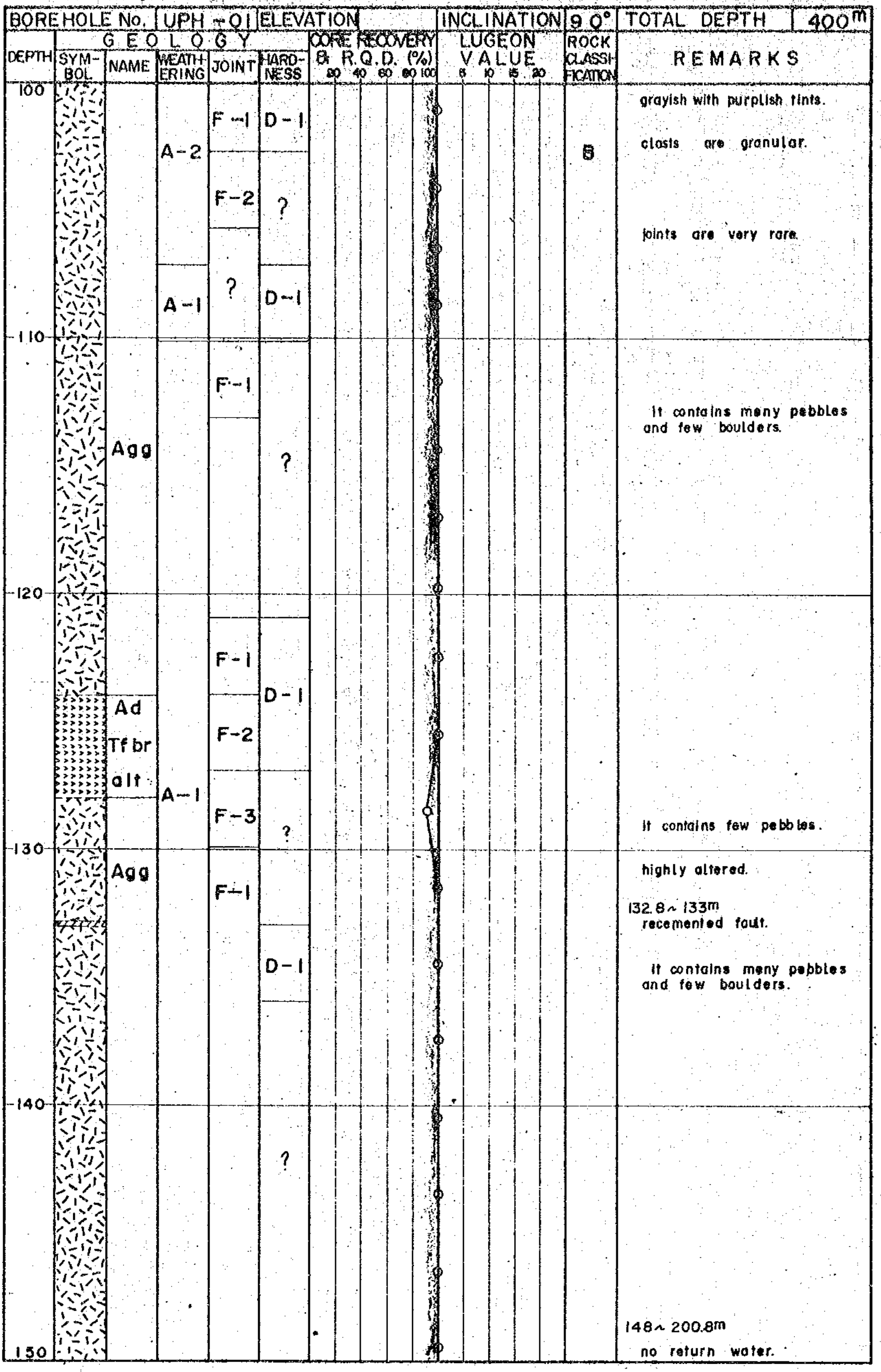
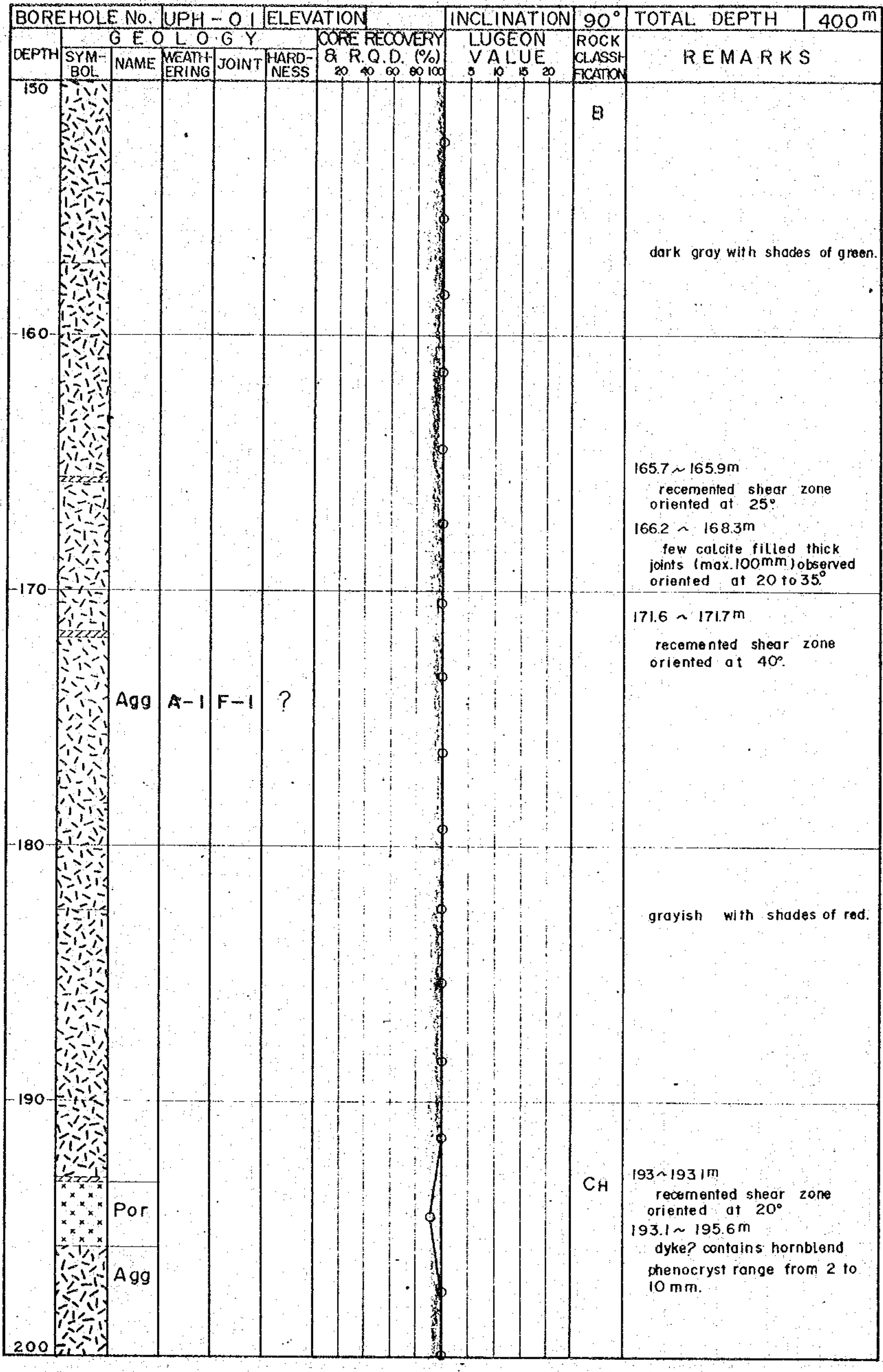
Fig. 2-2-36 (3) GEOLOGIC LOG OF UPH-01



To be continued

Fig. 2-2-36 (4) GEOLOGIC LOG OF UPH-01



To be continued

Fig. 2-2-36 (5) GEOLOGIC LOG OF UPH-01

BOREHOLE No.	UPH-01	ELEVATION		INCLINATION	90°	TOTAL DEPTH	400m

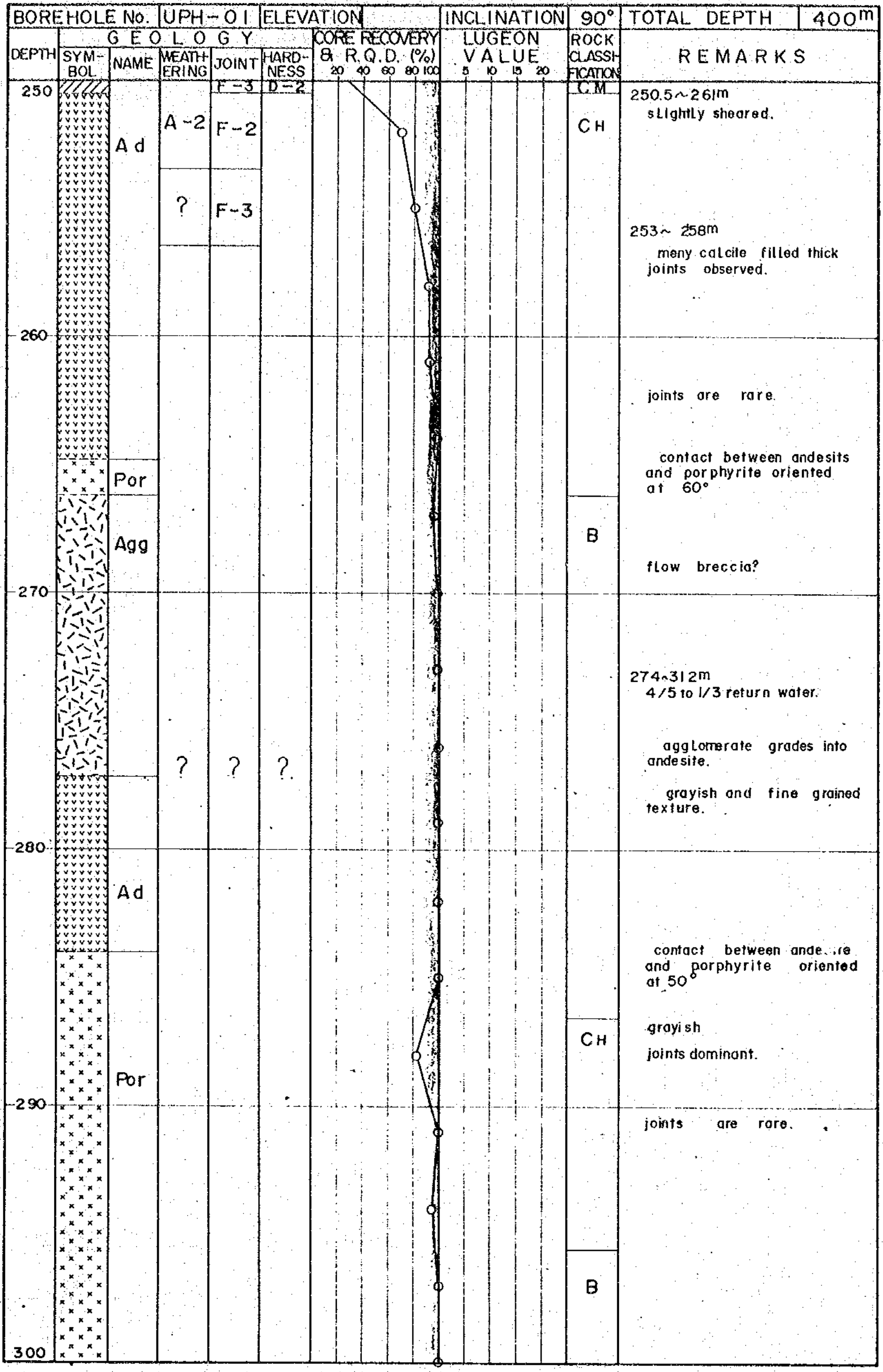
DEPTH	NAME	WEATHERING	JOINT	HARDNESS	ROCK CLASSIFICATION	REMARKS
200	Agg	A-1	F-1	D-1	CH	grayish with purplish tints.
			F-2			
			?	?		
210			F-2		B	
		?	F-3	D-1		
			?	?		219.5 ~ 221m few calcite filled thick joints (max 40mm) observed oriented at low angle.
220			F-3			
			?			
			F-2	D-1		
230		A-1	?	D-2		
		?				
240		A-1	F-1	?		246 ~ 250.5m sheared and altered with meny calcite filled joints.
	Ad	?	?		CM	
	Agg					contact between agglomerate and andsite oriented at 50°
250	Ad	A-2	F-3	D-2		

CORE RECOVERY & R.Q.D. (%): 20 40 60 80 100

LUGEON VALUE: 5 10 15 20

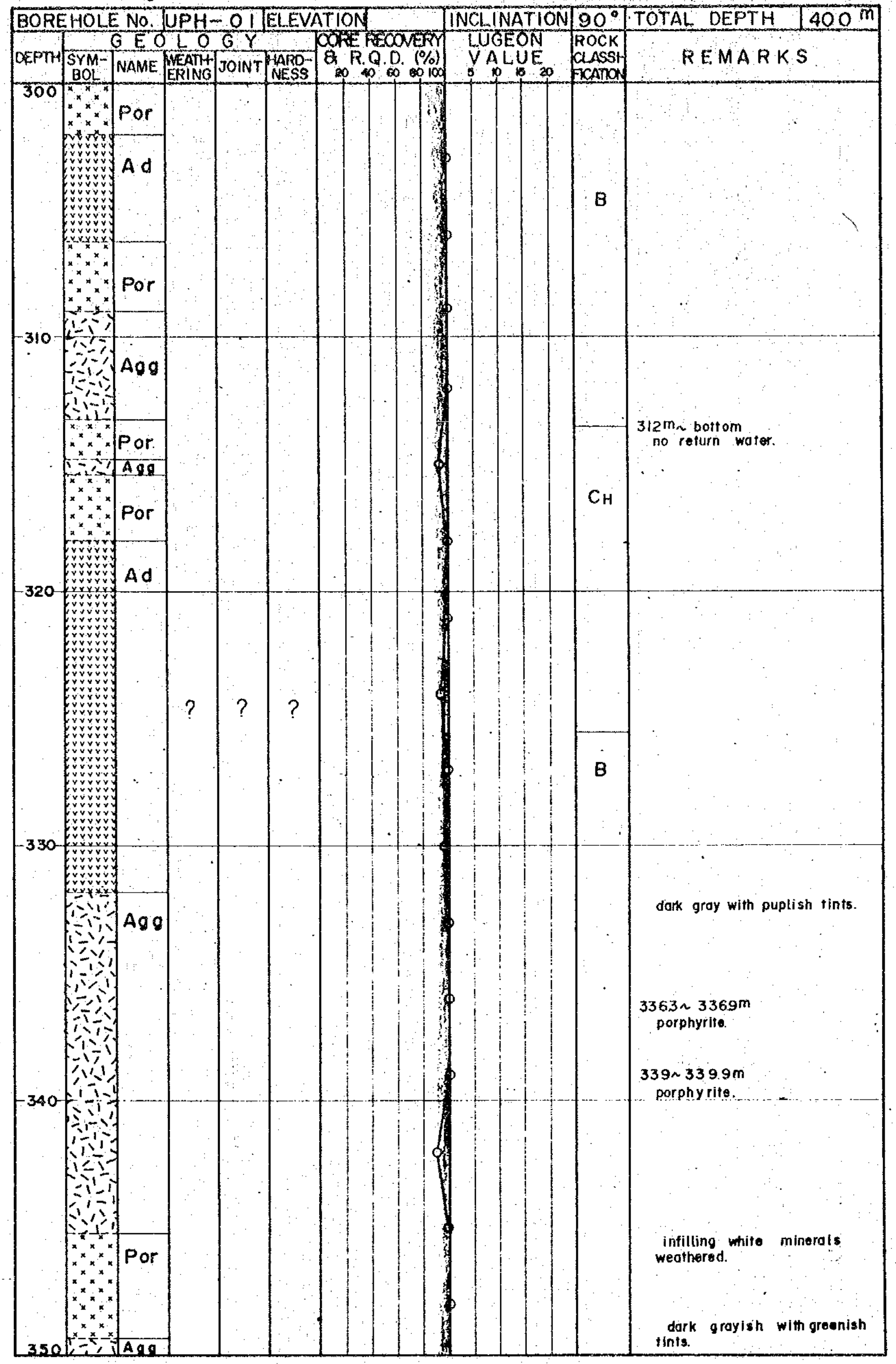
To be continued

Fig. 2-2-36(6) GEOLOGIC LOG OF UPH-01



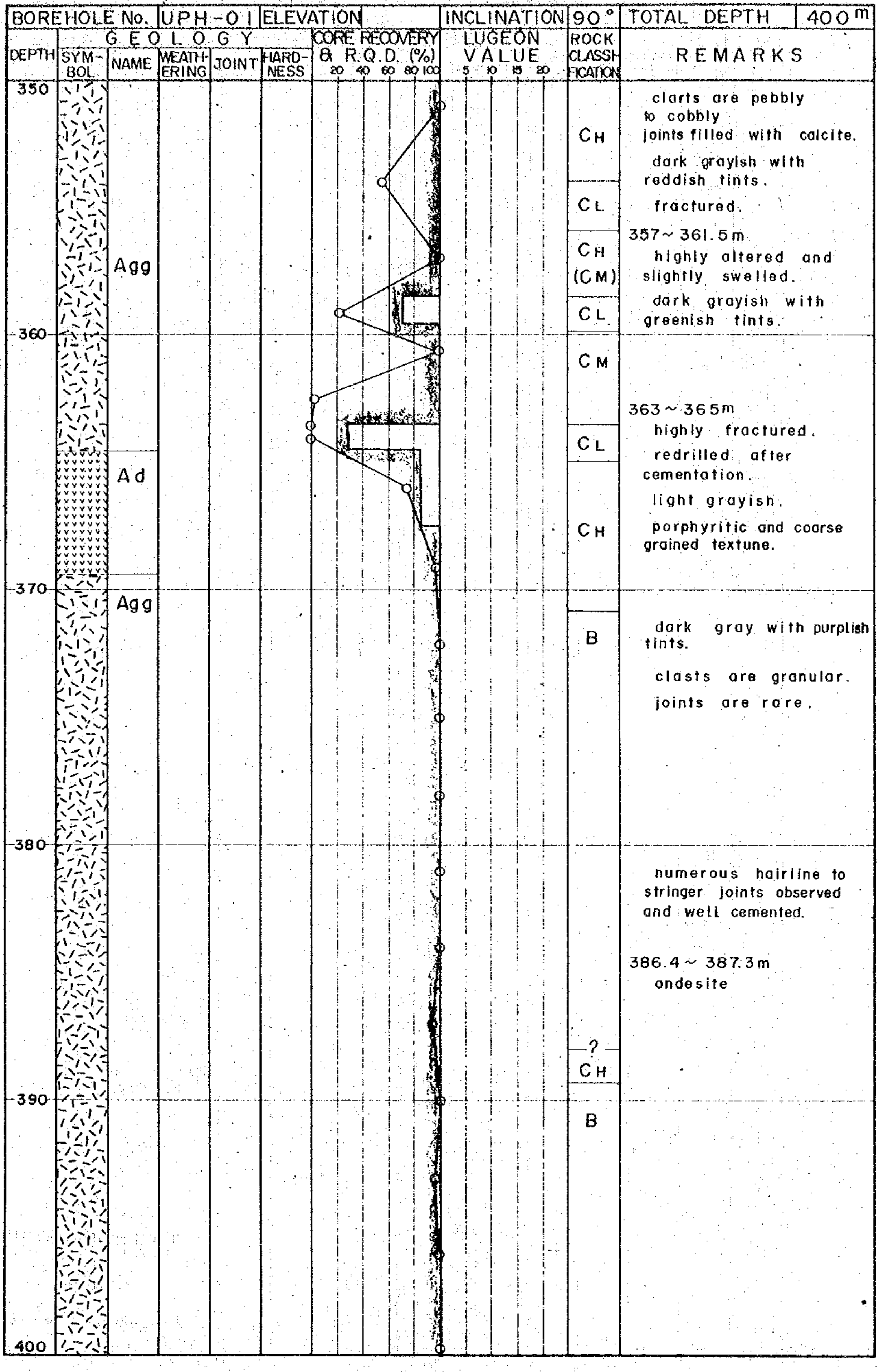
To be continued

Fig. 2-2-36(7) GEOLOGIC LOG OF UPH-01



To be continued

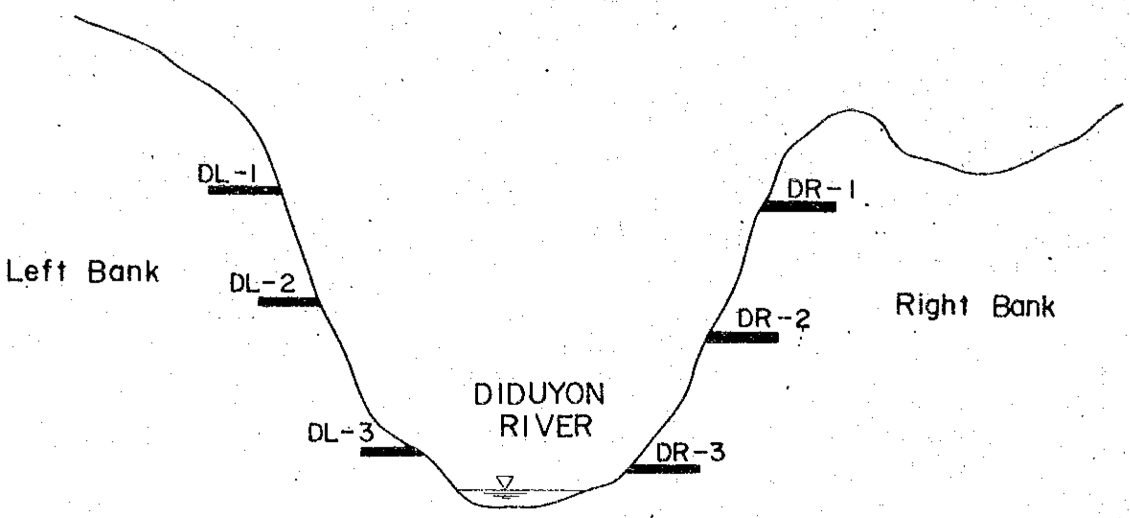
Fig. 2-2-36(8) GEOLOGIC LOG OF UPH-01



To be continued

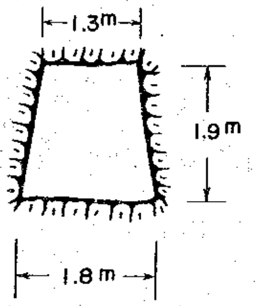
Arrangement of Test Adits

Damsite No. 3



Location	Test Adit	Length (m)	Remarks
Right Bank	DR-1	50	
	DR-2	50	
	DR-3	50	
	Total	150	
Left Bank	DL-1	50	
	DL-2	50	
	DL-3	50	
	Total	150	
Grand Total		300	

