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Seismic hazard analysis for central-western Argentina

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ABSTRACT

In this study, we present a PSHA (Probabilistic Seismic Hazard Analysis) for the city of San Juan, which is located in the central-western region of Argentina (30°S–35.5°S; 66.5°W–71°W). In addition to crustal earthquakes provided by catalogues, recent paleoseismological and neotectonic investigations have permitted to consider events which occurred during the last 400 years.

Four seismogenic sources that could cause damages to the studied site corresponding to Precordillera, Western Sierras Pampeanas, Basement of the Cuyana Basin and Cordillera Principal were identified. Based on the evaluation of the contribution of these sources, maximum moment magnitudes above 7.5 (*M*w) are expected.

High values of SA (spectral acceleration) (0.2 and 1 s periods) and PGA (peak ground acceleration) were found in the city of San Juan, which suggests that it is located in a zone of high seismic hazard.

Finally, the obtained SA spectra were compared with the seismic-resistant construction standards of Argentina INPRES-CIRSOC 103 [1]. Results suggest that for the city of San Juan and for a return period of 475 years, it covers the seismic requirements of the structures.

1. Introduction

The city of San Juan is located at 31.5°S and 68.5°W (central-western region of Argentina). It has an area of 30 km^2 and a population density of 3759.3 pop/km^2 (National Census 2010). In this area significant seismic activity has been observed within the continental crust (South American Plate) for shallow earthquakes at depths less than 35 km, and within the subducted plate (Nazca Plate) with depths ranging from 100 to 300 km. Comparatively, shallow earthquakes (≤35 km) have been responsible for the greatest natural disasters in the history of Argentina and are associated with the geological structures of Precordillera, western Sierras Pampeanas and the interaction between both in the north of the Mendoza Province (Fig. 1). As an example we can mention the earthquakes that occurred in San Juan in 1894, 1944, 1952 and 1977 and those that occurred in Mendoza in 1861 and 1985. These events caused great destruction and casualties that in some cases were counted by hundreds. For this reason, the region under investigation is recognized as the area exposed to the greatest occurrence of earthquakes, with some of them of great magnitude [2,3] possibly related to the type of crustal structure and the geometry of the Nazca plate that subducts horizontally under South America [4]. In this sense it becomes essential to analyze the seismic hazards in the area.

2. Preparation of the earthquakes catalog

A catalog of seismic parameters was compiled with data from the Centro Regional de Sismología para América Del Sur CERESIS until 1981 [7] and, after that and until July 2016 with data from the National Earthquake Information Centre NEIC [8]. Table 1 summarizes the primary sources of information used in the compilation of the instrumental part of the catalog.

