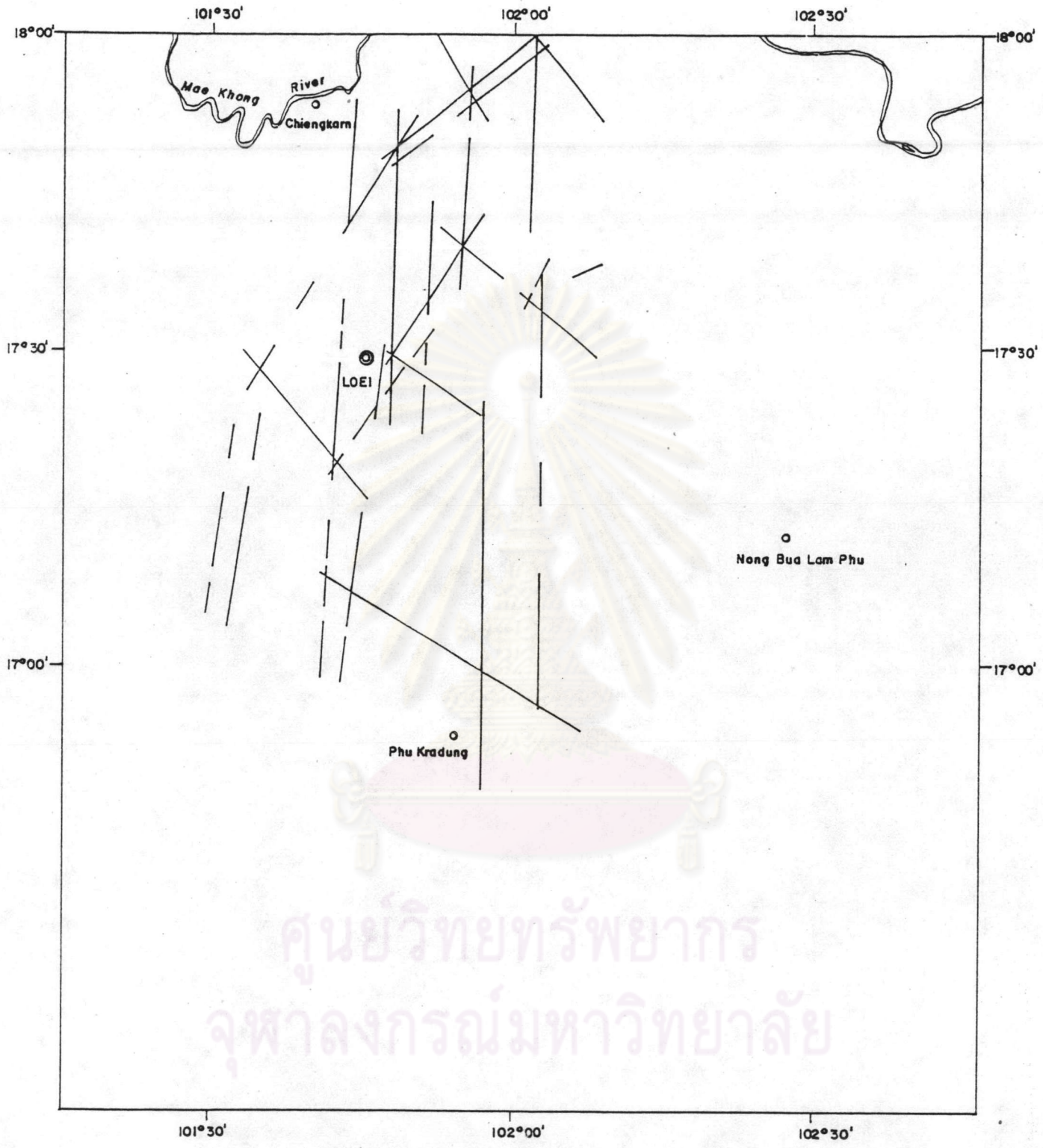

Figure 2B-6. Major linear structure of the Loei-Chiang Khan area, delineated from lineaments density contour map (Figure 2-9).

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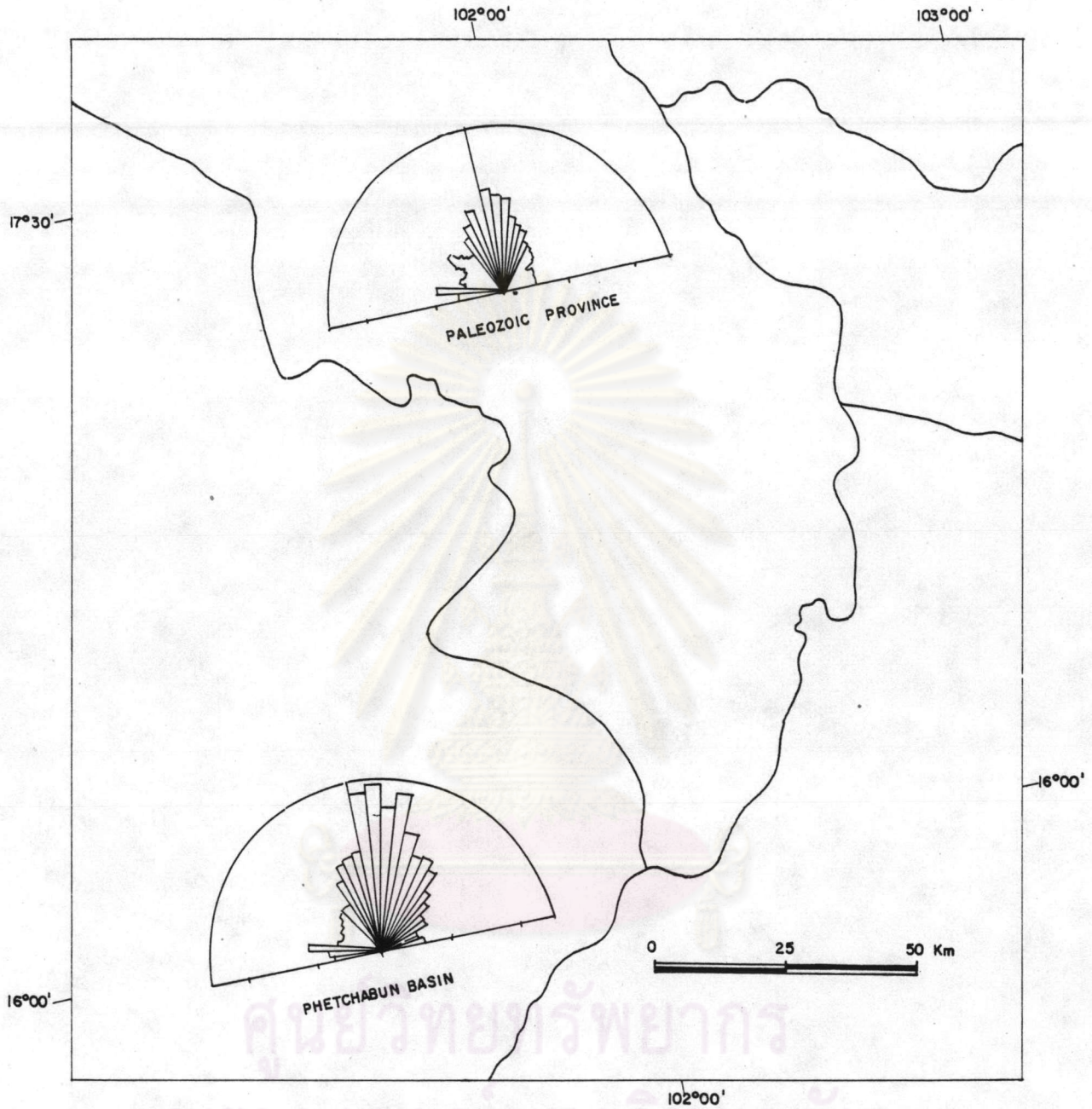