Adit Section



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Republic of the Philippines

Japan International Cooperation Agency

Geologic Logs of Test Adits

October 1980 | Fig. 2-2-37

Legend

Geology

Residual Soil / Talus Deposits

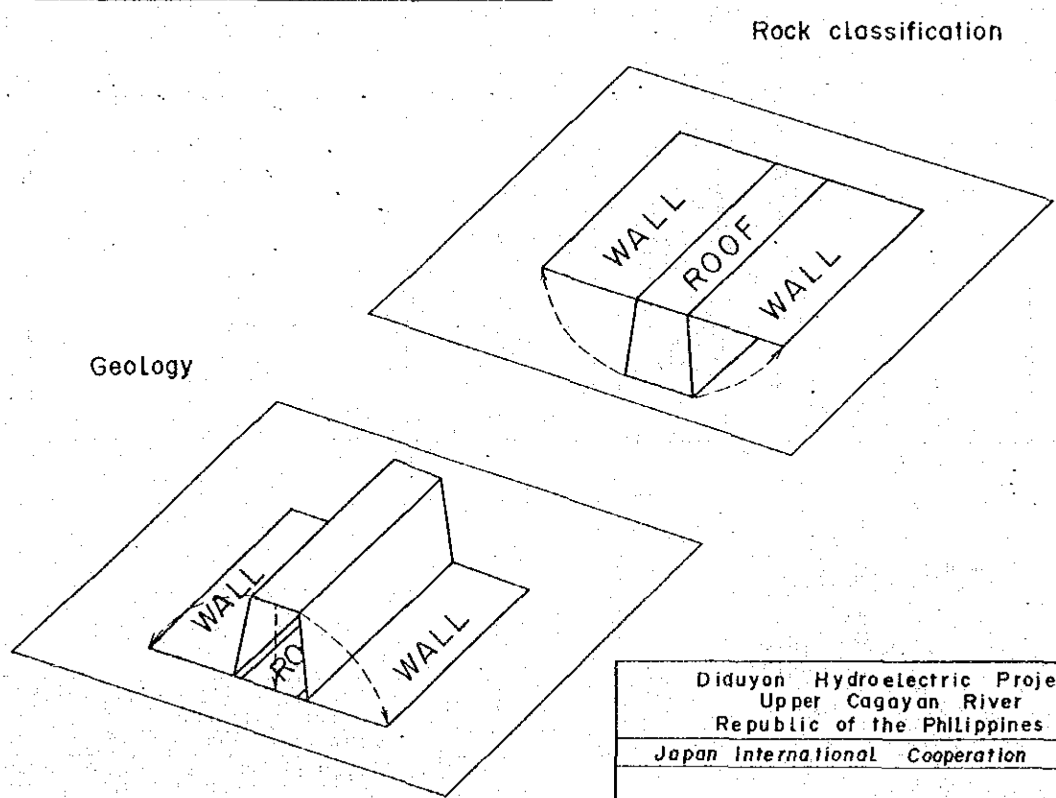
Agglomerate

Symbols

Timbered Section

Water Seepage

Method of Drawing the Log



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Republic of the Philippines

Japan International Cooperation Agency

Geologic Logs of Test Adits

October 1980	Fig. 2-2-38

Fig. 2-2-39 Geologic Log of DR-1

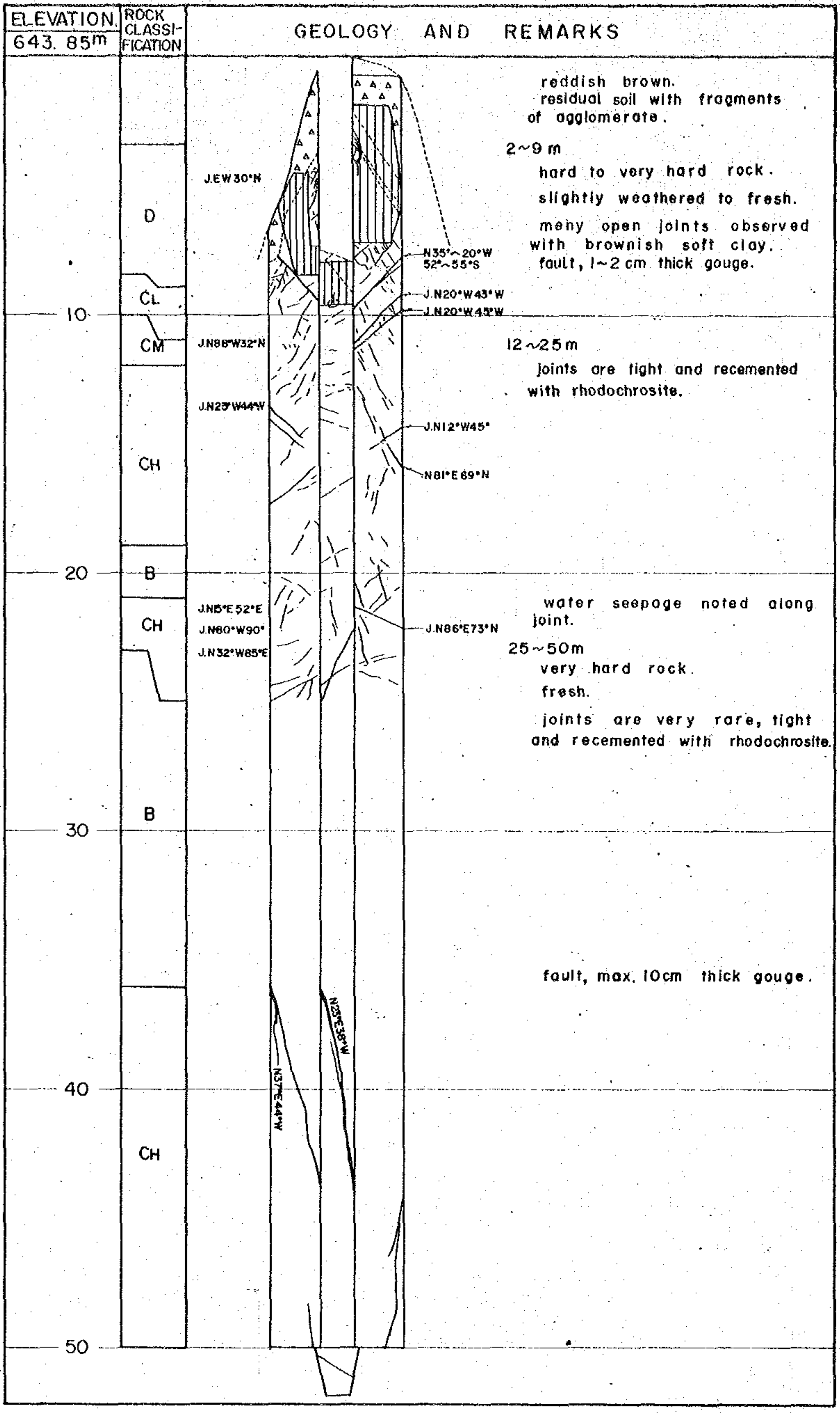


Fig. 2-2-40 Geologic Log of DR-2

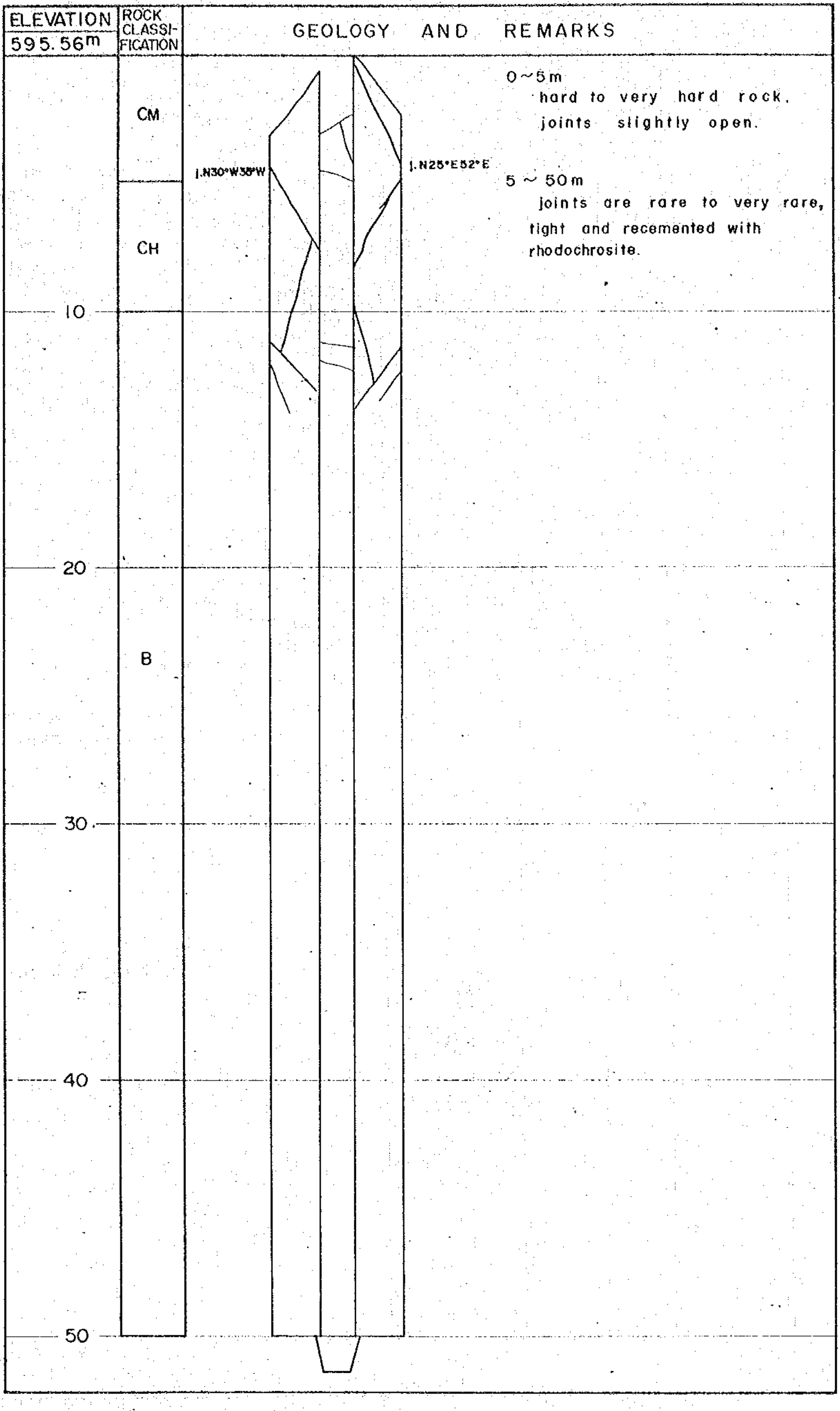


Fig. 2-2-41 Geologic Log of DR-3

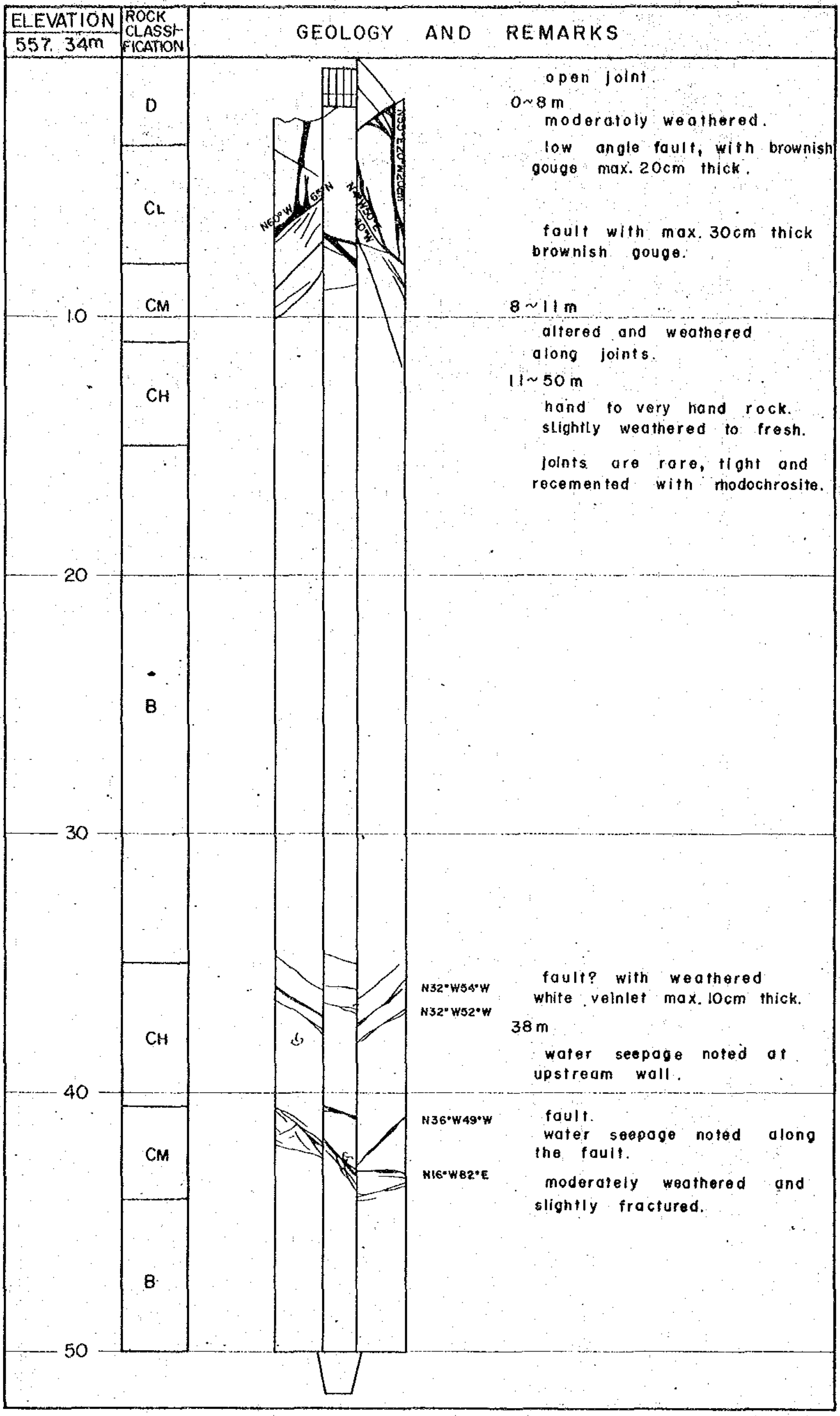


Fig. 2-2-42 Geologic Log of DL-1

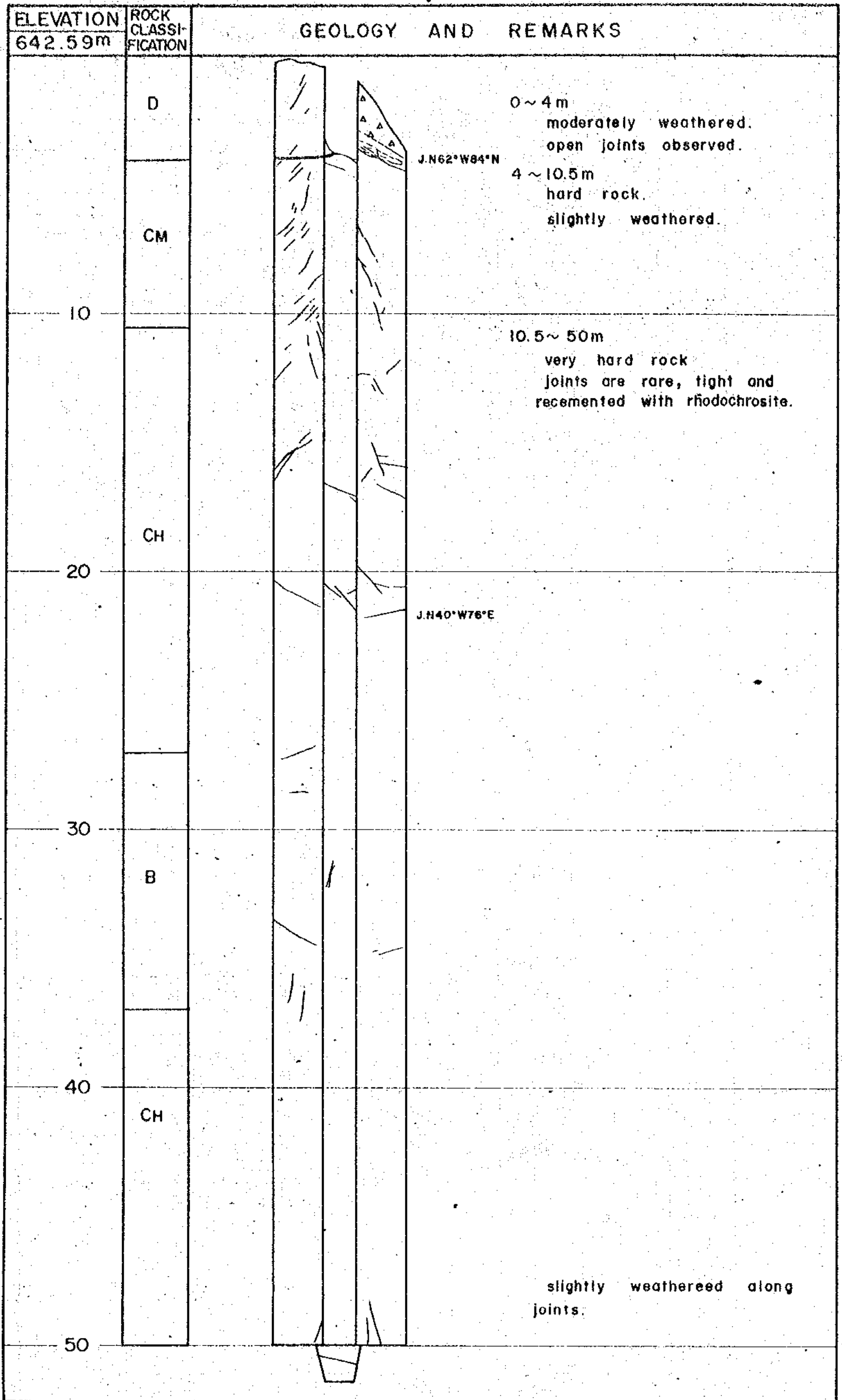


Fig. 2-2-43 Geologic Log of DL-2

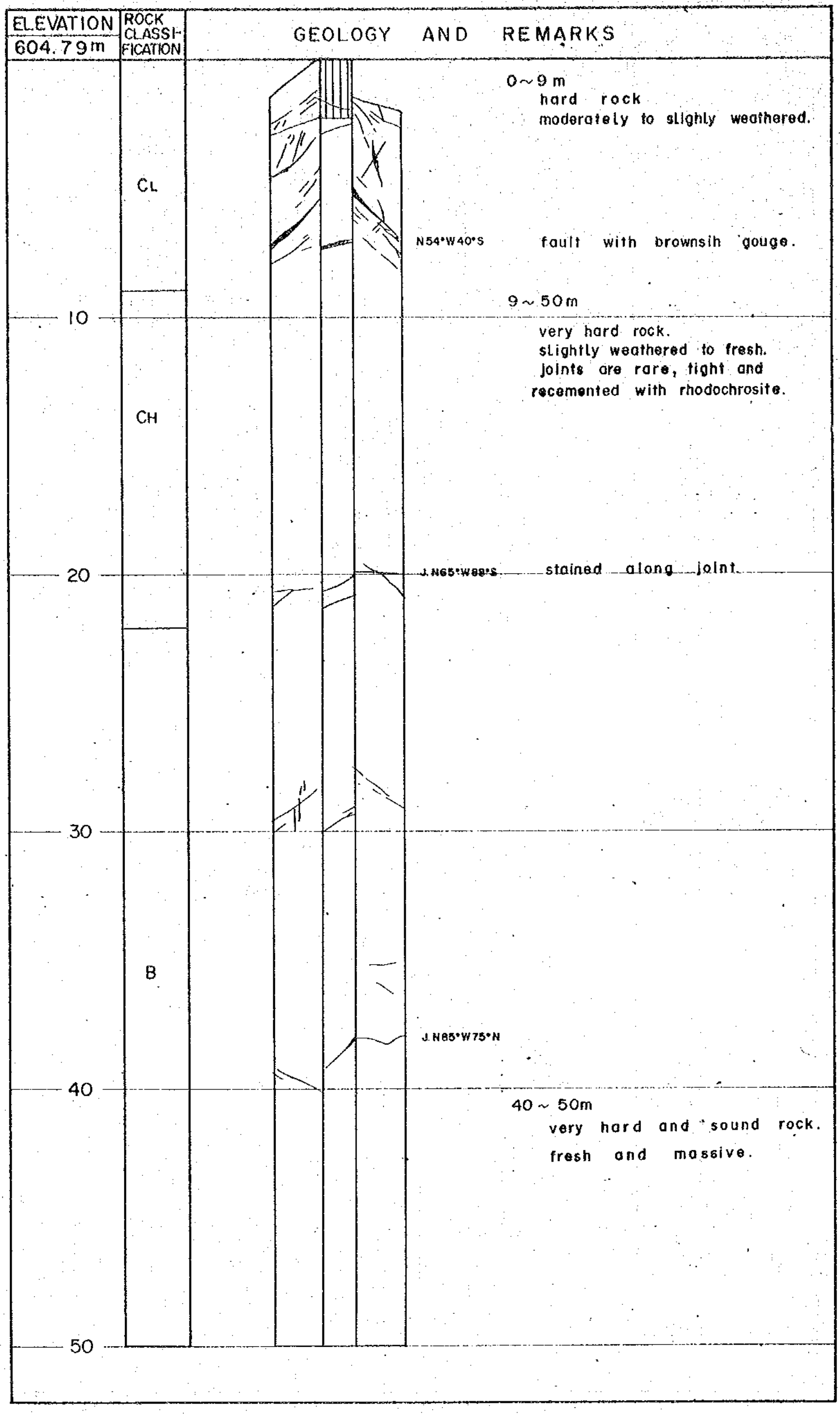
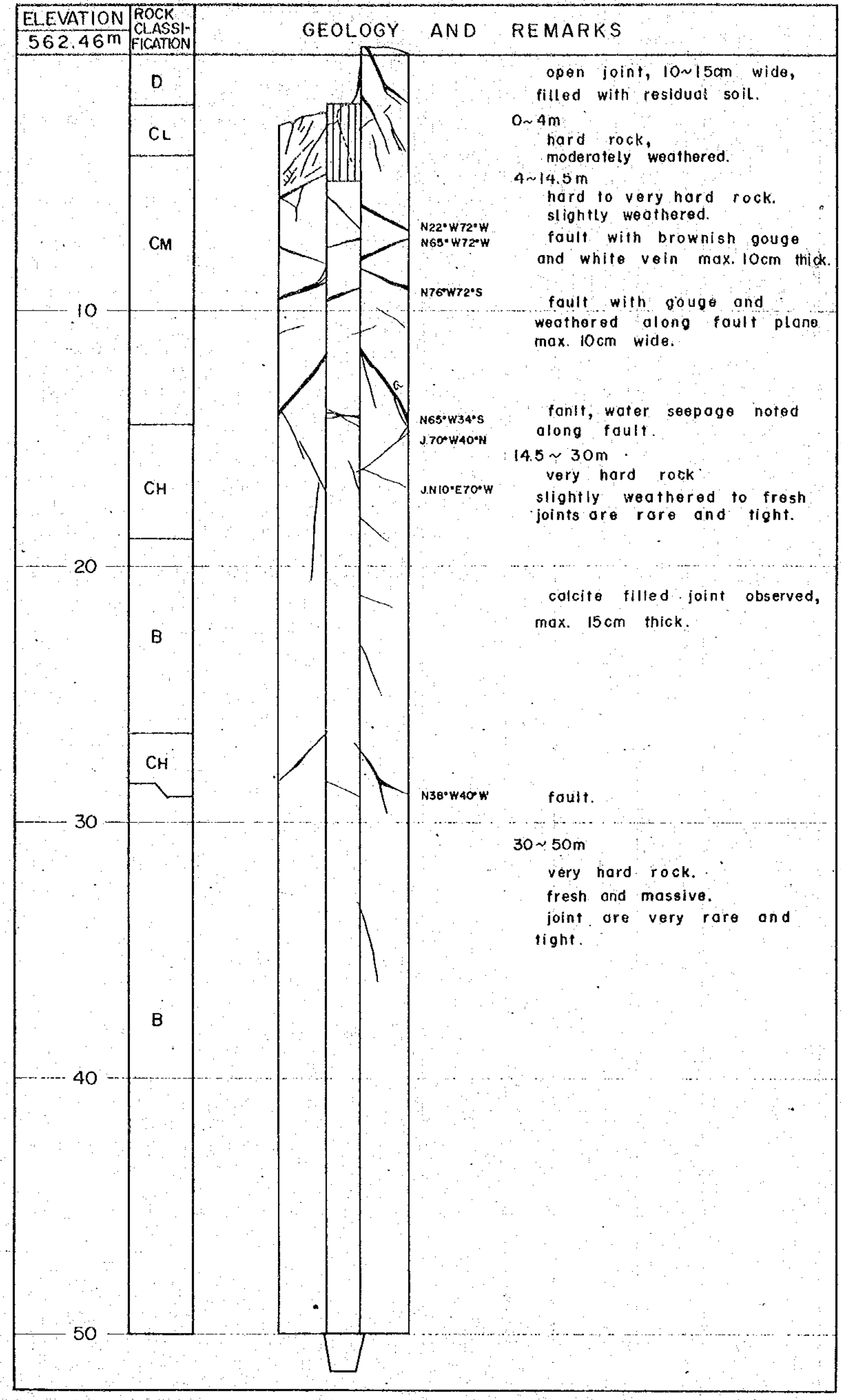
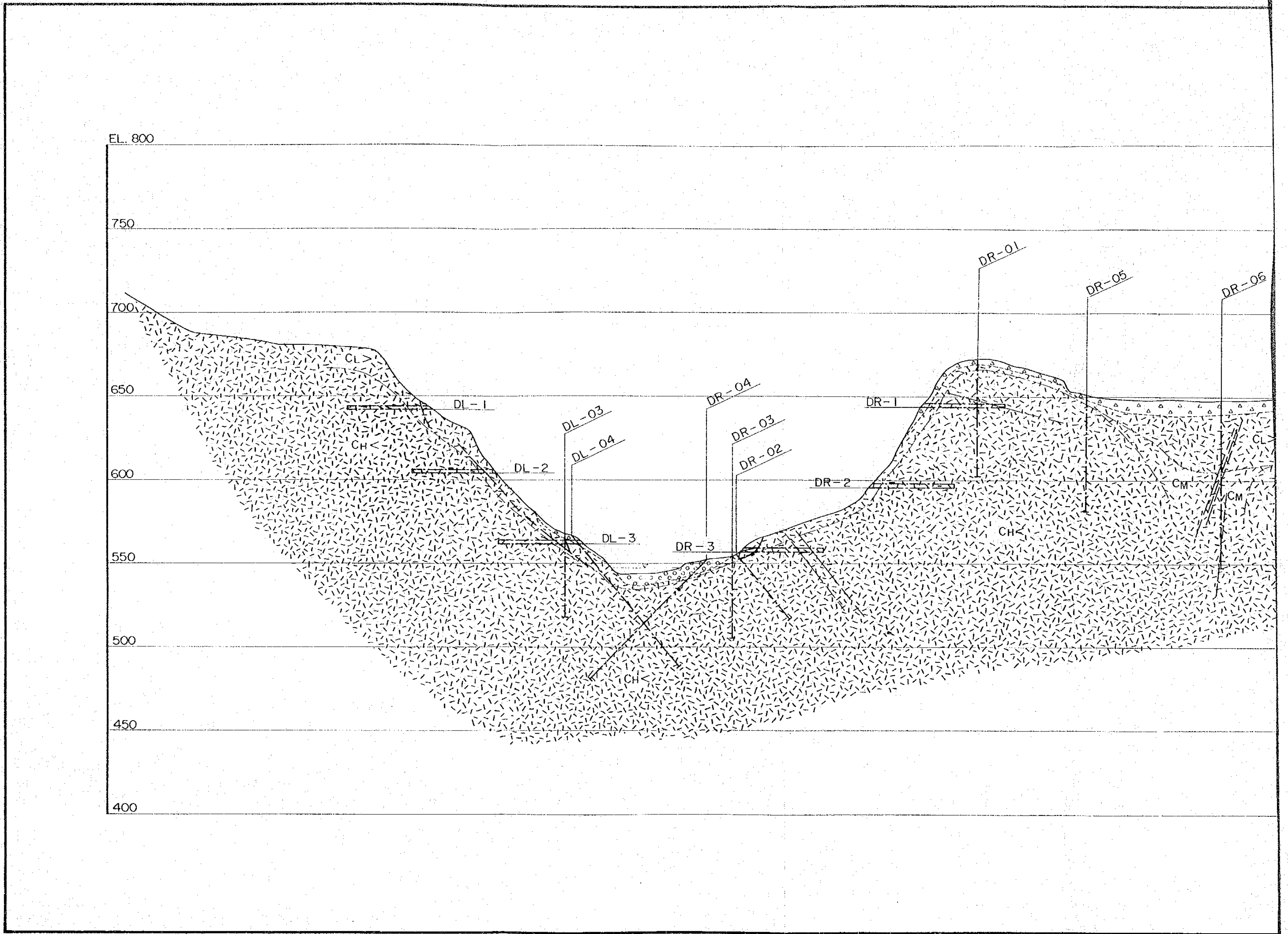
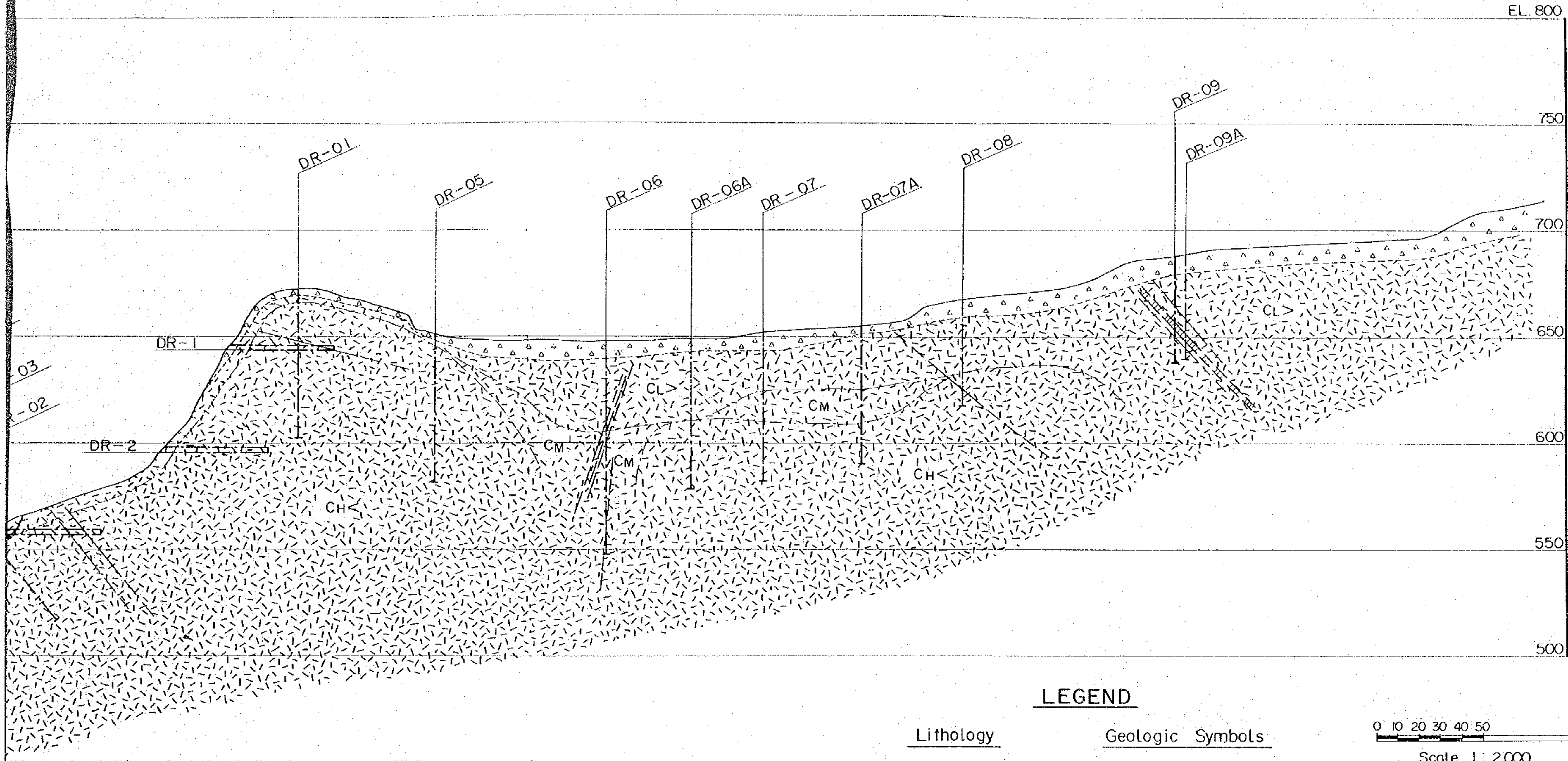


Fig. 2-2-44 Geologic Log of DL-3





EL. 800
750
700
650
600
550
500
450
400
DL - 1
DL - 2
DL - 3
DL - 03
DL - 04
DR - 04
DR - 03
DR - 02
DR - 3
DR - 1
DR - 2
DR - 01
DR - 05
DR - 06
CL
CH
CM



LEGEND

Lithology

- Residual Soil
- Alluvial Doposits
- Agglomerate

Geologic Symbols

- Geologic Contact
- Fault
- Infered Fault
- CL CM Rock Classifecation
- Boundery of Rock Classification

0 10 20 30 40 50 100m

Scale 1 : 2,000

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Geologic Section
Along No.3 Dam Axis

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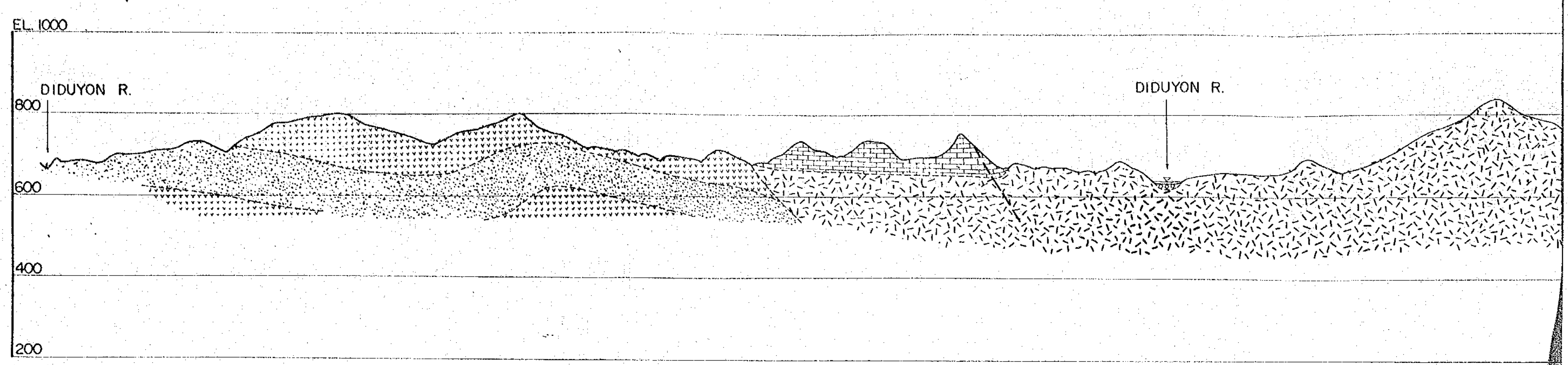
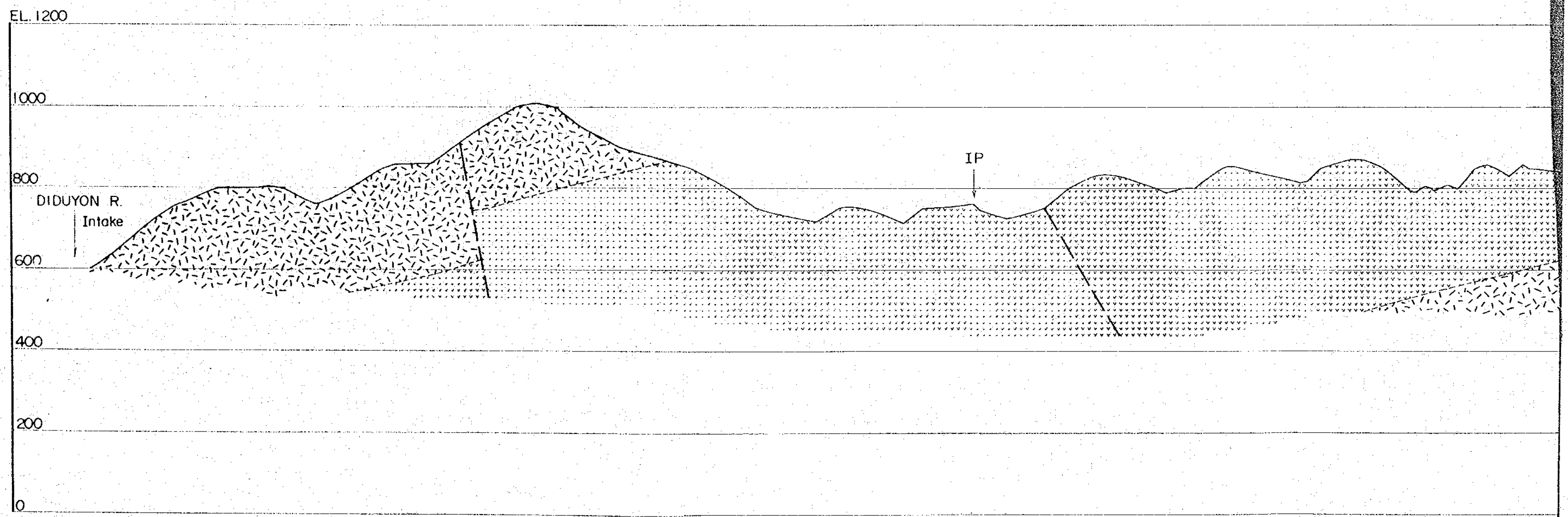
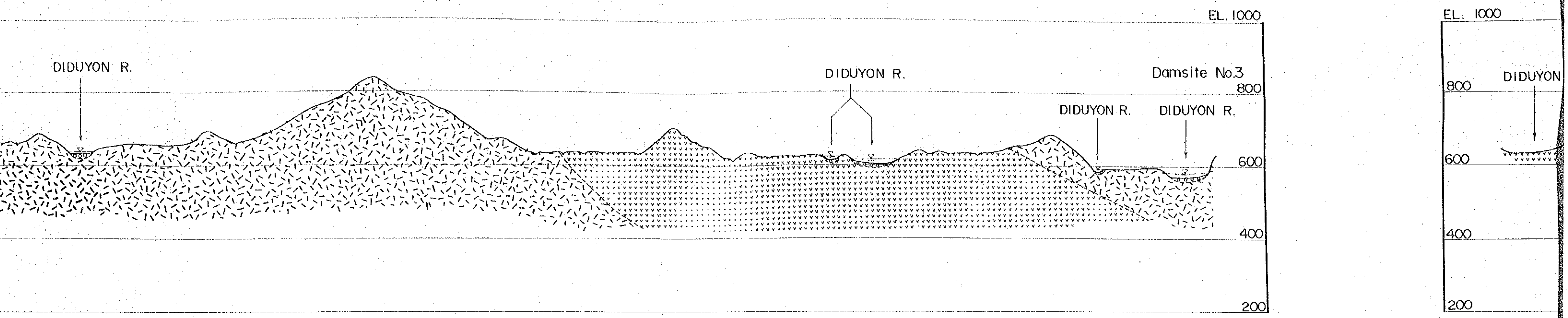


