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Seismic Anomalies and the Dynamic Evolution of the Earth's Crust and Upper Mantle

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The seismic activity of the Earth suggests that the crust is in a dynamic condition. A number of major regularities in the seismic energy release in major provinces on the Earth may be explained by the fact that each continent is uniquely dynamic and mobile. The American continent (especially South America) is more inclined to react to changes of external (cosmic) forces, which intensifies its greater mobility. Relative to this point, in the last quarter of the century (1940–1964) three-fourths of all earthquake energy was released when the position of the Moon was over the northern hemisphere of the Earth (at the northern apparent declination of the Moon). This positional relationship pertains to the seismic foci of the northern, as well as the southern hemispheres. Thus the position of the Moon in its orbit is primarily related to the seismicity of the American continent, which released more than 82% of global earthquake energy of magnitude $M \geqslant 8.4$ during the northern lunar declination.

Different degrees of reaction of individual continents to extraterrestrial influences do not agree with the idea of the constancy of the continents. However the mobility of continents, each of which reveals unequal dynamicity, is thought to be a direct consequence of the effect of cosmic forces.

I. Distribution of Strong Earthquakes

The distribution of strongest earthquakes and of their energy for the period of 1903–1956 according to even (2 and 4) and odd (1 and 3) spirals[1] depending on magnitude is shown in Table I. In all three main seismic regions of the world the quantity of the released earthquake energy with the magnitude $M = 7.9$–8.3 in the odd spirals is 350–520% over that shown in the even spirals (Fig. 1).

Earthquakes of magnitude $M \geqslant 8.4$ are approximately similar in the even and odd spirals. Yet one of the significant seismic regions, the western Pacific, does reveal some tendency to a greater total seismicity of the odd spirals and to a lesser total seismicity of the even spirals. The western American region reveals, on the contrary, the inverse tendency—an increase of the seismoactivity of the even spirals (Table I). Thus the western and the eastern borders of the Pacific circle show inverse trends in the release of seismic energy in odd and even spirals.

The western American region comprises 20% by area of the Earth's crust and accounts for 8% of the energy of the strongest earthquakes which originate in the mantle. This area is thus seismically active, even under extraterrestrial conditions of tide-generating forces which are usually unfavorable for triggering earthquakes. This great seismotectonic activity of the American continent indicates a high tendency for mobility.

In addition, in the western Pacific region the energy released by the strongest earthquakes ($M \geqslant 8.4$) is successively decreased from the first spiral (318×10^{23} ergs) to the second (313×10^{23} ergs), to the third (171×10^{23} ergs), to the fourth spiral (100×10^{23} ergs). All the remaining regions of the Earth taken together in this regard behave otherwise and their total seismic

[1] The technique by which the earthquake distribution spiral diagram was prepared is given in Tamrazyan (1968).

TABLE I

DISTRIBUTION OF THE STRONGEST EARTHQUAKES ($M \geqslant 7.9$) AND THEIR ENERGY ACCORDING TO ODD AND EVEN COSMIC SPIRALS OF SEISMIC ACTIVITY (1903–1956)

Regions	Number of earthquakes in spirals		Energy of earthquakes in spirals		Energy of odd spirals relative to even ones (%)
	2 and 4 (even)	1 and 3 (odd)	2 and 4 (even)	1 and 3 (odd)	
	Earthquakes of magnitude $M = 8.4$–8.9				
Western Pacific	8	10	413	488	118
Western America	4	1	266	25	10
Eurasia and the adjacent oceans	4	5	237	221	93
Subtotal	16	16	·916	734	80
	Earthquakes of magnitjde $M = 7.9$–8.3				
Western Pacific	9	59	103	536	520
Western America	4	22	58	203	350
Eurasia and the adjacent oceans	5	14	35	170	486
Subtotal	18	95	196	909	464
Total	34	111	1112	1643	148

energy, on the contrary, is increased successively from the first spiral to the last one (75, 141, 171, and 363×10^{23} ergs). This is clearly seen in Fig. 1.

II. TIDAL STRESSES AS A FUNCTION OF LUNAR DECLINATION

Owing to the inclination of the Earth's equator to the ecliptic (23°27′) various points of the planet change their distance from the ecliptic plane and are under different tidal stresses. This tidal force effect is compounded by consideration of the Moon's declination which changes in culmination (γ) from 18°09′ to 29°45′. Not all regions of the Earth, however, similarly react to changes of lunar declination (Fig. 2). In the northwestern part of the Pacific Ocean (at the Asian-American "join") earthquakes occur less frequently at declinations above the average (>23°27′). Sixty-five percent of the seismic energy in Eurasia occur mostly at a small γ and 35% of seismic energy occur at a large γ.