Figure 2B-7. The predominant trends of lineaments in the Loei structure and adjacent areas (after Thanoamsap, 1987).

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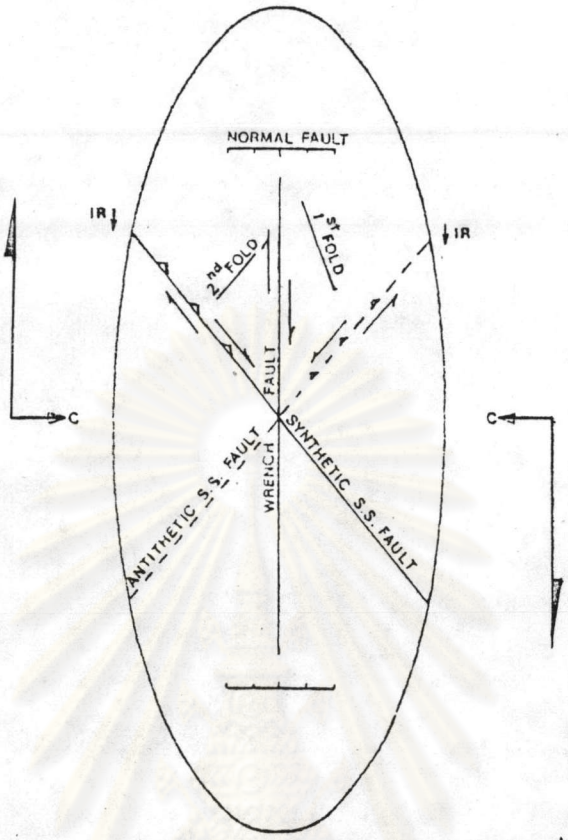

Figure 2B-8. The strain ellipsoid of right lateral which produces simple parallel wrenching (from Thanoamsap, 1987 cited after Harding, 1973 ; Ramsey, 1983).

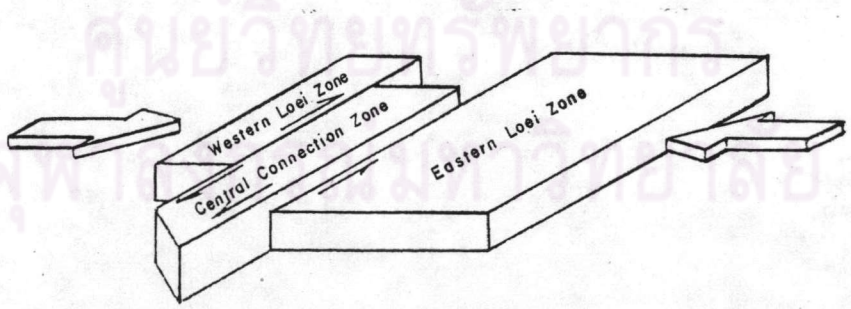

Figure 2B-9. Result of wrench tectonics of the Loei structure constructed base on Sylves and Smith's concept, 1976 (after Thanomsap, 1987).

APPENDIX C

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Table 3C-1. Physical properties of Phu Sanao Granites, Loei Province.

Sample No.	Can No.	Wt of Can (g)	Wt of Can+ Nat. sample (g)	Wt of Can+ dry sample (g)	Wt of Can+ Sat. Sample (g)	Bouyance Wt Sat. Sample (g)	Sat. Moisture Content (%)	Bulk Density Saturated (g/cc)	Bulk Density Dry (g/cc)	Porosity (%)
ps-1	1	21.01	405.25	404.65	406.06	132.37	0.37	2.91	2.90	1.10
ps-2	2	21.51	455.00	454.30	456.46	149.48	0.50	2.91	2.90	1.40
ps-3	3	20.80	554.27	553.97	556.31	185.00	0.44	2.89	2.88	1.30
ps-4	1	21.00	510.28	509.57	513.14	169.05	0.73	2.91	2.89	2.10
ps-5	3	20.43	513.27	512.55	518.28	169.25	1.16	2.94	2.91	3.40
ps-5	4	20.60	519.56	518.84	524.26	169.41	1.09	2.97	2.94	3.20
ps-6	2	21.48	485.21	484.59	490.66	159.15	1.31	2.95	2.91	3.80
ps-6	3	20.42	480.79	480.16	486.03	160.00	1.28	2.91	2.87	3.70
ps-7	4	20.61	497.69	496.92	506.98	163.95	2.11	2.97	2.91	6.10
ps-7	5	22.47	476.85	476.18	485.78	155.55	2.12	2.98	2.92	6.20
ps-8	6	20.94	515.55	514.08	519.67	169.98	1.13	2.93	2.90	3.30
ps-8	7	22.18	547.05	545.51	552.18	182.18	1.27	2.91	2.87	3.70
ps-9	1	21.21	443.02	442.04	449.59	145.90	1.79	2.94	2.88	5.20
ps-10	2	21.51	468.39	466.92	474.19	155.15	1.63	2.92	2.87	4.70
ps-11	3	20.46	504.92	503.96	506.22	161.90	0.47	3.00	2.99	1.40
ps-11	4	20.63	550.11	549.08	551.35	181.62	0.43	2.92	2.91	1.20
ps-12	1	21.01	521.16	520.69	523.28	171.65	0.52	2.93	2.91	1.50
ps-12	2	21.49	546.61	546.07	548.42	179.03	0.45	2.94	2.93	1.30
pl-18	3	20.45	446.00	445.98	446.50	148.50	0.12	2.87	2.87	0.40
pl-18	4	20.64	421.50	421.20	421.54	138.58	0.08	2.89	2.89	0.20
pl-19	3	20.45	468.25	466.56	471.27	152.35	1.06	2.96	2.93	3.10
pl-20	4	20.64	414.50	413.51	418.05	136.25	1.16	2.92	2.88	3.30
pl-21	5	22.48	535.66	534.00	542.81	175.05	1.72	2.97	2.92	5.00
pl-21	6	20.95	504.84	504.13	511.66	166.15	1.56	2.95	2.91	4.50
kd-24	5	22.50	390.00	388.80	390.45	125.70	0.45	2.93	2.91	1.30
kd-24	6	20.95	334.00	334.00	335.50	107.45	0.48	2.93	2.91	1.40
kd-25	5	22.47	494.20	493.34	495.37	161.05	0.43	2.94	2.92	1.30
kd-25	1	21.02	545.87	544.69	546.81	178.45	0.40	2.95	2.93	1.20
kd-26	8	22.22	495.78	494.25	507.47	160.87	2.80	3.02	2.93	8.20
kd-26	9	22.06	464.12	462.71	474.39	150.76	2.65	3.00	2.92	7.70
kd-27	9	20.02	545.72	548.31	556.78	185.00	1.60	2.90	2.86	4.60