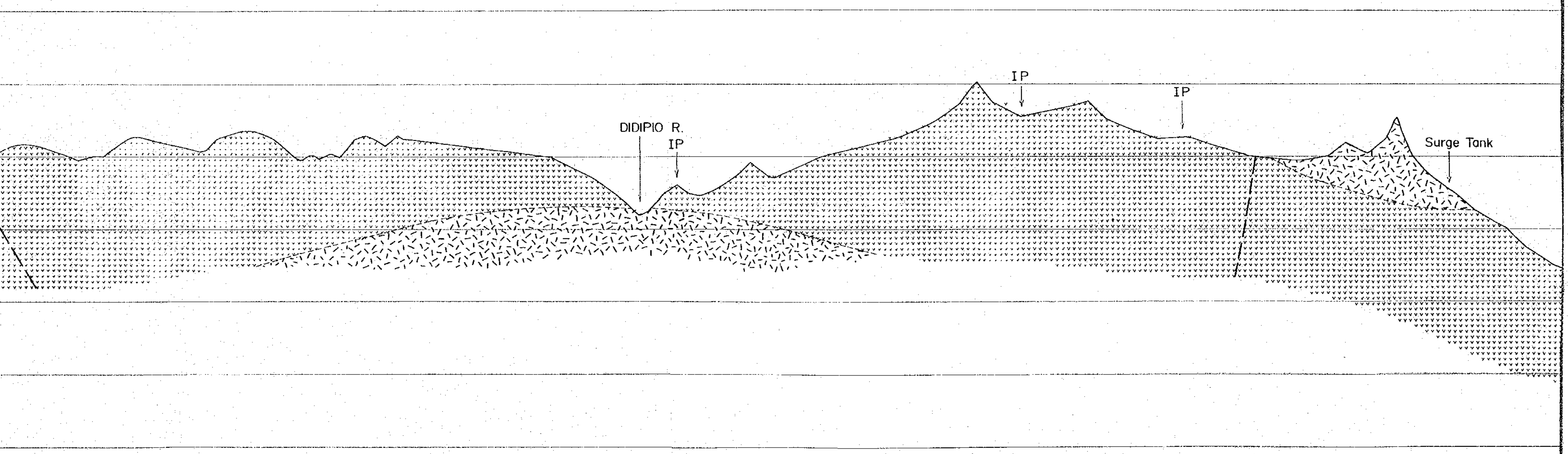
Section Along Line A – A'



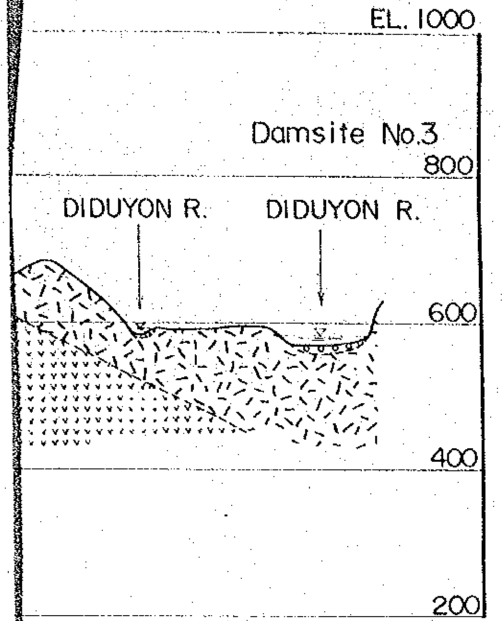
Se

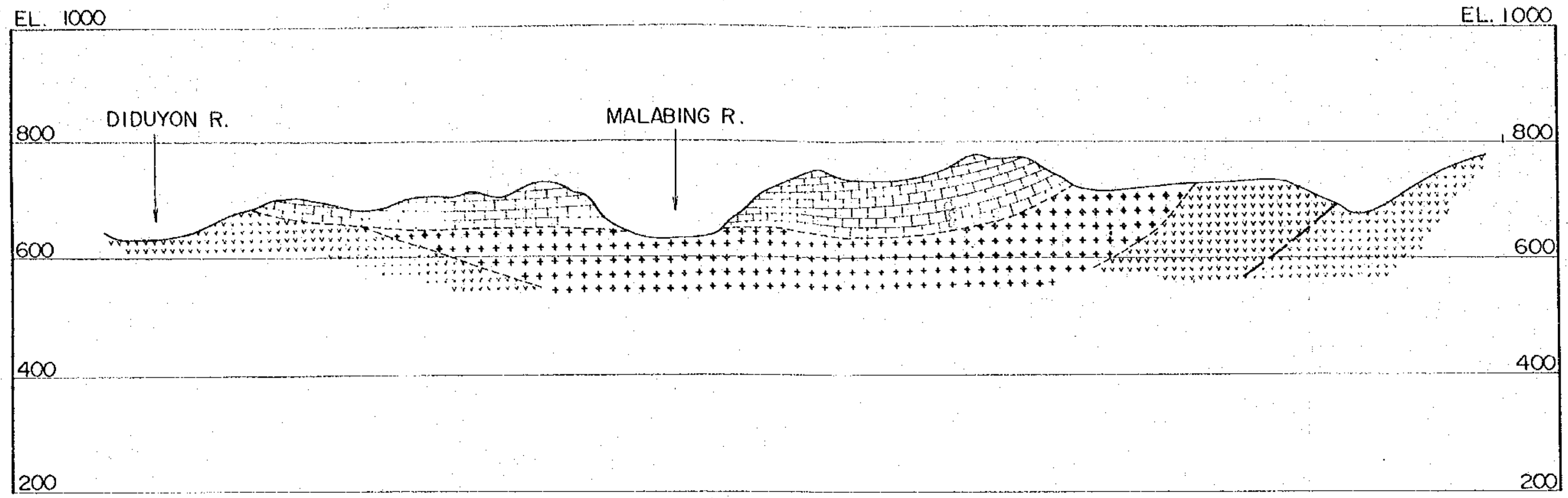


Section Along Line A – A'

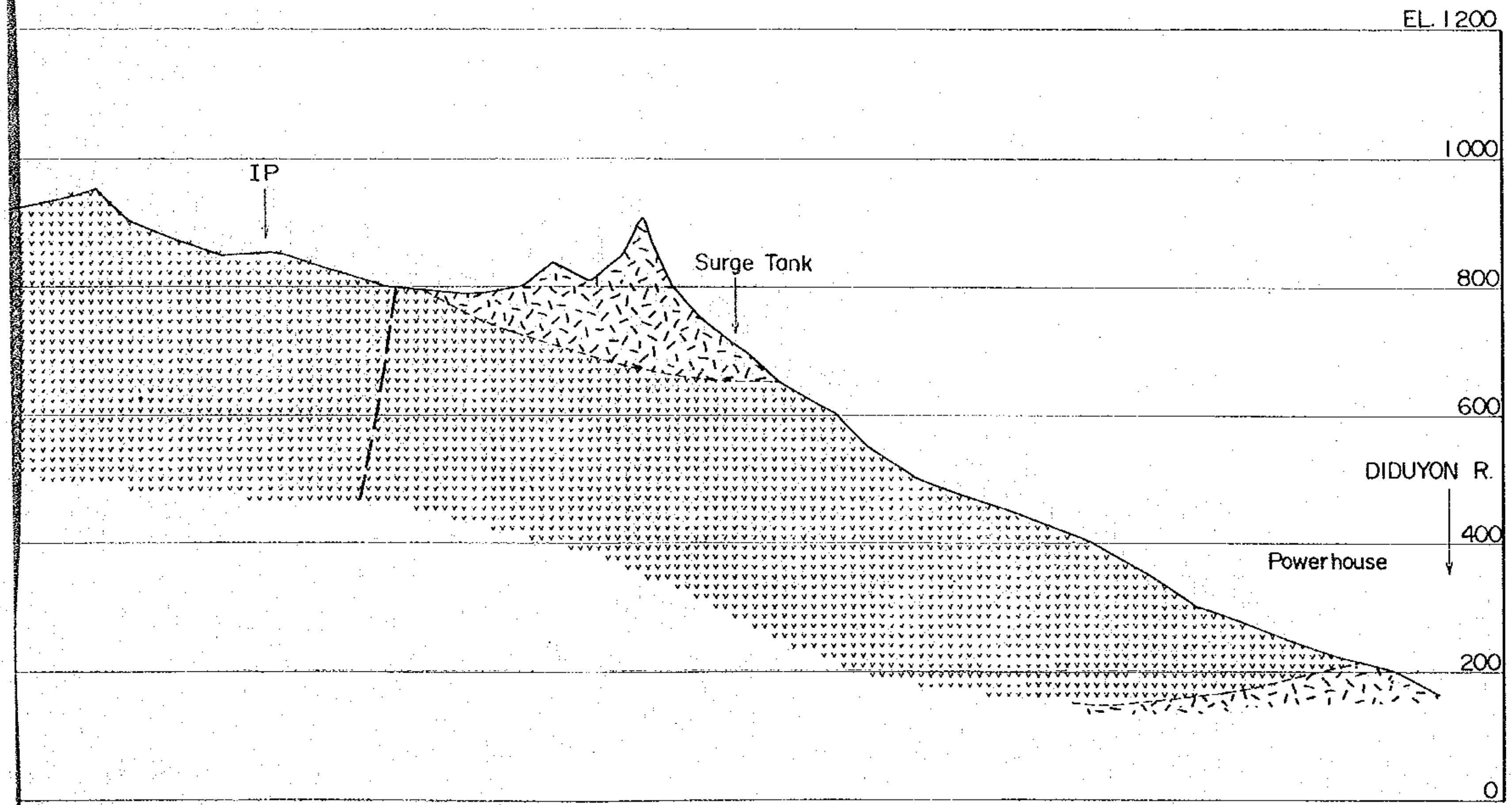


Section Along Waterway





Section Along Line B — B'



LEGEND

Lithology

- Terrace Gravel / Alluvial Deposits
- Andesite
- Sandstone / Conglomerate
- Limestone
- Trachyte
- Andesite with Tuff Layer
- Agglomerate

Geologic Symbols

- Infered Geologic Contact
- Infered Fault

SCALE

Horizontal 1 : 20,000

Vertical 1 : 10,000

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Republic of the Philippines

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Geologic Section

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2.3. Earthquake

2.3.1. Data on Past Earthquakes

For the purpose of computing a design seismicity that may act on the planned damsites, records of past earthquakes on Luzon and vicinity were investigated. Earthquake records were provided by the Geology and Geotechnics Division of NAPOCOR. They indicate the location of epicenters and magnitudes of earthquakes that have occurred during the 77 years between 1901 and 1977.

A total of 1,167 earthquakes have been observed. Observation results of past earthquakes are given in Fig. 2-3-1 and Table 2-3-1. These earthquake data are used as basis for calculating the design ground acceleration.

2.3.2. Seismic Analysis

(1) Magnitude and Seismic Intensity

The magnitude indicates the scale of an earthquake, while the seismic intensity indicates the violence of ground motion during an earthquake at the observation point. Consequently, it is not possible to discuss the seismic intensity and the magnitude on the same level. According to the Gutemberg-Richter system, the following relative equation exists between A/T and magnitude M:

$$\log 10\ A/T = 0.76 + 0.71M - 0.027M^2$$

where A : maximum amplitude (in microns)

T : cycle (in seconds).

The acceleration at the epicenter is

$$\alpha_0 = 4\pi^2 \; A/T \; .$$

Therefore, the following equation exists between α_0 and M:

$$\log 10\, \alpha_0 = -2.1 + 0.81M - 0.027M^2$$

In general the seismic intensity decreases when the epicenter is farther away. Dr. Kanai proposes these equations as shown below on the basis of large number of observation results. For earthquake dynamic spectra applicable to the earthquake bed from near the epicenter to a distance of about 200 km,

$$A = 10(0.61M - P\log_{10} X + Q') \times T$$

$$V = 10(0.61M - P\log_{10} X + Q'')$$

$$a = 10(0.61M - P\log_{10} X + Q)\ 1T$$

where

- M : magnitude of past earthquake
- A : subsurface displacement acting on the planned damsite
- V : subsurface velocity acting on the planned damsite
- a : subsurface acceleration(gal.) acting on the planned damsite
- X : epicenter distance - from the epicenters of past earthquakes to the projected damsite.

$$P : 1.66 - \frac{3.60}{X}$$

$$Q : 0.167 - \frac{1.83}{X}$$

$$Q' : -(1.43 + \frac{1.83}{X})$$

$$Q'' : -(0.631 + \frac{1.83}{X})$$

By T is represented the predominant period of the seismic waves. From the magnitude and the distance from the epicenter, T is obtained as shown in Table 2-3-2 using the Seed diagram shown in Fig.2-3-2.

The seismic intensity that acts on the projected damsite can be calculated using the above equations on the basis of data on past eqrthquakes that have occurred on Luzon Island. The maximum accelerations by year taken out of the calculated accelerations are given in Table 2-3-3.

(2) Calculation of Probable Acceleration

From results of the foregoing studies, probable accelerations at 100, 200, 300 and 500 years returns were estimated on the basis of the maximum accelerations by various methods such as the Thomas plotting method. As a result, probable accelerations were obtained and shown in Table 2-3-4.

Under the Thomas plotting method, 88 gals were obtained as the probable acceleration at the 200th year return. This agrees well with Table 2-3-3 in which year-by-year maximum accelerations are plotted.

(3) Design ground acceleration

In Figs. 2-3-4 and 2-3-5 earthquake energy of the Philippines and that of Japan are shown. In the figures, the contour lines show the degree of seismic energy accumulated in a year in units of $erg/km^2/year$.

Comparison of these figures shows Japan's seismic energy to be greater than that of the Philippines, though there are differences in the accuracy of the two sets of data.

In Japan, incidentally, 120-200 gals are adopted as the design seismic intensity for gravity dams. Also, in consideration of the 128-gal probable acceleration for the 500th year calculated under the Thomas plotting method, 120-gal design ground acceleration for the Diduyon Dam will be safe enough (the seismic intensity for general structures in the Philippines is 0.18 ≑ 100 gals). When an earthquake of 120-gal acceleration occurs directly below, the magnitude will be about M = 6.6.

(4) Design Seismicity for design of dam body

In the case of a gravity dam, the seismicity acting at right angles on the dam axis can generally be designed for the same value as the ground acceleration.

But as the proposed dam is a high dam of 100-meter class, the following examinations were made.

(a) Natural period of frequency of the gravity dam

If the dam is assumed to be of triangular wedge shape and subject to flexural vibration, the natural period of frequency of the dam To is derived from the quation :

$$To = 1.65 \frac{H^2}{B} \sqrt{\frac{12\gamma}{Eg}}$$

where

H : height of the dam (m)
B : width of the dam base (m)
E : Young's modulus of elasticity of the dam (2×16^6 t/m^2)
γ : volumetric weight per unit of dam material (2.5 t/m^3)
g : acceleration of gravity (9.8 m/sec^2)

when H = 110 m and B = 90 m are assumed for the Diduyon Dam, calculations result in To = 0.27 sec.

(b) Design seismicity

G.W. Housner obtained response spectra against typical severe earthquake records in the United States and produced Fig.2-3-6 by averaging them. From this figure, the average response coefficient of $\beta_0 = 1$ is obtained when the natural period of frequency is 0.27 sec. and the recession constant h of the gravity dam is assumed to be h = 0.1 - 0.2. Consequently, 120 gals, the same as for sub-surface acceleration, will be safely adopted for the dam body acceleration.

Table 2-3-1 (1) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC.	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
1	12-14-01	22-57-00	14°00'	122°00'	7.8	25	
2	4-18-07	20-59-48	14°00'	123°00'	7.6		
3	4-18-07	23-52-04	13°00'	123°00'	7.4		
4	7-21-21	00-16-12	14°30'	124°00'			
5	8-02-26	05-01-32	13°30'	124°00'			
6	10-29-26	00-08-36	16°18'	120°36'			
7	1-05-27	16-25-08	17°30'	119°06'			
8	1-12-27	00-05-53	15°18'	119°30'			
9	1-21-27	03-00-05	17°00'	124°00'			
10	4-06-27	21-47-46	19°00'	119°00'			
11	4-11-27	14-49-44	19°00'	120°30'			
12	4-13-27	13-44-14	16°00'	120°30'	6.25	140	
13	4-13-27	14-36-37	16°00'	120°30'	6.25	140	
14	4-19-27	17-30-10	16°00'	120°00'	6.75	100	
15	4-23-27	13-21-42	18°08'	120°00'			
16	5-13-27	15-13-28	13°42'	120°00'			
17	6-18-27	00-57-05	18°30'	120°12'			
18	5-21-28	04-01-02	16°30'	119°30'			
19	8-05-28	14-41-56	16°00'	119°30'	6.25		
20	9-14-28	21-11-00	13°36'	120°24'			
21	11-21-28	17-08-19	16°06'	120°30'			
22	1-15-29	17-29-40	16°30'	120°54'			
23	6-24-29	15-15-29	14°30'	124°00'			
24	7-21-29	13-13-59	14°30'	124°00'			
25	11-02-29	01-33-47	18°24'	120°00'			
26	3-16-30	04-39-35	19°00'	120°00'			
27	8-31-30	01-14-10	15°54'	122°12'			
28	10-01-30	02-53-00	18°00'	122°12'			
29	1-16-31	01-25-28	19°30'	122°00'			
30	3-19-31	06-25-00	18°00'	120°30'	6.9		
31	3-22-31	13-07-23	15°54'	121°36'			
32	3-30-31	13-30-13	18°30'	120°06'			
33	5-06-31	09-13-12	16°00'	121°06'			
34	8-22-31	16-30-21	15°06'	121°06'			
35	9-22-31	01-25-52	15°06'	121°36'			
36	9-28-31	05-35-03	17°30'	120°30'	6.25		
37	10-28-31	05-35-03	17°30'	121°30'	6.25		
38	1-18-32	20-26-47	19°30'	121°00'			
39	3-12-32	13-20-44	19°30'	120°24'			
40	6-03-32	22-43-47	17°12'	119°54'			
41	6-13-32	20-57-32	18°00'	119°00'	6.25		
42	6-14-32	05-59-38	18°30'	120°30'	6.5		VII
43	6-14-32	11-20-10	18°00'	120°30'	6		
44	7-18-32	05-02-05	14°00'	120°00'	6	100	
45	8-24-32	12-10-32	16°30'	120°30'	6.25		VII
46	1-25-33	02-35-01	13°54'	119°42'			
47	2-19-33	04-35-30	14°06'	120°36'			
48	03-03-33	02-19-00	15°30'	120°00'		120	IV
49	6-06-33	02-28-22	14°00'	120°00'	6.25		VII
50	2-14-34	03-59-34	17°30'	119°00'	7.6		
51	2-14-34	17-14-44	17°30'	119°00'			
52	4-01-34	21-55-32	17°18'	119°18'			
53	7-21-34	04-06-41	16°42'	121°06'			
54	7-31-34	05-58-34	15°00'	119°42'	5.6		
55	11-26-34	12-09-08	14°00'	120°00'	6.25		
56	12-27-34	17-43-11	14°00'	121°30'	6		
57	2-07-35	17-29-02	13°30'	122°30'	6		
58	5-28-36	00-16-01	13°30'	121°30'	6	160	
59	8-04-36	14-09-41	19°00'	121°00'			
60	12-14-36	04-03-42	14°18'	119°48'			
61	3-16-37	13-43-46	18°00'	121°30'	6.5		
62	8-20-37	11-59-16	14°30'	121°30'	7.5		VIII
63	2-05-38	09-55-10	14°00'	124°00'	6.5		VII
64	5-23-38	08-21-53	18°00'	119°30'	7		VI
65	5-06-39	17-00-07	13°30'	121°30'	6.5	110	
66	3-28-40	15-40-52	14°30'	120°00'	6.75	200	
67	5-09-41	05-32-37	14°00'	123°00'	6.75		
68	4-08-42	15-40-24	13°30'	121°00'	7.8	25	
69	3-03-48	09-09-54	18°30'	119°00'	7.2		
70	2-14-49	10-12-40	14°00'	121°00'			

Table 2-3-1 (2) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
71	9-05-49	05-18-09	17°00'	121°00'			
72	12-29-49	03-03-54	18°00'	121°00'	7.4		VII
73	1-01-50	12-39-00	17°00'	121°36'			
74	1-01-50	16-04-29	17°00'	121°30'			
75	1-02-50	13-10-00	17°00'	121°36'			
76	1-03-50	02-52-50	17°00'	121°36'	6.5		VII
77	1-17-50	06-57-31	14°12'	122°60'			
78	1-30-50	02-51-50	18°00'	122°30'	6.5		
79	4-06-50	19-10-52	13°30'	120°36'			
80	4-09-50	06-02-01	18°30'	120°36'			
81	4-28-50	21-14-18	17°00'	121°36'			
82	5-07-50	10-01-21	18°54'	121°30'			
83	5-11-50	02-35-55	18°54'	121°30'			IV
84	5-14-50	12-44-18	18°54'	121°30'			
85	5-15-50	21-05-26	18°54'	121°30'			
86	6-10-50	18-37-00	19°00'	119°00'			
87	7-02-50	10-12-49	17°48'	121°30'			
88	9-12-50	03-56-12	17°42'	120°12'			
89	10-10-50	16-52-28	18°54'	121°30'			
90	10-29-50	01-00-25	14°36'	123°42'			
91	4-16-51	19-57-08	18°48'	121°36'			
92	4-18-51	04-17-39	17°12'	121°42'			
93	4-23-51	11-13-22	14°48'	119°26'			
94	4-29-51	18-13-18	16°18'	122°42'			
95	5-30-51	07-34-05	19°30'	121°42'			
96	5-31-51	20-56-59	18°00'	119°00'			V
97	6-01-51	00-56-00	19°00'	121°00'			
98	7-03-51	05-52-06	14°42'	123°12'			
99	7-05-51	10-55-53	13°54'	120°18'			
100	9-06-51	23-11-56	15°36'	120°48'			IV
101	10-13-51	08-25-22	15°18'	120°18'			
102	10-26-51	16-17-21	15°48'	120°12'			
103	12-13-51	10-19-23	15°24'	122°00'			
104	12-28-51	00-59-55	18°42'	119°36'			
105	1-09-52	11-52-23	15°30'	119°36'			
106	1-16-52	11-52-23	15°30'	121°48'			
107	3-02-52	06-41-29	19°00'	122°30'			
108	3-12-52	01-07-39	15°18'	120°00'			
109	5-15-52	10-26-33	18°30'	121°18'			IV
110	5-20-52	15-13-16	18°30'	121°18'			IV
111	5-26-52	02-44-34	18°30'	121°18'			
112	6-02-52	18-09-00	18°30'	121°20'			V
113	6-03-52	04-03-38	14°30'	122°00'			
114	7-21-52	21-45-48	13°30'	120°00'			IV
115	8-03-52	21-45-48	13°30'	120°00'		96	
116	9-03-52	10-27-41	15°36'	119°54'			
117	9-27-52	10-32-65	17°30'	121°42'			
118	10-22-52	22-32-12	15°54'	122°00'			
119	2-26-53	11-14-06	16°24'	120°30'			IV
120	3-12-53	21-29-02	18°00'	120°00'			
121	3-16-53	17-29-20	16°24'	121°36'			
122	3-22-53	23-44-12	16°24'	121°36'			IV
123	4-21-53	22-36-00	19°10'	121°30'			
124	8-12-53	22-27-15	17°30'	121°48'			IV
125	12-14-53	10-38-15	18°42'	122°00'			
126	12-22-53	18-45-19	15°30'	119°00'			
127	1-22-54	12-52-34	18°30'	121°36'			
128	2-19-54	13-01-15	18°30'	121°36'			
129	2-23-54	23-17-53	14°30'	122°06'			
130	3-18-54	07-50-55	19°00'	122°06'			
131	3-29-54	04-02-36	19°00'	122°06'			
132	3-30-54	20-54-15	18°18'	119°06'			
133	4-09-54	07-16-29	19°24'	121°36'			
134	5-20-54	22-55-36	14°36'	119°18'			
135	6-09-54	10-08-41	17°48'	121°36'			
136	6-10-54	26-12-54	17°36'	221°00'			
137	9-05-54	19-22-58	18°06'	120°24'			
138	10-11-54	06-29-24	14°00'	123°12'			
139	11-21-54	19-16-14	14°42'	123°42'			
140	2-20-55	00-52-54	15°00'	119°30'			

Table 2-3-1 (3) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR.	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
141	4-05-55	02-38-05	15°00'	119°00'			
142	4-14-55	06-26-25	18°36'	123°06'			
143	5-11-55	11-38-26	19°06'	121°36'			
144	6-14-55	15-39-48	13°30'	120°00'			
145	7-02-55	16-03-52	19°06'	121°36'			
146	8-20-55	15-04-09	18°00'	119°48'			
147	11-15-55	15-22-44	15°36'	120°12'			
148	11-16-55	06-41-35	15°36'	120°12'			
149	11-24-55	04-52-36	18°54'	121°06'			
150	12-05-55	02-32-36	17°00'	121°42'			
151	12-05-55	18-13-11	17°18'	121°36'			
152	12-29-55	20-35-20	16°06'	120°48'			
153	2-12-56	21-49-20	19°00'	119°30'			
154	4-30-56	16-03-12	16°36'	121°00'			
155	5-04-56	18-46-49	15°42'	122°00'			
156	5-09-56	18-44-56	19°06'	121°36'			
157	5-28-56	09-15-02	13°30'	124°00'			
158	7-19-56	20-41-23	15°18'	119°18'			
159	10-23-56	8-42-00	14°05'	120°25'			
160	10-27-56	12-15-25	14°18'	123°36'			
161	10-28-56	10-45-44	14°18'	123°36'			
162	10-28-56	13-28-44	14°18'	123°36'			
163	10-28-56	14-00-34	14°18'	123°36'			
164	10-28-56	15-23-33	14°18'	123°36'			
165	10-29-56	03-17-02	14°18'	123°36'			
166	10-29-56	03-22-22	14°18'	123°36'			
167	11-02-56	19-54-08	14°18'	123°36'			
168	11-10-56	14-40-23	15°42'	120°12'			
169	11-13-56	14-39-29	14°18'	123°36'			
170	11-19-56	18-42-48	15°42'	120°12'			
171	12-04-56	14-37-14	15°42'	120°12'			
172	3-12-57	19-20-35	14°30'	123°30'			
173	3-12-57	19-20-35	14°30'	123°30'			
174	3-14-57	14-01-09	14°30'	123°30'			
175	6-11-57	18-50-25	17°36'	120°00'			
176	7-01-57	14-41-26	16°00'	120°54'			
177	7-25-57	22-16-32	18°00'	121°00'			
178	9-27-57	14-22-37	17°36'	121°42'			
179	11-20-57	16-14-59	18°48'	121°36'			
180	11-26-57	19-08-19	19°00'	121°00'			
181	12-30-57	13-58-29	18°36'	120°30'			
182	1-20-58	07-13-08	14°05'	120°00'			
183	1-20-58	07-13-22	14°60'	120°60'			
184	1-20-58	09-11-50	15°00	120°60'			
185	2-14-58	17-56-16	15°00'	119°48'			
186	2-19-58	14-31-03	15°30'	121°00'			
187	3-11-58	21-22-00	16°36'	121°42'			
188	3-19-58	14-15-07	18°48'	121°36'			
189	3-23-58	10-15-46	18°00'	120°00'			
190	4-15-58	09-59-55	15°00'	120°00'			
191	4-16-58	12-36-24	14°00'	120°30'			
192	4-20-58	12-57-34	19°00'	121°30'			
193	5-01-58	07-13-06	18°30'	120°00'			
194	8-01-58	12-28-28	13°30'	120°30'			
195	8-24-58	16-54-25	14°00'	121°00'			
196	9-23-58	19-07-50	15°00'	119°48'			
197	10-09-58	09-19-19	14°42'	123°00'			
198	11-12-58	03-58-35	18°42'	121°36'			
199	11-13-58	05-25-54	15°30'	122°06'			
200	11-13-58	00-30-00	15°40'	122°15'			
201	11-19-58	21-54-02	15°36'	119°36'			
202	12-03-58	09-48-26	19°00'	121°30'	6		
203	12-18-58	07-27-15	18°00'	120°30'			
204	1-21-59	11-08-10	19°00'	120°00'	5.5		
205	2-21-59	08-27-47	14°18'	120°18'			
206	2-21-59	11-08-10	19°00'	120°00'	5.5		
207	7-18-59	19-59-57	15°30'	120°30'	6.75		
208	6-10-59	09-49-53	13°30'	120°00'			
209	9-06-59	14-18-04	14°36'	126°00'	5.0		
210	1-04-60	13-35-00	18°00'	120°30'			

