Incorporating geologic data into the calculation of the seismic hazard: an example of Central Mexico

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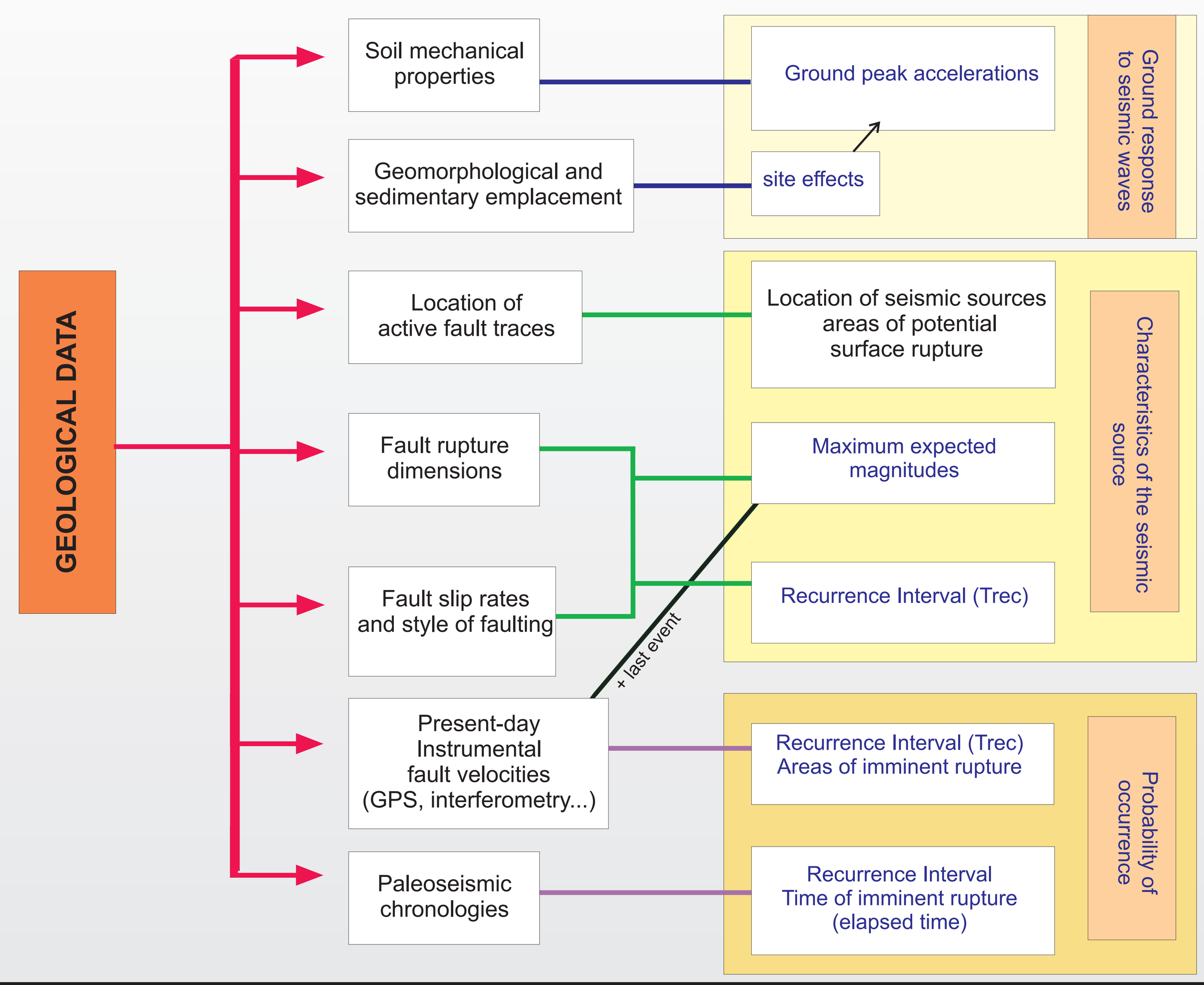
1. INTRODUCTION

One of the main challenges for the community working on seismic risk reduction is the incorporation of the geologic data into the seismic hazard parameters, such as probabilistic data or recurrence contour maps. In the last decades, the number of studies that focus on acquiring geologic data to characterise seismogenic faults has increased dramatically. However, the seismic hazard maps still are confectioned in most countries just by considering the historical and instrumental seismicity. In this work, we propose a procedure to calculate several seismic hazard parameters, such as the poissonean probability of occurrence and the average recurrence time of a damaging earthquake for a given area, by taking into account the number of potentially damaging neighbouring seismogenic faults, their average recurrence period and its uncertainty.

