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THE PRACTICE OF EARTHQUAKE HAZARD ASSESSMENT

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SEISMIC HAZARD IN CUBA

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HISTORY OF EARTHQUAKE HAZARD ASSESSMENT

The first attempt to obtain an earthquake hazard map of Cuba was based on historical-macroseismic data (Alvarez, 1970). Further developments included neotectonic information and quantitative estimations for interplate zones in the southeast (Chuy and Rodriguez, 1980; Chuy et al., 1983). A variant of the most recent map (Figure 1) is included in the seismic building code (NORMA CUBANA, 1985). Quantitative estimations of seismic hazard were first obtained for the nuclear power plant siting in Central Cuba (Alvarez et al., 1983). Estimates for the whole territory were derived using McGuire's (1976) probabilistic algorithms (Rubio, 1985). Alvarez and Bune (1985a) assessed seismic hazard in eastern Cuba using an especially prepared algorithm (Alvarez and Bune, 1985b). A local study for Santiago de Cuba city (Gonzalez and Kogan, 1987) was also performed. A more detailed study of the entire country was later conducted (Figure 2) for seismic zoning purposes (Alvarez et al., 1989a; Alvarez et al., in press), and non-published studies have been completed for important industrial objectives.

BASIC INPUT DATA

Seismicity of Cuba is not uniform. Earthquake catalogues reflect a clear interplate zone (North America-Caribbean) with high activity that affects southeastern Cuba, but the majority of territory is characterized by scarce intraplate seismicity. For intraplate zones, data are practically all macroseismic, while for interplate zones data are both instrumentally and historically macroseismic. A local network of seismic stations has been operating in eastern Cuba since 1979. While there is no information of ground motion parameters behavior during earthquakes in our territory, we have a reach of information about macroseismic effects in Cuba and neighboring islands. Isoseismal maps show a wide regional variability, both in shape and attenuation. From this fact a highly versatile model of elliptical isoseismals was proposed (Alvarez and Chuy, 1985) and successfully used in seismic hazard studies. This model also allowed for magnitude estimations of historical earthquakes with an acceptable degree of accuracy. Seismic source zones, mostly delineated on the basis of seismotectonic studies, have been defined for different regions, beginning for Central Cuba (Belousov et al., 1983) and are summarized by Orbera et al. (1987). A different approach was used for preparing a seismotectonical map 1:1,000,000 scale (Cotilla et al., 1991), and a brief description of Cuban seismotectonics is given by Cotilla and Alvarez (in press).

METHODS AND TECHNIQUES

In recent applications the computer program "SACUDIDA" (Alvarez and Bune, 1985b) is applied and takes a deterministic approach toward determining a shake's recurrence periods (Riznichenko, 1965). These periods, mathematical expectations of time between shocks of like values (Riznichenko, ed., 1979), are used for obtaining earthquake hazard probabilistic estimates with a Poissonian occurrence model. Attenuation is considered in terms of the elliptical isoseismal model previously cited. Instead of classical Soviet shakeability map construction, the method requires the following input data:

A. Seismic source zone map. It can be prepared on the basis of pure seismological considerations, or on geological-tectonical circumstances or both. For each zone M_{max} and depth of occurrence values should be determined.

B. Magnitude-frequency graphics for each zone. Parameters of these graphics may be indirectly obtained from intensity-frequency graphics if desired (Alvarez et al., 1989b).

C. Parameters of isoseismal models for each zone. These parameters concern the shape, geographical orientation and attenuation of isoseismals. Sometimes it may be necessary to generalize for bigger zones due to the lack of information in some seismic source zones.

EARTHQUAKE HAZARD PARAMETERS

Seismic intensity expressed in terms of MSK scale is the commonly used parameter for seismic hazard assessment in Cuba, and in the seismic building code. At the present time, this code is under revision, and for some building projects special maps are requested. Variants of these maps are prepared using deterministic or probabilistic estimates. Most typical are maps of intensities for 100 years' recurrence periods, followed by the maps for 1,000 and 10,000 years and the ones corresponding to intensities with probabilities in exceedence of 0.7 and 0.9 over 20- and 50-year waiting times respectively. Other (ground motion) parameters are considered less reliable since calculations used to derive them are based on attenuation laws not verified in our region.

HAZARD AND ZONING MAPS

A seismic building code map is presented in Figure 1 based on the intensity map prepared by Chuy et al. (1983). An exceedence probability map (Alvarez et al., in press) is shown in Figure 2.

FUTURE PLANS AND COMMENTS

At present, there are two main directions of investigations. The first concerns the preparation of high quality seismic source zone maps combining all geological-tectonical and seismotectonical methods, seismostatistical procedures of M_{max} estimation and pattern recognition techniques. The second is devoted to modeling seismicity of less active intraplate zones, for which current models, developed for high seismicity zones, seem to be non-applicable.