Table 2-3-1 (4) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
211	1-11-60	02-51-07	13°30'	120°30'			
212	1-13-60	01-22-00	17°40'	120°00'			
213	1-23-60	04-24-44	19°00'	120°00'	5.5		
214	1-24-60	21-12-07	13°30'	120°30'			
215	1-29-60	05-23-16	14°00'	120°00'			
216	2-29-60	05-22-53	14°00'	120°00'		150	
217	3-29-60	16-00-05	13°30'	121°00'			
218	4-27-60	22-43-49	18°00'	120°00'	5.25		
219	5-30-60	16-06-09	15°30'	121°30'	6.5	200	
220	10-27-60	10-51-35	16°18'	121°12'		54	
221	10-29-60	17-12-20.5	14°12'	120°42'			
222	11-06-60	06-40-12	16°48'	120°18'		98	
223	12-10-60	06-29-33	19°06'	119°30'			
224	12-15-60	13-48-00	13°36'	120°42'			
225	12-15-60	14-01-08	13°36'	120°42'			
226	12-23-60	19-30-41.6	15°42'	121°42'			
227	1-01-61	13-52-37.6	19°30'	121°00'			
228	1-11-61	02-51-07	13°30'	120°30'			
229	2-26-61	21-01-04.8	16°06'	121°36'	6.1	32	
230	3-20-61	11-27-05.4	16°24'	121°24'		30	
231	3-25-61	16-00-40.4	16°36'	120°24'		21	
232	3-26-62	01-21-57.4	16°12'	121°06'		43	
233	4-15-61	10-37-40.7	15°00'	119°18'			
234	5-09-61	17-27-44.9	13°54'	120°00'		18	
235	5-27-61	22-38-34.1	15°54'	119°42'		71	
236	5-27-61	22-38-34.1	15°54'	119°42'		25	
237	6-25-61	16-21-53.3	18°48'	121°12'			
238	7-14-61	00-06-52.5	15°48'	120°54'		168	
239	7-15-61	00-17-53.5	13°30'	120°36'	5.5	70	
240	12-12-61	21-18-32.5	13°54'	120°36'		120	
241	12-22-61	23-43-34.4	16°24'	120°24'		33	
242	1-13-62	05-31-03.4	13°48'	120°18'		83	
243	3-05-62	16-46-27.2	19°18'	121°12'			
244	4-15-62	11-35-21.1	13°42'	120°36'		40	
245	5-02-62	11-05-13.5	14°30'	120°12'		82	
246	5-28-62	02-48-13.1	16°24'	120°24'		25	
247	6-06-62	20-13-46	16°10'	120°18'			
248	6-30-62	19-29-51	16°30'	122°00'		82	
249	7-12-62	08-16-42	18°54'	121°24'			
250	9-27-62	13-07-57.8	18°36'	121°48'			
251	9-30-62	21-57-24.8	18°36'	120°54'	5.0		
252	10-28-62	12-06-21.5	14°48'	119°54'	5.0	56	
253	11-07-62	21-57-17.5	15°30'	120°24'		95	
254	11-10-62	11-03-36.8	19°18'	121°06'			
255	11-27-62	12-07-12.7	14°54'	119°54'			
256	12-07-62	13-55-03	13°54'	120°36'		178	
257	12-21-62	03-28-35.3	15°24'	121°48'		46	
258	12-21-62	18-20-44.7	15°18'	121°41'		55	
259	12-23-62	10-21-55.3	15°18'	121°42'		52	
260	12-30-62	07-07-10.5	15°24'	119°42'			
261	12-31-62	18-28-24	15°18'	122°30'		67	
262	1-12-63	04-19-27.8	15°06'	120°30'		83	
263	1-17-63	05-56-54.8	14°00'	120°36'		207	
264	2-07-63	17-36-52.8	14°42'	119°36'	4.5	151	
265	2-17-63	00-26-19	17°42'	122°18'	4.5		
266	2-25-63	04-49-51.5	15°00'	122°42'			
267	2-25-63	19-21-49.6	19°30'	121°48'	3.9		
268	2-25-63	23-45-16.8	15°30'	121°18'	4.3	33	
269	3-15-63	10-53-59.8	17°30'	119°48'	4.4		
270	3-25-63	03-55-01	14°00'	121°54'		33	
271	3-25-63	08-08-56	16°18'	119°42'	4.7	36	
272	5-17-63	06-09-18	15°42'	120°06'	5.5	80	
273	5-18-63	16-43-12.2	16°00'	119°30'	5.0	47	
274	5-20-63	09-08-04.1	19°06'	121°18'	4.7		
275	6-01-63	20-08-34.4	14°54'	119°42'	4.8	33	
276	6-07-63	15-49-57.4	19°00'	121°48'	4.7		
277	10-22-63	01-01-00	14°10'	122°10'			
278	12-21-63	13-09-09.6	16°06'	119°42'	5.6	49	
279	1-14-64	15-06-35	13°36'	120°30'		44	
280	1-20-64	20-38-16.5	18°48'	120°42'	4.8		

Table 2-3-1 (5) Past Earthquake Records in North Luzon 1901 -- 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
281	2-18-64	00-37-07	17°30'	121°18'	4.5		
282	3-12-64	22-33-00	13°30'	122°55'	5.3		
283	3-13-64	21-17-44.1	17°54'	120°00'	4.8		
284	3-23-64	22-28-45.6	19°18'	121°00'			
285	3-26-64	06-30-51.1	13°42'	120°36'	5.3	122	
286	6-22-64	14-28-23	16°36'	119°30'			
287	6-22-64	21-23-35.5	13°36'	120°36'	5.1	72	
288	7-09-64	05-47-09	15°18'	119°42'	5.3	48	
289	11-01-64	05-15-48.7	13°42'	120°36'	4.9	96	
290	11-30-64	06-25-16.3	13°48'	120°48'	5.3	207	
291	12-01-64	13-13-22.7	14°00'	120°30'		211	
292	1-05-65	20-34-21.6	13°54'	120°42'	4.8	165	
293	1-07-65	21-17-34.7	16°54'	119°42'		33	
294	1-13-65	15-04-27.1	13°00'	119°42'	4.9	20	
295	1-23-65	16-01-18.4	13°48'	119°54'		64	
296	1-23-65	22-38-26.5	13°42'	120°00'		59	
297	4-03-65	22-51-33.9	13°48'	119°54'	5.0	68	
298	5-14-65	21-10-59	15°12'	119°36'			
299	8-13-65	08-13-14.1	13°30'	120°00'	5.2	36	
300	8-15-65	04-44-25.3	13°48'	120°24'	4.9	51	
301	8-25-65	09-52-00	15°12'	120°00'			
302	9-09-65	03-03-00	14°42'	119°48'			
303	9-10-65	02-53-26.2	13°54'	120°54'	5.0	149	
304	9-17-65	02-06-00	14°30'	122°24'			
305	9-18-65	01-41-00	16°30'	120°30'			
306	9-25-65	02-51-00	15°30'	120°30'			
307	9-25-65	12-17-00	15°54'	121°00'			
308	10-02-65	00-00-00	16°18'	120°36'			
309	10-02-65	05-35-10	14°48'	119°36'			
310	10-24-65	00-00-00	15°42'	121°48'			
311	10-25-65	14-13-49	17°00'	120°54'	5.2	168	
312	11-01-65	00-00-00	13°42'	119°36'			
313	12-09-65	00-00-00	14°12'	122°24'			
314	12-13-65	00-00-00	16°24'	121°30'			
315	12-26-65	00-00-00	16°06'	121°48'			

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
316	1-01-66	00-00-00	14°48'	119°30'	4.8	3.7	
317	1-01-66	11-13-27	15°18'	120°00'	4.8	37	
318	1-10-66	01-19-12	13°48'	120°06'	5.5	134	
319	1-14-66	00-00-00	16°54'	122°54'			
320	1-26-66	11-58-35	16°30'	120°00'	5.8	69	
321	2-03-66	00-00-00	16°36'	120°00'	5.8	69	
322	2-04-66	00-00-00	15°24'	122°06'			
323	2-08-66	00-00-00	16°06'	121°48'			
324	2-12-66	00-00-00	16°06'	121°36'			
325	2-17-66	00-00-00	15°54'	121°06'			
326	2-17-66	15-14-46	15°36'	121°54'			
327	2-20-66	00-00-00	16°06'	122°00'			
328	3-03-66	00-00-00	14°24'	122°12'			
329	3-04-66	00-00-00	16°48'	119°42'			
330	3-04-66	00-00-00	15°30'	122°12'			
331	3-05-66	00-00-00	16°48'	121°12'			
332	3-12-66	00-00-00	15°06'	119°36'			
333	3-12-66	00-00-00	15°00'	119°42'			
334	3-15-66	00-00-00	14°30'	120°00'			
335	3-16-66	00-00-00	15°36'	121°12'			
336	3-22-66	00-00-00	15°30'	122°24'			
337	3-25-66	00-00-00	15°00'	119°30'			
338	3-26-66	00-00-00	14°06'	122°30'			
339	4-12-66	18-22-14	13°36'	120°42'	4.8	128	
340	4-21-66	00-00-00	16°30'	120°36'			
341	4-21-66	19-45-00	16°54'	120°00'			
342	4-29-66	00-00-00	13°54'	120°06'			
343	5-01-66	00-00-00	14°24'	121°54'			
344	5-03-66	00-00-00	14°24'	122°30'			
345	5-17-66	00-00-00	15°18'	199°30'			
346	5-28-66	00-00-00	13°54'	120°00'			
347	5-29-66	00-00-00	14°54'	120°00'			
348	6-04-66	00-00-00	14°12'	120°00'			
349	6-06-66	00-00-00	16°42'	119°30'			
350	6-08-66	00-00-00	16°24'	120°12'			

Table 2-3-1 (6) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
351	6-19-66	00-00-00	15°48'	121°12'			
352	6-19-66	00-00-00	15°30'	119°48'			
353	6-20-66	00-00-00	16°30'	120°42'			
354	6-22-66	00-00-00	13°34'	120°12'			
355	6-22-66	00-00-00	15°54'	121°54'			
356	6-29-66	00-00-00	15°00'	119°54'			
357	7-01-66	15-30-21	13°54'	120°30'			
358	7-06-66		16°42'	119°42'			
359	7-06-66		15°18'	122°00'			
360	7-13-66		13°54'	120°06'			
361	7-13-66		15°30'	121°54'			
362	7-15-66		14°42'	119°56'			
363	7-19-66		16°18'	120°06'			
364	7-22-66		14°54'	122°12'			
365	7-27-66		15°24'	122°10'			
366	8-01-66		13°48'	121°48'			
367	8-06-66		14°36'	119°30'			
368	8-28-66		16°18'	120°30'			
369	8-28-66	18-56-19	13°42'	120°42'	5.1	110	
370	8-31-66	15-42-13.0	15°16'	120°08'		76	
371	9-02-66	00-00-00	15°42'	121°12'			
372	9-09-66	00-00-00	14°00'	119°36'			
373	9-26-66		14°00'	119°36'			
374	9-26-66	21-50-51	15°36'	121°00'			
375	9-28-66		15°36'	121°00'			
376	10-01-66		13°54'	120°12'			
377	10-01-66		15°30'	119°54'			
378	10-04-66		16°42'	120°42'			
379	10-09-66		14°54'	120°54'			
380	10-11-66	12-06-16.0	13°54'	120°30'	5.2	83	
381	10-16-66		15°06'	119°36'			
382	10-18-66		14°48'	120°36'			
383	10-18-66		16°48'	121°42'			
384	10-21-66		16°12'	119°48'			
385	10-23-66		13°42'	120°00'			
386	10-26-66		15°30'	120°24'			
387	10-26-66	20-09-36	15°30'	121°00'	5.0	51	
388	10-27-66		16°48'	122°06'			
389	10-29-66		13°42'	120°30'			
390	10-31-66		13°42'	120°06'			
391	10-31-66		15°20'	119°30'			
392	11-05-66		15°36'	120°30'			
393	11-21-66		14°18'	121°42'			
394	11-30-66		15°36'	121°54'			
395	12-02-66		15°00'	122°24'			
396	12-20-66		13°54'	120°12'			
397	12-20-66		13°48'	120°12'			
398	12-20-66	18-20-66	14°18'	122°06'	5.4	37	
399	12-22-66		13°48'	123°18'			
400	12-23-66		16°42'	122°30'			
401	12-23-66		15°24'	122°12'			
402	12-24-66		14°48'	119°36'			
403	12-24-66		16°36'	122°30'			
404	12-24-66		13°54'	120°30'			
405	12-24-66		16°42'	122°30'			
406	12-26-66		15°18'	122°06'			
407	1-02-67		13°54'	120°18'			
408	1-05-67		13°48'	120°42'	5.4	166	
409	1-05-67	06-13-36	13°54'	120°42'	5.4	166	
410	1-14-67		16°54'	119°48'			
411	1-14-67	13-24-55	13°36'	120°36'	4.7	38	
412	1-19-67		15°30'	121°18'			
413	1-24-67		14°40'	122°18'			
414	1-24-67	23-03-23	15°18'	121°54'	4.5		
415	1-25-67		14°42'	119°48'			
416	1-25-67		14°54'	120°36'			
417	1-31-67		16°18'	121°36'			
418	1-31-67	13-24-26	13°48'	120°48'	4.8	197	
419	2-17-67		15°12'	119°36'			
420	2-18-67		14°12'	119°48'			

Table 2-3-1 (7) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
421	3-03-67		15°06'	120°09'			
422	3-05-67		16°36'	121°06'			
423	2-10-67		13°48'	119°42'			
424	3-19-67	5-53-3.0	13°42'	120°36'	6.9	96	
425	4-03-67		15°42'	121°18'			
426	4-05-67		16°36'	121°12'			
427	4-07-67		16°18'	121°48'			
428	4-08-67		15°48'	121°48'			
429	5-02-67		15°12'	122°18'			
430	5-05-67		15°00'	119°54'			
431	5-05-67	19-59-54	15°18'	119°48'	5.1		
432	5-09-67		15°00'	120°00'			
433	5-14-67	10-43-26.0	13°42'	120°42'	4.6	112	
434	6-06-67	6-48-51.0	15°00'	119°54'	4.5	61	
435	6-12-67		15°42'	121°48'			
436	6-15-67		15°06'	120°00'			
437	6-16-67		14°48'	119°56'			
438	7-01-67		15°24'	119°30'			
439	7-01-67		13°56'	119°54'			
440	7-05-67	21-09-06	13°48'	122°12'	5.0	40	
441	7-14-67		14°48'	119°42'			
442	7-30-67	20-29-18	15°54'	121°12'	4.7	17	
443	8-06-67	09-15-5.0	13°30'	120°54'			
444	8-15-67	19-54-6.0	16°30'	120°12'	4.5	97	
445	9-10-67	17-49-16	16°48'	121°12'	4.9	22	
446	9-12-67	11-58-47	13°54'	120°00'			
447	10-17-67	21-06-07	14°00'	121°54'			
448	6-06-68	19-44-70	14°54'	119°54'	5.4	80	
449	6-12-68	23-26-3	13°48'	120°42'	5.0		
450	7-05-68	11-18-49	14°54'	119°48'	4.8	78	
451	8-01-68	11-03-32.0	16°30'	122°30'			
452	8-01-68	11-58-55	16°24'	122°24'			
453	8-01-68	11-48-21	16°24'	122°24'			
454	8-01-68	18-23-36	15°54'	122°12'			
455	8-01-68	20-19-21	16°00'	122°30'	7.3	36	
456	8-01-68	20-43-10	16°30'	122°24'	4.9	33	
457	8-01-68	20-57-18	16°00'	122°12'	4.9	33	
458	8-01-68	21-15-3.0	15°42'	121°48'	5.7	33	
459	8-01-68	23-16-26.0	16°00'	122°18'	4.7	33	
460	8-01-68	23-45-10	15°54'	122°24'	4.9	33	
461	8-02-68	00-40-26	16°12'	122°30'	4.9	33	
462	8-02-68	01-05-49	16°06'	122°12'	5.0	33	
463	8-02-68	01-55-38	16°18'	121°54'	4.8	33	
464	8-02-68	01-55-38	16°18'	121°54'	4.8	33	
465	8-02-68	02-10-18	16°48'	122°24'			
466	8-02-68	03-48-21	15°36'	121°48'	4.7	49	
467	8-02-68	04-24-40	16°00'	122°24'			
468	8-02-68	04-58-29	16°12'	122°06'			
469	8-02-68	05-20-54	15°48'	122°18'			
470	8-02-68	05-44-27	15°48'	122°30'			
471	8-02-68	06-23-06	16°06'	122°18'			
472	8-02-68	07-11-51	16°54'	122°18'			
473	8-02-68	07-38-34	16°42'	122°12'			
474	8-02-68	07-45-04	16°12'	122°12'			
475	8-02-68	07-58-16	15°12'	122°18'			
476	8-02-68	09-37-16	16°36'	122°30'			
477	8-02-68	10-13-40	15°48'	122°24'			
478	8-02-68	10-50-58	16°30'	122°12'			
479	8-02-68	12-09-40	17°00'	122°30'			
480	8-02-68	12-29-52	16°06'	122°18'			
481	8-02-68	12-43-13	15°36'	122°30'			
482	8-02-68	19-33-23	16°30'	122°18'			
483	8-03-68	00-39-38	16°18'	121°54'			
484	8-03-68	00-54-47	15°42'	122°06'			
485	8-03-68	01-50-24	15°48'	122°12'			
486	8-03-68	01-55-28	15°36'	122°30'			
487	8-03-68	02-01-23	16°06'	122°00'			
488	8-03-68	02-08-31	16°00'	122°30'			
489	8-03-68	02-10-18	15°30'	122°18'			
490	8-03-68	02-22-01	15°54'	122°12'			

Table 2-3-1 (8) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
491	8-03-68	04-47-23	15°54'	122°24'			
492	8-03-68	06-25-05	16°30'	122°18'	5.9	37	
493	8-03-68	09-34-01	15°42'	122°30'			
494	8-03-68	10-06-11	15°48'	122°30'			
495	8-03-68	11-50-50	16°36'	122°12'			
496	8-03-68	14-17-35	15°30'	121°54'	4.7	33	
497	8-03-68	15-38-35	15°30'	122°30'	4.9	33	
498	-do-	15-51-48	16°00'	122°24'	4.7	33	
499	-do-	19-19-01	16°18'	122°30'			
500	-do-	22-16-58	15°30'	122°30'			
501	-do-	23-06-36	15°36'	122°30'			
502	8-04-68	02-04-44	16°42'	122°30'		33	
503	8-04-68	02-39-41	15°42'	121°54'			
504	8-04-68	02-39-41	15°62'	122°30'			
505	-do-	03-32-41	15°24'	122°30'			
506	-do-	04-09-08	16°18'	121°48'			
507	-do-	05-08-42	15°36'	122°30'			
508	-do-	05-18-39	15°54'	122°06'			
509	-do-	05-30-40	15°42'	122°06'			
510	-do-	05-41-22	15°24'	122°06'			
511	-do-	06-06-10	16°18'	121°42'			
512	-do-	07-10-38	15°36'	122°30'			
513	-do-	07-56-16	15°30'	122°18'			
514	-do-	08-05-14	16°30'	122°24'	5.1	18	
515	-do-	15-22-38	16°12'	122°30'	5.0	33	
516	8-05-68	02-19-45	16°00'	121°54'			
517	8-05-68	05-27-06	16°54'	122°24'			
518	-do-	06-31-04	16°54'	122°24'			
519	-do-	08-40-45	16°06'	121°48'			
520	-do-	09-46-56	15°42'	121°48'			
521	-do-	10-48-46	16°18'	122°12'			
522	-do-	12-53-33	15°54'	122°24'			
523	-do-	16-51-09	16°00'	122°00'	4.6	43	
524	-do-	19-44-33	16°12'	122°18'			
525	-do-	19-46-41	16°12'	122°00'			
526	8-05-68	22-32-12	15°54'	122°18'			
527	8-05-68	23-36-17	15°30'	122°12'			
528	8-06-08	01-18-45	15°42'	121°42'			
529	-do-	02-12-44	15°36'	122°12'			
530	-do-	03-06-27	16°36'	122°24'	5.1	33	
531	-do-	03-16-29	16°12'	121°54'	4.8	43	
532	-do-	04-53-04	15°42'	121°54'	5.2	50	
533	-do-	05-53-52	15°42'	121°54'			
534	-do-	06-07-48	16°18'	122°06'			
535	-do-	07-21-57	15°42'	121°54'			
536	-do-	08-05-33	15°24'	122°30'			
537	-do-	12-36-32	15°54'	122°00'			
538	-do-	12-57-34	16°06'	122°30'			
539	-do-	13-25-39	15°42'	122°24'			
540	-do-	14-22-00	15°54'	122°24'			
541	-do-	15-02-59	15°30'	122°24'			
542	-do-	15-43-53	16°18'	122°24'			
543	-do-	15-49-41	15°18'	122°30'			
544	-do-	21-48-29	15°36'	121°54'			
545	-do-	22-11-47	15°54'	122°06'			
546	-do-	23-39-27	15°30'	122°30'			
547	-do-	23-44-35	15°30'	121°48'	5.1	33	
548	8-07-68	01-29-16	15°30'	122°30'			
549	8-07-68	03-53-25	15°42'	121°54'	4.8	34	
550	-do-	05-57-11	15°48'	122°30'			
551	-do-	05-57-11	15°48'	122°30'			
552	-do-	10-58-02	16°00'	122°24'			
553	-do-	16-08-43	15°24'	122°12'			
554	-do-	18-23-35	16°12'	122°12'			
555	8-08-68	01-44-24	16°36'	122°24'			
556	8-08-68	03-00-12	16°00'	122°00'			
557	8-08-68	08-06-50	16°18'	122°30'			
558	8-08-68	14-00-44	16°00'	122°00'	5.1	17	
559	8-08-68	20-35-19	15°24'	122°24'			
560	8-08-68	21-10-06	16°00'	122°24'			

Table 2-3-1 (9) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
561	8-08-68	21-54-10	16°00'	122°24'			
562	8-09-68	02-22-57	16°00'	122°06'			
563	8-09-68	02-30-48	15°36'	122°24'			
564	8-09-68	02-47-48	16°36'	122°06'			
565	8-09-68	07-05-33	16°00'	122°24'			
566	8-09-68	17-32-17	15°54'	122°00'			
567	8-09-68	18-13-46	15°12'	121°00'	4.6	39	
568	8-09-68	20-09-00	16°12'	122°24'			
569	8-09-68	21-33-56	15°42'	121°56'	4.9	66	
570	8-10-68	01-59-38	16°54'	122°24'			
571	8-10-68	07-31-26	16°00'	122°12'			
572	8-10-68	10-03-10	15°42'	121°36'			
573	8-10-68	16-41-25	15°38'	121°36'	5.4	33	
574	8-10-68	17-59-39	15°54'	122°24'			
575	8-10-68	19-49-58	17°00'	122°24'	4.9	43	
576	8-11-68	05-03-30	15°54'	122°06'			
577	8-11-68	17-21-49	16°24'	122°24'			
578	8-12-68	09-37-53	15°30'	122°24'			
579	8-12-68	12-59-23	17°00'	122°24'		20	
580	8-12-68	17-49-10	16°48'	122°30'		20	
581	8-12-68	18-09-56	15°54'	121°48'			
582	8-13-68	0-14-59	15°36'	121°42'	5.1	45	
583	8-13-68	01-51-13	15°24'	121°54'			
584	8-13-68	17-19-16	15°12'	122°00'			
585	8-13-68	19-05-03	16°00'	122°24'			
586	8-13-68	22-53-25	16°06'	122°24'			
587	8-13-68	23-44-18	16°00'	122°24'			
588	8-14-68	03-55-23	15°18'	122°12'			
589	8-14-68	07-56-55	15°06'	122°30'	5.4	8	
590	8-14-68	11-43-28	15°30'	122°30'			
591	8-14-68	17-00-16	15°36'	122°18'			
592	8-15-68	04-14-01	15°42'	122°06'			
593	8-15-68	09-17-57	15°48'	122°18'			
594	8-15-68	11-11-05	15°42'	122°06'			
595	8-15-68	11-15-14.0	15°36'	122°24'			
596	8-16-68	20-44-19	15°30'	122°00'			
597	8-17-68	11-08-11	15°48'	122°18'			
598	8-17-68	11-11-18	15°54'	121°42'			
599	8-17-68	20-02-18	16°00'	122°00'			
600	8-18-68	04-16-31	15°36'	122°18'			
601	8-18-68	07-00-00	15°48'	121°54'			
602	8-20-68	24-17-05	15°54'	122°00'			
603	8-20-68	13-13-13	15°54'	121°42'			
604	8-20-68	13-41-07	15°36'	122°24'			
605	8-21-68	13-21-39	15°54'	122°24'			
606	8-21-68	15-23-05	15°48'	121°54'			
607	8-21-68	15-31-53	16°00'	122°00'			
608	8-22-68	16-42-13	15°24'	121°30'	5.2	25	
609	8-22-68	19-29-55	16°24'	121°54'			
610	8-22-68	21-24-43	16°36'	122°24'			
611	8-23-68	05-19-36	15°54'	122°24'			
612	8-23-68	14-06-26	15°48'	122°00'			
613	8-25-68	07-58-38	15°36'	122°12'			
614	8-25-68	23-11-35	15°42'	122°06'			
615	8-26-68	23-08-05	15°36'	122°42'			
616	8-27-68	04-24-45	15°12'	122°00'			
617	8-28-68	02-15-16	15°18'	122°18'			
618	8-28-68	20-42-16	15°36'	122°00'			
619	8-29-68	01-36-18	15°48'	121°54'	5.3	17	
620	8-29-68	02-11-24	15°24'	122°30'			
621	8-29-68	04-15-13	16°06'	122°30'			
622	8-29-68	04-52-30	15°48'	121°54'			
623	8-29-68	05-34-07	16°06'	121°48'			
624	8-29-68	06-18-05	15°42'	122°00'			
625	8-29-68	06-19-49	15°30'	122°06'			
626	8-29-68	06-32-07	16°06'	121°36'			
627	8-29-68	08-05-30	15°30'	122°06'	5.1	22	
628	8-29-68	08-37-21	15°48'	122°18'			
629	8-29-68	12-26-03	15°48'	121°30'			
630	8-29-68	15-13-05	15°30'	122°06'			

Table 2-3-1 (10) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
631	8-29-68	15-28-15	15°30'	122°24'			
632	8-29-68	15-53-49	15°36'	122°18'			
633	8-29-68	16-08-12	15°18'	122°12'			
634	8-29-68	17-22-38	15°54'	122°18'			
635	8-29-68	18-05-53	15°36'	122°18'			
636	8-29-68	21-08-07	15°54'	121°42'	5.2	39	
637	8-29-68	21-20-02	16°00'	122°06'			
638	8-29-68	22-19-43	15°30'	122°18'			
639	8-30-68	00-34-13	16°00'	122°30'			
640	8-30-68	02-24-57	15°24'	122°12'			
641	8-30-68	05-22-21	15°12'	122°24'			
642	8-30-68	11-03-05	15°12'	122°24'			
643	8-30-68	11-35-33	16°00'	122°00'			
644	8-30-68	20-20-14	15°36'	122°12'			
645	8-30-68	22-28-17	15°00'	122°06'			
646	8-30-68	23-48-32	15°36'	122°12'			
647	8-31-68	06-46-18	15°18'	122°06'			
648	8-31-68	07-34-16	15°48'	122°18'			
649	8-31-68	19-54-18	15°36'	122°24'			
650	8-31-68	01-51-56	15°30'	122°24'			
651	9-01-68	01-51-56	15°36'	122°12'			
652	9-01-68	07-28-45	15°30'	122°18'			
653	9-01-68	18-45-57	15°36'	122°24'			
654	9-01-68	13-21-57	15°30'	122°12'			
655	9-01-68	18-06-48	15°42'	122°18'			
656	9-01-68	22-19-43	15°36'	122°18'			
657	9-01-68	23-24-45	15°48'	122°00'			
658	9-01-68	07-28-45	15°24'	122°12'			
659	9-03-68	01-29-46	15°36'	122°12'			
660	9-03-68	02-18-14	15°24'	122°12'			
661	9-03-68	04-12-26	15°30'	122°18'			
662	9-03-68	07-53-49	15°36'	122°12'			
663	9-03-68	14-18-27	15°42'	121°48'			
664	9-03-68	19-38-44	15°18'	122°12'			
665	9-04-68	02-30-58	15°30'	122°06'			

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
666	9-04-68	10-54-30	15°54'	122°12'			
667	9-04-68	13-00-04	15°24'	122°18'			
668	9-04-68	17-02-35	15°30'	122°18'			
669	9-06-68	05-00-05	16°18'	122°24'			
670	9-06-68	10-17-04	15°30'	122°12'			
671	9-07-68	07-32-09	15°54'	121°42'			
672	9-08-68	04-10-47	15°30'	122°12'			
673	9-11-68	05-47-45	15°36'	122°18'			
674	9-11-68	08-36-40	15°42'	122°24'			
675	9-13-68	15-09-51	15°30'	122°18'			
676	9-13-68	17-05-26	15°24'	122°18'			
677	9-14-68	03-07-19	16°48'	122°18'			
678	9-14-68	06-02-21	15°54'	121°48'			
679	9-14-68	11-07-33	16°00'	121°48'			
680	9-16-68	05-25-23	15°48'	122°24'			
681	9-17-68	14-33-10	15°36'	121°48'			
682	9-18-68	04-11-48	15°24'	122°24'			
683	9-18-68	06-53-24	15°30'	122°18'			
684	9-18-68	09-23-01	15°42'	122°00'			
685	9-18-68	14-02-30	15°42'	122°06'			
686	9-18-68	14-04-51	15°30'	122°18'			
687	9-18-68	14-33-11	15°36'	122°12'			
688	9-19-68	09-39-59	15°12'	122°18'			
689	9-19-68	09-39-59	15°12'	122°18'			
690	9-20-68	20-37-23	16°24'	122°18'			
691	9-22-68	06-23-12	16°00'	122°00'			
692	9-22-68	17-21-14	15°42'	122°12'			
693	9-22-68	12-15-52	15°48'	122°00'			
694	9-22-68	16-08-06	15°42'	122°12'			
695	9-22-68	17-21-14	15°42'	122°12'			
696	9-22-68	17-21-14	15°42'	122°12'			
697	9-22-68	18-05-30	15°42'	122°18'			
698	9-22-68	21-20-42	15°42'	122°24'			
699	9-22-68	23-10-01	15°42'	122°18'			
700	9-23-68	04-54-52	16°00'	122°00'			

Table 2-3-1 (11) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
701	9-23-68	18-06-43	15°18'	122°06'			
702	9-23-68	19-51-01	15°18'	122°12'			
703	9-24-68	04-51-22	15°54'	122°12'			
704	9-24-68	04-53-21	15°54'	122°06'			
705	9-24-68	09-49-61	16°18'	122°00'			
706	9-24-68	14-50-50	15°30'	122°24'			
707	9-24-68	14-59-46	16°06'	122°00'			
708	9-24-68	19-05-42	15°48'	122°06'			
709	9-25-68	06-09-36	15°36'	122°12'			
710	9-07-68	04-03-48	15°42'	121°30'			
711	9-28-68	09-24-24	15°30'	122°06'			
712	9-30-68	08-51-35	16°00'	121°48'			
713	11-02-68	08-34-57	16°06'	121°54'	5.1	45	
714	11-06-68	22-21-19	13°30'	120°24'	5.2	68	
715	11-22-68	08-59-23	16°18'	122°18'	5.8	26	
716	11-22-68	09-41-16	16°18'	122°18'	5.1	0	
717	11-28-68	08-03-18	16°24'	122°06'	5.0	67	
718	12-12-68	16-00-30	16°24'	122°12'	5.0	50	
719	12-29-68	07-15-50	13°36'	120°30'	5.5	0	
720	1-04-69	06-02-26	15°30'	121°54'	4.7	0	
721	1-11-69	17-31-29	16°18'	122°18'	5.0	16	
722	1-13-69	05-37-30	13°42'	120°36'	5.0	121	
723	3-06-69	07-41-31	15°48'	121°42'	-	33	
724	3-06-69	15-27-40.6	16°12'	122°12'	-	36	
725	5-09-69	02-10-21	14°42'	119°36'	4.7	64	
726	5-15-69	07-53-03	16°06'	121°54'	5.2	57	
727	6-04-69	20-17-25	15°12'	122°18'	5.1	29	
728	6-21-69	17-05-17	14°54'	119°36'	5.0	33	
729	6-23-69	11-06-37	15°42'	120°42'	4.7	198	
730	6-25-69	00-08-55	13°30'	120°18'	5.1	0	
731	8-25-69	13-12-55	16°00'	121°12'	4.3	102	
732	9-04-69	18-10-36	16°18'	119°36'	5.1	53	
733	10-06-69	12-48-05	15°00'	120°06'	5.6	59	
734	10-20-69	08-48-47.1	14°54'	119°36'		33	
735	10-28-69	07-19-08	16°18'	122°12'	4.9	60	

