

SEISMIC PROVINCES OF CHILE

by

E. Gajardo* and C. Lomnitz*

ABSTRACT

The seismic provinces of Chile are defined by using the statistical method of C. Tsuboi. Several thousand shocks collected during fifteen years were used in the computation. Tables and maps showing the relative seismicity of the regions are given.

INTRODUCTION

The earthquake distribution in Chile shows certain known geographic peculiarities¹. The frequency of earthquakes is not evenly distributed but shows several peaks, the most prominent among which occur at Latitudes 28° and 32° South. It has also been established that the magnitude-frequency relation varies slightly for different regions of the country.

These preliminary results made it seem worthwhile to attempt a definition of seismic regions in Chile. Apart from its scientific value such a study was expected to provide information for the revision of the present earthquake provisions in the Building Code. These regulations calling for uniform design factors over the entire territory of Chile are being recognized as unrealistic and wasteful by many engineers.

From the seismic point of view Chile is a part of the Circum-Pacific earthquake belt. Its overall seismicity ranks between that of California and that of Japan. Chile, however, is unique in that it spans 38 degrees of latitude, or 2 1/2 times as much as the combined states of Washington, Oregon and California which form the West Coast of the United States. It constitutes the world's longest continuous earthquake belt under a single flag.

It is hardly surprising to find the existence of several seismic zones in a region of this length. Yet the actual zoning of the country is not easy to achieve. In the United States a zoning has been accepted on the basis of active, intermediate and inactive regions. In Chile the entire country, at least down to Parallel 40° South, is active.

C. Tsuboi² has proposed the concept of "Earthquake Province" which fits the Chilean situation very well. As in Japan we have here a continuous earthquake belt, but within this belt there are clusters of earthquake foci the activity of which can be correlated not only in space but in time as well. We hope to show that these earthquake provinces exist in Chile and that they are probably based upon separate tectonic mechanisms. To this end we have applied the statistical method used by Tsuboi in the above reference.

*Instituto de Geofisica y Sismologia, Universidad de Chile

SEISMIC CORRELATION STUDY

Tsuboi defines a correlation coefficient as follows:

$$r(1,m) = \frac{\sum_{t=1}^n \{N(1,t) - \bar{N}(1)\} \{N(m,t) - \bar{N}(m)\}}{\sqrt{\sum_{t=1}^n \{N(1,t) - \bar{N}(1)\}^2 \sum_{t=1}^n \{N(m,t) - \bar{N}(m)\}^2}}$$

in which $N(1,t)$ is the number of earthquakes in the 1-th compartment during the t -th year and $\bar{N}(1)$ means the annual average number of earthquakes in the 1-th compartment. Then $r(1,m)$ represents the correlation between compartments 1 and m as to yearly seismicity fluctuations.

In order to apply this criterion we have divided Chile into 37 compartments of one degree of latitude each (fig. 1). The earthquake statistics are given in Table I for the period 1942-1958 and partial periods 1942-49 and 1950-58. The compartments have been numbered according to latitude. As the information is based on the number of reported felt earthquakes a sketch of population density is given in fig. 1. The number of larger earthquakes (Mercalli intensities 6 and up) is also given in order to show that the data are not appreciably influenced by the density of observers. The general similarity between frequency curves indicates that the relative seismicity between regions is largely time-invariant.

The annual number of earthquakes in each region is given in Table II. This table may be used to find the correlation coefficients $r(1,m)$ according to the formula above. The results are given in Table III and shown graphically in fig. 2. The value of $r(1,m)$ is found at the intersection of the 1-th column and the m -th row.

ANALYSIS AND CONCLUSIONS

In the case of a continuous seismic belt with an even or random distribution of seismic activity the correlation coefficients are expected to vary as a function of the distance between compartments only. Figure 2 shows, to the contrary, that the high values of $r(1,m)$ tend to cluster about certain latitudes. These are the Earthquake Provinces defined by Tsuboi. The four most important ones are:

<u>Earthquake Province</u>	<u>Latitudes</u>
A. PAMPA DEL TAMARUGAL	19° to 22° South
B. ATACAMA PROVINCE	26° to 29° South
C. CENTRAL CHILE (Combarbalá to Curicó)	31° to 35° South
D. CHILE SUR (Chillán to Osorno)	37° to 40° South

The region of Arica (18°- 19° South) is probably part of another earthquake province extending towards the North. There are some indications that Provinces B and C tend to grade into each other. The boundary seems to be in the latitude of La Serena (about 30° South).