Table 3C-2. Unconfined compressive strength of Phu Sanao granites, Loei Province.

Sample No.	length cm	diameter cm	volume cc	weight dry, g	weight wet, g	density dry,g/cc	density wet,g/cc	moisture content %	failure load,kN	UCS MN/sq.m	Porosity (%)
ps-1	10.72	5.47	251.92	653.68	655.31	2.59	2.60	0.25	296.00	125.96	0.60
ps-1.1	11.00	5.46	257.55	673.10	674.45	2.61	2.62	0.20	260.00	111.04	0.50
ps-1.2	5.53	5.46	129.48	338.47	339.12	2.61	2.62	0.19	340.00	145.21	0.50
ps-2.1	11.01	5.46	257.79	675.03	676.14	2.62	2.62	0.16	280.00	119.59	0.40
ps-2.2	5.46	5.46	127.84	332.33	332.95	2.60	2.60	0.19	344.00	146.92	0.50
ps-3	11.22	5.47	263.67	683.63	684.56	2.59	2.60	0.14	216.00	91.92	0.40
ps-4	11.11	5.47	260.80	680.36	682.19	2.61	2.62	0.27	268.00	114.17	0.70
ps-5	11.08	5.47	260.09	673.34	674.44	2.59	2.59	0.16	184.00	78.38	0.40
ps-6	5.67	5.48	133.49	343.20	344.55	2.57	2.58	0.39	176.00	74.76	1.00
ps-7	11.07	5.47	259.61	657.94	662.11	2.53	2.55	0.63	84.00	35.81	1.60
ps-8	11.08	5.48	260.74	671.06	674.12	2.57	2.59	0.46	108.00	45.87	1.20
ps-9	11.36	5.47	266.89	681.34	685.47	2.55	2.57	0.61	104.00	44.26	1.50
ps-9	5.70	5.47	133.88	339.06	341.26	2.53	2.55	0.65	108.00	45.96	1.60
ps-10	5.64	5.47	132.68	334.70	336.19	2.52	2.53	0.45	128.00	54.41	1.10
pl-18.1	11.05	5.48	260.09	677.45	678.36	2.60	2.61	0.13	352.00	149.51	0.30
pl-18.2	5.42	5.48	127.84	332.78	333.17	2.60	2.61	0.12	360.00	152.63	0.30
pl-18.3	11.03	5.47	258.79	677.35	678.23	2.62	2.62	0.13	360.00	153.47	0.30
pl-18.4	10.91	5.47	255.97	670.76	671.71	2.62	2.62	0.14	344.00	146.65	0.40
pl-18.5	5.68	5.47	133.42	342.63	343.05	2.57	2.57	0.12	356.00	151.49	0.30
pl-19	5.71	5.47	134.12	342.18	344.17	2.55	2.57	0.58	132.00	56.22	1.50
pl-19(2)	5.55	5.47	130.19	336.38	337.66	2.58	2.59	0.38	208.00	88.67	1.00
pl-20	11.14	5.47	262.09	674.54	676.80	2.57	2.58	0.34	132.00	56.12	0.90
pl-21	5.31	5.48	125.13	314.59	316.64	2.51	2.53	0.65	88.00	37.34	1.60
pl-22	10.95	5.47	257.21	664.35	666.89	2.58	2.59	0.38	104.00	44.26	1.00
kd-24	11.13	5.47	261.20	678.95	680.26	2.60	2.60	0.19	528.00	224.89	0.50
kd-25	11.09	5.47	260.67	673.68	675.24	2.58	2.59	0.23	624.00	265.53	0.60
kd-26.1	5.62	5.48	132.19	329.73	332.12	2.49	2.51	0.72	192.00	81.55	1.80
kd-26.2	10.27	5.47	241.56	608.84	612.35	2.52	2.53	0.58	148.00	62.92	1.50

Table 3C-3. LOS ANGLES ABRASIVE TEST OF GRANITES AND WEATHERED GRANITE LOEI PROVINCE.

Sample No.	Initial Wt g	Wt 100 g	Wt 500 g	% of Wear	UF
ps-1	4999.00	4456.50	2805.50	43.88	0.25
ps-3	5000.00	4470.00	2730.00	45.40	0.23
ps-4	5000.00	4328.20	3001.00	39.98	0.34
ps-5	5000.00	4126.00	1630.50	67.39	0.26
	5000.00	4107.50	1666.50	66.67	0.27
ps-6	5000.00	4240.00	2025.00	59.50	0.26
	5000.00	4247.00	2050.00	59.00	0.26
ps-7	5000.00	3873.50	1684.00	66.32	0.34
	5000.00	3820.00	1490.00	70.20	0.34
ps-8	5007.00	4307.00	1824.00	63.57	0.22
	5003.00	4150.00	2136.00	57.31	0.30
ps-9	5000.00	3733.50	1350.50	72.99	0.35
ps-10	4996.00	3749.50	1457.50	70.83	0.35
ps-11	5000.00	4495.50	2870.00	42.60	0.24
	5000.00	4501.00	2886.00	42.28	0.24
ps-12	5025.00	4143.00	2595.00	48.36	0.36
ps-13	5000.00	4340.00	2364.00	52.72	0.25
pl-18	4997.00	4574.50	3186.50	36.23	0.23
pl-19	5008.00	4129.00	1805.00	63.96	0.27
pl-20	5000.00	4016.50	2968.50	40.63	0.48
pl-21	5000.00	3609.00	1247.00	75.06	0.37
	5000.00	3626.00	1197.00	76.06	0.36
kd-24	4999.00	4716.50	3716.50	25.66	0.22
kd-25	5000.00	4714.00	3680.00	26.40	0.22
kd-26	5000.00	2637.00	830.00	83.40	0.57
	5000.00	2953.50	556.50	88.87	0.46
kd-27	5005.00	3820.00	1487.00	70.29	0.34