To illustrate the use of this program, we choose Atlacomulco, which is a mainly industrial town of near 80,000 inhabitants, located ~ 40 km NW of Mexico city. This town is in the easternmost part of the Acambay Graben (Central part of the TransmexicanVolcanic belt), one of the few tectonic regions of Mexico for which paleoseismological data are available.

2. GEOLOGICAL DATA MOST COMMONLY USED IN SEISMIC HAZARD PLANS



To the date, the available programs for the calculation of seismic hazard assume some of these parameters and employ them in the probabilistic calculations, but they do not allow to freely modify them.

3. CALCULATING OF THE PROBABILITY OF OCURRENCE

INPUT DATA:

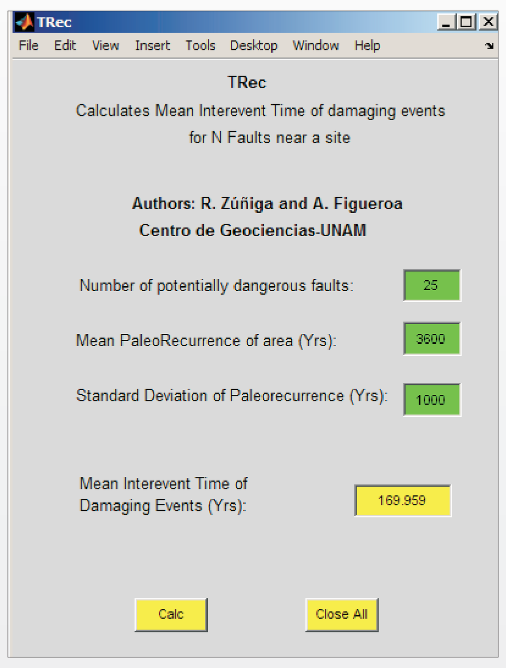
1) Number of seismogenic faults sufficiently close as to produce damage

2) Mean recurrence period of these faults and standar deviation of this value

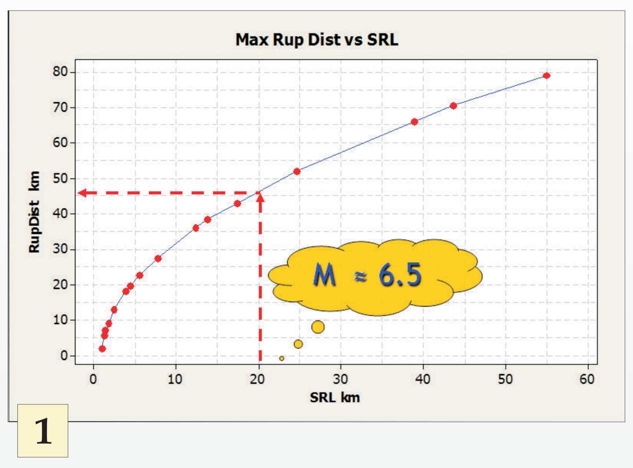
OUTPUT DATA:

1) Probability of occurrence of a damaging earthquake in the next 50 years (in %)

2) Mean recurrence of the occurrence of a damaging earthquake affecting the studied area



TREC CODE:
We implemented a mathematical code (Trec) written in Matlab® programming language and allows us to calculate the probability of occurrence of one or more seismic events that could cause damage to the population 1) for a given geographical site (i.e., an urban area or a given geographical site (i.e., an urban area or a town) and 2) for a given time spam.