The effect of γ on earthquake frequency is elucidated most clearly for America. Here most intensive earthquakes occur at small declinations. At γ 23°27′ the seismic energy release was 8 times greater (84%) than at γ 23°27′. The seismoactivity of both Americas reacts differently to the change of declination. North and Central America at γ 23°27′ release 82% of all their seismic energy and only 18% of the energy is released at γ 23°27′. Therefore at small declinations the seismoactivity of the North and Central America was 4.6 times higher than at the declination of higher than average declination.

In the South America the role of declination becomes very considerable. Here at small γ (>23°27′) the quantity of the released energy (93%) increased up to 14 times or more compared to the energy (6–7%) released at great γ.

In general the seismicity of America, primarily South America, is more affected by the variations of declination at the lunar culminations than that of any other continent. The mantle in this region is much more susceptible to the strongest earthquakes at small γ (Fig. 2). The Americas thus indirectly indicate high mobility and a greater tendency to react rapidly with the changes of extraterrestrial

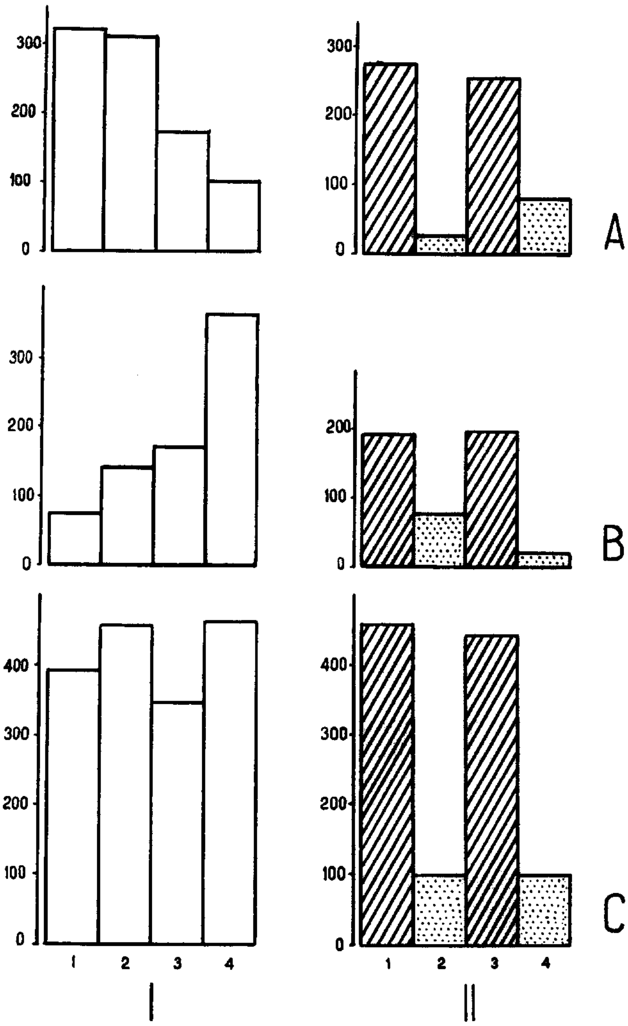

FIG. 1. The distribution of energy of the strongest earthquakes according to spirals of seismic activity (1903–1956): 1, earthquakes of magnitude 8.4–8.9; 2, earthquakes of magnitude 7.9–8.3; 3, energy of earthquakes ($\times 10^{23}$ ergs). 1, 2, 3, and 4 are the numbers of the spirals of seismoactivity. Regions: A, the western Pacific; B, western America (shown by dots); Eurasia and the foci of the Indian and Atlantic Oceans. C, all regions taken together.

forces. The advocates of immobile continents are obliged to explain this special feature of America.

The tendency of large terrestrial land masses to "drift" is suggested not only in the fact that separate continents react differently to the tide-generating forces, but also by the analysis of the relations of the strongest earthquakes with V numbers discussed in the previous paper.