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Table 3C-4. SLAKE DURABILITY INDEX GRANITES AND WEATHERED GRANITES, LOEI PROVINCE

Sample No	Wi	W1	W2	Id1	Id2	AveId1	AveId2
ps-1	384.04	382.78	380.31	99.67	99.03	99.67	99.03
PS-2	432.55	430.46	428.26	99.52	99.01	99.52	99.01
ps-4	487.36	486.60	485.90	99.84	99.70	99.84	99.70
ps-5	543.13	536.42	533.08	98.76	98.15	-	-
	465.86	459.34	456.71	98.60	98.04	98.68	98.09
ps-6	459.97	455.29	453.10	98.98	98.51	-	-
	463.18	457.09	453.30	98.69	97.87	98.83	98.19
ps-7	453.39	448.26	440.28	98.87	97.11	-	-
	476.18	470.56	464.60	98.82	97.57	98.84	97.34
ps-8	456.76	448.88	445.28	98.27	97.49	-	-
	523.56	515.43	510.40	98.45	97.49	98.36	97.49
ps-9	445.74	439.71	433.25	98.65	97.20	98.65	97.20
ps-10	457.95	447.64	441.57	97.75	96.42	97.75	96.42
ps-11	468.71	465.43	462.13	99.30	98.60	-	-
	543.53	539.64	536.75	99.28	98.75	99.29	98.67
ps-12	433.07	430.81	427.91	99.48	98.81	-	-
	499.02	494.45	492.63	99.08	98.72	99.28	98.76
ps-13	470.87	467.85	466.19	99.36	99.01	-	-
	384.99	382.85	380.14	99.44	98.74	99.40	98.87
pl-18	400.72	398.57	364.42	99.46	90.94		
	425.42	423.57	422.68	99.57	99.36	99.51	95.15
pl-19	392.92	386.42	381.12	98.35	97.00	98.35	97.00
pl-20	446.07	440.15	424.64	98.67	95.20	98.67	95.20
pl-21	509.25	489.19	449.68	96.06	88.30	-	-
	479.56	459.13	472.68	95.74	98.57	95.90	93.43
kd-24	366.20	364.90	364.42	99.65	99.51	-	-
	313.52	312.52	312.09	99.68	99.54	99.66	99.53
kd-25	523.86	522.27	521.32	99.70	99.52	-	-
	484.86	482.60	481.40	99.53	99.29	99.62	99.40
kd-26	440.64	422.50	410.10	95.88	93.07	-	-
	471.99	453.24	441.75	96.03	93.59	95.96	93.33

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Table 3C-5. Point load strength index of Phu Sanao granites, Loei Province.

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
ps-1	1	43.50	138.00	10.32	9.30	5.10
	2	48.50	90.00	5.41	5.20	
	3	54.50	180.00	8.57	9.00	
	4	55.00	180.00	8.57	9.00	
	5	56.50	153.00	7.16	7.50	
	6	55.00	111.00	5.19	5.50	
	7	46.00	70.00	3.10	3.00	
	8	45.00	80.00	3.74	3.60	
	9	52.00	25.00	1.67	1.71	
	10	56.00	135.00	9.43	10.00	
	11	63.00	85.00	4.45	4.80	
	12	64.00	77.00	3.47	3.80	
	13	51.00	142.00	5.06	5.10	
	14	64.00	110.00	3.80	4.30	
	15	50.00	70.00	3.81	3.81	
	16	37.50	120.00	4.14	3.65	
	17	59.00	100.00	5.66	6.15	
	18	45.00	116.00	11.67	10.80	
	19	61.00	90.00	3.66	4.00	
	20	53.50	80.00	5.59	5.70	
	21	56.50	120.00	4.56	4.90	
	22	54.50	113.00	5.59	5.70	
ps-3	1	42.00	210.00	16.84	14.70	10.80
	2	46.00	100.00	6.69	6.20	
	3	51.00	135.00	7.34	7.50	
	4	41.00	145.00	12.20	10.70	
	5	45.00	185.00	12.92	12.00	
	6	41.00	200.00	16.83	14.50	
	7	41.00	145.00	12.20	10.90	
	8	44.00	130.00	9.50	8.90	
	9	55.00	155.00	7.25	7.80	
	10	48.00	230.00	14.12	14.00	
	11	46.00	140.00	9.36	9.00	
	12	48.00	210.00	12.89	12.50	
	13	44.00	170.00	12.42	11.50	
	14	39.00	150.00	13.95	11.80	
	15	41.00	135.00	11.36	10.00	
	16	49.00	151.00	8.90	8.85	
	17	43.00	180.00	13.77	12.00	
	18	48.00	185.00	11.36	11.10	
	19	41.00	140.00	11.78	10.70	
	20	48.00	160.00	9.82	9.50	

Table 3C-5. (Cont.)