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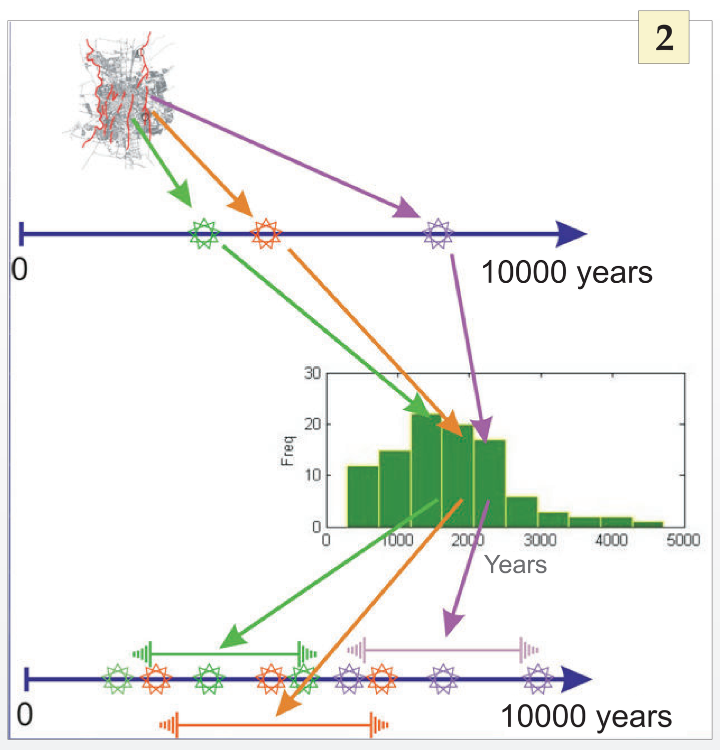
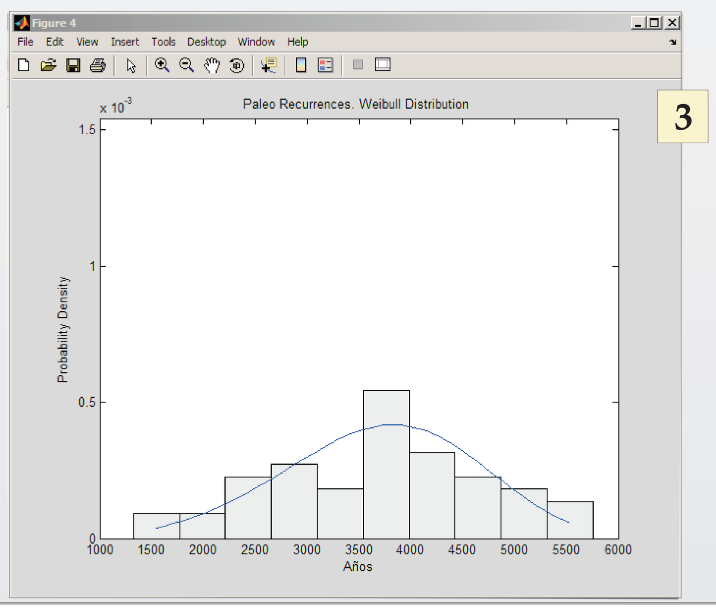
*To select the faults which pose a hazard for a given locality, an empirical relationship between the horizontal distance to the trace and the length of the fault trace is obtained by taking into account attenuation laws for continental earthquakes (**1**). Then, the recurrence time of these faults, derived from paleoseismological studies and/or geological and geomorphological studies is considered to obtain the mean recurrence time and the recurrence standard deviation for the selected group of faults. With these values, a sequence of occurrences of seismic events is generated for variable time periods using a Weibull distribution and iterating in a Monte Carlo fashion in order to produce a sequence of 500,000 years or more (**2** and **3**). The mean interevent time is then used to estimate the probability of one or more damaging earthquakes in the next 50 years (**4**).*