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
736	11-05-69	23-04-59.7	19°12'	120°30'	4.8	-	
737	11-11-69	16-06-03.6	15°42'	119°18'	4.3		
738	11-11-69	16-16-56.6	15°30'	119°24'	4.4		
739	12-22-69	05-06-27.9	13°36'	120°36'	4.7	54	
740	12-23-69	14-08-00.5	13°48'	120°36'	5.3	127	
741	12-28-69	22-47-38.2	13°24'	120°18'	4.5		
742	1-05-70	00-20-15	19°12'	121°12'	5.4		
743	1-21-70	10-57-46.7	18°06'	119°18'	4.7		
744	1-24-70	19-00-00	17°24'	122°06'	5.1		
745	1-29-70	02-21-16.1	15°00'	119°54'	4.8	56	
746	2-12-70	16-30-32.9	15°54'	120°24'			
747	2-23-70	20-48-17.8	19°12'	121°12'	5.2		
748	2-24-70	06-22-34.4	19°12'	121°00'	4.6		
749	2-26-70	15-50-11	13°36'	100°36'	5.3		
750	3-04-70	01-17-44.5	13°30'	120°24'	5.2	61	
751	3-13-70	15-38-34.4	18°42'	120°54'	4.6		
752	3-29-70	02-18-01	13°54'	120°42'	5.3	118	
753	4-06-70	00-54-30.8	13°54'	120°12'	5.6	75	
754	4-07-70	05-34-05.6	15°48'	121°42'	6.4	37	
755	4-07-70	05-53-40.1	15°48'	121°48'	5.1	35	
756	-do-	06-04-36.9	15°24'	121°42'	5.1	-	
757	-do-	06-11-52.3	15°42'	121°54'	5.7	22	
758	-do-	06-34-18.6	15°30'	121°54'	5.5	-	
759	4-07-70	07-45-16.7	15°24'	121°42'	4.9	-	
760	-do-	07-58-57.4	15°36'	121°54'	4.8		
761	-do-	07-59-57	15°18'	121°42'			
762	-do-	08-25-31.2	15°18'	121°42'	4.7		
763	-do-	09-13-26.1	15°30'	121°54'	4.3		
764	-do-	09-24-27	15°24'	121°48'	4.8	21	
765	-do-	09-39-09.2	15°36'	121°48'	4.9		
766	-do-	10-31-35.8	15°18'	121°48'	4.8	29	
767	-do-	10-43-29.6	15°24'	121°48'	4.6	20	
768	-do-	13-03-30.7	15°18'	121°36'	4.5		
769	-do-	13-10-12.7	15°18'	121°48'	4.8		
770	-do-	13-28-54.2	15°18'	121°36'	4.9		

Table 2-3-1 (12) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
771	4-07-70	15-05-50.5	15°24'	121°42'	5.0	18	
772	-do-	15-56-26.4	15°48'	121°42'	4.8	37	
773	-do-	18-06-22.8	15°24'	121°36'	4.6		
774	-do-	19-11-15.5	15°18'	121°54'	4.7		
775	-do-	19-58-19.7	15°18'	121°42'	4.7		
776	-do-	22-27-47.2	15°12'	121°42'	4.6	31	
777	4-08-70	05-13-40.8	15°18'	121°42'	4.9	36	
778	-do-	07-22-47.4	15°48'	121°54'	4.3		
779	-do-	08-30-08	15°18'	121°36'	4.7		
780	-do-	08-45-16.6	15°18'	121°36'	5.2		
781	-do-	09-52-58	15°40'	121°42'	4.9		
782	-do-	09-58-30.2	15°30'	121°48'	4.6		
783	-do-	14-38-22.5	15°48'	121°36'	4.9		
784	-do-	16-14-31.3	15°30'	122°00'	4.2		
785	-do-	17-54-29.5	15°36'	121°42'	5.3		
786	-do-	20-13-17.7	15°12'	121°42'	4.1		
787	-do-	21-23-56.6	15°24'	121°48'	5.7		
788	04-08-70	21-33-52.3	15°30'	121°42'	5.0		
789	04-08-70	21-46-60	15°24'	121°54'	5.1		
790	04-08-70	22-07-39	15°18'	121°42'	4.3		
791	04-08-70	22-33-48.3	15°30'	121°48'	4.8		
792	04-08-70	22-47-10.2	15°24'	121°54'	4.6		
793	04-08-70	23-33-46.2	15°30'	121°42'	5.2		
794	04-08-70	23-38-20.8	16°00'	121°42'	4.3		
795	04-09-90	00-24-35	15°54'	122°00'	4.8		
796	04-09-70	04-38-08	15°30'	121°48'	4.8		
767	04-09-70	08-43-27	15°30'	121°48'	4.6		
798	04-09-70	10-08-05	15°24'	121°42'	4.1		
799	04-09-70	10-18-49	15°18'	121°36'	4.5		
800	04-09-70	11-39-35.2	15°24'	121°48'	4.3		
801	04-09-70	17-59-52.9	15°30'	121°48'	4.6		
802	04-10-70	00-01-15.4	15°42'	121°42'	4.8		
803	04-10-70	00-23-15.2	15°30'	121°30'	4.8		
804	04-10-90	13-17-57.2	15°54'	122°00'	5.0		
805	04-10-70	22-04-27.5	15°48'	121°48'	4.9		
806	04-11-70	16-19-03.1	15°48'	121°48'	4.6		
807	04-11-70	23-32-57.4	15°36'	121°42'	4.5		
808	04-12-70	04-01-44	15°06'	122°06'	5.9		
809	04-12-70	04-15-32.5	15°06'	121°54'	4.9		
810	04-12-70	04-16-57.1	15°12'	122°00'	5.5		
811	04-12-70	04-26-38.5	15°06'	122°06'	3.6		
812	04-12-70	05-10-37.1	15°00'	122°06'	5.3		
813	04-12-70	05-27-52.4	15°06'	122°00'	4.8		
814	04-12-70	05-27-52.4	15°06'	122°00'	4.8		
815	04-12-70	05-34-53	15°00'	122°12'	4.8		
816	04-12-70	06-03-48.7	15°00'	122°12'	4.8		
817	04-12-70	06-23-31.7	15°06'	121°54'	4.7		
818	04-12-70	06-29-56.4	15°06'	121°54'	5.0		
819	04-12-70	06-36-52.6	15°06'	122°00'	4.6		
820	04-12-70	06-51-01.8	15°06'	122°24'	4.6		
821	04-12-70	06-58-26.0	15°06'	122°00'	4.7		
822	04-12-70	07-03-48.4	15°06'	121°48'	4.7		
823	04-12-70	07-16-03.2	15°06'	122°24'	4.7		
824	04-12-70	08-33-18	15°06'	122°12'	4.7		
825	04-12-70	09-01-46.6	15°06'	122°00'	5.0		
826	04-12-70	10-48-42.8	15°06'	122°00'	5.2		
827	04-12-70	12-11-37.9	15°06'	121°54'			
828	04-12-70	12-34-52.5	15°00'	121°54'			
829	04-12-70	13-55-41.3	15°00'	122°18'	4.9		
830	04-12-70	14-22-38.9	15°06'	122°30'	5.4		
831	04-12-70	15-33-47.0	14°48'	121°54'	4.1		
832	04-12-70	17-02-01.8	15°06'	121°54'	4.6		
833	04-12-70	22-36-52.3	15°00'	121°54'	4.4		
834	04-12-70	23-52-07.6	15°06'	122°24'	5.0		
835	04-13-70	08-28-21.8	15°12'	122°12'	5.2		
836	04-13-70	12-52-21.3	15°18'	121°36'	4.6		
837	04-15-70	12-02-30.4	14°54'	121°18'	4.6		
838	04-15-70	13-14-21.4	15°06'	122°42'	5.7		
839	04-15-70	13-24-30.2	15°06'	122°54'	4.7		
840	04-15-70	13-30-52.8	15°00'	122°30'	4.8		

Table 2-3-1 (13) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
861	24-15-70	17-21-08.5	15°06'	122°36'	4.6		
862	04-15-70	17-33-46.6	15°06'	122°48'	4.8		
863	04-17-70	08-31-06.4	15°00'	122°36'	4.9		
864	04-17-70	12-37-23.6	15°36'	121°48'	4.4		
865	04-17-70	13-14-55.8	15°06'	122°18'	4.8		
866	04-17-70	14-33-59.2	15°00'	122°24'	4.1		
867	04-22-70	13-48-53.5	15°18'	121°48'	5.0		
868	04-23-70	13-26-23.4	15°16'	122°26'	4.7		
869	04-25-70	17-53-26.1	15°16'	122°18'	4.4		
850	04-26-70	22-14-54.8	15°12'	122°36'	4.8		
851	04-27-70	09-43-09.5	15°06'	122°06'	4.6		
852	04-28-70	04-12-30.9	15°18'	121°30'	4.4		
853	04-28-70	14-29-12.5	15°24'	122°30'	4.1		
854	05-01-70	03-22-13.4	15°42'	121°48'	5.5		
855	05-02-70	17-49-04.9	15°08'	122°30'	4.5		
856	05-06-70	02-35-17.2	15°42'	121°42'	5.2		
857	05-09-70	01-16-59.6	14°54'	123°54'	4.6		
858	05-16-70	03-17-05.2	14°18'	119°12'	4.5		
859	05-17-70	06-02-23.3	15°00'	122°26'	4.5		
860	06-12-70	12-53-55.5	18°42'	122°16'	5.0		
861	06-16-70	08-08-15.6	15°06'	122°08'	5.1		
862	06-20-70	13-03-13.1	15°06'	122°18'	5.0		
863	06-23-70	16-22-46.5	18°54'	120°00'	4.7		
864	06-24-70	14-30-37.9	18°42'	121°24'	4.3		
865	06-25-70	20-36-53.8	15°48'	122°00'	4.7		
866	07-10-70	14-11-08.1	15°30'	121°30'	-		
867	08-20-70	14-11-00.1	15°30'	121°30'	-		
868	08-23-70	09-04-13.3	14°42'	120°12'	4.8		
869	08-26-70	15-11-54.6	18°06'	120°30'	5.4		
870	08-28-70	18-22-02.9	18°36'	121°00'	5.1		
871	10-22-70	23-59-35.9	19°00'	120°06'			
872	10-04-70	23-38-02.5	19°54'	122°12'	4.6		
873	10-06-70	17-08-38.2	19°54'	122°18'	3.5		
874	10-08-70	20-15-36.6	19°42'	122°06'	4.4		
875	10-22-70	23-46-26.6	16°12'	119°18'	4.8		
876	10-26-70	11-46-55.6	18°24'	120°48'	4.9		
877	11-03-70	15-12-11.6	18°24'	120°54'	5.5		
878	11-07-70	23-18-24.0	18°30'	120°54'	5.4		
879	11-21-70	12-19-39.2	15°00'	120°06'	5.5		
880	11-27-70	22-44-33.8	15°00'	122°48'	4.7		
881	01-05-70	07-08-24.7	18°48'	120°48'	4.6		
882	02-24-71	19-20-16.8	19°12'	121°06'	4.6		
883	03-04-71	04-59-51.6	14°54'	120°36'	4.9		
884	03-10-71	11-50-18.9	14°06'	119°54'			
885	03-12-71	22-32-51.0	18°48'	119°48'	5.0		
886	03-26-71	14-51-22.9	19°12'	120°54'			
887	04-27-71	10-04-06.3	19°12'	121°12'	5.0		
888	04-29-71	00-46-45.4	18°12'	120°42'	5.2		
889	06-01-71	00-26-13.6	18°00'	120°18'	5.0		
890	06-15-71	05-27-34.9	18°00'	119°30'	5.1		
891	07-02-71	01-21-38	15°54'	120°12'	4.9		
892	07-04-71	11-30-51.5	15°36'	121°54'	5.5		
893	07-06-71	06-35-43.5	17°12'	120°18'	4.9		
894	07-20-71	10-34-11.5	15°18'	120°18'	5.4		
895	08-20-71	11-19-51.9	13°54'	120°42'	4.9		
896	09-03-71	02-17-26.2	14°00'	120°36'			
897	09-04-71	14-11-31.5	19°36'	121°42'	4.8		
898	10-07-71	09-39-21.6	15°54'	121°48'			
899	10-12-71	15-56-14.6	13°36'	122°30'			
900	10-15-71	02-33-16.1	19°00'	121°06'			
901	11-03-71	01-38-52.4	17°48'	122°24'	5.0		
902	11-09-71	01-39-27.7	19°54'	121°18'	5.2		
903	01-14-72	00-01-32.8	13°36'	120°54'	5.1		
904	02-01-72	02-13-21.1	18°18'	123°24'	5.1		
905	02-02-72	08-32-31.0	17°48'	121°30'	4.8		
906	02-08-72	08-37-52.4	19°18'	122°00'	5.7		
907	02-14-72	00-39-20.8	17°30'	122°18'	5.2		
908	02-24-72	11-32-00.2	18°48'	119°48'	4.9		
909	02-29-72	13-00-45.0	18°12'	120°24'	5.1		
910	03-16-72	05-09-06.2	15°42'	121°48'	5.1		

Table 2-3-1 (14) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
911	03-28-72	08-29-20.6	13°30'	120°48'	4.5		
912	14-13-72	05-03-46	18°06'	120°18'	4.3		
913	04-14-72	12-44-13.2	14°54'	119°42'	5.0		
914	04-25-72	20-46-35.9	13°30'	120°30'	5.4		
915	04-26-72	04-16-40.5	13°30'	120°24'	4.6		
916	04-06-72	06-30-19.5	13°30'	120°30'	5.1		
917	04-26-72	06-18-44.9	13°30'	120°36'	5.0		
918	04-26-72	06-49-42.9	13°30'	120°36'	5.1		
919	04-26-72	08-38-34.6	13°30'	120°30'	5.3		
920	04-26-72	06-69-42.9	13°30'	120°36'	4.0		
921	04-26-72	08-38-34.6	13°30'	120°30'	4.7		
922	04-26-72	14-17-45.1	13°30'	120°30'	4.7		
923	04-26-72	01-29-38.2	13°30'	120°42'			
924	04-30-72	15-15-34.3	13°30'	120°30'	5.5		
925	04-30-72	16-07-08.6	13°36'	120°30'	5.3		
926	05-22-72	06-24-00.1	16°36'	122°18'	5.7		
927	05-22-72	06-11-13.0	16°36'	122°30'	5.3		
928	05-22-72	06-46- 6.1	16°30'	122°36'	4.8		
929	05-22-72	07-29-22.3	16°24'	122°18'	4.7		
930	05-22-72	10-[illegible]-21.1	16°24'	122°24'	4.8		
931	05-22-72	20-24-46.9	16°24'	122°12'	5.0		
932	05-23-72	08-19-28.6	16°48'	122°24'	5.0		
933	05-23-72	17-51-27.6	16°42'	122°12'	5.1		
934	05-24-72	08-11-26.6	16°36'	122°18'			
935	05-25-72	04-47-28.9	16°24'	122°30'			
936	05-25-72	05-31-51.4	16°24'	122°24'	5.1		
937	06-01-72	08-31-15.5	16°36'	122°24'	5.0		
938	06-06-72	19-05-16.3	16°36'	122°24'	4.6		
939	06-12-72	11-19-44.4	16°36'	122°24'	4.9		
940	66-26-72	23-27-45.5	16°48'	122°12'	4.9		
941	08-07-72	01-36-55.0	18°12'	120°54'	4.6		
942	09-05-72	14-31-13.3	15°30'	121°30'	5.2		
943	10-24-72	02-30-29.6	14°48'	121°34'			
944	11-02-72	17-06-39.9	19°06'	121°54'			
945	11-24-72	22-56-38.4	16°24'	122°18'	4.7		
946	01-03-73	04-10-04.5	13°30'	120°48'	4.8		
947	01-04-73	12-23-45.8	15°00'	120°12'	4.5		
948	01-07-73	12-42-11.1	17°18'	120°00'	4.8		
949	02-14-73	08-27-32.7	13°48'	120°48'	4.6		
950	03-06-73	03-58-40.2	18°06'	120°42'	5.1		
951	03-15-73	17-58-39.4	13°54'	120°24'	5.2		
952	03-23-73	06-22-06.5	13°36'	122°48'	4.3		
953	04-03-73	16-56-41.9	15°54'	119°36'			
954	04-07-73	09-34-05.7	13°36'	120°42'	4.6		
955	04-29-73	02-03-56.1	19°42'	120°54'	4.5		
956	05-10-73	13-46-38.5	15°54'	119°36'	4.8		
957	05-13-73	12-55-42.6	13°36'	120°48'	5.3		
958	05-23-73	20-32-34.4	13°42'	120°48'			
959	06-14-73	21-10-23.1	18°30'	121°06'	4.7		
960	06-25-73	07-19-46.3	19°06'	121°12'	5.7		
961	06-25-73	08-04-00.5	19°48'	121°18'	4.7		
962	06-25-73	15-12-50.5	16°24'	122°24'	4.8		
963	06-29-73	08-17-17.7	13°48'	120°30'			
964	07-18-73	03-53-41.2	14°54'	119°54'	5.1		
965	08-06-73	09-15-29.0	18°18'	120°48'	4.6		
966	08-23-73	17-25-37.7	16°24'	122°00'	5.1		
967	08-25-73	21-50-01.4	19°30'	121°36'	5.1		
968	08-31-73	09-11-57.7	15°24'	120°30'	4.5		
969	09-10-73	09-29-01.8	15°06'	119°42'	4.9		
970	09-15-73	02-44-24.6	19°06'	121°18'	4.7		
971	09-21-73	13-48-32.2	18°48'	120°42'	5.2		
972	09-23-73	22-02-55.9	19°18'	121°00'	4.7		
973	09-25-73	02-24-34.9	18°18'	120°36'			
974	10-07-73	11-11-26.2	16°12'	122°12'	4.8		
975	10-07-73	11-42-08.2	16°12'	122°24'	4.6		
976	10-07-73	12-20-37.2	16°18'	122°18'	5.0		
977	10-07-73	21-17-52.0	16°06'	122°24'	4.6		
978	10-09-73	01-44-57.5	15°18'	122°24'	5.2		
979	10-29-73	15-53-07.9	19°12'	121°06'	4.7		
980	11-09-73	11-58-10.2	19°12'	121°12'	4.4		

Table 2-3-1 (15) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
981	11-10-73	14-06-58.8	19°18'	120°42'	4.5		
982	11-10-73	22-26-59.9	19°18'	120°42'	4.6		
983	11-18-73	08-38-26.5	15°54'	119°12'	4.9		
984	11-21-73	12-05-46.3	15°30'	121°00'	5.1		
985	01-07-74	03-55-39.4	19°06'	121°06'	5.0		
986	01-17-74	02-44-08.9	16°42'	119°54'	5.2		
987	02-03-74	10-08-48.4	18°54'	120°06'	5.9		
988	02-09-74	08-28-15.3	15°54'	119°48'	5.2		
989	02-12-74	09-47-44.8	13°30'	120°30'	5.5		
990	02-19-74	03-30-21.8	13°54'	122°06'	5.7		
991	02-19-74	19-35-19.3	14°00'	122°06'	4.7		
992	03-22-74	01-58-30.2	17°06'	119°42'	5.1		
993	04-02-74	03-55-18	19°54'	121°06'	4.6		
994	04-15-74	03-43-52.6	18°54'	120°48'	4.8		
995	04-15-74	05-37-48.1	18°54'	120°48'	4.7		
996	04-16-74	11-22-52.9	13°48'	120°36'	5.4		
997	04-20-74	04-25-51.5	13°42'	123°06'	5.1		
998	05-03-74	11-28-09.7	15°36'	121°42'	4.6		
999	05-25-74	18-54-13.0	16°36'	119°40'	4.2		
1000	06-20-74	22-46-05.7	18°18'	121°06'	5.0		
1001	07-14-74	19-17-57.7	14°12'	120°36'	4.7		
1002	07-23-74	00-52-38.4	17°54'	121°00'	4.4		
1003	08-15-74	23-04-51.8	18°30'	120°42'	4.9		
1004	09-03-74	05-55-08.4	18°18'	119°12'	5.9		
1005	09-03-74	05-59-41.0	18°12'	119°06'	5.6		
1006	09-18-74	04-47-13.1	16°06'	122°06'	4.8		
1007	10-17-74	13-55-26.8	13°42'	120°36'	4.9		
1008	10-22-74	22-45-42.1	13°38'	120°36'	5.2		
1009	11-03-74	16-29-08.8	13°00'	122°42'	5.1		
1010	11-19-74	03-55-18.9	19°00'	121°18'	5.7		
1011	12-02-74	06-34-07.7	19°06'	121°12'	5.5		
1012	12-08-74	20-00-03.2	17°00'	121°18'	4.7		
1013	01-10-75	02-49-55.8	13°48'	119°54'	4.7		
1014	01-20-75	22-14-46.6	19°18'	121°18'	4.9		
1015	01-22-75	05-44-28.1	19°48'	121°30'	4.7		
1016	01-26-75	03-33-23.7	13°36'	120°36'	4.7		
1017	03-24-75	21-14-38	13°48'	121°06'	3.7		
1018	04-02-75	10-35-26.4	17°12'	121°12'	5.0		
1019	04-03-75	06-26-44.3	17°00'	120°18'	5.2		
1020	04-04-75	00-30-43.0	15°36'	119°18'	4.4		
1021	04-12-75	17-10-55.5	14°30'	119°12'	4.9		
1022	04-29-75	08-41-53.7	13°36'	120°48'	5.2		
1023	40-29-75	08-49-25.8	13°48'	120°54'	5.0		
1024	04-30-75	23-22-53.2	18°30'	120°54'	4.8		
1025	05-01-75	12-27-1.1	13°41'	120°47'	4.9		
1026	05-01-75	21-09-40.5	13°37'	120°46'	5.1		
1027	05-11-75	14-16-00.4	19°51'	121°19'	4.9		
1028	05-13-75	20-32-13.2	16°10'	122°10'	4.8		
1029	05-23-75	23-16-12.1	13°36'	120°51'	5.0		
1030	06-01-75	01-39-46.6	18°40'	120°57'	5.0		
1031	06-05-75	20-22-19.4	19°09'	120°37'	4.2		
1032	06-11-75	19-06-18.6	14°19'	120°05'	4.8		
1033	06-18-75	04-11-02.3	13°56'	120°39'	5.4		
1034	06-18-75	17-32-21.2	17°14'	122°09'	4.7		
1035	07-08-75	18-07-37.5	13°27'	120°04'	4.9		
1036	07-30-75	22-80-15.1	13°49'	119°57'	4.3		
1037	08-18-75	06-14-33.2	16°52'	120°32'	4.8		
1038	09-15-75	02-14-21.9	16°52'	121°34'	4.5		
1039	10-05-75	12-45-33.9	14°12'	121°55'	5.0		
1040	10-06-75	13-53-47.4	18°06'	120°21'	4.3		
1041	10-08-75	10-27-36.7	13°56'	120°11'	5.3		
1042	10-31-75	02-25-51.5	19°56'	122°00'	5.0		
1043	11-09-75	13-39-51.5	13°41'	120°59'	4.4		
1044	12-06-75	05-13-11.7	17°25'	119°48'	4.9		
1045	12-18-75	06-12-38.5	19°06'	121°20'	5.1		
1046	12-25-75	15-44-56.6	17°22'	120°08'	4.8		
1047	12-25-75	15-44-56.6	17°22'	120°08'	4.8		
1048	12-31-75	01-09-00.6	16°09'	121°54'	4.6		
1049	01-22-76	16-05-17.0	18°54'	120°02'	5.2		
1050	02-13-76	08-07-32.6	15°40'	121°42'	5.4		

Table 2-3-1 (16) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
1051	02-13-76	10-33-42.7	13°55'	120°07'	5.6		
1052	02-15-76	01-52-16.3	19°34'	120°11'	5.0		
1053	03-09-76	10-23-18.8	19°46'	122°31'	4.8		
1054	03-14-76	01-22-33.2	19°32'	122°22'	5.2		
1055	05-04-76	09-23-18	13°30'	120°31'	5.2		
1056	05-18-76	21-08-45.3	14°55'	120°01'	4.9		
1057	05-21-76	01-29-33.2	13°28'	120°37'	4.9		
1058	05-26-76	19-52-11.2	18°19'	120°58'	4.6		
1059	05-28-76	06-09-35.3	16°51'	120°31'	4.8		
1060	06-15-76	18-16-37	18°47'	120°05'	4.9		
1061	06-23-76	19-22-06.2	17°01'	121°31'	4.7		
1062	07-03-76	04-22-34.7	15°03'	119°57'	4.9		
1063	07-17-76	09-08-07.5	18°41'	120°09'	4.9		
1064	08-19-76	19-04-46	14°30'	123°46'	5.5		
1065	09-04-76	12-11-14.2	15°57'	119°32'	4.7		
1066	09-21-76	16-41-59.7	17°56'	120°49'	4.2		
1067	09-22-76	09-08-33.3	13°47'	120°42'	5.2		
1068	10-08-76	21-05-31	18°57'	121°18'	5.7		
1069	10-22-76	11-10-51.6	18°56'	120°36'	4.7		
1070	11-01-76	02-09-15.6	15°34'	120°58'	4.7		
1071	11-27-76	04-12-38.6	13°41'	120°05'	4.7		
1072	12-05-76	23-28-55.7	17°23'	120°04'	5.0		
1073	01-07-77	21-31-27.3	18°44'	120°48'	4.9		
1074	01-08-77	06-41-4.1	15°19'	121°54'	5.3		
1075	01-10-77	03-28-54.9	15°20'	121°51'	5.0		
1076	02-13-77	04-06-46.9	15°39'	119°10'	5.4		
1077	02-13-77	04-07-14.5	15°40'	119°09'	5.7		
1078	02-14-77	13-25-17.2	15°41'	119°09'	4.4		
1079	02-28-77	08-03-56.8	18°10'	120°25'	4.6		
1080	02-23-77	10-35-02.1	17°21'	119°43'	5.2		
1081	02-23-77	12-37-17.6	17°20'	120°11'	4.9		
1082	02-23-77	20-45-34.4	16°47'	120°55'	4.8		
1083	03-11-77	06-58-02.3	19°08'	121°14'	5.4		
1084	03-18-77	21-43-52.4	16°46'	122°19'	6.2		
1085	03-18-77	22-10-29.3	19°00'	120°01'	4.9		

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPICENTER LATITUDE	EPICENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
1086	03-18-77	22-34-00.7	16°36'	122°10'	5.2		
1087	03-18-77	22-38-00	16°56'	122°31'	5.0		
1088	03-18-77	23-57-38.1	16°46'	122°31'	5.3		
1089	03-19-77	00-41-08.7	16°50'	122°27'	5.2		
1090	03-19-77	00-51-16.9	17°03'	122°25'	5.1		
1091	03-19-77	01-14-18.7	16°30'	122°25'	4.9		
1092	03-19-77	01-23-11.7	16°35'	122°22'	4.9		
1093	03-19-77	01-29-55.8	16°19'	122°23'	5.0		
1094	03-19-77	01-53-19.2	17°08'	122°26'	5.3		
1095	03-19-77	02-43-03.7	16°48'	122°33'	-		
1096	03-19-77	03-02-42.6	17°08'	122°30'	5.1		
1097	03-19-77	03-46-13.9	16°36'	122°40'	5.0		
1098	03-19-77	05-06-56.5	16°46'	122°41'	4.6		
1099	03-19-77	06-05-54.3	16°40'	122°32'	5.1		
1100	03-19-77	07-22-32.5	16°38'	122°33'	5.2		
1101	03-19-77	08-22-16.4	16°41'	122°24'	4.9		
1102	03-19-77	11-54-05.7	16°47'	122°20'	5.0		
1103	03-19-77	12-17-03.6	16°36'	122°25'	5.4		
1104	03-19-77	12-36-03.7	16°39'	122°27'	5.3		
1105	03-19-77	13-00-24.4	16°44'	122°27'	5.5		
1106	03-19-77	13-27-10	16°42'	122°27'	4.7		
1107	03-19-77	14-30-54.8	17°03'	122°21'	5.2		
1108	03-19-77	19-35-08	16°49'	122°21'	5.6		
1109	03-20-77	17-45-58.4	16°52'	122°23'	3.8		
1110	03-20-77	10-39-09.5	16°19'	122°14'	4.8		
1111	03-20-77	11-01-56.1	16°36'	122°36'	5.0		
1112	03-20-77	14-15-18.1	16°40'	122°39'	4.8		
1113	03-20-77	15-24-58.6	16°46'	122°33'	-		
1114	03-21-77	06-28-40.5	16°46'	122°25'	4.6		
1115	03-21-77	08-05-33.2	16°37'	122°31'	4.5		
1116	03-21-77	08-41-30.1	16°39'	122°31'	4.9		
1117	03-22-77	06-57-10.5	16°47'	122°31'	4.6		
1118	03-23-77	23-16-05.9	16°18'	122°14'	4.8		
1119	03-24-77	19-33-33	16°44'	122°33'	5.1		
1120	03-26-77	00-09-28.8	17°13'	122°23'	4.6		