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
ps-4	1	48.00	80.00	4.91	4.80	4.57
	2	59.00	100.00	4.06	4.50	
	3	59.00	102.00	4.15	4.55	
	4	39.00	40.00	3.72	3.30	
	5	51.00	98.00	5.33	5.35	
	6	56.00	142.00	6.41	7.10	
	7	57.00	71.00	3.09	3.30	
	8	62.00	130.00	4.78	5.60	
	9	47.00	73.00	4.68	4.90	
	10	35.00	113.00	13.05	9.90	
	11	54.00	113.00	5.48	5.70	
	12	60.00	70.00	2.75	2.95	
	13	54.50	42.00	2.00	2.10	
	14	50.00	100.00	5.66	5.66	
	15	47.50	150.00	9.41	9.10	
	16	57.50	74.00	3.17	3.40	
	17	57.50	80.00	3.42	3.65	
	18	42.00	42.00	3.37	2.95	
	19	45.00	45.00	3.14	2.75	
	20	39.00	39.00	3.63	3.25	
ps-5	1	66.50	71.00	2.27	2.60	2.85
	2	70.00	120.00	3.46	3.60	
	3	55.50	109.00	5.01	5.50	
	4	50.50	47.00	2.61	2.60	
	5	76.50	50.00	1.21	1.42	
	6	56.00	41.00	1.85	1.90	
	7	49.50	54.00	3.12	3.10	
	8	61.00	64.00	2.43	2.60	
	9	74.50	55.50	1.41	1.70	
	10	69.50	70.00	2.05	2.40	
	11	64.00	33.00	1.14	1.32	
	12	63.00	48.00	1.71	1.90	
	13	48.00	78.00	4.79	4.60	
	14	65.00	31.00	1.04	1.12	
	15	54.50	78.00	3.72	3.95	
	16	51.50	82.00	4.37	4.50	
	17	48.00	53.00	3.25	3.10	
	18	61.50	72.00	2.69	2.85	
	19	55.50	97.00	4.46	4.75	
	20	64.50	103.00	3.50	3.95	
	21	49.00	53.00	3.12	3.05	
	22	60.50	35.00	1.35	1.45	

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Table 3C-5. (Cont.)

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
ps-6	1	40.00	25.00	2.21	1.89	2.50
	2	43.00	30.00	2.30	2.01	
	3	41.00	10.00	0.84	0.74	
	4	44.00	31.00	2.27	2.10	
	5	53.00	68.00	3.42	3.55	
	6	56.00	58.00	2.62	2.73	
	7	57.00	50.00	2.18	2.39	
	8	47.50	52.00	3.26	3.15	
	9	56.00	14.00	0.63	0.67	
	10	41.00	61.00	5.13	4.70	
	11	35.00	10.00	1.15	0.95	
	12	48.00	35.00	2.15	2.10	
	13	51.00	21.00	1.14	1.15	
	14	37.00	39.00	4.03	3.45	
	15	38.00	42.00	4.11	3.65	
	16	38.00	41.00	4.02	3.60	
	17	52.00	63.00	3.30	3.40	
	18	53.00	43.00	2.17	2.20	
	19	65.00	82.00	2.75	2.95	
	20	38.00	28.00	2.74	2.50	
ps-7	1	48.00	20.00	1.23	1.21	1.15
	2	57.00	30.00	1.31	1.39	
	3	58.00	9.00	0.38	0.39	
	4	37.00	3.00	0.31	-	
	5	47.00	19.00	1.22	1.19	
	6	35.00	2.00	0.23	-	
	7	41.00	16.00	1.35	1.22	
	8	63.00	18.50	0.66	0.74	
	9	47.50	15.00	0.94	0.90	
	10	50.00	23.00	1.30	1.30	
	11	61.00	24.00	0.91	0.99	
	12	41.00	9.50	0.80	0.76	
	13	55.00	14.00	0.65	0.73	
	14	52.00	9.00	0.47	0.48	
	15	58.00	36.00	1.51	1.68	
	16	47.00	18.00	1.15	1.11	
	17	67.00	63.00	1.99	2.39	
	18	62.00	30.00	1.10	1.23	
	19	52.00	22.00	1.15	1.18	
	20	40.00	10.00	0.88	0.78	

Table 3C-5. (Cont.)

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
PS-8	1	71.50	75.00	2.08	2.40	2.63
	2	68.00	186.00	5.69	6.70	
	3	77.00	45.00	1.07	1.19	
	4	75.00	90.00	2.26	2.65	
	5	56.50	76.00	3.37	3.60	
	6	50.00	46.00	2.60	2.60	
	7	42.00	36.00	2.89	2.75	
	8	59.50	20.00	0.80	0.88	
	9	63.00	75.00	2.67	2.75	
	10	50.00	82.50	4.67	4.67	
	11	54.00	62.00	3.01	3.30	
	12	53.00	20.00	1.01	1.30	
	13	50.00	77.00	4.36	4.36	
	14	52.00	25.00	1.31	1.33	
	15	47.00	30.00	1.92	1.90	
	16	57.50	50.00	2.14	2.35	
	17	60.00	40.00	1.57	1.68	
	18	63.50	59.00	2.07	2.20	
	19	47.00	48.00	3.07	2.95	
	20	47.00	80.00	5.12	4.95	
	21	42.00	20.00	1.60	1.49	
	22	46.00	48.00	3.21	3.24	
	23	42.00	46.00	3.69	3.40	
ps-9	1	35.00	10.00	1.15	0.95	1.18
	2	57.00	25.00	1.09	1.18	
	3	48.00	25.00	1.54	1.51	
	4	42.00	18.00	1.44	1.36	
	5	46.00	43.00	2.87	2.75	
	6	55.00	35.00	1.64	1.71	
	7	37.00	5.00	0.52	0.46	
	8	45.00	0.00	0.00	0.00	
	9	49.00	20.00	1.18	1.17	
	10	53.00	29.00	1.46	1.50	
	11	44.50	27.00	1.93	1.85	
	12	33.00	8.00	1.04	0.82	
	13	56.50	23.00	1.02	1.09	
	14	54.00	14.00	0.68	0.69	
	15	34.00	10.00	1.22	1.01	
	16	37.00	8.00	0.83	0.70	
	17	45.00	30.00	2.10	1.93	
	18	51.00	25.00	1.36	1.39	
	19	41.00	10.00	0.84	0.74	
	20	50.00	11.00	0.62	0.62	

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Table 3C-5. (Cont.)

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
ps-11	1	44.50	150.00	10.72	8.95	7.00
	2	48.50	103.00	6.19	6.00	
	3	31.50	82.00	11.69	8.00	
	4	41.50	85.00	6.98	6.20	
	5	56.50	162.00	7.18	7.70	
	6	32.50	80.00	10.71	7.90	
	7	54.00	125.00	6.06	6.60	
	8	44.50	80.00	5.72	5.40	
	9	37.50	130.00	13.08	10.60	
	10	45.50	123.00	8.41	7.75	
	11	39.50	70.00	6.35	5.65	
	12	64.50	220.00	7.48	8.90	
	13	60.50	160.00	6.18	7.00	
	14	49.50	105.00	6.06	6.00	
	15	61.50	185.00	6.92	7.80	
	16	54.50	108.00	5.14	5.50	
	17	38.50	60.00	5.73	4.95	
	18	31.50	50.00	7.13	5.45	
	19	45.50	130.00	8.88	8.05	
	20	35.50	35.00	3.93	3.30	
ps-12	1	49.00	170.00	10.02	10.00	10.55
	2	37.00	155.00	16.02	13.20	
	3	38.00	190.00	18.61	15.30	
	4	37.00	100.00	10.33	8.70	
	5	42.00	100.00	8.02	7.30	
	6	45.00	155.00	10.83	10.00	
	7	42.00	155.00	12.43	10.90	
	8	53.00	295.00	14.86	16.10	
	9	45.00	140.00	9.78	9.05	
	10	50.00	180.00	10.19	10.19	
	11	45.00	155.00	10.83	10.00	
	12	40.00	190.00	16.80	13.70	
	13	48.00	215.00	13.20	13.00	
	14	40.00	150.00	13.26	11.00	
	15	36.00	135.00	14.74	11.00	
	16	52.00	175.00	9.16	9.50	
	17	45.00	135.00	9.43	8.80	
	18	49.00	175.00	10.31	10.20	
	19	45.00	145.00	10.13	9.20	
	20	46.00	195.00	13.04	12.90	
	21	49.00	240.00	14.14	14.10	

Table 3C-5.(Cont.)