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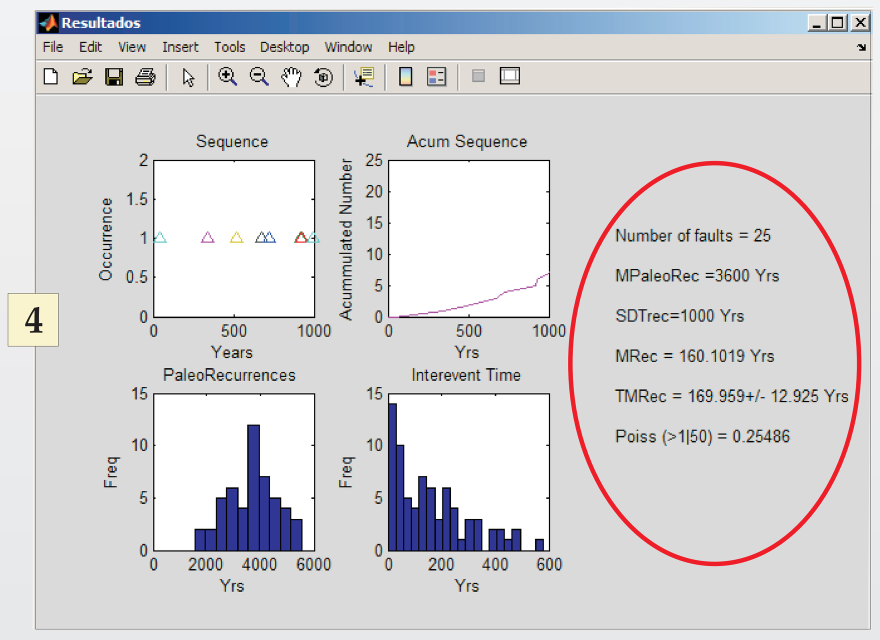

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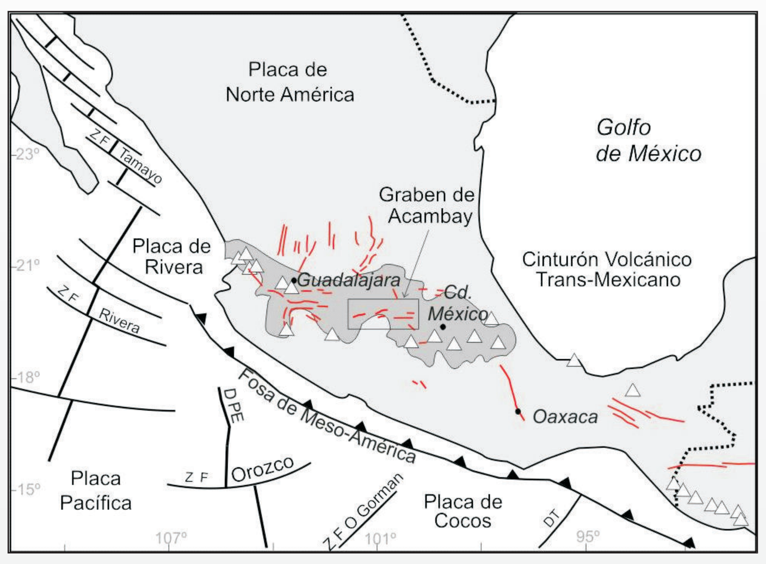
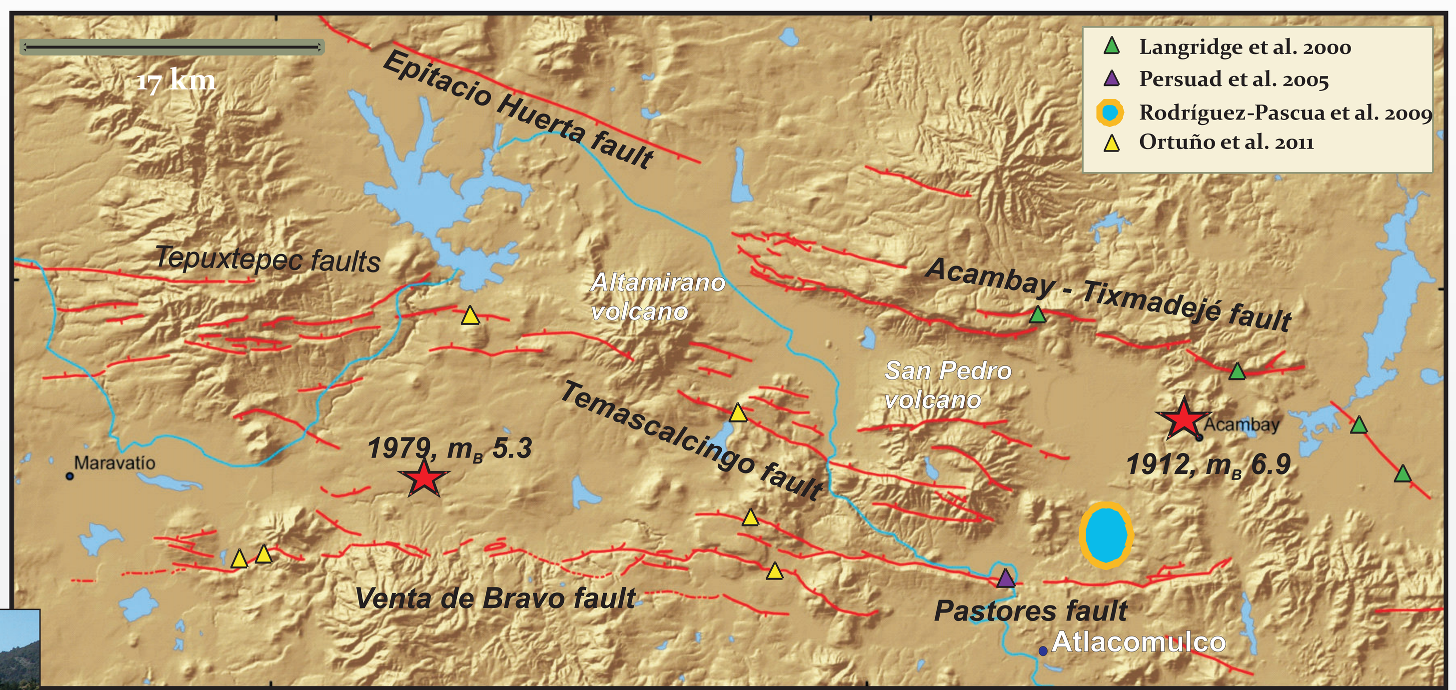
Geological data recently acquired for the seismogenic faults in Central Mexico and data from Langride et al. (2000) are used to illustrate this statistical calculation.

