

SEISMOGENIC SOURCES AND REGIONAL TECTONIC STRESSES IN THE SUBANDEAN ZONE OF MAJOR SEISMIC HAZARD OF ARGENTINA.

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RESUMEN: Se analizan las fuentes sismogénicas y su relación con los esfuerzos tectónicos regionales en la zona centro-oeste de la Argentina, desde los 66° W hasta el límite con Chile y desde los 28° S hasta los 33° S, que corresponde al área de mayor peligro sísmico de este país. Es ésta una de las zonas andinas donde la Placa de Nazca subduce en forma horizontal debajo de la Placa Sudamericana. En dicha zona se grafican los mecanismos focales de buena resolución, correspondientes a sismos superficiales modelados con ondas internas, observándose que todos son de tipo compresivo. También se muestran las fallas activas, predominantemente inversas, así como los principales terremotos históricos asociados a ellas. Los ejes de presión de los eventos considerados varían su orientación azimutal, entre 65° y 115°, lo que corresponde a un esfuerzo tectónico regional promedio de este-oeste, coincidente con la orientación general del fallamiento.

KEY WORDS: Seismogenic sources, tectonic stresses, focal mechanisms.

INTRODUCTION

The central west part of Argentina is the region with major seismic hazard of this country. Evidences of such hazard are given by historical destructive earthquakes and active faulting. Four historical earthquakes arises over the rest, due to their particular characteristics: (a) the March 20, 1861 earthquake which destroyed the old city of Mendoza, killing 6,000 people over a population of 18,000; (b) the October 27, 1894 earthquake with estimated magnitude $M_s \geq 7.5$, was felt in an area of more than three million square kilometers and produced extensive liquefaction; (c) the January 15, 1944 earthquake which produced heavy damage to the city of San Juan, killing 10,000 people over a population of 90,000, and (d) the November 23, 1977 earthquake ($M_s = 7.4$) that killed 65 people in the small city of Caucete and, as it happen with the 1894 earthquake, produced extensive liquefaction in the same area.

In this region, the main populated centers at risk are the cities of Mendoza and San Juan, with 700,000 and 350,000 inhabitants respectively, and also the cultivated areas and the basic infrastructure, mainly irrigation channels and roads.

Active faults, with observed surface displacements during Holocene time, are present all over the region, some of them bordering or even crossing through the populated areas.

REGIONAL SEISMOTECTONIC SETTING

The region under study is located in a tectonic setting resulting from the ongoing subduction of the Nazca plate eastward beneath the South American plate. This process has created such major structural features as the complex of faulted, folded and uplifted basement rocks called the

Andes and the linear zone of volcanoes occurring within much of the Andes. These features continue to the east with the Precordillera and, finally, the Pampean Ranges. The major tectonic changes along the east side of the Andes are related to the change in orientation of the subducted Nazca plate as it passes east of the axis of the Andes. It changes dip between 28° S and 33° S to a near horizontal orientation (figure 1), and then rapidly resumes a steep eastward dip. The region overlying the sub-horizontal Nazca plate also demarks a gap in the volcanic chain.

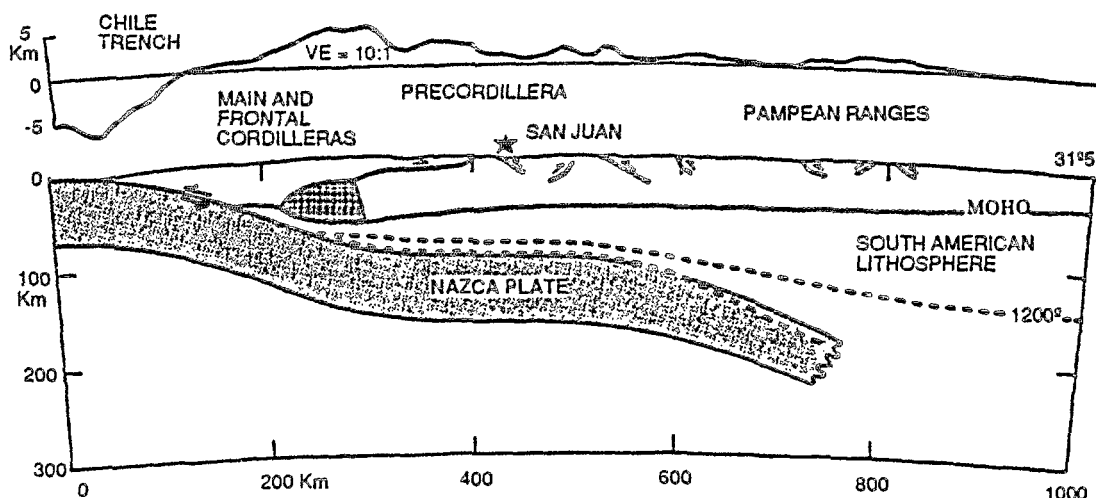


Figure 1: Vertical cross section in the area under study.

In brief, the regional geologic and tectonic setting of this region is characterized by east-west compression. The South American plate is actively deformed along its broad western margin, resulting in active geologic structures, some of which are seismic sources in and around the area under study, mainly thrust faults with generally north-south trending.

SEISMOGENIC SOURCES

Based upon geologic and seismologic studies undertaken in the region, two types of seismogenic sources were identified: (1) active faults and (2) seismic volumes.

Active faults were considered of great importance to this investigation for two primary reasons: (a) they have been and probably will be sources of damaging earthquakes, and (2) they are potential sources of surface rupture. To study them, the methodology used involved the following steps: literature review, aerial reconnaissance using low sun angle techniques, ground reconnaissance, topographic profiling and trenching. As a result of this study fifteen active faults or fault systems were located and characterized (figure 2), some of them directly related with the historical destructive earthquakes described in the Introduction.

