



# JEM446

## ŞEHİR PLANLAMASINDA JEOLojİ

Ders Notları 10.Hafta  
Depremsellik

Dr. Koray ULAMIŞ

Ankara

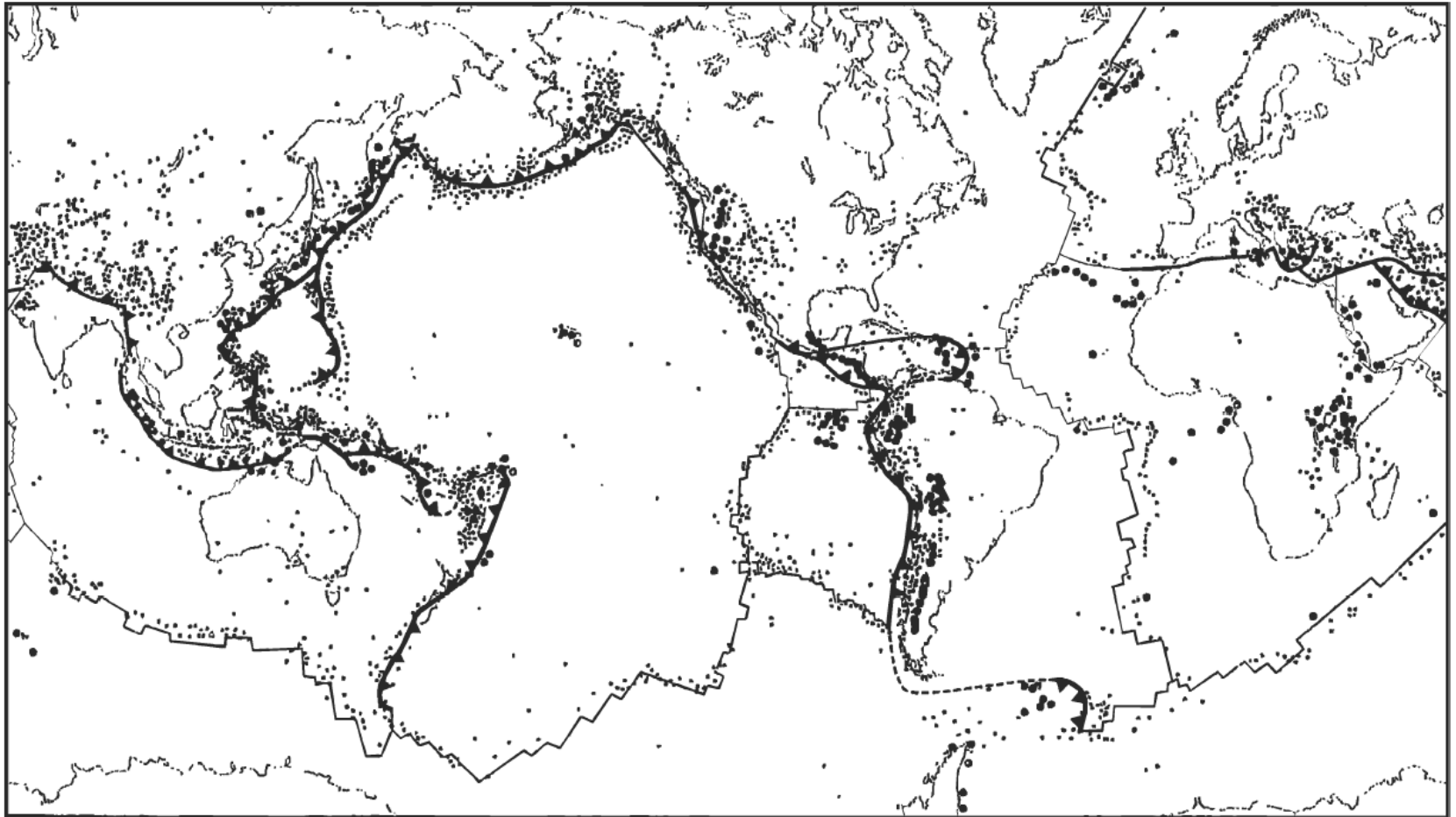
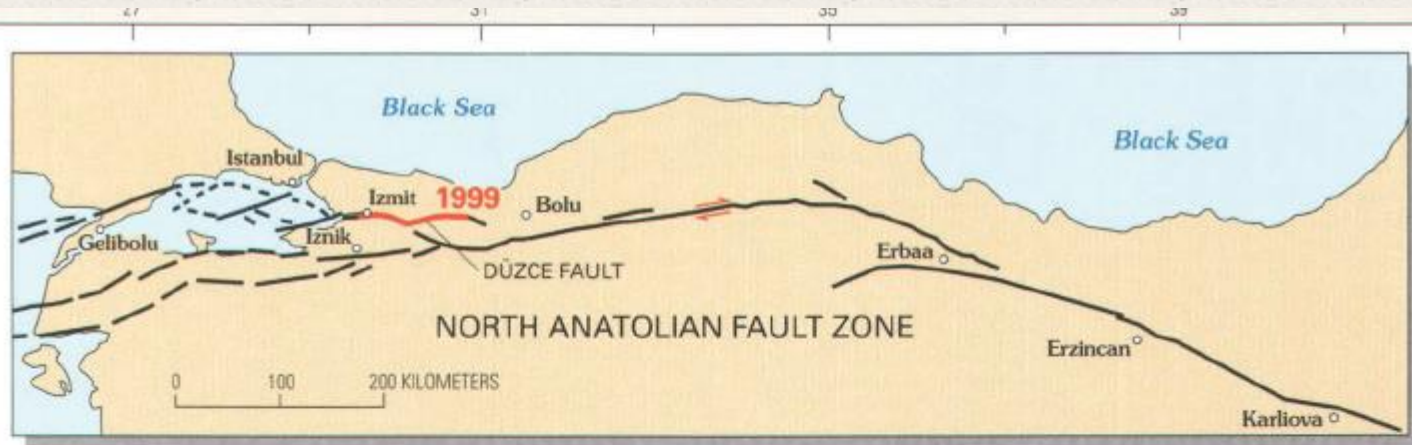