4. APLICATION CASE: the Acambay Graben (Central TransMexican Volcanic Belt)





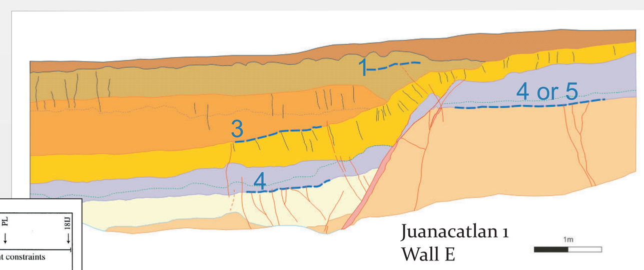
1) Historical damaging seismicity:

1912, Acambay earthquake (mB 6.9, November 19) on the Acambay-Tixmadejé Fault *(Urbina & Camacho, 1913; Langridge et al. 2000)*

1979, Maravatio earthquake (mB 5.3, February 22) Possibly on the Venta de Bravo fault *(Astíz Delgado 1980; Suter et al. 1992)*

2) Paleoseismology: Paleo-earthquake chronologies available:
- Acambay-Tixmadejé fault
- Pastores Fault

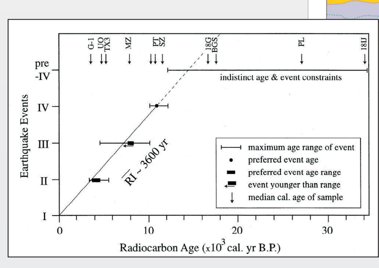
"coming soon":
- Venta de Bravo fault
- Temascalcingo fault
- Tepuxtepec fault



3) Tectonic Geomorphology
Other potentially damaging faults
Faults in the Tepuxtepec system
Internal faults of the graben

Fault	Maximum height(m)	Trace Lenght (km)	M_w (Villamor et al., 2001)	TRec(ka) S Rate = 0,17 mm/a
Acambay	400	35	6.8	~~9.1~~ 3.6
Venta de Bravo	400	50.6	7.0	13.1
Pastores	200	20	6.4	5.2
Temascalcingo	70	18.3	6.4	4.8
Tepuxtepec	70 -40	6.9	5.7	1.4

Trec ellapsed time



3) Aplication of TREC code

Total of potentially seismogenic faults= 11 – 15
Mean recurrence time (MRec) = 3600 ka

(15 faults, MRec= 500)
Poiss (1>50) = 0.19
TMRec= 243 +/- 24
MRec = 3647

(11 faults, MRec= 1000)
Poiss (1>50) = 0.14
TMRec= 331 +/- 30
MRec = 3617

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