Seismic Provinces of Chile

The average value of correlation coefficients within the provinces defined above is + 0.37. Outside the provinces it is only about + 0.04. Another manner to define the earthquake provinces is to list the correlation coefficients between adjacent compartments (Table IV). One sees immediately that high positive correlation coefficients within the provinces are separated by negative coefficients. South of Puerto Montt (Parallel 42° South) the correlation coefficients are uniformly zero or negative.

Let us now lump all earthquakes in each province together and find the correlation coefficient between provinces (Table V). We see at once that the correlation between adjacent provinces A-B and B-C is rather high. In the case of the Japanese earthquake provinces the highest coefficient between adjacent provinces was + 0.16. This might mean that the regional mechanism called "earthquake field" by Tsuboi extends to a much greater distance in Chile than in Japan, where the mechanism is more of a local character. In particular it will be observed that the correlation coefficient between provinces A and B is + 0.40 while the coefficient between B and C is only + 0.26 in spite of the fact that these two provinces grade into each other geographically. We conclude that Northern Chile (North of La Serena, Parallel 30° South) forms a super-province or tectonic region in the sense of the "earthquake regions" defined by Gutenberg and Richter³. Such a new division appears well justified on geological and geographical grounds alone.

In conclusion it may be stated that the result of the present analysis confirms and clarifies the known information about earthquake distribution and tectonics in Chile. While it is recognized that the number of earthquake regions found by this procedure depends on the choice of size for the compartments, we believe that the four provinces defined herein do represent the fundamental zones of concomitant seismic activity in Chile.

BIBLIOGRAPHICAL FOOTNOTES

1. F. Greve (1956), "Estudio Estadístico de los Sismos Sentidos en Chile durante los Años 1942 a 1955," Anales Fac Ciencias Fis. y Mat., U. de Chile 13, p 219.
2. C. Tsuboi (1958), "Earthquake Province -- Domain of Sympathetic Seismic Activities," Jour. Phys. of the Earth 6, p. 35.
3. B. Gutenberg and C. F. Richter, "Seismicity of the Earth" (Princeton University Press, 2nd Edition, 1954).

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SEISMIC ACTIVITY BY COMPARTMENTS