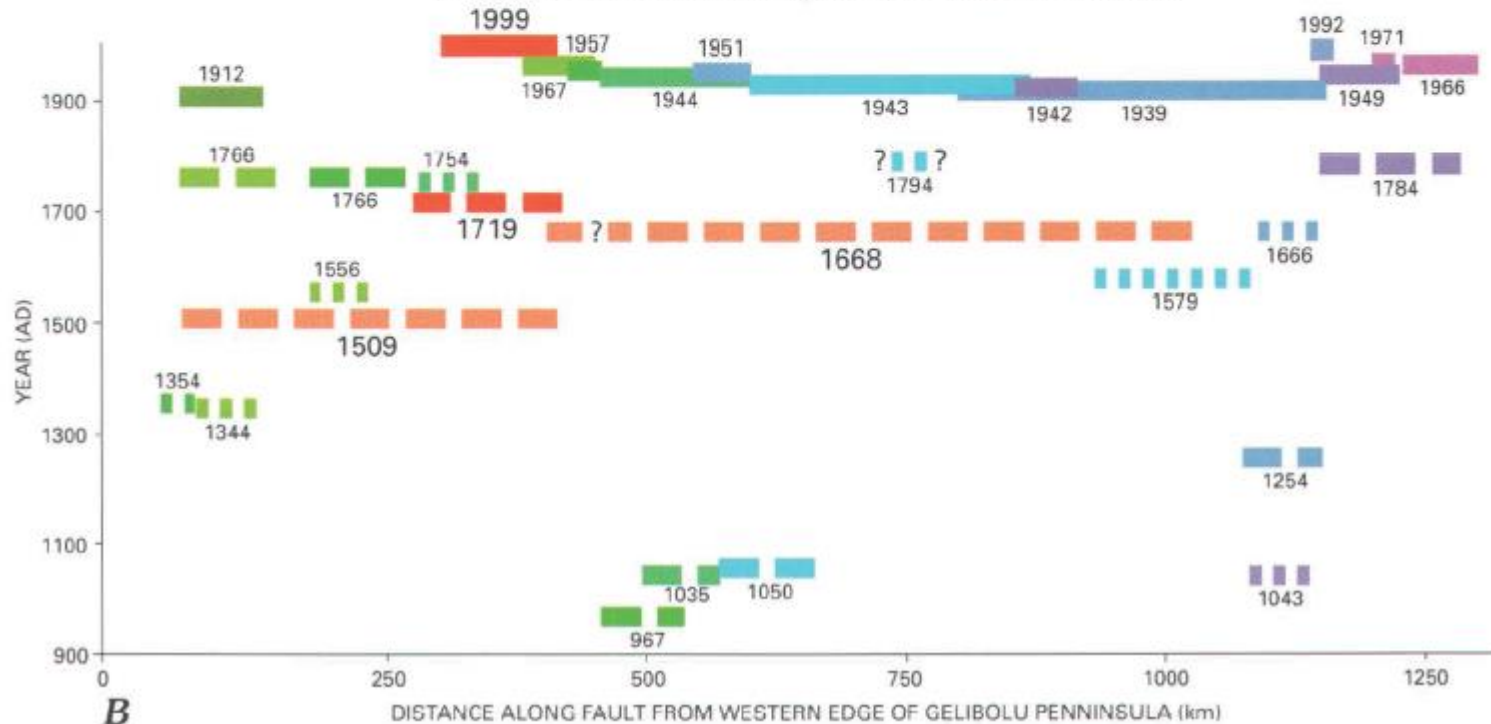
FIGURE 2.2 The major tectonic plate margins (heavy lines) and sample of most active seismic areas (heavy and light dots). Subduction zones marked with triangles (down dip).