Table 2-3-1 (17) Past Earthquake Records in North Luzon 1901 - 1977

NO.	DATE MO-DAY-YR	TIME HR-MIN-SEC	EPECENTER LATITUDE	EPECENTER LONGITUDE	MAG	DEPTHS (km)	INTENSITY
1121	03-28-77	00-52-41.8	16°59'	122°29'	4.5		
1122	03-31-77	15-34-08.8	16°21'	122°23'	4.8		
1123	04-19-77	05-09-13.5	15°07'	122°43'	4.7		
1124	04-20-77	15-21-05.4	16°22'	121°54'	5.4		
1125	04-29-77	13-01-37.5	16°22'	122°14'	4.4		
1126	05-12-77	14-00-57.0	18°00'	121°09'	5.0		
1127	05-13-77	18-06-36.1	18°41'	120°20'	4.2		
1128	05-14-77	16-23-01	18°38'	120°19'	4.4		
1129	05-18-77	03-53-22.9	16°43'	122°24'	4.9		
1130	05-20-77	15-10-15.9	17°32'	120°14'	4.5		
1131	05-21-77	05-35-22.5	15°42'	120°49'	5.7		
1132	05-23-77	12-17-39.9	16°28'	120°27'	4.9		
1133	05-24-77	05-20-26.8	16°44'	122°23'	4.9		
1134	05-24-77	08-37-42.3	16°17'	119°50'	5.2		
1135	05-25-77	05-40-58.6	18°29'	120°25'	4.5		
1136	06-01-77	22-23-38.1	13°47'	122°12'	4.8		
1137	06-01-77	22-26-57.8	13°56'	122°15'	4.9		
1138	06-10-77	16-38-45.7	13°51'	120°35'	4.6		
1139	06-12-77	16-48-47.8	14°30'	123°44'	5.3		
1140	07-10-77	01-47-33.3	16°41	122°37'	4.6		
1141	07-16-77	15-38-00.8	14°52'	120°00	5.2		
1142	07-21-77	13-45-54	16°53	122°21	6.1		
1143	07-21-77	15-23-33.5	17°08'	122°42'	4.7		
1144	07-21-77	16-53-30.3	17°15'	122°49'	-		
1145	07-21-77	12-55-34.6	17°12'	122°49'	5.1		
1146	07-21-77	22-08-43.0	16°58'	122°31'	4.5		
1147	07-22-77	00-45-01.4	16°41'	122°09'	4.8		
1148	07-22-77	05-13-39.8	17°20'	122°18'	5.1		
1149	07-22-77	21-37-28.6	17°22'	122°42'	4.7		
1150	07-27-77	17-25-16.2	17°03'	122°29'	5.4		
1151	07-27-77	17-25-16.2	17°03'	122°29'	5.2		
1152	07-29-77	22-23-41.2	18°38'	121°03'	5.2		
1153	08-18-77	17-46-59.5	17°22'	122°41'	5.0		
1154	08-29-77	14-23-40.5	17°26'	119°52'	6.0		
1155	09-25-77	22-40-13.1	19°08'	121°08'	4.7		
1156	10-04-77	11-01-33.1	17°15'	119°44'	4.6		
1157	10-09-77	15-24-27.3	16°41'	122°13'	4.5		
1158	10-13-77	08-35-51.3	15°57'	120°09'	4.8		
1159	10-14-77	11-47-41.8	16°31'	119°34'	4.9		
1160	10-14-77	20-44-18.2	19°16'	121°04'	4.7		
1161	10-25-77	18-11-19.3	19°46'	121°09'	-		
1162	10-30-77	20-52-56.1	15°32'	123°02'	5.1		
1163	11-13-77	21-12-46.3	19°12'	121°11'	5.2		
1164	11-26-77	22-17-27.4	18°00'	119°58'	4.5		
1165	11-30-77	13-05-19.5	13°45'	121°00'	4.8		
1166	12-09-77	20-53-29.7	15°07'	120°01'	4.5		
1167	12-26-77	09-39-26.1	14°42'	123°37'	5.3		

Table 2-3-2 Maximum Amplitude of Earthquake with Magnitude 5.5 ∿ 8.5

x (km)	T(sec)M = 5.5 ∿ 6.5	T(sec)M = 6.6 ∿ 7.5	T(sec)M = 7.6 ∿ 8.5
0 ∿ 50	0.25	0.3	0.4
51 ∿ 100	0.3	0.4	0.5
101 ∿ 150	0.4	0.5	0.6
151 ∿ 200	0.5	0.6	0.8
201 ∿ 250	0.6	0.7	0.9

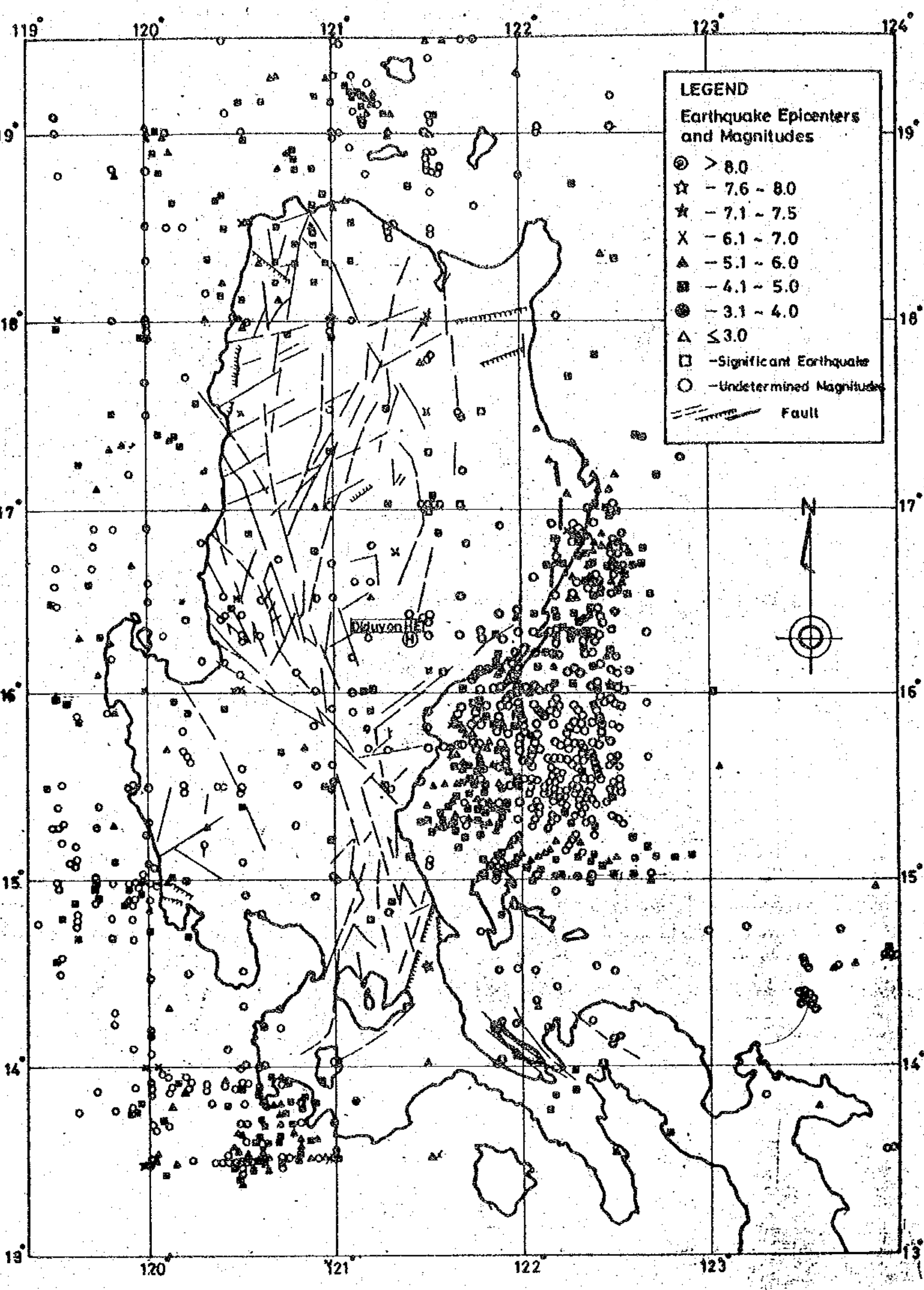
Table 2-3-3 Maximum Acceleration

Date of Earthquakes			Epicenter N	E	Magnitude	Acceleration at Diduyon (gal)	Order
1901	12	14	14.000	122.000	7.80	8.42	9
1907	4	18	14.000	123.000	7.60	4.93	16
1927	4	19	16.000	120.000	6.75	4.62	18
1928	8	5	16.000	119.500	6.25	1.87	28
1931	10	28	17.500	121.500	6.25	5.64	13
1932	8	24	16.500	120.500	6.25	8.13	10
1933	6	6	14.000	120.000	6.25	1.15	32
1934	2	14	17.500	119.000	7.60	4.88	17
1935	2	7	13.500	122.500	6.00	0.69	36
1936	5	20	13.500	121.500	6.00	0.64	37
1937	8	20	14.500	121.500	7.50	12.95	5
1938	5	23	18.000	119.500	7.00	2.92	23
1939	5	6	13.500	121.500	6.50	1.42	31
1940	3	28	14.500	120.000	6.75	1.75	29
1941	5	9	14.000	123.000	6.75	1.92	27
1942	4	8	13.500	121.000	7.80	6.29	11
1948	3	3	18.500	119.000	7.20	2.64	24
1949	12	29	18.000	121.000	7.40	9.10	8
1950	1	3	17.000	121.600	6.50	22.33	4
1958	12	3	19.000	121.500	6.00	0.77	34
1959	7	18	15.500	120.500	6.75	9.58	7
1960	5	30	15.500	121.500	6.50	5.37	14
1961	2	26	16.100	121.600	6.10	44.09	1
1962	10	28	14.800	119.900	5.00	0.27	39
1963	5	17	15.700	120.100	5.50	1.05	33
1964	2	18	17.500	121.300	4.50	0.48	38
1965	10	25	17.000	120.900	5.20	0.75	35
1966	1	26	16.500	120.000	5.80	1.65	30
1967	7	30	15.900	121.200	4.70	4.45	19
1968	8	1	16.000	122.500	7.30	23.12	3
1969	5	15	16.100	121.900	5.20	4.10	21
1970	4	7	15.800	121.700	6.40	26.72	2
1971	7	4	15.600	121.900	5.50	5.22	15
1972	5	22	16.600	122.300	5.70	4.15	20
1973	11	21	15.500	121.000	5.10	2.56	25
1974	9	18	16.100	122.100	4.80	2.50	26
1975	12	31	16.150	121.900	4.60	3.18	22
1976	2	13	15.667	121.700	5.40	6.25	12
1977	4	20	16.367	121.900	5.40	9.67	6

Table 2-3-4 Probability Acceleration

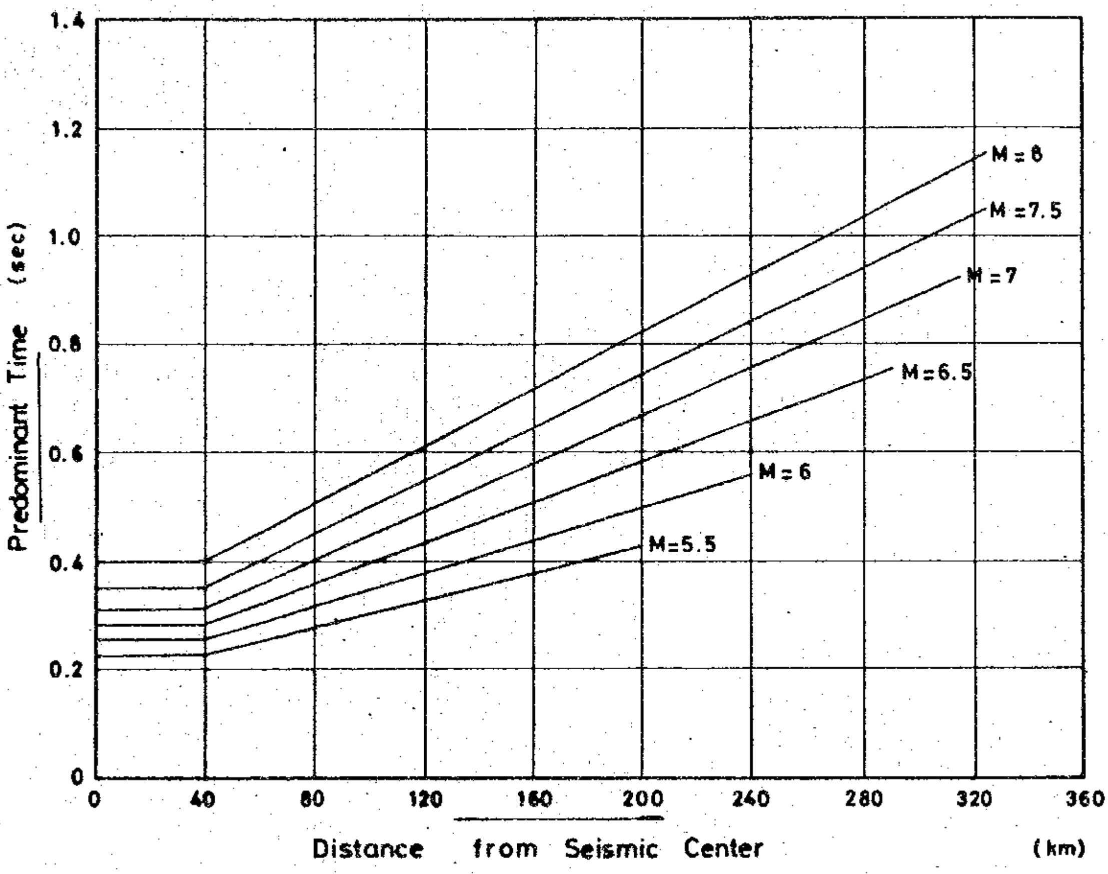
Probability Method / Probable Year	Thomas Plot Method	Logarithmic Normal Method	Iwai Method	Gumble Method
Probability Strength 100 years	64 gal.	51 gal.	53 gal.	37 gal.
Probability Strength 200 years	88	69	71	43
Probability Strength 300 years	104	80	84	46
Probability Strength 500 years	128	97	101	50

Earthquake Epicenters and Magnitudes



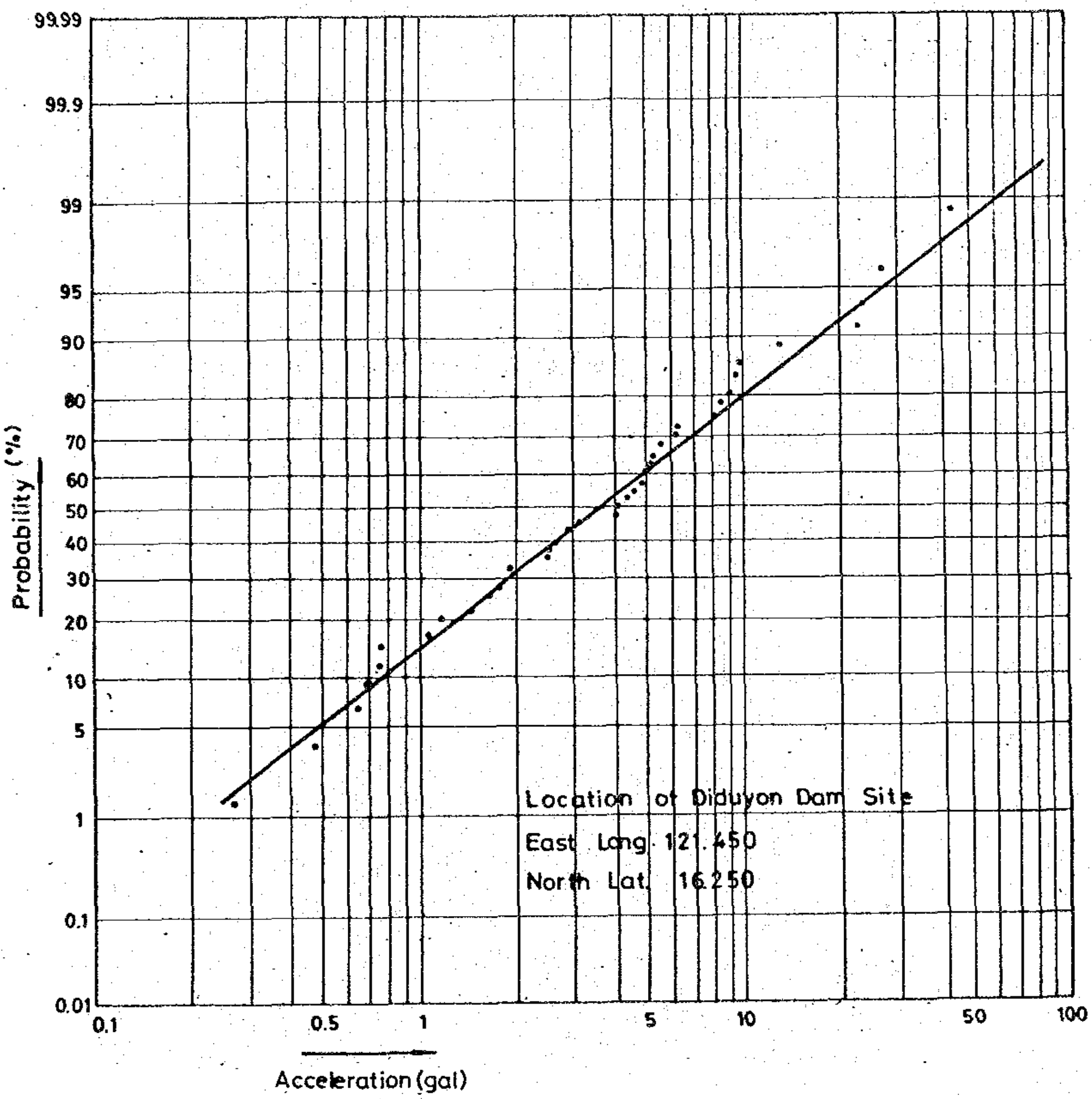
Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Earthquake Epicenters and Magnitudes	
October 1980	Fig. 2-3-1

Predominant Time of Maximum Earthquake Acceleration



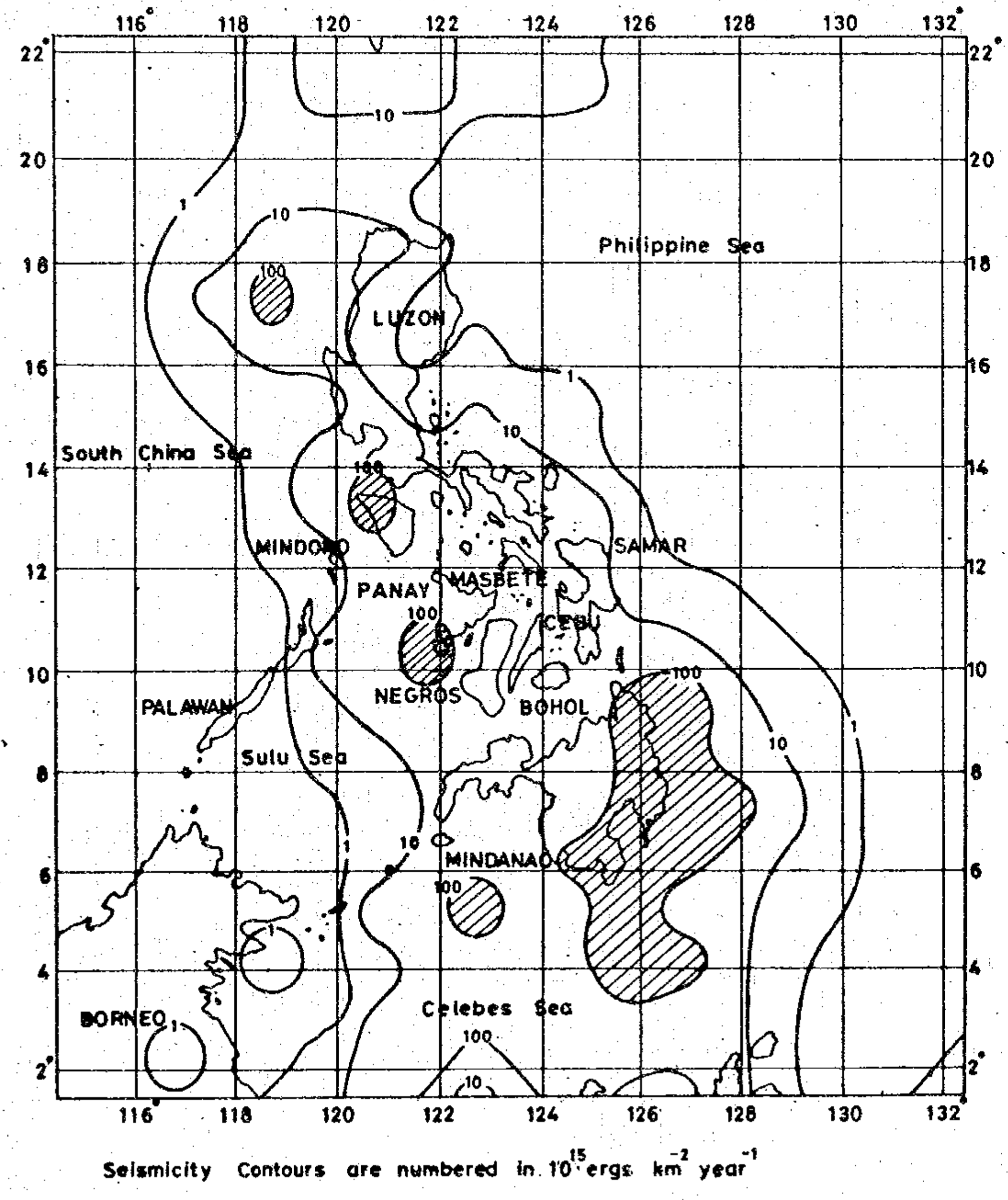
Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Predominant Time of Maximum Earthquake Acceleration	
October 1980	Fig. 2-3-2

Probability Diagram of Anticipated Seismic Intensity at Diduyon Damsite (1901-1977)



Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Probability Diagram of Anticipated Seismic Intensity at Diduyon Damsite	
October 1980	Fig. 2-3-3

Seismicity of the Philippines



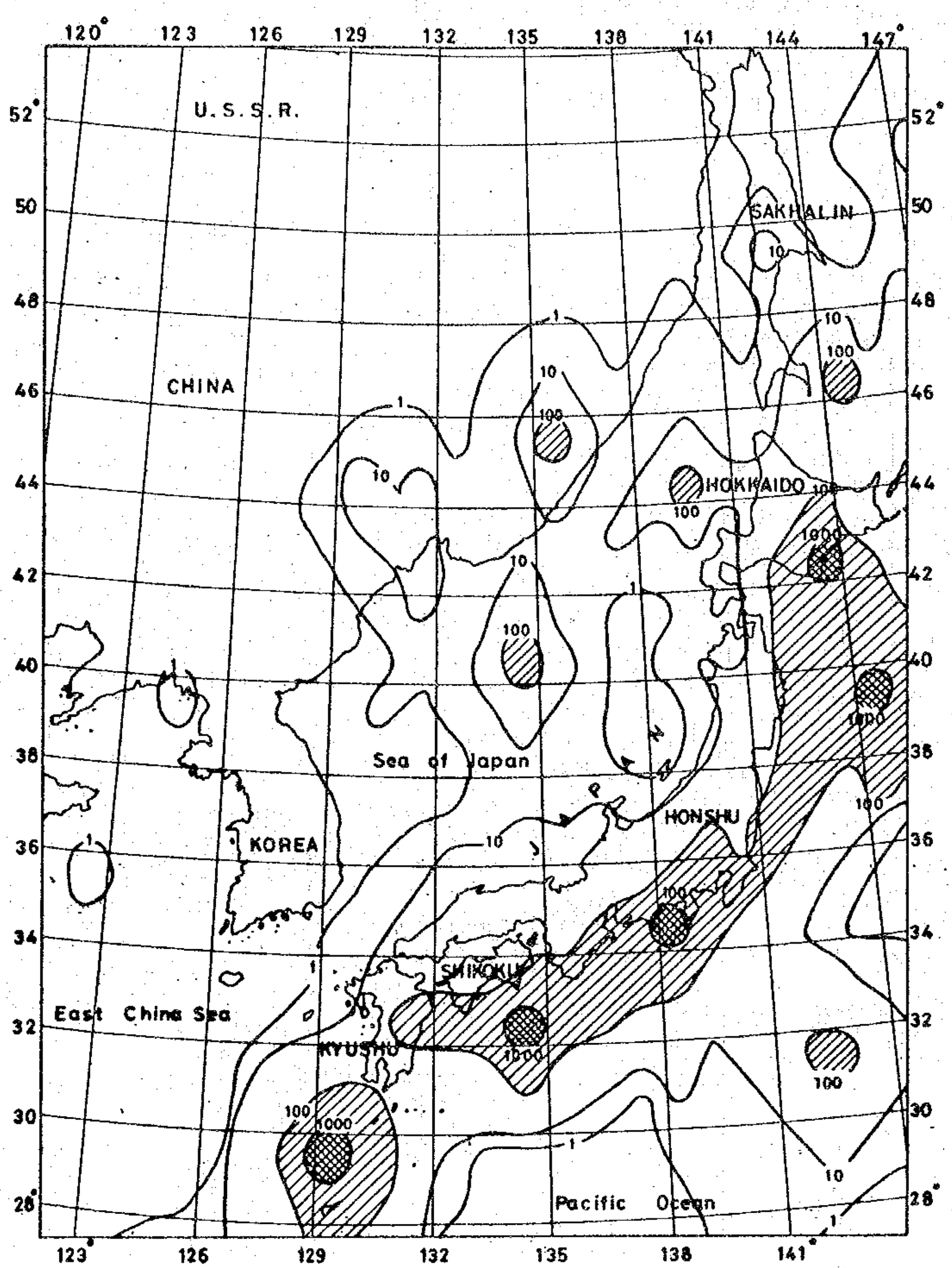
Seismicity Contours are numbered in 10^{15} ergs km^{-2} $year^{-1}$

Legend

Seismicity of 10^{17} ergs km^{-2} $year^{-1}$

Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines
Japan International Cooperation Agency
Seismicity of the Philippines
October 1980 | Fig. 2-3-4

Seismicity of Japan



Seismicicity Contours are numbered in 10^{15} eags km^{-2} $year^{-2}$

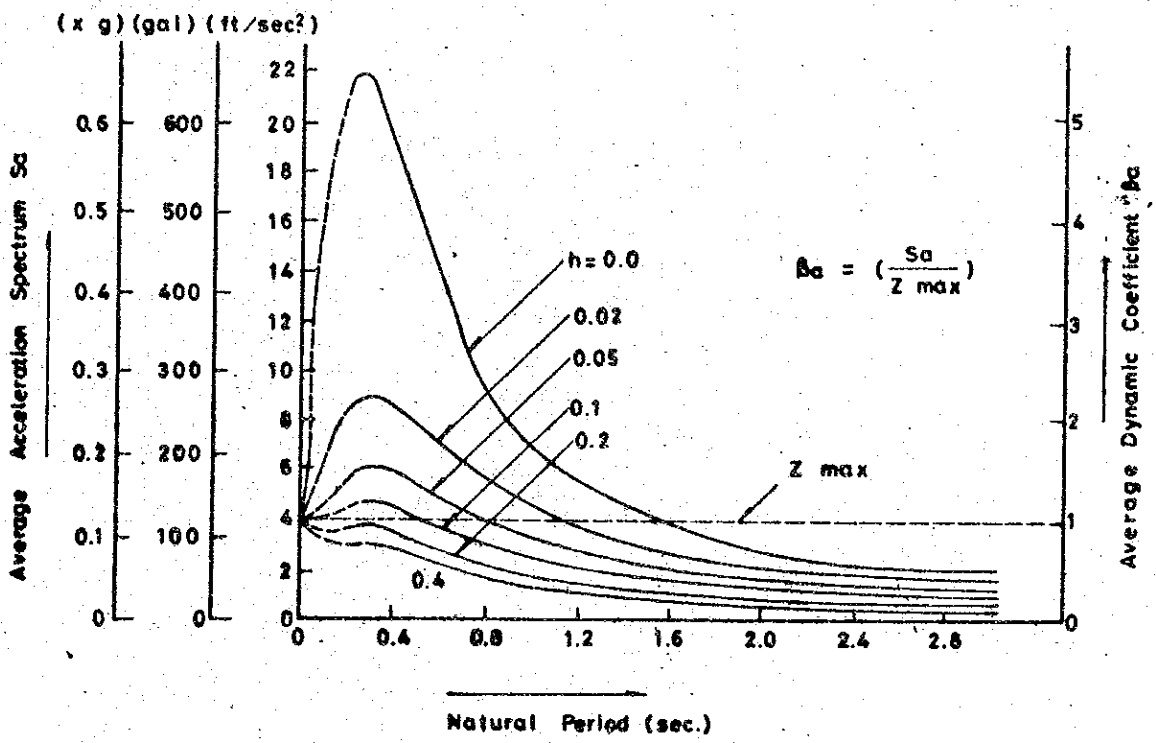
Legend

----- 10^{18} ergs km^{-2} $year^{-1}$

----- 10^{17} ergs km^{-2} $year^{-1}$

Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Seismicity of Japan	
October 1980	Fig. 2-3-5

Relation between Average Acceleration Spectrum and Average Dynamic Coefficient



Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Relation between Average Acceleration Spectrum and Average Dynamic Coefficient	
October 1980	Fig. 2-3-6

2.4. Hydrology

2.4.1. Highwater Discharge

(1) Outline

In designing a dam, it is necessary to calculate the design flood volume needed for planning the capacities of spillway and diversion tunnels. Depending on the type of dam, a design spillway flood of 200-year return period for a concrete dam, and 1.2 times thereof for a fill dam, will be adopted. For the diversion tunnel, a design flood of 2-year to 20-year return period will be adopted. Here will be given the result of estimating the highwater discharge from study of the measurements of past floods and the run-off hydrographs derived by the kinematic wave method.

(2) Estimate from measured flood volumes in the entire Cagayan River Basin

Peak flood flows measured in the various rivers of the Cagayan River basin are given in Table 2-4-1. All of 23 gauging sites in the table have more than 100 km^2 of the catchment area. The minimum is 162 km^2 and the maximum is 6,266 km^2. The data made available as of 1965 cover from 2 to 25 years.

From the given values, the relation of unit discharge q ($m^3/s/km^2$) to basin area A (km^2) was approximated in $q = C \cdot A^P$, and constants C and P were determined so as to form a envelope curve. Thus we obtain : $q = 137A^{-0.41}$ (Fig.2-4-1).

In table 2-4-2 is given a tabulation of the annual maximum discharges over the period of 12 years between 1959 and 1970 at the Pangal gauging station (C.A. = 4,244 km^2) on the lower reaches of the project site, available from the BPW flow data. The probable highest discharges for the corresponding return periods of T = 2 to 200 years, are obtained using these values. From the logarithimic normal distribution equation based on the moment method and the extreme value distribution equation based on the Gumble method, the following values were obtained (see also Fig. 2-4-2) :

Return period	Probable flood discharge	
	logarithmic normal distribution	Gumbel distribution
T (year)	$Q_p (m^3/S)$	Q_p (m^3/S)
1,000		40,000
200	27,500	32,200
100	24,500	28,600
20	17,600	20,300
10	14,500	16,600
2	6,700	7,000

As these are values for the catchment area = 4,244 km^2, it is necessary to convert them to the probable flood volume at a point having optional catchment area. The Creager equation $q = C \cdot A^P$ form is assumed between the unit discharge q = $(m^3/s/km^2)$ of the flood and the catchment area A (km^2). Where the value P =-0.41 calculated from the flood peak values actually measured at the 23 points in the Cagauan River basin was used, then C_T, the value of C corresponding to each return period T, was obtained as in the table below from Qp obtained in the above. For the value of Qp, a value by the Gumble distribution was adopted, allowing for safety.