The most important volume of seismic activity affecting this region is the Benioff zone, with an average depth of 100 Km. The April 14, 1927 earthquake, with magnitude $M_s = 7.1$ and depth $H = 110$ Km, which produced damages to Mendoza city (Argentina) and Santiago (Chile), is a sample of the potentiality of this seismic source.

FOCAL MECHANISMS

The state of tectonic stresses resulting from the analysis of observables evidences was confirmed by fault plane solutions of the earthquakes which occurred in the region. Eight seismic events were studied. Only very reliable solutions were considered, which were obtained mainly by modeling body waves of earthquakes with magnitude $m_b \geq 5.3$.

These solutions, which are presented in figure 2, show that the pressure axis of all the events have a variable azimuthal orientation between 65° and 115° . This result could be interpreted as an average regional tectonic stress regime directed east to west (90°), coinciding with the

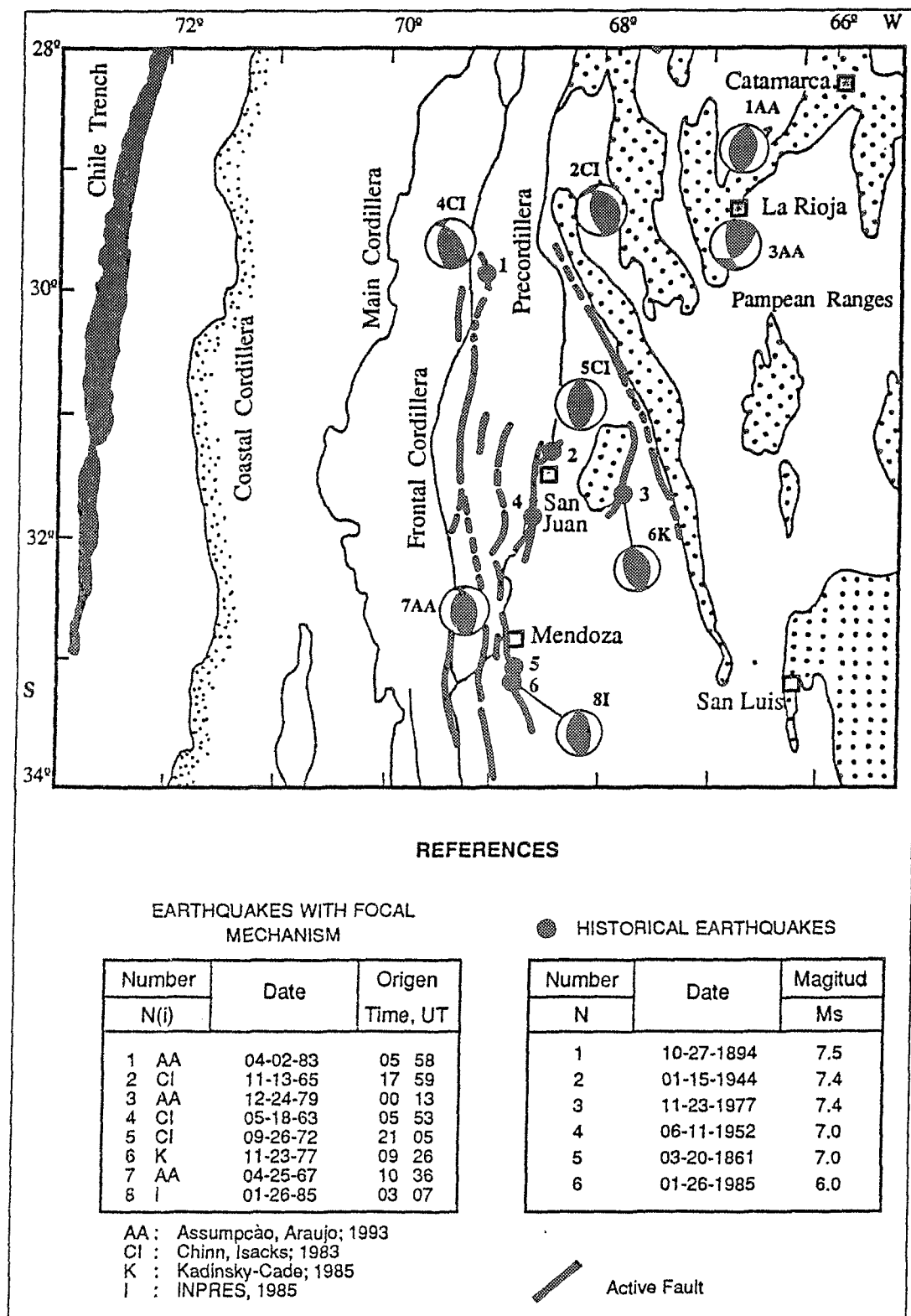


Figure 2: Active faults, historical earthquakes and focal mechanisms.

general orientation of fault movement, with localized deformations from this average in certain areas, due to concentrated local stresses.

CONCLUSIONS

The main characteristics of the clear evidences of active faulting observed in the subandean zone of major seismic hazard of Argentina, agree with the results obtained from the analysis of focal mechanisms of important earthquakes which occurred in the region.

This is in accordance with the tectonic setting of this particular portion of the Andes, where the ongoing subduction of the Nazca plate eastward beneath the South American plate, with near horizontal orientation, gives place to an east-west compression frame, where important intraplate earthquakes occur and where no volcanic activity is present.

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