# Kuzey Anadolu Fay Zonu



A

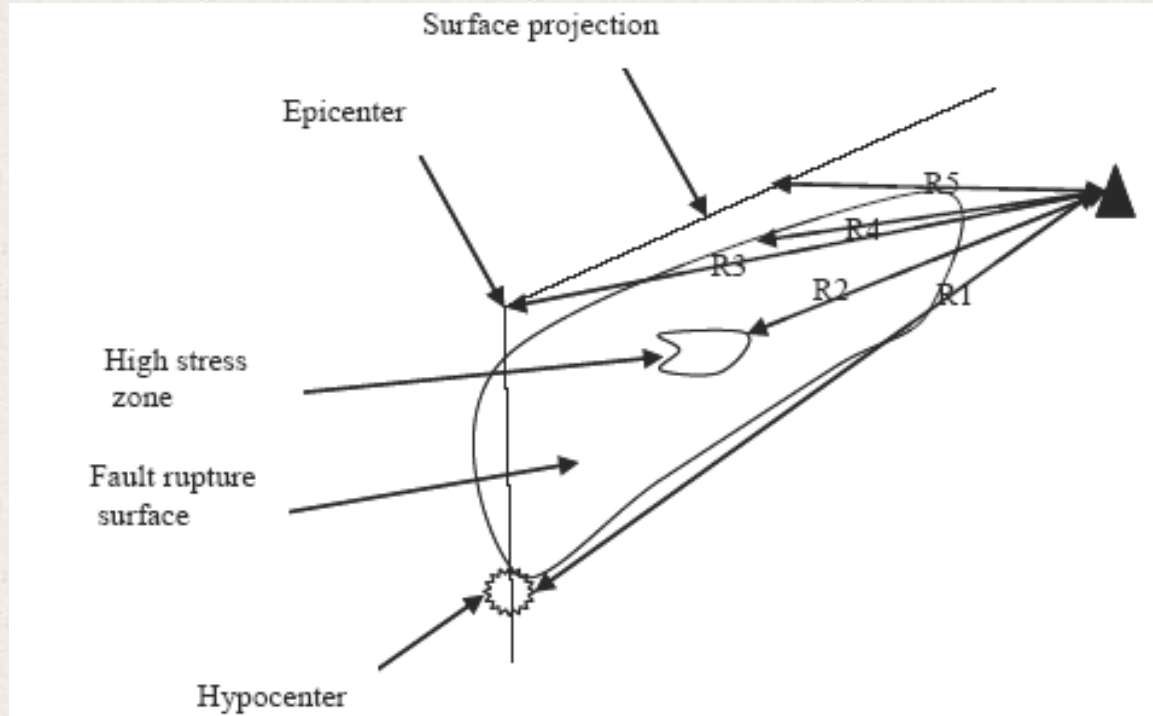
## Historic Earthquakes Along the North Anatolian Fault