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
ps-13	1	43.50	65.00	4.86	4.50	6.50
	2	44.00	58.00	4.24	3.80	
	3	36.50	50.00	5.31	4.60	
	4	40.00	40.00	3.54	3.30	
	5	38.50	60.00	5.73	5.00	
	6	46.00	80.00	5.35	5.10	
	7	34.50	120.00	14.26	10.90	
	8	36.50	78.00	8.28	6.50	
	9	39.50	75.00	6.80	5.90	
	10	43.50	123.00	9.20	8.80	
	11	34.50	80.00	9.51	7.40	
	12	47.50	120.00	7.52	7.30	
	13	45.50	60.00	4.10	3.80	
	14	46.50	110.00	7.20	6.90	
	15	38.50	70.00	6.68	5.70	
	16	42.50	110.00	8.62	7.70	
	17	51.50	110.00	5.87	5.90	
	18	37.50	85.00	8.55	7.15	
	19	34.00	70.00	8.57	6.70	
	20	36.50	92.00	9.77	7.70	
pl-18	1	49.50	232.00	13.39	13.20	9.85
	2	39.50	134.00	12.15	10.30	
	3	57.50	146.00	6.25	6.90	
	4	41.50	129.00	10.60	9.10	
	5	41.00	160.00	13.47	11.80	
	6	42.00	90.00	7.22	6.50	
	7	47.50	196.00	12.29	12.00	
	8	54.50	135.00	6.43	6.80	
	9	41.00	160.00	13.47	11.70	
	10	51.00	136.00	7.40	7.60	
	11	35.00	124.00	14.32	11.00	
	12	39.00	150.00	13.95	11.80	
	13	37.00	151.00	15.60	12.70	
	14	53.00	162.00	8.16	8.60	
	15	41.00	110.00	9.26	7.80	
	16	44.00	232.00	16.95	15.20	
	17	51.50	232.00	12.37	12.50	
	18	42.50	89.00	6.97	6.30	
	19	48.00	142.00	8.72	8.60	
	20	31.00	93.00	13.69	9.40	
	21	36.00	162.00	17.68	13.70	
	22	34.00	86.00	10.52	8.00	

Table 3C-5. (Cont.)

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
pl-19	1	61.00	87.00	3.31	3.60	1.50
	2	73.50	23.00	0.60	0.70	
	3	55.00	28.00	1.31	1.39	
	4	42.00	43.50	3.49	2.50	
	5	45.00	28.00	1.96	1.85	
	6	46.00	22.00	1.47	1.40	
	7	58.00	33.00	1.39	1.50	
	8	44.00	68.00	4.97	4.70	
	9	49.50	21.00	1.21	1.20	
	10	50.00	108.00	6.11	6.11	
	11	67.00	48.00	1.51	1.66	
	12	59.00	18.00	0.73	0.78	
	13	41.00	34.00	2.86	2.60	
	14	55.00	32.00	1.50	1.58	
	15	46.00	32.00	2.14	2.00	
	16	79.00	50.00	1.13	1.31	
	17	43.50	16.00	1.20	1.12	
	18	49.50	19.50	1.13	1.11	
	19	43.50	17.00	1.27	1.19	
	20	61.00	15.00	0.57	0.63	
pl-21	1	33.00	17.20	2.23	1.75	1.38
	2	35.50	18.00	2.02	1.69	
	3	39.50	21.00	1.90	1.69	
	4	45.50	5.50	0.38	0.37	
	5	36.50	14.00	1.49	1.28	
	6	44.50	14.00	1.00	0.93	
	7	44.50	14.50	1.04	0.95	
	8	39.50	16.50	1.50	1.38	
	9	35.50	15.00	1.68	1.39	
	10	30.50	12.80	1.95	1.50	
	11	32.50	14.00	1.88	1.49	
	12	41.50	27.00	2.22	1.90	
	13	39.50	8.00	0.73	0.66	
	14	35.50	10.00	1.12	0.90	
	15	35.50	17.00	1.91	1.58	
	16	33.50	15.80	1.99	1.61	
	17	41.50	16.00	1.31	1.18	
	18	39.50	12.50	1.13	1.00	
	19	36.50	6.00	0.64	0.55	
	20	36.50	25.00	2.65	2.40	

Table 3C-5. (Cont.)

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
kd-24	1	44.00	230.00	16.81	15.20	11.10
	2	52.50	200.00	10.27	10.80	
	3	45.00	253.00	17.67	16.00	
	4	39.00	250.00	23.25	19.00	
	5	40.50	228.00	19.66	16.80	
	6	31.00	175.00	25.76	17.00	
	7	43.50	198.00	14.80	12.50	
	8	34.00	171.00	20.93	15.80	
	9	41.00	145.00	12.20	10.70	
	10	40.00	130.00	11.49	9.70	
	11	50.00	220.00	12.45	12.45	
	12	32.50	98.00	13.13	11.10	
	13	52.00	133.00	6.96	7.20	
	14	34.50	179.00	21.28	15.90	
	15	52.00	157.00	8.21	8.80	
	16	42.00	128.00	10.27	9.20	
	17	41.00	79.00	6.65	5.70	
	18	22.50	49.00	13.69	-	
	19	30.50	105.00	15.97	11.10	
	20	40.00	106.00	9.37	7.90	
	21	43.00	138.00	10.56	9.50	
kd-25	1	58.00	223.00	9.38	10.90	12.25
	2	65.00	247.00	8.27	9.30	
	3	48.00	177.00	10.87	10.70	
	4	61.00	238.00	9.05	10.30	
	5	64.00	214.00	7.39	9.70	
	6	35.00	300.00	34.65	29.00	
	7	35.00	145.00	16.75	13.00	
	8	37.00	202.00	20.87	16.00	
	9	28.00	148.00	26.71	18.80	
	10	35.00	130.00	15.01	11.80	
	11	27.00	163.00	31.63	19.00	
	12	35.00	160.00	18.48	14.50	
	13	31.00	140.00	20.61	14.50	
	14	47.00	160.00	10.25	10.00	
	15	37.00	155.00	16.02	12.30	
	16	40.50	160.00	13.80	11.30	
	17	32.50	100.00	13.39	9.70	
	18	36.00	150.00	16.37	12.50	
	19	43.50	185.00	13.83	12.40	
	20	38.50	163.00	15.56	13.00	
	21	42.50	180.00	14.10	12.20	
	22	36.50	162.00	17.20	14.00	

Table 3C-5. (Cont.)