T	Q_{PT}	$Q_{PT} = Q_{PT}/A$	$C_T = q_{PT}/A^{-0.41}$
Year	(m^3/s)	(m^3/s)	(m^3/s)
1,000	40,400	9,519	292
200	32,200	7,587	233
100	28,600	6,739	207
20	20,300	4,783	147
10	16,600	3,911	120
2	7,000	1,649	51

Probable flood discharges for the various return periods obtained using this C_T for No. 2 damsite (C·A = 462 km^2) and for No. 3 damsite (C·A = 477 km^2) result in the values shown on Table 2-4-3. And the 200-year probable flood for No. 3 damsite (concrete gravity dam) would be 8,900 m^3/s, and that for No. 2 damsite (fill dam) would be 10,500 m^3/s.

(3) Estimates from Rainfall

Normally, riverflow analysis of a site under investigation requires a hyetograph representing the basin in question and actually measured hydrological values corresponding thereto.

In other words, various constants showing the runoff characteristics of the basin are determined on the basis of several typical hyetographs and hydrographs actually measured in the basin. Probable flood corelating to probable rainfall can be obtained using these constants. With regard to the upper basin of the Cagayan River now udner investigation, no actually measured rainfall records that can be referred to are available, as the observation equipment has been very recently installed and measured data is insufficient. At the Pangal gauging station on the lower reaches, too, observations have been made merely by periodical reading of the water stages; no flood hydrograph data and available. Consequently, in developing the estimates at this time, average values (without verification of actual measurements) that can be empirically proved from past investigations were used as the constants for riverflow analysis. The procedure given below was applied for rainfall analysis.

i) As no long-range data were availabe at the observation stations around the basin, records of maximum daily rainfalls over a period of 28 years for the entire territory of the Philippines were used as basic data.

ii) Verification was made using actually measured rainfalls for October 16 - 17, 1967, which were taken out of the hyetographs observed in Baguio as giving the maximum values.

As these methods were considered to produce the value on the adequately safe side at least as far as the point in question was concerned, that is, as they should give flood discharge on the higher magnitude they may be considered compatible with the purpose of estimating the desing floods for the project.

(4) Method of Runoff Analysis

There are several methods available for calculating the runoff from the rainfall in the basin. Here runoff calculation was made under the kinematic wave method that permits direct incorporation of the topographical characteristics of the basin into the computation. Under this method, the basin is assumed as a combination of a number of square slopes and flow channels, and the flow of rain water down these sloped channels is hydraulically traced by means of the equation of motion and the equation of continuity. The basic equations are as given below.

For river channel

$$Q = AR^{2/3} j^{1/2}/n \quad \ldots\ldots \quad (1)$$

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q\ (t) \quad \ldots \quad (2)$$

For basin slopes

$$h = KqP \quad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$\frac{\partial h}{\partial t} + \frac{\partial q}{\partial x} = \alpha\gamma_e \quad \ldots\ldots \quad (4)$$

where j : water surface slope

h : depth

A : Flow section area

Q : Flow volume in the river channel

n : Manning's roughness coefficient

q : unit flow on the slope

K : $\sqrt{N/\sin\theta}^{\,P}$ (P = 3/5)

γ_e: Effective rainfall

N : Equivalent slope roughness

α : Unit conversion constant

θ : Slope angle

With equation (1), (2), (3), and (4) set up simultaneously, numerical integration is performed to obtain a solution. Of the parameters in the above equations, equivalent slope roughness N and effective rainfall γ_e are of particular importance in practical calculation. Generally, such values should be those measured at appropriate gauging points in the basin area. In this case, however, 1.0 is employed as an emprically feasible value for N. While the effective rainfall γ_e is, for simplicity, assumed to be 70 % the actual amount of rainfall, taking into consideration the runoff coefficient to be incorporated in rational equations with respect to possible runoff into the rivers in mountainous regions. Topographic features of the watershed are modeled based on 1/250,000 and 1/50,000 topographic maps.

Figure 2-4-3 shows a model topography in the basin and constants applied.

(5) Analysis of runoff based on daily rainfall in the vicinity of the watershed

i) Daily rainfall

During a period of 28 years from 1948 to 1975, a total of 112 typhoons (cyclones) hit the Philippine Archipelago. Table 2-4-4 lists how much the 24-hour rainfalls were and where they were gauged at the time of 28 typhoons that caused the heaviest 24-hour precipitation in each year. As evident from this table, maximum daily rainfalls were recorded 9 times in the Baguio City, 100 km west of the upper watershed of the Cagayan River System. Of those, 9 belong to the first 7 of the 28 cases listed. Accordingly, it might be good to use this data, which was collected in the survey covering the entire territory of the Philippines as basic material for computing the probable daily precipitation in the upper basin of the Cagayan River, though the resultant figures could be somewhat inflated. From these 28 pieces of data, probable rainfalls were worked out through the equation of extreme value distribution with Gumbel's method. The table below presents the results for the return periods of 2, 10, 20, 100, and 200 years.

Return Period T (Year)	Probable Daily Rainfall R_{24} (mm/24 hrs)
200	1,345
100	1,212
20	901
10	763
5	404

ii) Hyetograph

Based on the probable daily rainfall for a 200-year return period obtained from the above table, a rainfall pattern was composed as shown in Fig. 2-4-4, which is necessary for computing flood wave. Using this hyetograph, runoff is calculated for three patterns. In composing the rainfall patterns, the following assumptions and conditions were incorporated.

a) The unit period of time for rainfall patterns must be a duration within which peak flood is reached. Based on the results of some trial computations, the unit is set at 6 hours.

b) For the conversion of daily rainfall into rainfall intensity, it is convenient to use the well-known equation $R = \alpha T^{\beta}$, which expresses the relationship between the rainfall duration T (hr) and the total rainfall depth R(mm). In this expression, $\beta = 1/2$ is employed for the coefficient β. This value is determined by measurement at the basin of the Chico River, one of the tributaries of the Cagayan

River (according to the design data on the Chico River). The value of α is then obtained by $\alpha = R_{24}/24^{1/2}$.

c) The duration of rainfall is taken as long as 48 hours. For credibility's sake, preparation of the hyetograph is such that the peak rainfall appears in the latter 24 hours preceded by the first half period of antecedent rainfall.

d) The aforementioned probable daily rainfall is the amount of spot rainfall. The conversion into the average precipitation for the watershed is carried out according to the Depth-Area-Duration Cuve presented in Figure 2-4-5, which was created with data from the Lower Agno Report.

As s a result of calculations, it was found that no conspicuous difference exists in the values of flood peak (Qp) due to the variation in the amount of rainfall as read from the prepared hyetograph, and 8,652 m^3/s was obtained for the Diduyon No.3 Damsite. Figures 2-4-6 and 2-4-7 show the hyeto-hydrographs for the Diduyon No.3 Damsite and the Diduyon No.2 Damsite, respectively.

(6) Analysis of runoff based on the record of storm rainfalls in Baguio City

NAPOCOR provided us the record of Baguio Storm on the amount of rainfall (record of precipitation taken every 6 hours) observed in the past. According to this material, a maximum value of precipitation appears during the period shown in Table 2-4-5. The hyetograph is presented on a day basis in Figure 2-4-8. As generally said, extreme values are given by the data for the two consecutive days, 16th and 17th of October, 1967 (maximum daily rainfall 1,216 mm). Based on this data, analytical study was conducted under the same conditions as those for the preceding runoff analysis by daily rainfall in the vicinity of the watershed.

Figure 2-4-9 shows a hydrograph prepared in this way for the Diduyon No.2 and No.3 damsites. For the damsite No. 3, the runoff is estimated at 6,753 m^3/sec.

(7) Design-flood discharge

As stated in the preceding paragraphs, the probable flood discharge for a given return period was calculated from known flood discharges in the past in the watershed of the Cagayan River. Aside from this, the runoff in the river basin was studied from the amount of rainfall in the area by analytical means. The results of these computations are listed in the following table. (For information, the past highest flood as computed for the damsite is 614 m^3/sec.)

<u>200-year Probable Flood Discharge for Diduyon Damsite (m^3/sec)</u>

Damsite	Estimate from Peak Flood Discharges in the Entire Cagayan Watershed	Estimate from Rainfall	
		Estimate from 200-year probable rainfall	Estimate from Baguio Storm
No.2 Damsite (Fill type)	<u>10,500</u>	10,100	7,900
No.3 Damsite (Concrete gravity)	<u>8,900</u>	8,652	6,753

For the design flood discharge of a concrete dam, a flood discharge of 200-year return period is generally adopted. As seen in the above table, no basic inconsistency exists between the values worked out from peak flood discharges of adjacent rivers and those calculated from the amount of rainfall through runoff analysis. Rather, it might be concluded that these two figures are well corelated with each other. Accordingly, flood discharges of 8,900 m^3/sec and 10,500 m^3/sec are adopted for the design of spillways at the Diduyon damsites No. 3 (concrete dam) and No. 2 (fill dam), respectivly. In case of the fill dam, the design flood discharge is usually taken 20% more than that of the concrete dam.

Fig. 2-4-10 presents an envelope curve plotting unit discharges (q) and drainage agreas (A) of past floods recorded at the watershed of the Cagayan River, q and A for each of the return periods of 2 through 1,000 years, and design values computed for other projects in the neighboring areas. As for typhoons and runoff, refer to Figs.2-4-11(1) through 2-4-11(3), which provide corellations with the measurements at the Pangal district.

Table 2-4-1

Observed Peak Flows in Cagayan River Basi

No.	River	Station	Drinage Area (km^2)	Maximum Discharge (m^3/sec)	Specific Discharge ($m^3/sec/km^2$)	Period of Observation	Number of Year
1	Cagayan	Dippaddiw	2,323	13,071	5.626	1959-65	7
2	Dabubu	Dabubupequino	162	344	2.123	64-65	2
3	Oibulan	Minuri	272	666	2.448	64-65	2
4	Addalam	Guinalvin	721	1,420	1.969	64-65	2
5	Diadi	Cabulay	196	663	3.382	55-65	11
6	Cagayan	Pangal	4,244	17,550	4.135	58-65	8
7	"	Palattao	6,266	8,063	1.286	61-65	5
8	Matuno	Bante	558	790	1.415	56-65	10
9	Magat	Bats	1,784	1,540	0.863	58-65	8
10	Ibulad	Hapio	606	645	0.899	64-65	2
11	Magat	Oscariz	4,150	6,795	1.637	41-65	25
12	Taotao	Caipilan	430	531	1.234	55-65	11
13	Pin. De. Ilagan	Mananga	1,565	1,800	1.150	64-65	2
14	Casile Creek	Casile	195	241	1.235	49-65	17
15	Siffu	Munoz	686	997	1.453	48-65	18
16	Pin. De. Tumauni	Antagan	170	1,004	5.905	64-65	2
17	Pinacauan	Larionalts	655	2,775	4.236	55-65	11
18	Pangal	Pangal	312	4,014	12.865	55-65	11
19	Paret	Calantac	907	2,476	2.729	57-65	9
20	Chico	Pasonglao	1,987	4,040	2.033	63-65	3
21	Matalag	Escolta	655	1,195	1.824	64-65	2
22	Dummon	Calaoagan	308	1,238	4.019	64-65	2
23	Sinunouogan	Simay	189	1,265	6.693	59-65	7

Source : Technical Series No. 18
Envelope Curve for Peak
Discharges in the Republic
of the Philippines
Jan., 1973

Table 2-4-2

Annual Maximum Discharge at Pangal (C.A. = 4,244 km^2)

Year	Discharge (m^3/sec.)
1959	17,550
60	4,810
61	5,270
62	7,560
63	6,790
64	4,300
65	1,460
66	12,320
67	16,010
68	5,030
69	1,460
70	9,710

Source: Chico River

Hydrology Report No. 2
Flood Studies
Feb., 1975

Table 2-4-3 Design Flood Discharge

	Diduyon No. 2			Diduyon No.3		
T	Specific Discharge	Flood Discharge (m^3/s)		Specific Discharge	Flood Discharge (m^3/s)	
year	($m^3/s/km^2$)	100%	120%	($m^3/s/km^2$)	100%	120%
1,000	23.60	10,900	13,100	23.29	11,100	13,300
200	18.83	8,700	10,500	18.59	8,900	10,700
100	16.73	7,700	9,300	16.51	7,900	9,500
20	11.88	5,500	6,600	11.73	5,600	6,700
2	4.12	1,900	2,300	4.07	1,900	2,300

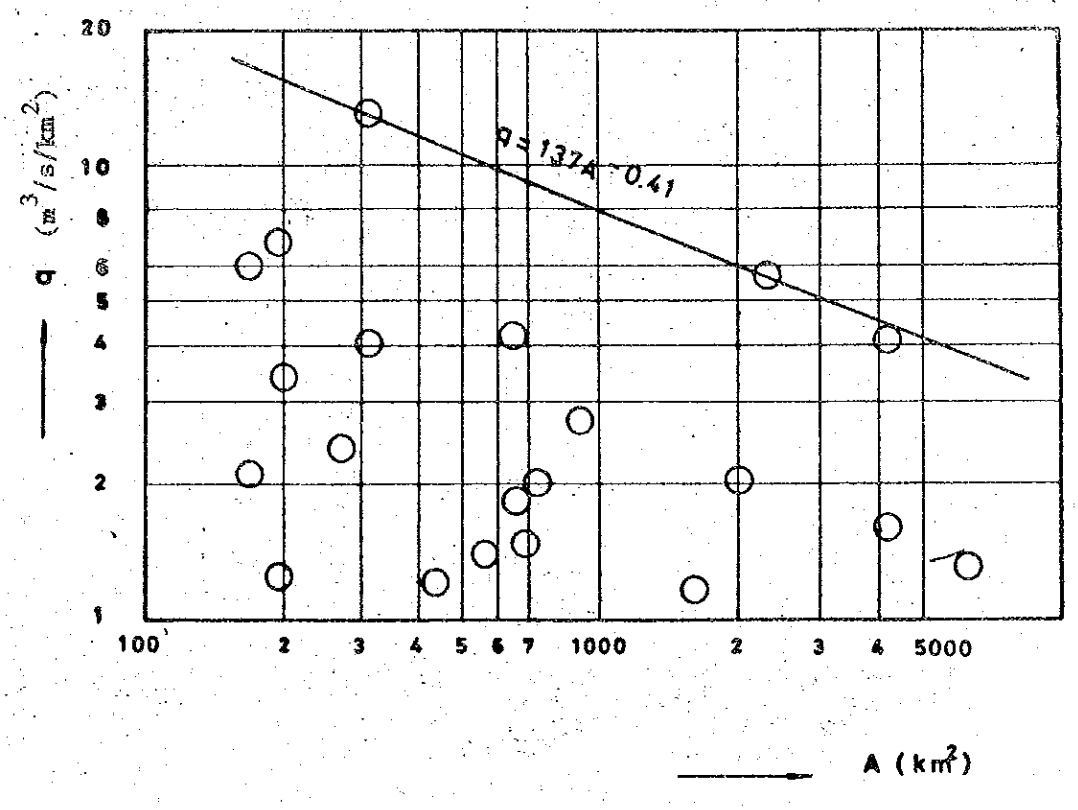
Table 2-4-4 Annual Highest 24-hr. Rainfalls

No.	Year	Rainfall (mm)	Location
1	1948	530	Clarian
2	9	391	Daet
3	1950	418	Balatoc Mr. Province
4	1	754	Atoc
5	2	432	Valderama, Antique
6	3	214	Laoag
7	4	368	Ilagan,Isabela
8	5	389	Baguio
9	6	283	Casiguran
10	7	423	Baler
11	8	459	Virac
12	9	388	Catbalagan
13	1960	356	Iba
14	1	288	Laoag
15	2	409	Laoag
16	3	320	Baguio
17	4	417	Virac
18	5	368	Baguio
19	6	316	Roxas
20	7	1,216	Baguio
21	8	650	Baguio
22	9	546	Baguio
23	1970	235	Catbalagan
24	1	121	Legaspi
25	2	480	Baguio
26	3	331	Baguio
27	4	818	Baguio
28	5	278	Legaspi

Table 2-4-5 Six-hr Maximum Rainfall Data at Baguio City

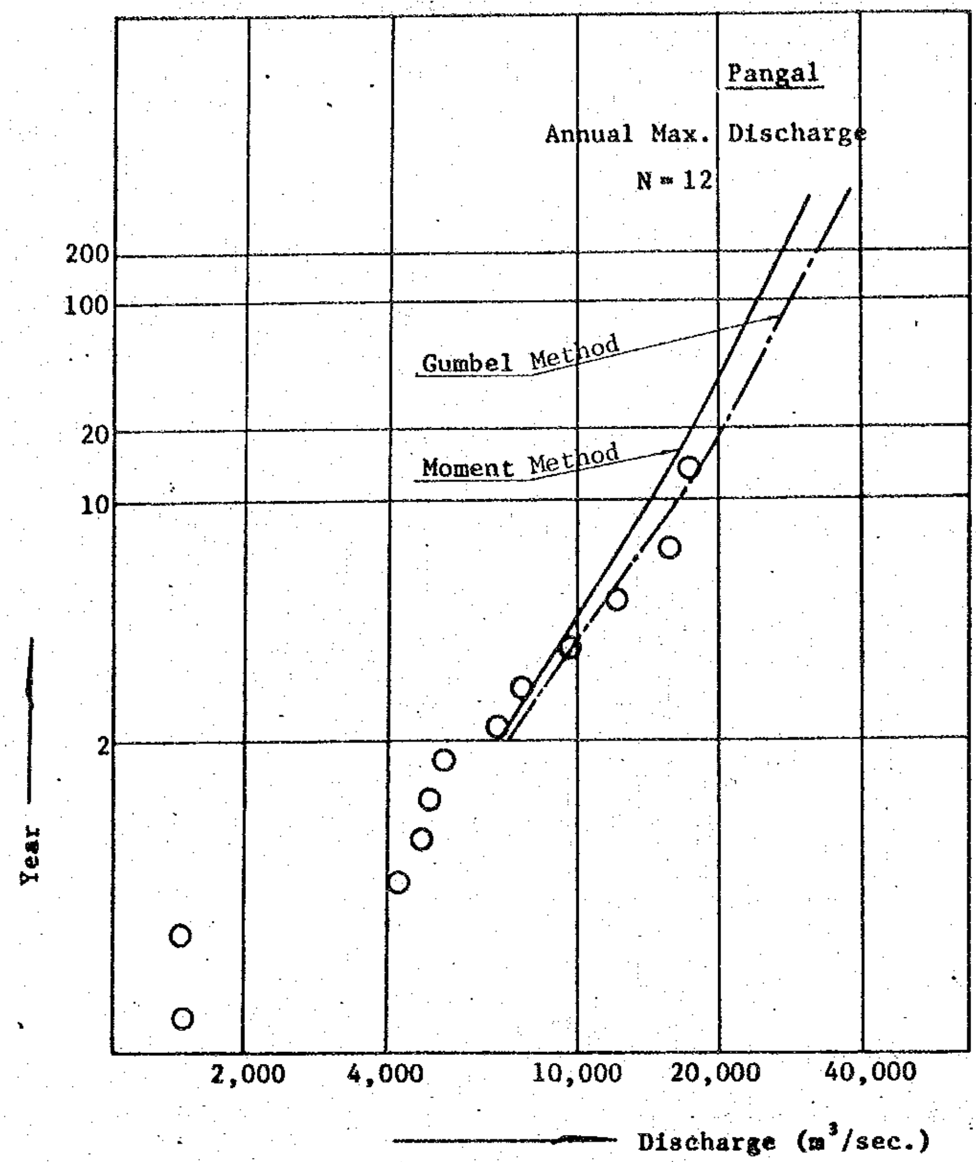
DATE	2:00 P.M.	8:00 P.M.	2:00 A.M.	8:00 A.M.	TOTAL
May 25, 1976	171.7	141.2	162.1	130.3	605.3
June 30, 1976	57.7	132.4	95.5	99.8	385.4
October 11, 1974	157.0	390.2	151.4	82.8	781.4
July 17, 1972	57.7	128.3	142.2	151.4	479.6
June 6, 1967	22.4	80.0	53.3	57.2	212.9
October 16, 1967	0.3	10.2	96.3	268.0	374.8
October 17, 1967	445.8	334.5	167.4	31.7	979.4

Envelope Curve for Observed Peak Flows In Cagayan River Basin



Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Envelope Curve for observed Peak Flows in Cagayan River Basin	
October 1980	Fig. 2-4-1

Logarithmic Normal Distribution of Flood Discharges



Return Period (year)	Flood Discharge (m /sec)	
	Moment Method	Gumbel Method
200	27,500	32,200
100	24,500	28,600
20	17,600	20,300
10	14,500	16,600
2	6,700	7,000

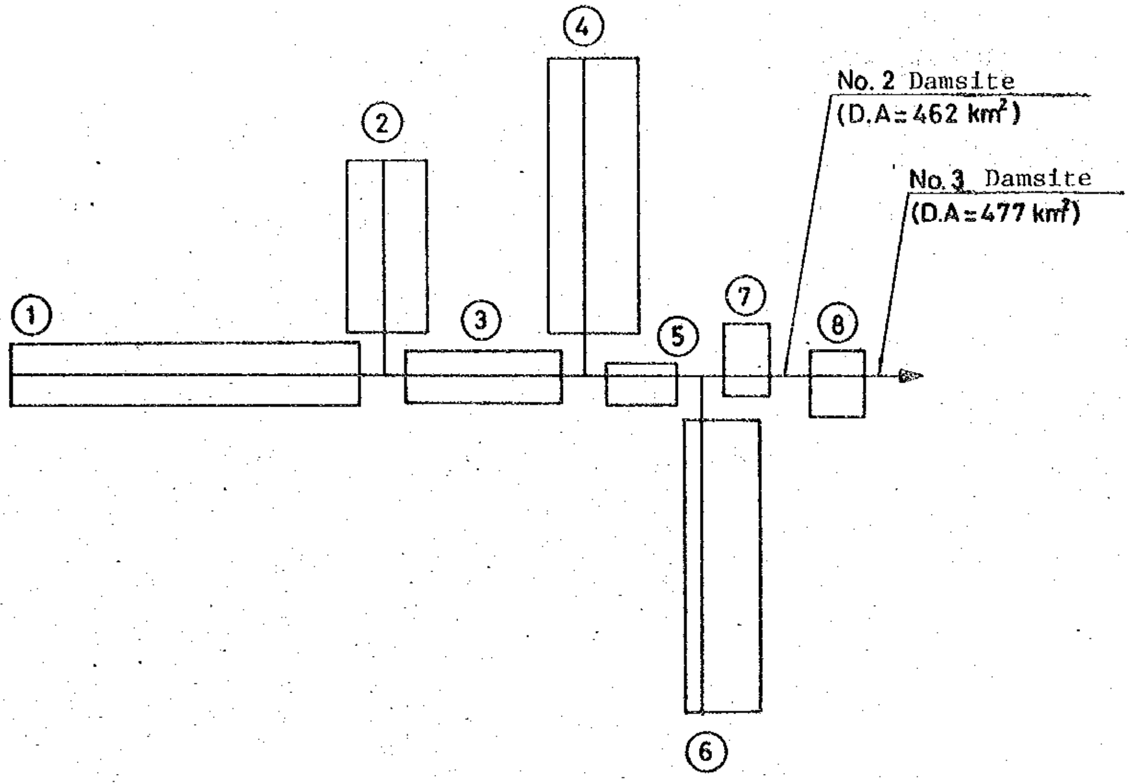
Diduyon Hydroelectric Project
Upper Cagayan River
Republic of the Philippines

Japan International Cooperation Agency

Logarithmic Normal Distribution of Flood Discharges

October 1980 Fig. 2-4-2

Hydrological Model of Diduyon Drainage Area for Kinematic Wave Method



Block	River Channel		Left Bank Area			Right Bank Area			Drainage Area
	L	I	L	I	A	L	I	A	Σ A
	km	10^{-3}	km	10^{-3}	km^2	km	10^{-3}	km^2	km^2
1	24.45	64.4	2.25	156	55.01	2.22	123	54.28	109.29
2	11.9	29.8	2.96	152	35.22	2.4	100	28.56	63.78
3	11.15	1.8	1.67	109	18.62	1.82	110	20.29	38.91
4	18.85	7.5	3.7	68	69.75	2.39	105	45.05	114.80
5	4.95	1.1	0.85	155	4.21	2.12	110	10.49	14.70
6	20.15	33.7	1.31	118	26.40	3.91	105	78.79	105.19
7	3.15	4.8	3.71	129	11.69	1.21	153.5	3.81	15.5
8	3.80	4.8	1.18	160	4.48	2.79	110	10.60	15.08
Total									477.25

L : Length

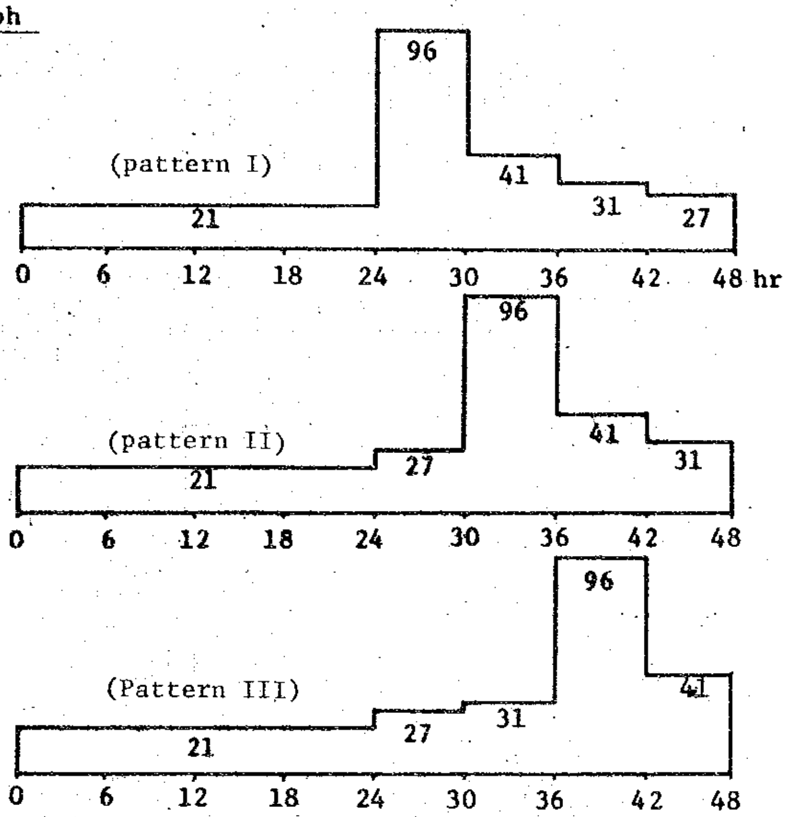
I : Slope

A : Area

Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Hydrological Model of Diduyon Drainage Area for Kinematic Wave Method	
October 1980	Fig. 2-4-3

Rainfall Patterns for Computation of Flood Waves

Hyetograph



1. 200-year probable daily rainfall (spot rainfall) R_{24} = 1345 mm
2. 6-hour continuous rainfall $R_t = R_{24}(t/24)^{1/2} = K_t^{1/2}$*

$(K = 1345/24^{1/2} = 275)$

t (hr)	Rt (mm)	Δ Rt (mm)	rt (mm/hr)	P**	r (mm/hr)
6	673	673	112	0.86	96
12	953	280	47	0.87	41
18	1167	214	35	0.88	31
24	1345	178	30	0.89	27
48	1905	560	23	0.91	21

Diduyon No. 3 Dam

D.A. = 477 km^2

* $R_t = \alpha t^{1/2}$, $R_{24} = \alpha\, 24^{1/2}$ } $\frac{R_t}{R_{24}} = (\frac{t}{24})^{1/2}$

** Refer to Fig. 2-4-5

Diduyon Hydroelectric Project
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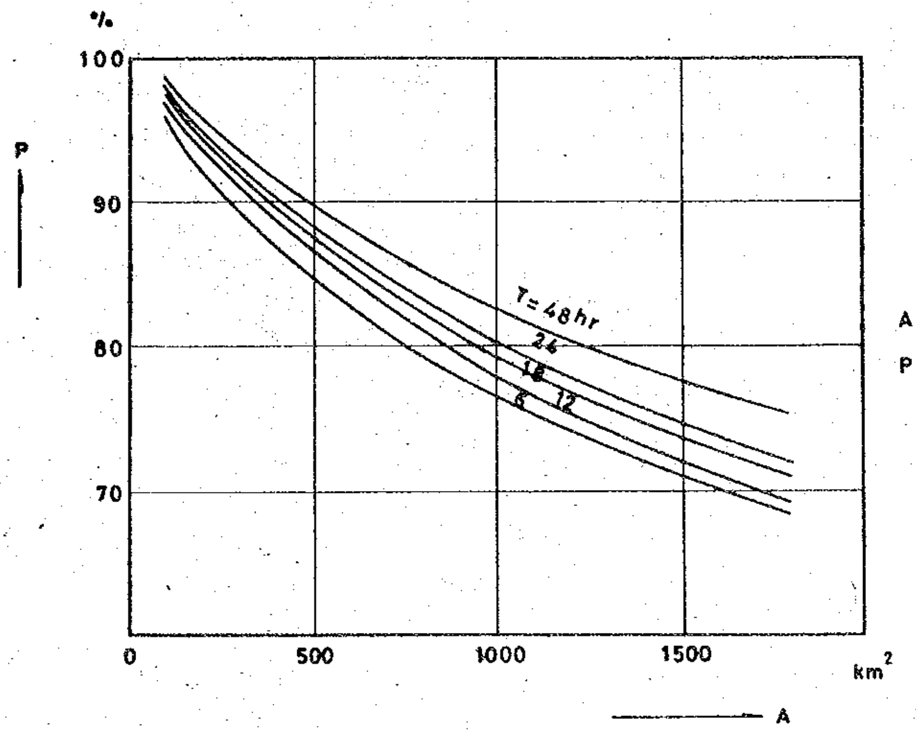
Rainfall Patterns for Computation of Flood Waves

October 1980 | Fig. 2-4-4

Depth - Area - Duration Curve



Legend

A: Area (km^2)

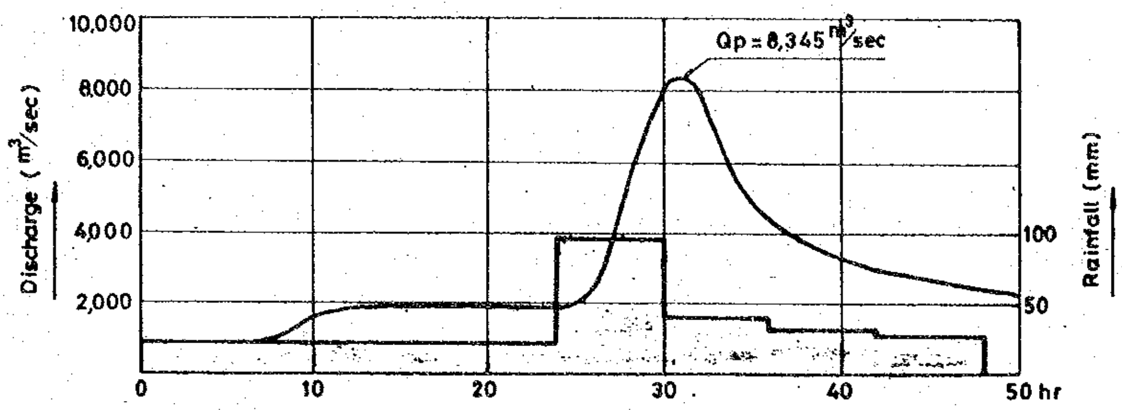
P: Average Rainfall as % of Point Rainfall