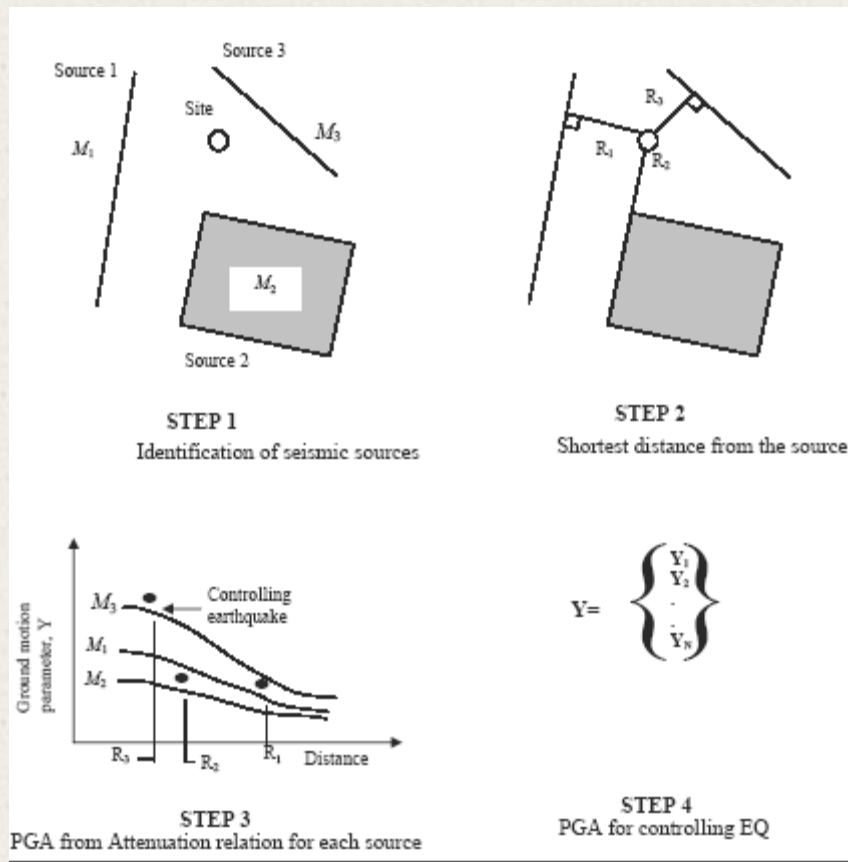


B

## Deprem ve Fay Karakteristikleri

- ☐ Fay kırılma geometrisi
- ☐ Segmentli veya tekil fayın kırılması (Farklı enerji miktarı oluşması)
- ☐ Kırılan fayın etki alanı ve sakinim bandı genişliği
- ☐ Fay doğrultusu
- ☐ Fay türü
- ☐ Proje alanının fay odak noktasına uzaklığı
- ☐ Yüzey projeksiyonu
- ☐ Lokal jeoloji





## Deterministik Sismik Tehlike Analizi

Proje alanı yakınındaki sismik kaynakların belirlenmesi

Alan en yakın mesafe

Her kaynaktaki pik ivmenin azalım ilişkileri ile ilgili alana uygulanması



# Deprem Büyüklük Ölçekleri

## Lokal Manyitüd ( $M_L$ )

Richter ölçeği olarak da adlandırılan ölçek sığ ve yerel depremler için 1935'de önerilmiştir.

$$M_L = \log A - \log A_0 = \log A / A_0$$

En büyük genlik (mm). Genliğin ölçüldüğü sismografta doğal salınım periyodu 0.8 s, sönüm oranı %80 ve standard ölçekleme 2800'dür.

$A_0$ : 0.001 mm.

## Yüzey Dalgası Manyitüdü ( $M_s$ )

Yüzeyde hareket eden ve periyodu 20s olan dalga genliği için önerilmiştir (Gutenberg, Richter 1956). Lokal manyitüde göre avantajı, en büyük deplasmana göre hesaplanmasıdır.

$$M_s = \log A' + 1.66 \log \Delta + 2.0$$

$A'$ : En büyük deplasman,  $\mu m$

$\Delta$ : Sismograf ile episentr arası mesafe

## **Moment Manyitüdü ( $M_w$ )**

Büyük depremlerin büyüklüklerinin belirlenmesinde tercih edilen büyüklüktür.

En önemli avantajı, tüm deprem kaydının hesaba katılabilmesidir.