Sample No.	Test No.	Distance (mm)	Pressure (kg/sq.cm)	Is (MN/sq.m)	Is50 (MN/sq.m)	Median
kd-26	1	44.00	19.00	1.39	1.32	2.10
	2	46.00	69.00	4.61	4.30	
	3	46.00	38.00	2.54	2.41	
	4	47.00	60.00	3.84	3.65	
	5	46.00	28.00	1.87	1.80	
	6	35.00	32.00	3.70	3.20	
	7	38.00	25.00	2.45	1.90	
	8	35.00	10.00	1.15	0.93	
	9	45.00	8.00	0.56	0.55	
	10	36.00	38.00	4.15	3.60	
	11	53.00	15.00	0.76	0.79	
	12	53.00	39.00	1.96	2.10	
	13	48.00	38.00	2.33	2.05	
	14	35.00	40.00	4.62	3.70	
	15	35.00	30.00	3.46	2.95	
	16	40.00	18.00	1.59	1.41	
	17	37.00	36.00	3.72	3.30	
	18	51.00	19.00	1.03	1.02	
	19	41.00	35.00	2.95	2.80	
	20	31.00	20.00	2.94	2.40	
kd-27	1	37.00	40.00	4.13	3.60	3.35
	2	45.00	40.00	2.79	2.70	
	3	53.00	40.00	2.01	2.10	
	4	44.00	40.00	2.92	2.80	
	5	47.00	45.00	2.88	2.72	
	6	45.00	51.00	3.56	3.40	
	7	37.00	30.00	3.10	2.70	
	8	49.00	40.00	2.36	2.35	
	9	41.00	40.00	3.37	2.95	
	10	34.00	35.00	4.28	3.60	
	11	39.00	40.00	3.72	3.45	
	12	42.00	30.00	2.41	2.20	
	13	39.00	40.00	3.72	3.40	
	14	34.00	45.00	5.51	4.50	
	15	46.00	45.00	3.01	2.80	
	16	32.00	40.00	5.53	4.45	
	17	46.00	50.00	3.34	3.30	
	18	48.00	45.00	2.76	2.70	
	19	45.00	45.00	3.14	3.30	
	20	35.00	40.00	4.62	3.95	

APPENDIX D

ศูนย์วิทยทรัพยากร
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Table 4D-1. Granitoids and tectonic environment.

Tectonic environment	Locality	References
1. Island arc	Papua New Guinea-Solomon Islands (21, 65)*	Griffin (1979), Johnson and Jaques (1980), Mason and Heaslip (1980), Mason and McDonald (1978), Whalen (1985)
2. Continental arc	Sierra Nevada batholith (101, 107)	Bateman (1983), Bateman and Chappell (1979), Bateman and Dodge (1970), Bateman and Lockwood (1970), Bateman and Wones (1972), Bateman and others, (1963), Hietanen (1973), Dodge and Moore, (1968), Miller (1977, 1978), Noyes and others (1983)
	Idaho batholith (54, 57)	Hyndman (1983, 1984), Shuster and Bickford (1985), Taubeneck (1971)
3. Continental collision	North and High Himalayas (59, 15)	Le Fort (1975a, 1975b, 1981), Cocherie (1976), Ghose and Singh (1977), Ferrara and others, (1983), Hamet and Allegre (1976), Vidal and others, (1982), Honegger and others (1982), Scharer and others (1986), Blattner and others (1983), DeBon and others (1986)
	South Brittany (24, 0)	Le Metour (1978), Strong and Hanmer (1981)
4. Post-orogenic	Egypt (66, 62)	Greenberg (1981a, 1981b, Hussein and others (1982), El-Gaby and others (1975), Rogers and others (1978), Rogers and Greenberg (1981a, 1981b)
5. Rift related	Oslo rift (61, 31)	Oftedahl (1978), Barth (1944), Neumann (1974, 1976, 1978), Neumann and others (1977), Petersen (1978), Schonwandt and Petersen (1983), Ramberg and Spjeldnaes (1978), Khalil and others (1978), Neff and Khalil (1978), Czamanske (1963), Czamanske and Wones (1973), Czamanske and Mihalik (1972), Jensen (1985), Bockelie (1978)
	Wichita Mountains (49, 34)	Gilbert and Donovan (1982), Johnson and Denison (1973), Hamilton (1956, 1959), Hanson and Al-Shaieb (1980), Merritt (1965), Powell and Phelps (1977), Huang (1958), Myers and others (1981), Gilbert (1983)
6. Aborted rift/hotspot related	Niger-Nigeria (43, 60)	Black and Girod (1970), Cahen and others (1984), Bowden and Kinnaird (1984), Bowden and Whitley (1974), Bowden and Turner (1974), Lameyre and Bowden (1982), Bonin and Giret (1984), Imeokparia (1984), Aleksiyev (1970), Borley (1963), Greenwood (1951), Giret and others (1980), Clifford (1970), Harris (1970)
7. Plagiogranites	Karmoy Ophiolite	Pedersen and Malpas (1984)
	Canyon Mt., Oregon	Gerlach and others (1981)
	Indian Ocean	Engel and Fisher (1975)
	General (43, 15)†	Spulber and Rutherford (1982), Coleman and Peterman (1975), Coleman and Donato (1979)

*Numbers in brackets correspond to the number of analyses (major elements, modal) used in this study after the criterion described in the text has been applied.
†These numbers represent a total for all of the oceanic plagiogranites considered.

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Table 4D-2. Mineralogy of granitoids by tectonic environment.