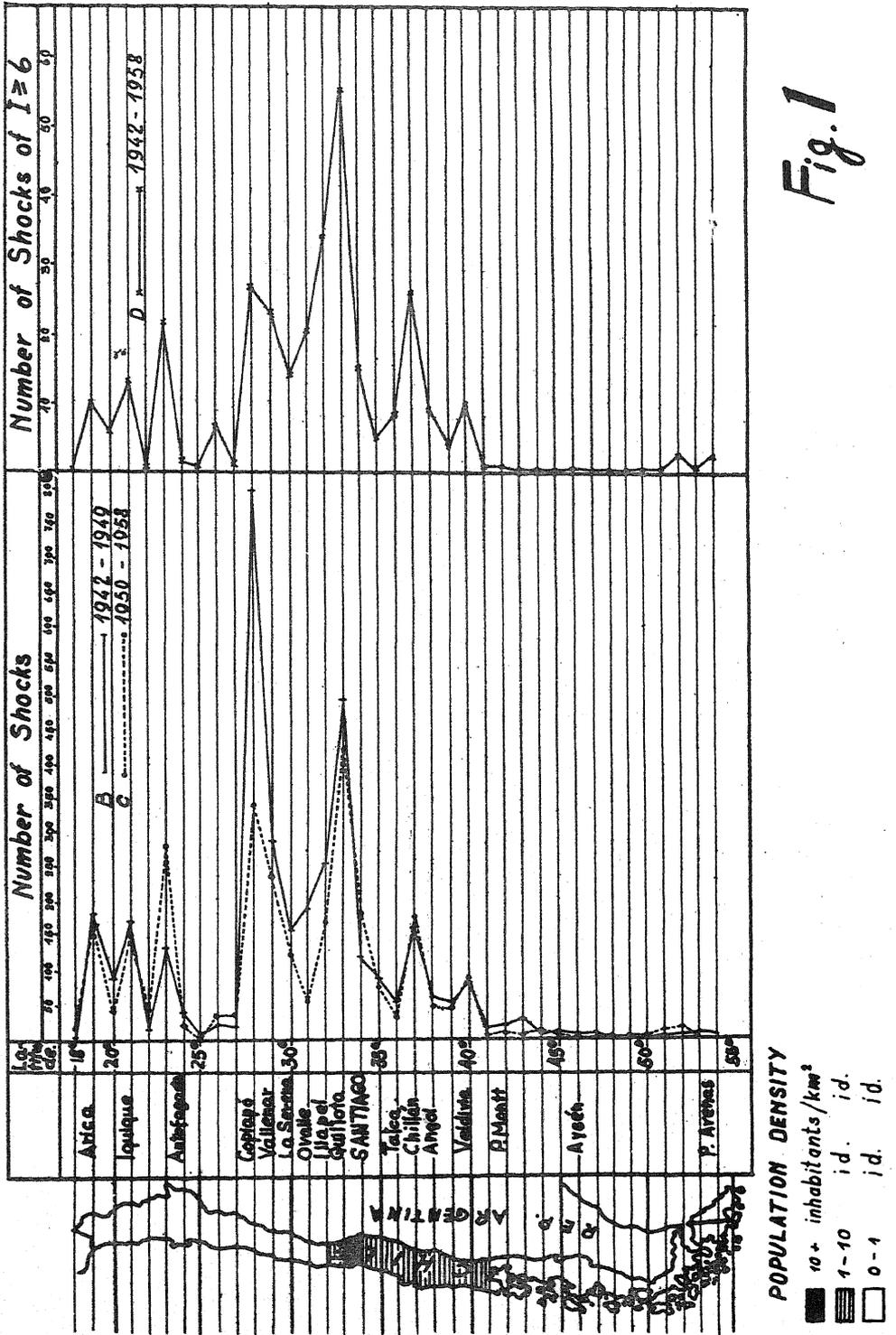


Fig. 1

Seismic Provinces of Chile

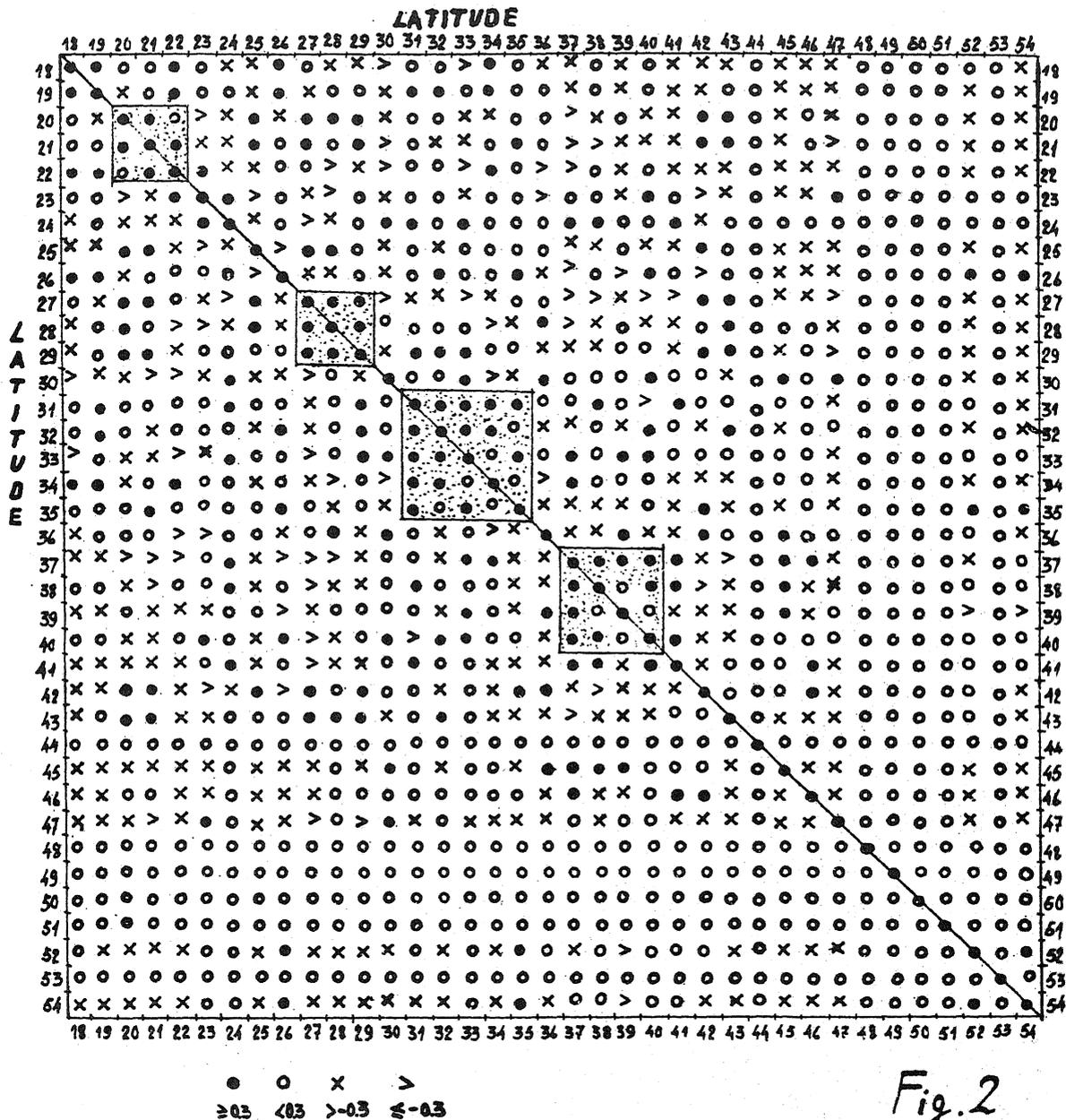


TABLE I

Total number of earthquakes per Compartment

A 1942-1958
 B 1942-1949
 C 1950-1958
 D 1942-1958
 (shocks of Mercalli Intensity 6 and larger).

COMPARTMENT	A	B	C	D
18	1	0	1	0
19	345	167	178	10
20	113	83	30	6
21	337	172	165	13
22	39	2	37	0
23	415	135	280	22
24	62	39	23	2
25	12	12	0	2
26	53	25	28	6
27	52	25	27	2
28	1134	801	333	227
29	528	289	239	23
30	278	153	125	13
31	249	190	59	18
32	431	258	173	34
33	950	522	428	55
34	288	121	167	15
35	196	90	106	5
36	93	60	33	8
37	338	164	174	26
38	121	64	57	9
39	98	57	41	4
40	164	84	80	10
41	31	19	12	1
42	36	21	15	1
43	41	27	14	0
44	0	0	0	0
45	2	2	0	0
46	1	1	0	0
47	1	0	1	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	16	6	10	2
53	0	0	0	0
54	21	3	18	2

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TABLE II
Annual Number of Earthquakes per Compartment

	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	I	II	III	IV	V	VI
20°	18 11	52	16	18	16	10	34	19	18	15	15	11	14	17	6	21	45	1	139	10	1		1
	28	10	2	29	43	25	20	15	17	22	7	5	6	16	59	33	179	145	13				337
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	195	10	1		345
	22	34	10	21	5	5	12	26	28	7		30	45	44	47	20	191	200	-	6	1	1	113
	6	6	6	8	10	1	2	10	1	1		1	8	2	5	1	30	29	22	2	1	1	39