III. INFLUENCE OF V NUMBERS

On the basis of V numbers, active and passive epochs are significant in defining the general distribution of seismoactivity of the Earth during the first half of the 20th century. During these active epochs 84% of the strongest earthquakes ($M \geqslant$ ($M \geqslant 8.4$) and 81% (134×10^{24} ergs) of the seismic energy released by these

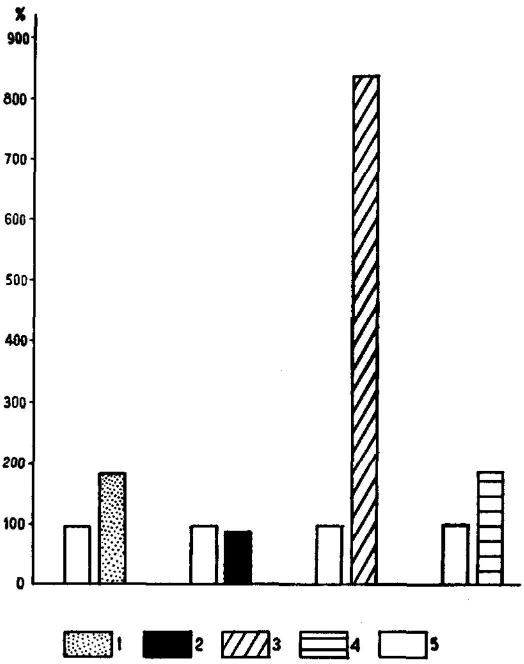

FIG. 2. The energy of strongest earthquakes ($M \geqslant 7.9$) relative to lunar declination (1900–1964). Total energy (in %) of earthquakes given for separate regions: 1, Eurasia and some foci of the oceans (except the Pacific Ocean); 2, the western Pacific region; 3, the American region; 4, the whole planet. The value of declination of the Moon during culmination is less than the value of the obliquity of the Earth's equator to the ecliptic (less than 23°27′) for cases 1, 2, 3, and 4, and is greater than this value for case 5. The earthquake energy of each region in this last case is taken as 100%.

strongest earthquakes occur. During the passive epochs only 16% of the strongest earthquakes and 19% (31×10^{24} ergs) of the seismic energy occurs. The most intense earthquakes ($M = 8.4$–8.9) disclose the clearest association with V numbers. Earthquakes of less magnitude ($M \geqslant 8.3$) are equally frequent in the active and passive stages within the "Old World" (15×10^{23} ergs/year) but somewhat different in frequency in the "New World," where the energy release during active stages was 1.5 times greater (6.7×10^{23} ergs/year) than in passive stage (4×10^{23} ergs/year).

Thus the American continent reacts to change of V numbers not only with regard to the earthquakes of magnitude $M = 8.4$–8.9 but, in contrast to the Eastern hemisphere, with regard to the earthquakes of lesser magnitude $M = 8.0$–8.3, emphasizing a greater tendency to dynamic mobility of North and South America.

IV. Conclusions

(a) The Western and Eastern borders of the Pacific seismic ring reveal inverse tendencies in energy release of the strongest earthquakes ($M \geqslant 8.4$) in their intramonthly distribution as shown by the uneven and even zones of the spiral diagram. The American region is seismoactive even under the least attenuated conditions of extraterrestrial tide-generating forces. These regions of the Pacific are more disposed to react to global tectonic activity during the general time period of perihelion.

(b) The western and eastern boarders of the Pacific seismic ring show inverse trends even in the intradiurnal distribution of the strongest earthquakes.

(c) The northwestern and the southwestern parts of the borders of the Pacific react oppositely to variations in tidal forces related to changes in lunar declination at culmination.

The maximum energy of the strongest earthquakes ($M \geqslant 8.4$ and even $M \geqslant 8.3$) is released preferentially during the northern (positive) apparent declination of the Moon ($d_1\gamma_1$), i.e., when the Moon is over the northern hemisphere of the Earth. During 1940–1964 during the northern lunar declination 80–88% of high magnitude earthquake energy ($M \geqslant 8.3$) was released.

(d) Intermediate earthquakes are related to V numbers, particularly for magnitudes $M = 7.9$–8.9. Normal earthquakes show an association with the V numbers, especially for the most intense ones ($M = 8.4$–8.9) The American continents react to the change of V numbers, not only with regard to earthquakes of magnitude

$M = 8.4$–8.9 but, in contrast to the Eastern Hemisphere, also with regard to the earthquakes of magnitude $M = 8.0$–8.3, suggesting a greater mobility of the "New World."

(e) Specifically, North America and especially South America, often demonstrate a tendency to greater dynamicity and mobility than other regions usually in the Northern Hemisphere. The Americas are more inclined to react quickly to the changes produced by extraterrestrial forces. In general this conclusion applies to the large regions of the Southern Hemisphere and the near-equatorial zones of the South America, the southwestern border of the Pacific Ocean, etc. This reflects the mobile nature of Earth's crust during geological time. This contrast (with certain but different regularities of the seismic energy release of each region) cannot be explained if we assume permanent continental land masses.

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