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ORGANIZATIONS

- Academy of Sciences, Centro Nacional de Investigaciones Sismológicas, Calle 17 No. 61 e/ 4 y 6, Rpto. Vista Alegre, Santiago de Cuba.
- Subcomité de Normas Antisísmicas, Comité de Normas para la Construcción of the Ministry of Building, Empresa de Proyectos No. 15, Calle 7 esq., 8, Rpto. Vista Alegra, Santiago de Cuba.

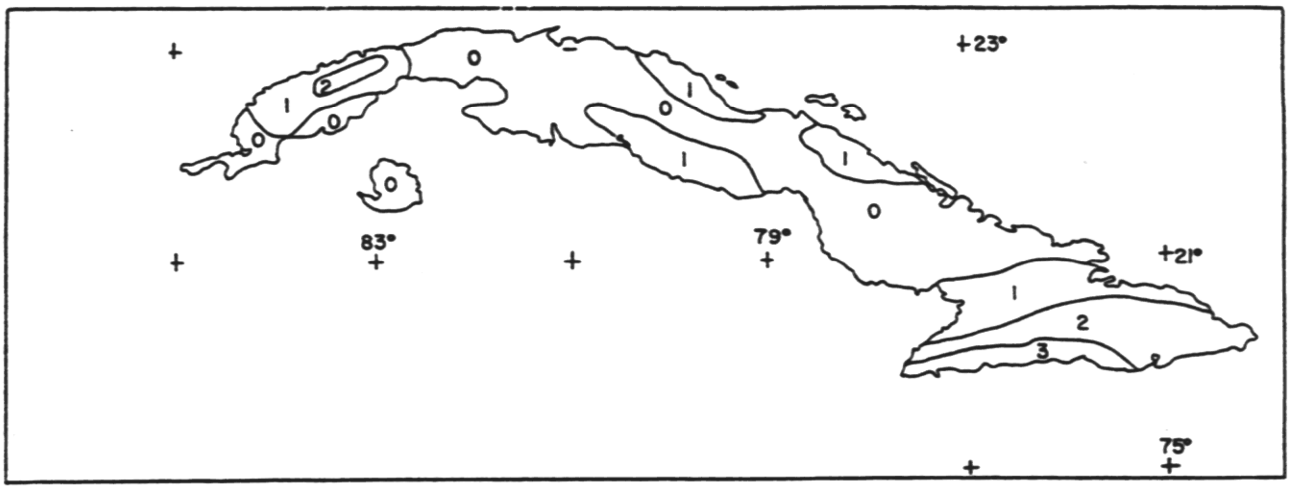

Figure 1: Seismic zones for seismic building code NC-53-114.
O-I < VI, 1 - I = VI, 2- I = VII, 3 - I = VIII.

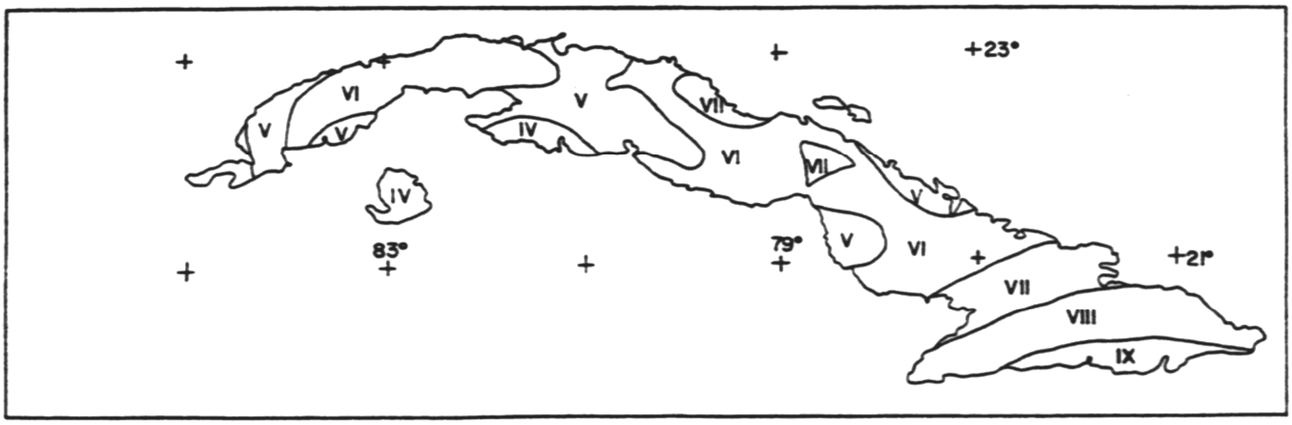

Figure 2: Intensities that cannot be reached or exceeded in a waiting time of 50 years with a probability level of 0.9.