	-	-	-	1	10			1				1	4	4		1	1	8	2	2	1		415
25°	1	5	1	5	8	4	4	5	7	2	1	1	4	1	3	3	6	25	21	6	1		53
	1	1	3	1	8	4	6	2	3	3	1	3	2	1	3	8	4	18	31	2	1		52
	84	87	68	73	153	154	115	67	54	45	33	27	27	36	55	29	771	336	27	27	1		1134
	37	54	31	32	46	36	39	14	27	18	18	29	32	10	39	47	19	216	288	23	1		528
	23	25	28	21	13	15	14	14	10	13	24	1	18	29	18	8	4	124	135	13	6		278
30°	30	49	16	31	16	9	6	33	3	2	2	2	4	3	6	17	20	98	133	18	1		249
	27	95	14	15	16	48	23	20	18	8	2	19	15	29	20	26	29	211	184	34	1		431
	64	103	61	86	61	51	44	52	66	53	45	56	52	40	45	42	29	457	435	55	3		950
	20	28	17	17	9	9	9	12	12	21	14	28	13	11	12	24	32	163	108	15	1		288
	12	19	8	17	14	5	3	12	26	14	9	6	5	7	6	21	12	94	95	5	2		196
35°	6	3	11	9	8	6	12	5	7	3	6	2	2	6	11	4	3	43	44	8			93
	31	25	33	23	15	8	9	20	20	18	21	36	28	18	11	11	11	145	163	26	3		338
	5	12	12	6	5	5	3	16	4	2	6	8	10	7	6	6	8	62	48	9	1		121
	5	6	12	12	8	5	6	3	1	4	4	10	4	7	4	3	4	68	25	4	1		98
	13	16	12	14	6	6	5	12	9	4	3	7	12	13	12	9	11	87	67	10	1		164
40°	7	2	2	2	6	1	1	4	2	3	1	1	6	1	1	3	1	19	10	1	1		31
	4	2	3	2	6	1	1	1	3	3	2	1	1	1	1	4	2	12	23	1			36
	2	3	1	3	4	7	4	3	1	1								11	30				41
			2															1	1				-
45°	1													1				1	1				2
																		1	1				1
50°																							
				1				5	9							1		2	12	2			16
								3	12				4					11	7	2	1		21
															1								-