	Orogenic				Anorogenic		
	IAG	CAG	CCG	POG	RRG	CEUG	OP
Type	2 feldspar; perth < plag	2 feldspar; perth < plag	2 feldspar; perth ~ plag	2 feldspar; perth ≥ plag	1 feldspar; perth ± Ab (primary?)	1 feldspar; perth ± Ab (primary?)	1 feldspar; plagioclase
Perthite composition (molecular)	>Or75	>Or75	>Or75	>Or75	~<Or50	~<Or50	..
Plagioclase composition	Oligoclase-andesine	Oligoclase	Oligoclase	Oligoclase	Albite	Albite	Oligoclase-andesine
Type	Biotite ± hbld ± pyx	Biotite ± hbld ± epid	Biotite muscovite ± tour ± cord ± sill ± gt	Biotite ± hbld or biotite ± musc	Biotite ± hbld ± pyx or alkali amph ± biotite ± hbld ± pyx		Hbld ± pyx
H+/B+*	~<0.20–2.5	~<0.20–2.5	~<0.20–2.5	~<0.20–2.5	~>2.0–2.5	~>2.0–2.5	~>2.0–2.5
M+/B+†	..	~<1.3	~>1.3	~<1.3	..	..	..

Note: H+ = hbld + pyx + ol; B+ = biotite + epid; M+ = musc + cord + gt + tour + sill, as determined by modal analysis. For references, see Table 1. For classification of granitoids, see Appendix 2.

*When both amph and biotite present.

†When both musc and biotite present.

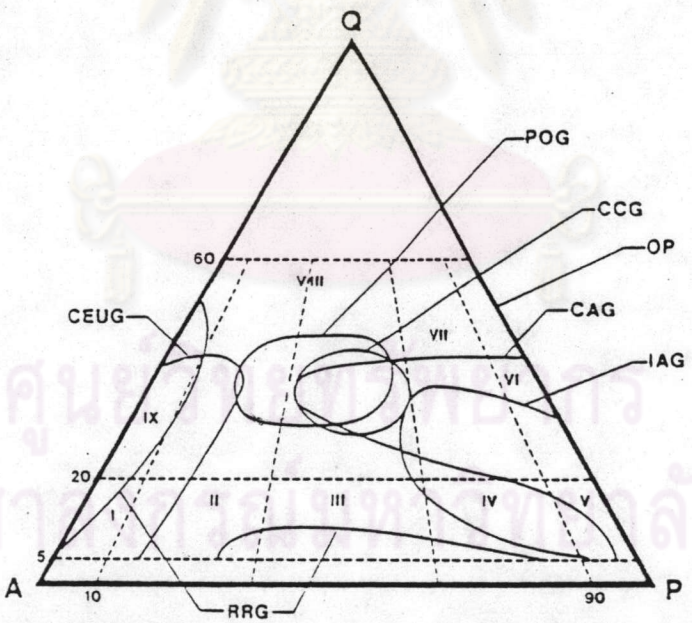

Fig.4D-1. Modal quartz (Q)–alkali feldspar (A)–plagioclase (P) ternary plot. IAG = island arc granitoids, CAG = continental arc granitoids, CCG = continental collision granitoids, POG = post-orogenic granitoids, RRG = rift-related granitoids, CEUG = continental epeirogenic uplift granitoids, OP = oceanic plagiogranites. For references, I = quartz alkali syenite; II = quartz syenite; III = quartz monzonite; IV = quartz monzodiorite; V = quartz diorite; VI = tonalite, trondhjemite; VII = granodiorite; VIII = granite, IX = alkali granite.

Table 4D-3. Chemistry of granitoids by tectonic environment.

	Orogenic				Anorogenic		
	IAG	CAG	CCG	POG	RRG	CEUG	OP
Silica range (wt. %)	60–68 unimodal	62–76 unimodal	70–76 unimodal	70–78 unimodal	72–78 60–63 bimodal	71–77 60–62 bimodal	61–78 unimodal
Alkali-lime index	Calcic to calc-alkaline	Calc-alkaline	Calc-alkaline to alkali-calcic	Alkali-calcic	Alkalic	Alkalic	Calcic
Shand's index (Fig. 2)	Predominantly metaluminous	Metaluminous peraluminous	Peraluminous	Peraluminous metaluminous peralkaline (minor)	Peraluminous (minor) metaluminous peralkaline	Peraluminous (minor) metaluminous peralkaline	Peraluminous metaluminous
Na_2O/CaO (wt. %)	~1.0	~<4.0	~2.0–10.0	~2.0–18.0	~2.0–25.0	~1.0–12.0	~<4.0
Na_2O/K_2O (wt. %)	~0.4–3.0	~0.4–2.0	~0.4–1.5	~0.6–1.2	~0.7–1.0	~0.6–1.0	0.0–50.0
MgO/FeO(T) (wt. %)	0.3–0.85	0.10–0.50	0.05–0.6	0.02–0.30	0.0–0.20	0.0–0.12	0.0–0.70
MgO/MnO (wt. %)	12.0–28.0	2.0–38.0	2.0–45.0	2.0–18.0	0.0–7.5	0.0–7.5	0.0–50.0
$Al_2O_3/(Na_2O + K_2O)$ (molar)	>1.5	>1.1	>1.1	0.9–1.4	<1.15	<1.15	>1.0

Note: for references, see Table 1. For terminology, see Appendix 1.

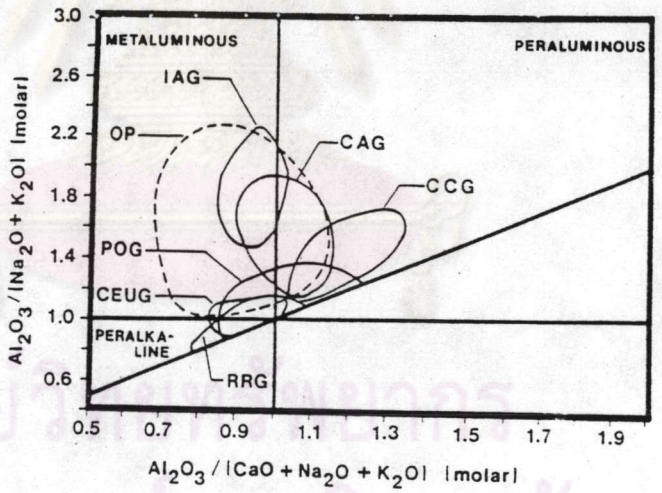

Figure 4D-2. Shand's index.

BIOGRAPHY

Mr. Pansak Wannakao was born in Kalasil in 1959. He studied at Udorn Pittayanukul school for the pre University education in Udorn Thani. He graduated with the B.Sc. in Geology from Khon Kaen University in 1982. He has been working at Khon Kaen University since 1982 in the Lecturer position. He was on leave for graduated study in 1988 to 1990. He returned back to Khon Kaen but still carries on the graduated study program.

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