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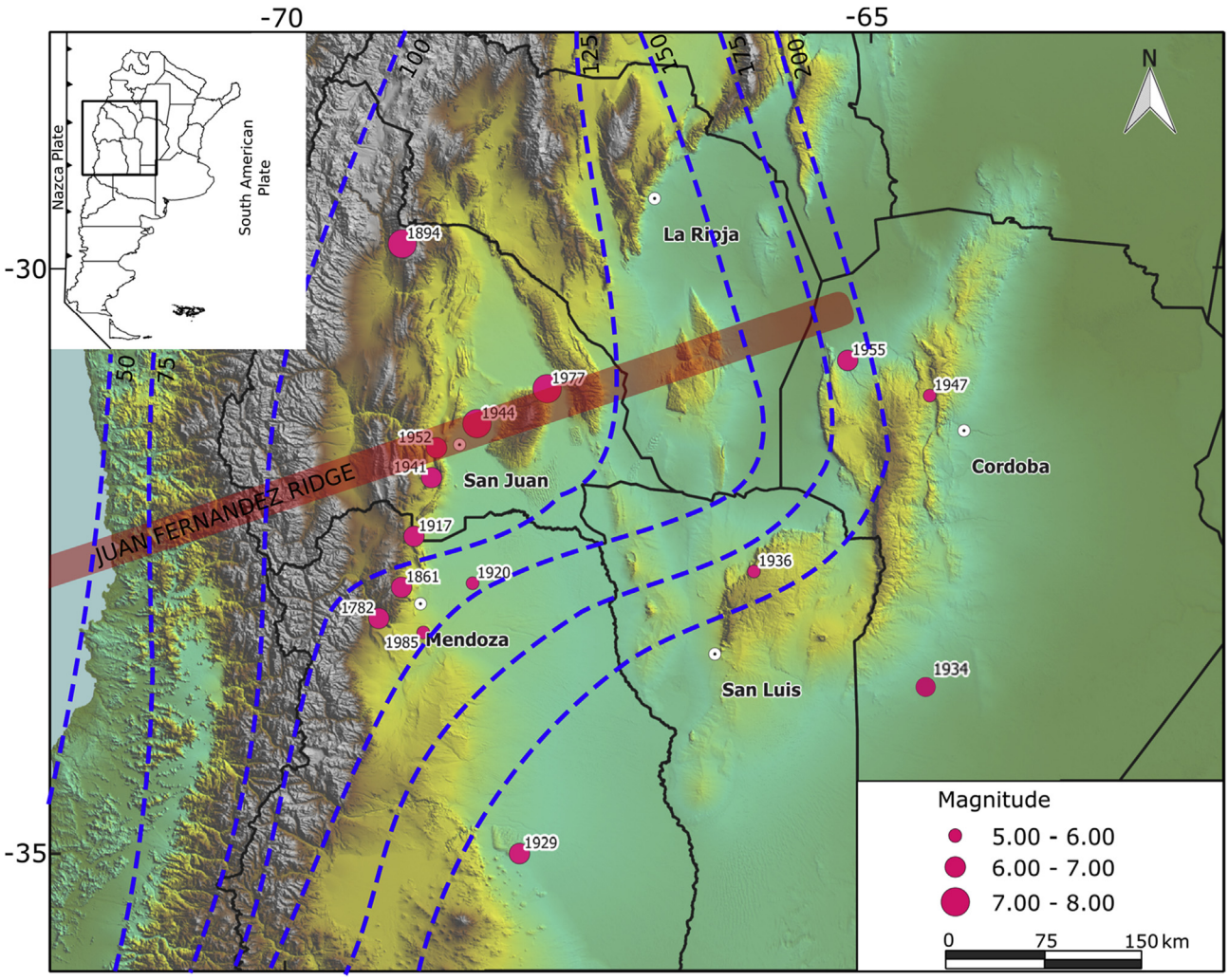

Fig. 1. Epicentral distribution of historical earthquakes in the central-western region of Argentina. The range of magnitudes reported by INPRES (ML) are indicated in the box. Blue dashed lines represent the Crustal and Upper Mantle Structure in the Flat Slab Region of Central Chile and Argentina (Modified from Refs. [5,6]).

Table 1
Main sources of information used in the catalog taken from Ref. [7].

Time interval	Source
1906–1917	G-R
1918–1932	G-R + ISS
1933–1950	G-R + ISS + USCGS
1951–1960	ISC + USCGS + BCI
1961–1963	ISC + USCGS
1964–1973	USCGS + ISC + USGS
1974–1981	ISC + USGS
1982–2016	USGS

G-R: Gutenberg and Richter; ISS: International Seismological Summary; USCGS: United States Coast and Geodetic Survey; BCI: Bureau Central International de Seismologie; ISC: International Seismological Centre; USGS: U. S. Geological Survey - NEIC.

3. Identification of the main seismic sources and seismotectonic regionalization

To evaluate the seismic hazard in a region, it is necessary to subdivide it into a system of geological subregions that are seismically homogeneous and also called seismic sources. This means that the parameters of the Gutenberg and Richter relationship remain fixed to the occurrence of earthquakes and can be attributed to the tectonic characteristics of that subregion. Such subdivision is called seismotectonic regionalization.

3.1. Regional morphostructural units

The area under study forms a part of the Andean retroarc as a consequence of the east-west compression generated by the subduction of the Nazca plate under the South American plate. GPS studies indicate a relative movement velocity of 63–79 mm/year [9].

From the analysis of the crustal seismic activity associated with the morphostructural units and neotectonic studies, four seismotectonic subregions or seismic sources have been selected in this work (Fig. 2 and Table 2).

4. Conversion of magnitudes – elimination of aftershocks

Prior to the elimination of the aftershocks, all catalog magnitudes were converted to moment magnitude scale through the multipath process proposed by Scordilis [10]. This procedure uses globally valid empirical relationships that allow the conversion of magnitudes expressed in different scales to moment magnitude

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