459 696 969 453 510 439 374 377 358 259 222 288 316 288 317 421 369 3261 2836 316 27 6 6446

T A B L E I I I
Correlation Coefficients by Compartments

	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
18	+1.00	+0.52	+0.13	+0.22	+0.92	+0.16	-0.21	-0.08	+0.37	+0.09	-0.25	-0.25	-0.40	+0.10	+0.05	-0.40	+0.53	+0.02	-0.19
19	+0.52	+1.00	-0.05	+0.11	+0.38	+0.14	+0.09	-0.10	+0.46	-0.04	+0.02	+0.23	-0.04	+0.58	+0.64	+0.25	+0.52	+0.28	+0.06
20	+0.13	-0.05	+1.00	+0.87	-0.16	-0.32	-0.27	+0.75	-0.20	+0.06	+0.63	+0.40	-0.26	+0.13	+0.04	-0.07	-0.15	+0.12	+0.17
21	+0.22	+0.11	+0.87	+1.00	+0.31	-0.05	-0.11	+0.40	+0.10	+0.72	+0.25	+0.43	-0.45	+0.22	-0.04	-0.11	+0.15	+0.46	+0.04
22	+0.92	+0.38	+0.16	+0.31	+1.00	+0.42	-0.23	-0.04	+0.26	+0.24	-0.37	-0.13	-0.43	+0.02	+0.01	-0.49	+0.57	+0.02	-0.39
23	+0.16	+0.14	-0.32	-0.05	+0.42	+1.00	+0.37	+0.32	+0.29	-0.14	+0.56	+0.06	-0.11	+0.09	+0.21	-0.10	+0.29	+0.13	-0.53
24	-0.21	+0.09	-0.25	-0.11	-0.23	+0.37	+1.00	-0.21	+0.22	-0.38	-0.11	+0.02	+0.38	+0.60	+0.13	+0.35	+0.02	+0.09	+9.04
25	-0.08	-0.10	+0.70	+0.40	-0.04	-0.32	+0.21	+1.00	-0.34	+0.50	+0.50	+0.28	-0.10	+0.09	-0.14	+0.11	-0.29	+0.12	+0.22
26	+0.37	+0.46	-0.20	+0.10	+0.26	+0.29	+0.22	-0.34	+1.00	-0.09	-0.07	+0.01	-0.28	+0.28	+0.30	+0.17	+0.29	+0.10	+0.08
27	+0.09	-0.04	+0.66	+0.72	+0.24	-0.14	+0.38	+0.50	-0.09	+1.00	+0.32	+0.41	-0.58	-0.23	-0.19	-0.37	-0.10	+0.07	+0.19
28	-0.25	+0.02	+0.63	+0.25	-0.37	-0.56	-0.11	+0.55	-0.07	+0.32	+1.00	+0.47	-0.00	+0.26	+0.29	+0.29	-0.48	-0.10	+0.49
29	-0.25	+0.23	+0.40	+0.43	-0.13	+0.06	+0.02	+0.28	+0.01	+0.41	+0.47	+1.00	-0.00	+0.33	+0.50	+0.48	+0.08	+0.19	-0.00
30	-0.40	-0.04	-0.26	-0.45	-0.43	-0.11	+0.38	-0.10	-0.28	-0.58	+0.12	-0.00	+1.00	+0.23	+1.00	+0.61	+0.64	+0.36	+0.05
31	+0.10	+0.58	+0.13	+0.22	+0.02	+0.09	+0.60	+0.09	+0.28	-0.23	+0.26	+0.38	+0.23	+1.00	+0.61	+1.00	+0.51	+0.32	+0.17
32	+0.06	+0.64	+0.04	-0.04	+0.01	+0.21	+0.13	-0.14	+0.30	-0.19	+0.29	+0.50	+0.19	+0.61	+1.00	+0.51	+0.32	+0.17	-0.19
33	-0.40	+0.25	-0.07	-0.11	-0.49	-0.10	+0.35	+0.11	+0.17	-0.37	+0.29	+0.48	+0.34	+0.64	+0.51	+1.00	+0.14	+0.55	+0.11