Source: Lower Agno Dev. Plan
By Electroconsult,
July, 1976

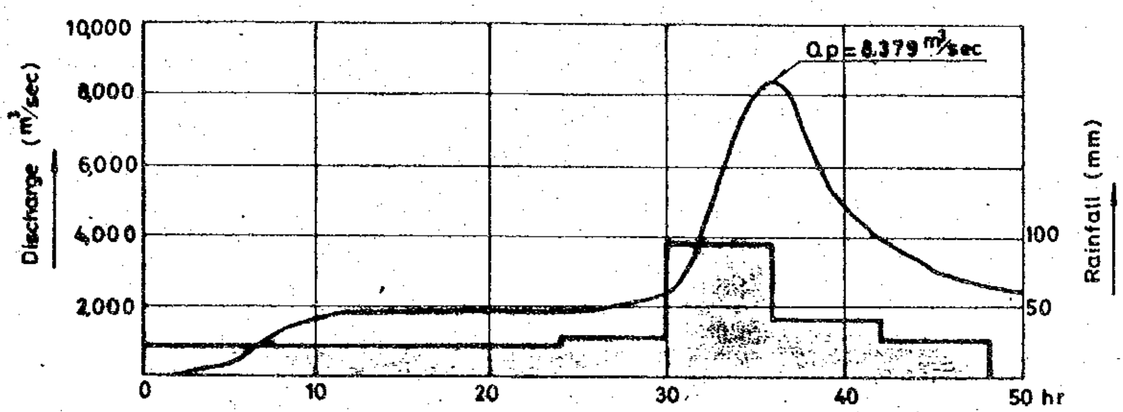
Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Depth-Area-Duration Curve	
October 1980	Fig. 2-4-5

Peak Flood of Hyetograph and Hydrograph at No. 2 Damsite

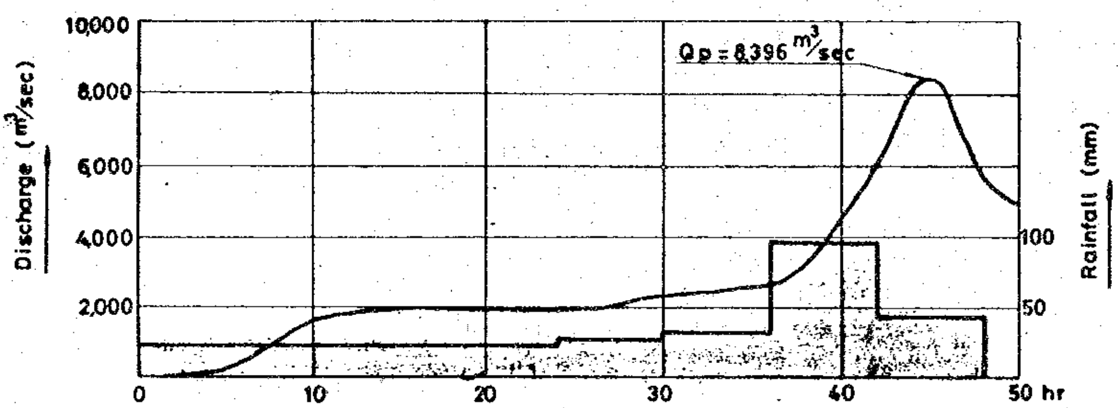
(Pattern I)



(Pattern II)



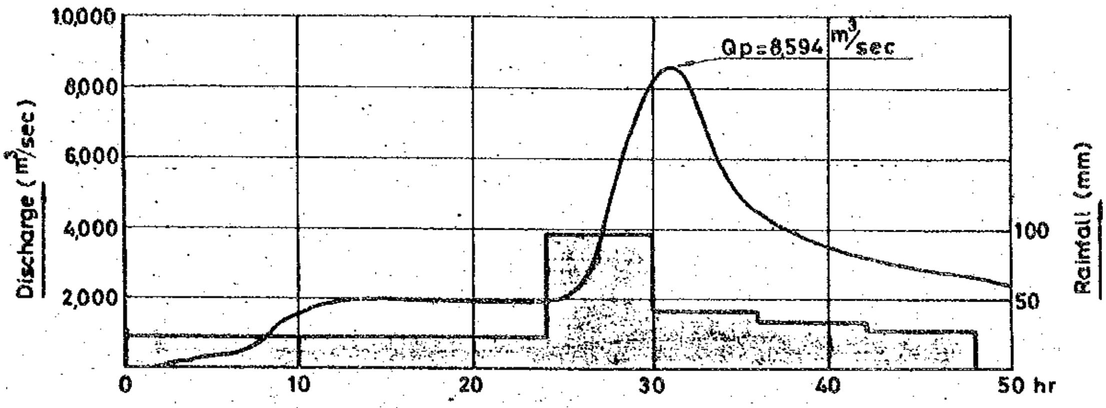
(Pattern III)



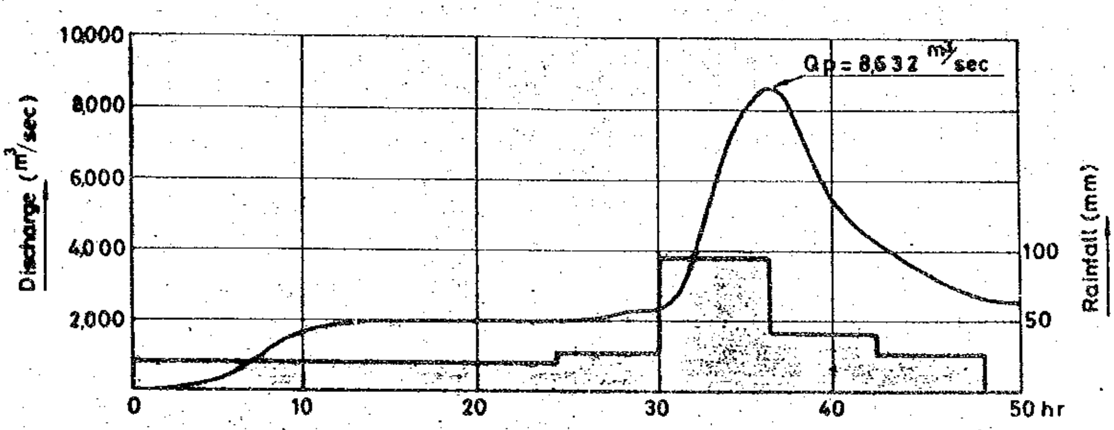
Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Peak Flood of Hyetograph and Hydrograph at No. 2 Damsite	
October 1980	Fig. 2-4-6

Peak Flood of Hyetograph and Hydrograph at No. 3 Damsite

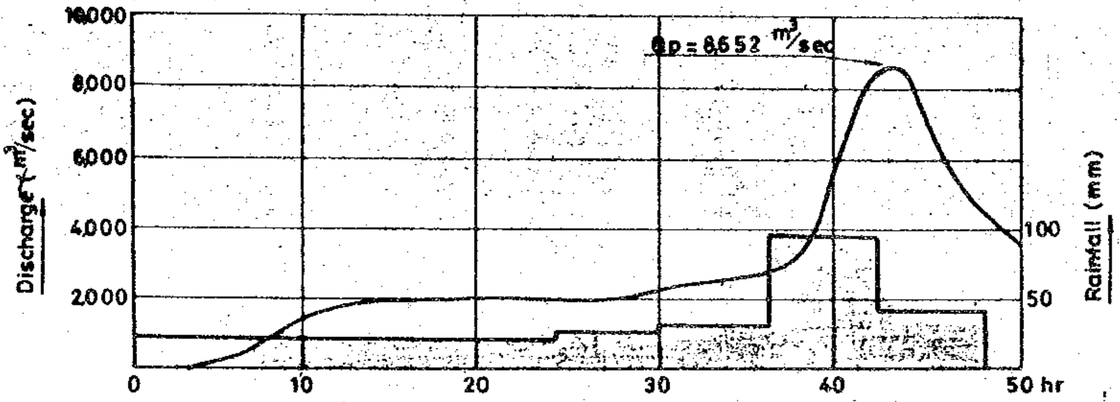
(Pattern I)



(Pattern II)



(Pattern III)



Diduyon Hydroelectric Project
Upper Cagayan River
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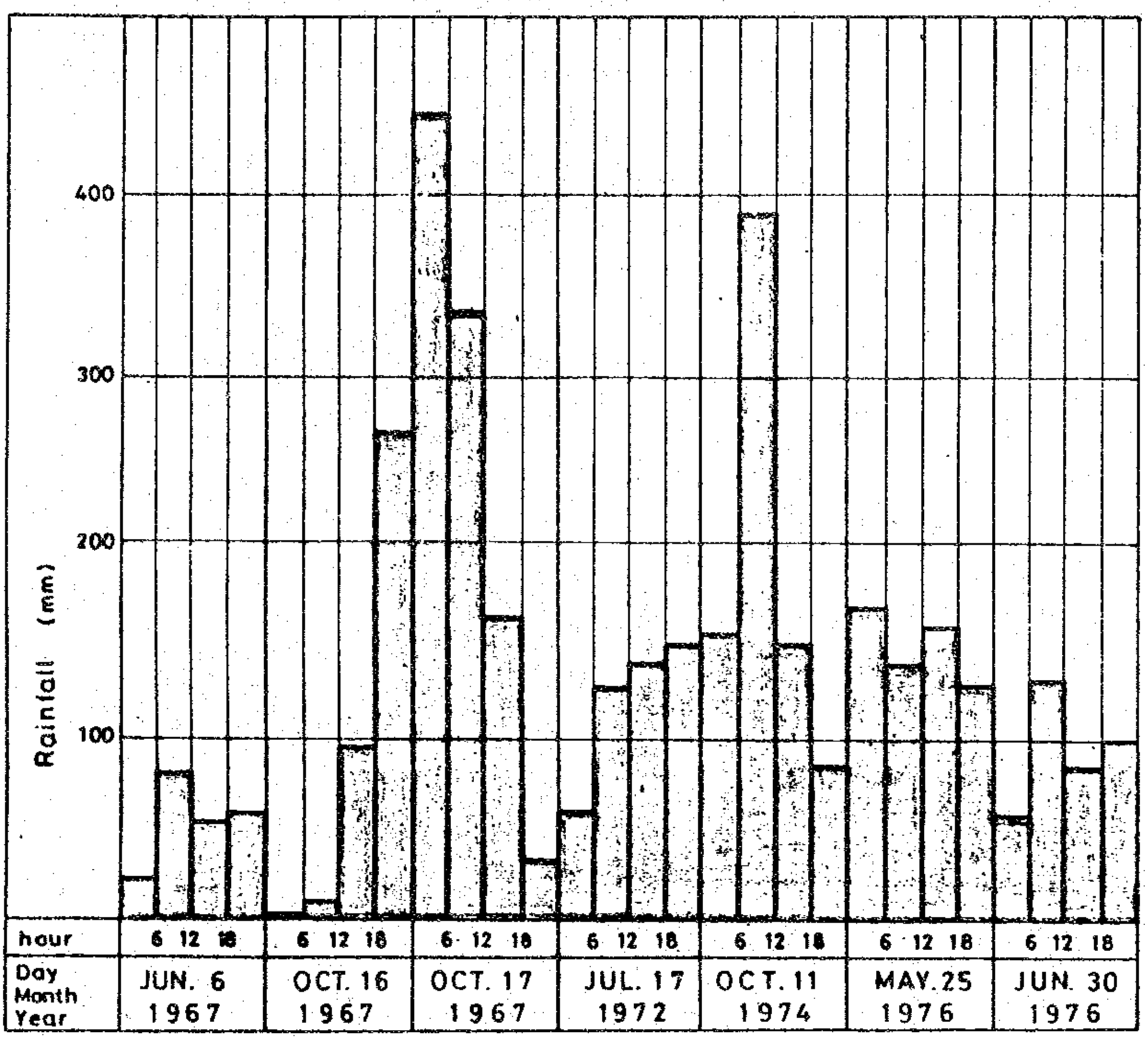
Peak Flood of Hyetograph and Hydrograph at No. 3 Damsite

October 1980	Fig. 2-4-7

Rainfall Intensity at Baguio City



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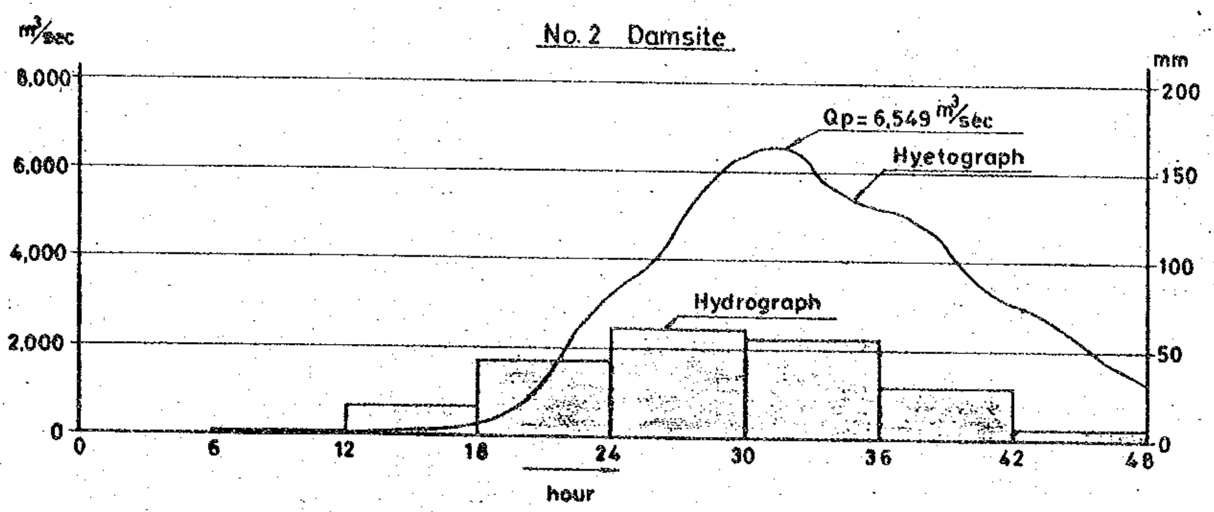
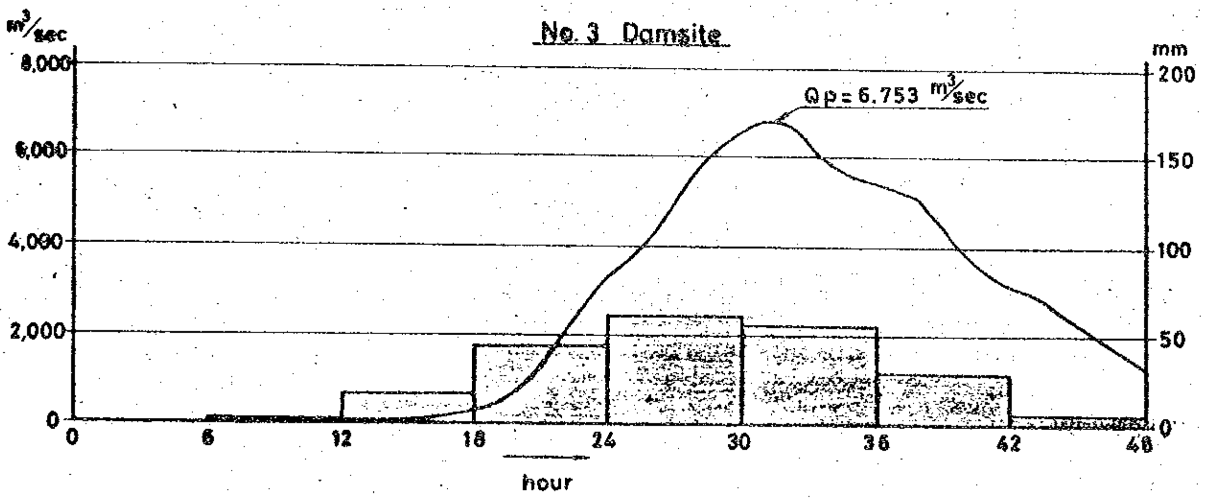
Rainfall Intensity at Baguio City

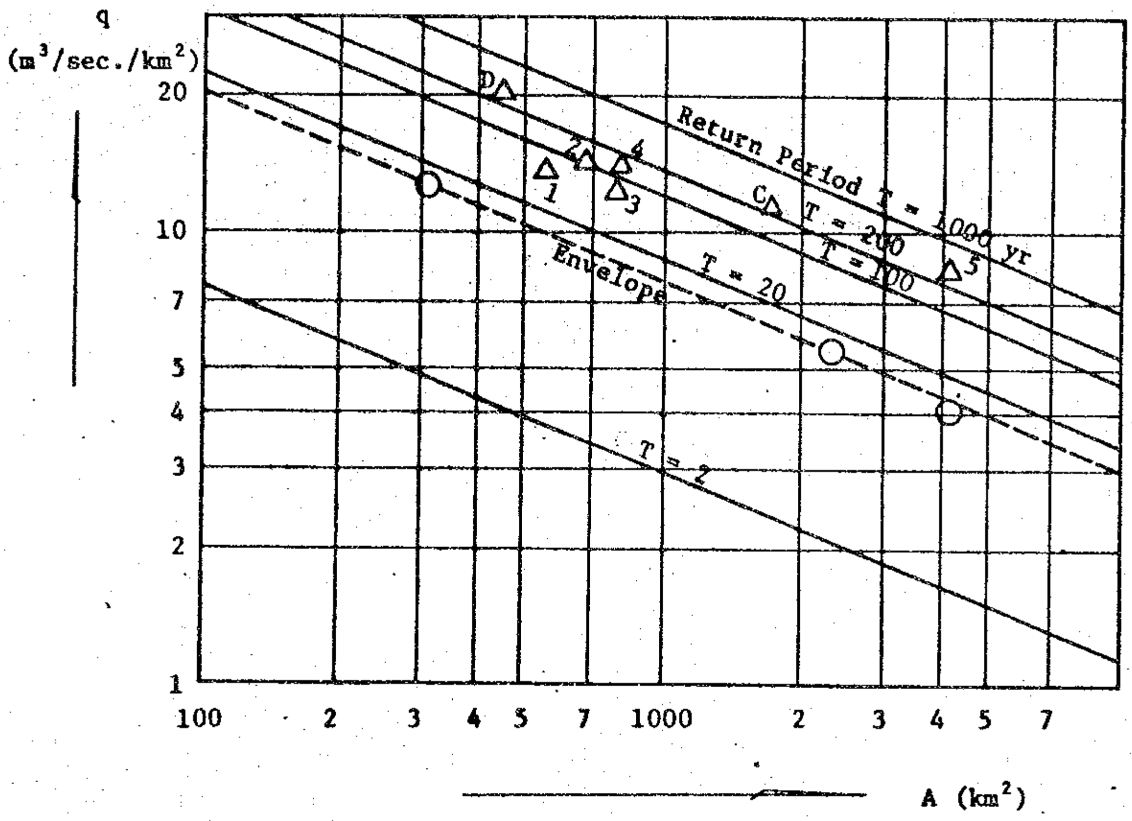
October 1980	Fig. 2-4-8





Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Peak Flood of Hyetograph and Hydrograph at Diduyon Damsite	
October 1980	Fig. 2-4-9

Relation between Specific Discharge and Catchment Area (North Luzon)



1: Angat
2: Ambuklao
3: Binga
4: UPRP
5: Magat

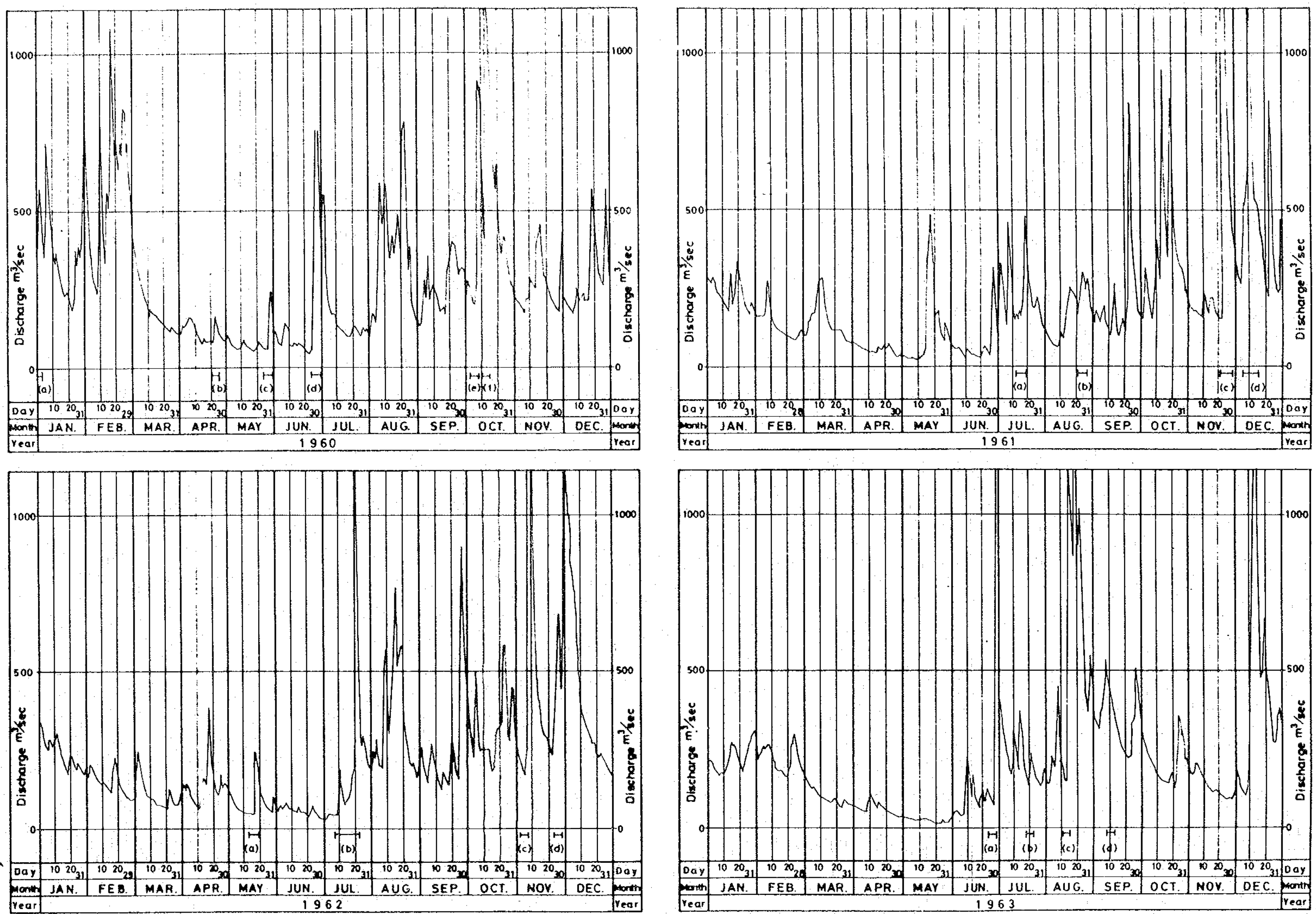
C: Cabingatan
D: Diduyon

Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines	
Japan International Cooperation Agency	
Relation between Specific Discharge and Catchment Area (North Luzon)	
October 1980	Fig. 2-4-10

Station Name : Pangal

Catchment Area : 4244 km^2

Daily Discharge at Pangal (1)



1960

		1	2	3
(a)	HARRIET	122 Kts Virac	954.6mb Virac	205.7mm Caranan
(b)	KAREN	35 Kts Surigao	1.001.9mb Cebu	173.0mm Surigao
(c)	STORN	34 Kts Manila		229.1mm Mia
(d)	OLIVE	100Kts Leguspi	995.4mb Virac	356.4mm Iba
(e)	KIT	100Kts Lalanan	972.0mb Legaspi	261.9mm Catbalogan
(f)	LCLA	38Kts Dagupan	993.0mb Casiguran	325.9mm Iba

1961

		1	2	3
(a)	STORM	33 Kts Lacag	992.0mb Tuguegarao	137.2mm Lacag
(b)	LORNA	43 Kts Basco	997.0mb Lacag	287.8mm Lacag
(c)	STORM	52 Kts Calapan	991.9mb Aurora	182.9mm Casiguran
(d)	ELLEN	96 Kts Virac	982.4mb Virac	207.8mm Virac

1962

		1	2	3
(a)	HOPE	50 Kts Tacloban	995.5mb Paet	981mm Surigao
(b)	KATE	56 Kts Manila	998.1mb Aparri	319.5mm Dagupan
(c)	JEAN	44 Kts Legaspi	995.3mb Catarman	285.5mm Casiguran
(d)	LUCY	65 Kts Cugao	989.7mb Cebu	183.4mm Hinatuan

1963

		1	2	3
(a)	DIDING	65 Kts Casiguran	978.0mb Casiguran	218.9mm Baguio
(b)	ISING	43 Kts Vigan	999.5mb Tuguegarao	172.0mm Laoag
(c)	LUDING	87 Kts Virac	963.0mb Virac	247.4mm Iba
(d)	ONYANG	48 Kts Manila		319.5mm Baguio

Diduyon Hydroelectric Project
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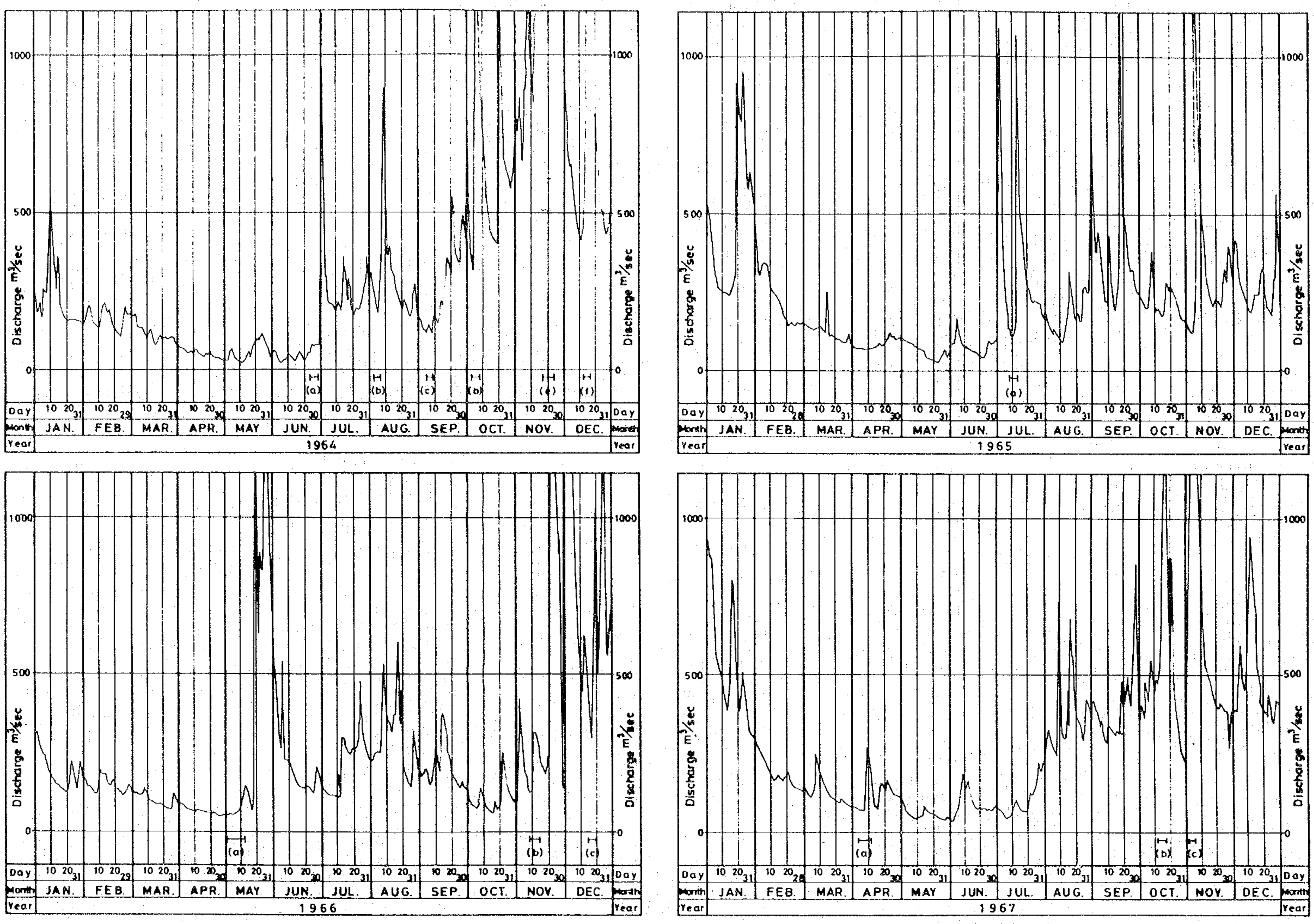
Daily Discharge at Pangal (1)

October 1980 Fig. 2-4-11 (1)

Station Name : Pangal

Catchment Area : 4244 km^2

Daily Discharge at Pangal (2)



1964

		1	2	3
(a)	DADING	69 Kts Infanta	974.0mb Infanta	209.6mm Lucena
(b)	SENIANG	60 Kts Baguio	973.9mb Aparri	562.4mm Baguio
(c)	ARING	56 Kts Tuguegarao	991.0mb Tuguegarao	86.6mm Vigan
(d)	DORANG	78 Kts Casiguran	979.9mb Casiguran	168.7mm Baquio
(e)	INING	48 Kts Casiguran	992.2mb Cebu	242.8mm Casiguran
(f)	NANING	85 Kts Virac	970.0mb Virac	416.6mm Virac

1965

		1	2	3
(a)	MILING	97 Kts Tuguegarao	954.4mb Tuguegarao	368.0mm Baguio

1966

		1	2	3
(a)	KLARING	105 Kts Tacloban	967.9mb Borongan	315.5mm Roxas
(b)	UDING	72 Kts Infanta	974.6mb Virac	244.4mm Balea
(c)	ANING	100 Kts Masbate	977.4mb Borongan	264.3mm Borongan

1967

		1	2	3
(a)	KARING	91 Kts Tuguegarao	974.6mb Tuguegarao	157.8mm Tuguegarao
(b)	TRINING	113 Kts Tuguegarao	962.7mb Tuguegarao	1215.7mm Baquio
(c)	ILMING	100 Kts Masbate	970.6mb Daet	158.5mm Masbate

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Daily Discharge at Pangal (2)

October 1980 Fig. 2-4-11 (2)