34	+0.53	+0.52	-0.15	+0.15	+0.57	+0.29	+0.02	-0.29	+0.11	-0.10	+0.48	+0.08	-0.34	+0.36	+0.32	+0.14	+1.00	+0.29	+0.43
35	+0.02	+0.28	+0.12	+0.46	+0.02	+0.13	+0.09	+0.12	+0.40	+0.07	-0.10	+0.19	-0.15	+0.40	+0.17	+0.55	+0.29	+1.00	-0.01
36	-0.19	+0.06	+0.17	+0.04	-0.39	-0.56	+0.04	+0.22	-0.08	+0.19	+0.49	-0.00	+0.31	+0.05	-0.19	+0.14	-0.43	-0.01	+1.00
37	-0.26	-0.13	-0.40	-0.52	-0.38	+0.02	+0.35	-0.14	-0.30	-0.51	-0.31	-0.07	+0.24	+0.17	-0.06	+0.46	+0.30	-0.01	-0.02
38	+0.07	+0.22	-0.24	-0.37	+0.02	+0.29	+0.68	-0.10	+0.16	-0.34	-0.15	-0.10	+0.20	+0.52	+0.28	+0.21	+0.18	-0.06	-0.15
39	-0.15	-0.10	+0.01	-0.22	-0.18	-0.21	+0.12	+0.19	-0.42	-0.09	+0.13	+0.11	+0.19	+0.12	-0.06	+0.34	+0.10	-0.20	+0.36
40	+0.09	+0.28	-0.10	-0.16	+0.12	+0.64	+0.21	-0.20	+0.30	-0.49	-0.16	+0.15	+0.40	-0.52	+0.42	+0.43	+0.23	+0.18	-0.18
41	-0.10	-0.01	-0.19	-0.23	-0.21	+0.16	+0.65	-0.20	+0.11	-0.46	-0.05	-0.09	+0.28	+0.33	+0.02	+0.23	-0.03	-0.06	-0.00
42	-0.20	-0.10	+0.64	+0.52	-0.23	-0.43	-0.15	+0.57	-0.33	+0.39	+0.15	+0.37	+0.43	+0.18	-0.08	+0.26	-0.16	+0.46	+0.43
43	-0.08	+0.10	+0.63	+0.49	-0.08	-0.42	+0.11	+0.25	+0.24	+0.45	+0.70	+0.47	-0.17	+0.28	+0.37	+0.08	-0.23	+0.06	+0.20
44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	-0.04	-0.09	-0.16	-0.20	-0.12	+0.23	+0.19	-0.07	-0.27	-0.00	-0.02	+0.37	+0.03	-0.14	+0.07	+0.00	-0.14	+0.00	+0.43
46	-0.07	-0.05	+0.10	+0.14	-0.06	-0.04	+0.19	-0.07	-0.25	-0.23	+0.10	+0.12	+0.21	+0.23	+0.02	+0.11	+0.10	+0.01	+0.04
47	-0.07	-0.07	-0.16	-0.32	-0.06	+0.33	+0.02	-0.07	-0.25	-0.33	-0.19	-0.44	+0.40	-0.21	+0.04	-0.23	-0.26	-0.18	+0.04
48	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
49	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
51	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
52	+0.01	-0.01	-0.14	-0.05	-0.09	+0.08	+0.08	-0.06	+0.61	-0.07	-0.06	-0.25	-0.24	+0.02	-0.12	+0.12	-0.19	+0.52	+0.09
53	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
54	-0.11	-0.14	-0.06	-0.03	-0.15	+0.08	+0.00	-0.10	+0.54	-0.07	-0.17	-0.15	-0.24	-0.23	-0.17	+0.10	+0.23	+0.45	-0.04

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T A B L E I I I (C O N T I N U A T I O N)

	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
18	-0.26	+0.07	-0.15	+0.09	-0.10	-0.20	-0.08	0.00	-0.04	-0.07	-0.07					+0.01		-0.11
19	-0.13	+0.22	-0.10	+0.28	-0.01	-0.10	+0.10	0.00	-0.09	-0.05	-0.07					-0.01		-0.14
20	-0.40	-0.24	+0.01	-0.10	-0.19	+0.64	+0.63	0.00	-0.16	+0.10	-0.16					-0.14		-0.06
21	-0.52	-0.37	-0.22	-0.16	-0.23	+0.52	+0.49	0.00	-0.29	+0.14	-0.32					-0.05		-0.03
22	-0.33	+0.02	-0.18	+0.12	-0.21	-0.23	-0.08	0.00	-0.12	-0.06	-0.06					-0.09		-0.15
23	+0.02	+0.29	-0.21	+0.64	+0.16	-0.43	-0.12	0.00	-0.23	-0.04	+0.33					+0.08		+0.08
24	+0.36	+0.68	+0.12	+0.21	+0.65	+0.15	+0.11	0.00	+0.19	+0.19	+0.02					+0.08		+0.00
25	-0.14	-0.10	+0.19	-0.20	-0.20	+0.67	+0.25	0.00	-0.07	-0.07	-0.07					+0.06		+0.10
26	-0.30	+0.16	-0.42	+0.30	+0.11	-0.33	+0.24	0.00	-0.27	-0.25	-0.25					+0.61		+0.54
27	-0.51	-0.34	-0.09	-0.49	-0.46	+0.39	+0.45	0.00	-0.00	-0.23	-0.33					-0.07		-0.07
28	-0.31	-0.15	+0.13	-0.16	-0.55	+0.15	+0.70	0.00	+0.00	+0.10	-0.19					-0.06		-0.17
29	-0.07	-0.10	+0.11	+0.15	-0.09	+0.37	+0.47	0.00	-0.02	+0.12	-0.44					-0.25		-0.15
30	+0.24	+0.20	+0.19	+0.40	+0.28	+0.13	-0.17	0.00	+0.37	+0.21	+0.40					-0.24		-0.24
31	+0.17	+0.52	+0.12	-0.58	+0.33	+0.18	+0.28	0.00	+0.03	+0.28	-0.21					+0.02		-0.23
32	-0.06	+0.28	-0.06	+0.42	+0.02	-0.08	+0.37	0.00	-0.14	+0.02	+0.04					-0.12		-0.17
33	+0.46	+0.21	+0.34	+0.43	+0.23	+0.26	+0.08	0.00	+0.07	+0.11	-0.23					+0.10		+0.10
34	+0.30	+0.18	+0.10	+0.23	-0.03	-0.16	-0.23	0.00	+0.00	+0.10	-0.20					-0.19		-0.23
35	-0.01	-0.06	-0.20	+0.18	-0.06	+0.46	-0.06	0.00	-0.14	+0.01	-0.18					+0.52		+0.45
36	-0.02	-0.15	+0.36	-0.18	-0.00	+0.34	+0.20	0.00	+0.43	+0.04	+0.04					+0.09		-0.04
37	+1.00	+0.41	+0.50	+0.31	+0.55	-0.02	-0.46	0.00	+0.39	+0.33	-0.05					-0.01		+0.10
38	+0.41	+1.00	+0.14	+0.56	+0.37	-0.31	-0.04	0.00	+0.35	-0.14	-0.00					+0.11		+0.00
39	+0.50	+0.14	+1.00	+0.14	-0.10	-0.03	-0.05	0.00	+0.47	-0.07	+0.08					-0.43		-0.44
40	+0.31	+0.56	+0.14	+1.00	+0.45	-0.17	-0.07	0.00	+0.15	+0.21	+0.21					+0.07		+0.04
41	+0.55	+0.37	-0.10	+0.45	+1.00	-0.01	+0.00	0.00	+0.02	+0.65	-0.10					+0.14		+0.24
42	-0.02	-0.31	-0.03	-0.17	-0.01	+1.00	+0.15	0.00	+0.15	+0.34	-0.18					+0.02		+0.01
43	-0.46	-0.04	-0.05	-0.07	+0.00	+0.15	+1.00	0.00	-0.21	-0.07	-0.22					-0.14		-0.19
44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	+1.00	0.00	0.00	0.00					0.00		0.00
45	+0.39	+0.35	+0.47	+0.15	+0.02	+0.15	-0.21	0.00	+1.00	-0.03	-0.03					-0.10		-0.10
46	+0.33	-0.14	-0.07	+0.21	+0.65	+0.34	-0.07	0.00	-0.03	+1.00	-0.07					-0.09		-0.11
47	-0.05	-0.00	+0.08	+0.21	-0.10	-0.18	-0.22	0.00	-0.03	-0.07	+1.00					-0.09		-0.11
48																		
49																		
50																		
51																		
52	-0.01	+0.11	-0.43	+0.07	+0.14	+0.02	-0.14	0.00	-0.10	-0.09	-0.09					+1.00		+0.89
53																		
54	+0.10	+0.00	-0.44	+0.04	+0.24	-0.01	-0.19	0.00	-0.10	-0.11	-0.11					+0.89		+1.00

TABLE IV

Correlation Coefficients $r(m, m+1)$ between Adjacent Compartment

COMPARTMENT	r	TOTAL NUMBER OF EARTHQUAKES
18		1
19	+0,52	345
20	-0,05	113
21	+0,87	337
22	+0,31	39
23	+0,42	415
24	+0,37	62
25	-0,21	12
26	-0,34	53
27	-0,09	52
28	+0,32	1134
29	+0,47	528
30	0,00	278
31	+0,23	249
32	+0,61	431
33	+0,51	950
34	+0,14	288
35	+0,29	196
36	-0,01	93
37	-0,02	338
38	+0,41	121
39	+0,14	98
40	+0,14	164
41	+0,45	31
42	-0,01	36
43	+0,15	41
44	0,00	0
45	0,00	2
46	-0,03	1
47	-0,07	1
48	0,00	0
49	0,00	0
50	0,00	0
51	0,00	0
52	0,00	16
53	0,00	0
54	0,00	21

AVERAGE OF r +0,17

Seismic Provinces of Chile

TABLE V

Correlation Coefficient between
Seismic Provinces

	A	B	C	D
A	+1.00	+0.40	+0.02	-0.48
B	+0.40	+1.00	+0.26	-0.19
C	+0.02	+0.26	+1.00	+0.37
D	-0.48	-0.19	+0.37	+1.00

DISCUSSION

C. Tsuboi, University of Tokyo, Japan:

I have been much interested to know that the idea of "earthquake province" which I introduced in 1958 could be applied successfully to Chilean earthquakes also.

The difference which I have seen so far between Chilean and Japanese earthquake provinces is that the former is generally larger than the latter. I do not think this difference is caused by the difference in the compartment width used in these two studies: it is 110km for Chile and is 40km for Japan. I agree with Dr. Lomnitz's opinion that the difference in the average size of an earthquake provinces in Chile and in Japan represents something real.

S. Uyeda, University of Tokyo, Japan:

Your finding shows that the seismic regions in Chile seem definitely larger than those in Japan. Do you think this result is reality or would it be caused by your taking the size of each compartment larger than Prof. Tsuboi's in Japan?

C. Lomnitz:

In the case of Chile we took a compartment about 3 times as large as used by Prof. Tsuboi for Japan. If a tighter mesh size were used one would probably be able to determine several sub-regions within the four provinces defined herein. But the correlation coefficients within these provinces were rather high so I believe they do represent the basic four earthquake provinces in Chile.

D. S. Carder, U.S. Coast & Geodetic Survey, U. S. A.:

Is there any correlation between energy release and the number of shocks reported in the seismic zones that you showed on the first slide?

C. Lomnitz:

The correlation coefficient is a measure of time correlation of seismicity in a region. If the correlation coefficient is high, it means that the level of seismicity will be high or low at the same time within the region, but the actual value of the seismicity is not involved. Negative correlation coefficients indicate that if one zone becomes active the other is less active than normal.