İlk olarak sismik manyitüd ( $M_0$ ) hesaplanmalıdır (Idriss, 1985).

$$M_0 = \mu A_f D$$

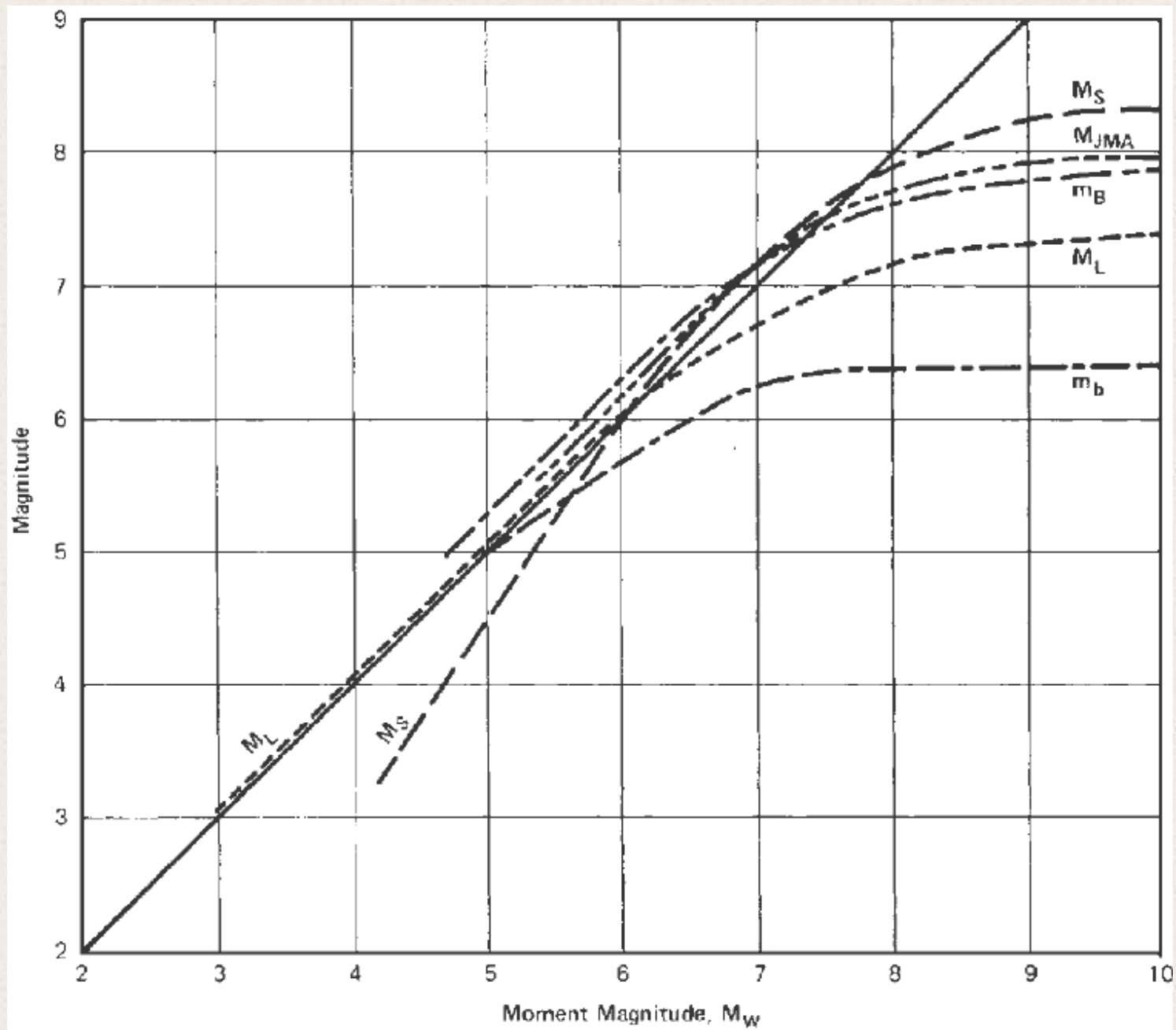
$M_0$ : Sismik moment (N.m)

$\mu$ : Fay düzlemindeki malzemenin makaslama modülü (N/m<sup>2</sup>). Kabuk için ortalama  $3 \times 10^{10}$  N/m<sup>2</sup>, manto için  $7 \times 10^{12}$  N/m<sup>2</sup>.

$A_f$ : Hareket eden fayın alanı (m<sup>2</sup>).

$D$ : Fayın tamamı veya kırılan segment üzerindeki deplasman (m)

$$M_w = -6.0 + 0.67 \log M_0 \text{ (Hanks and Kanamori, 1979; Kanamori, 1977)}$$

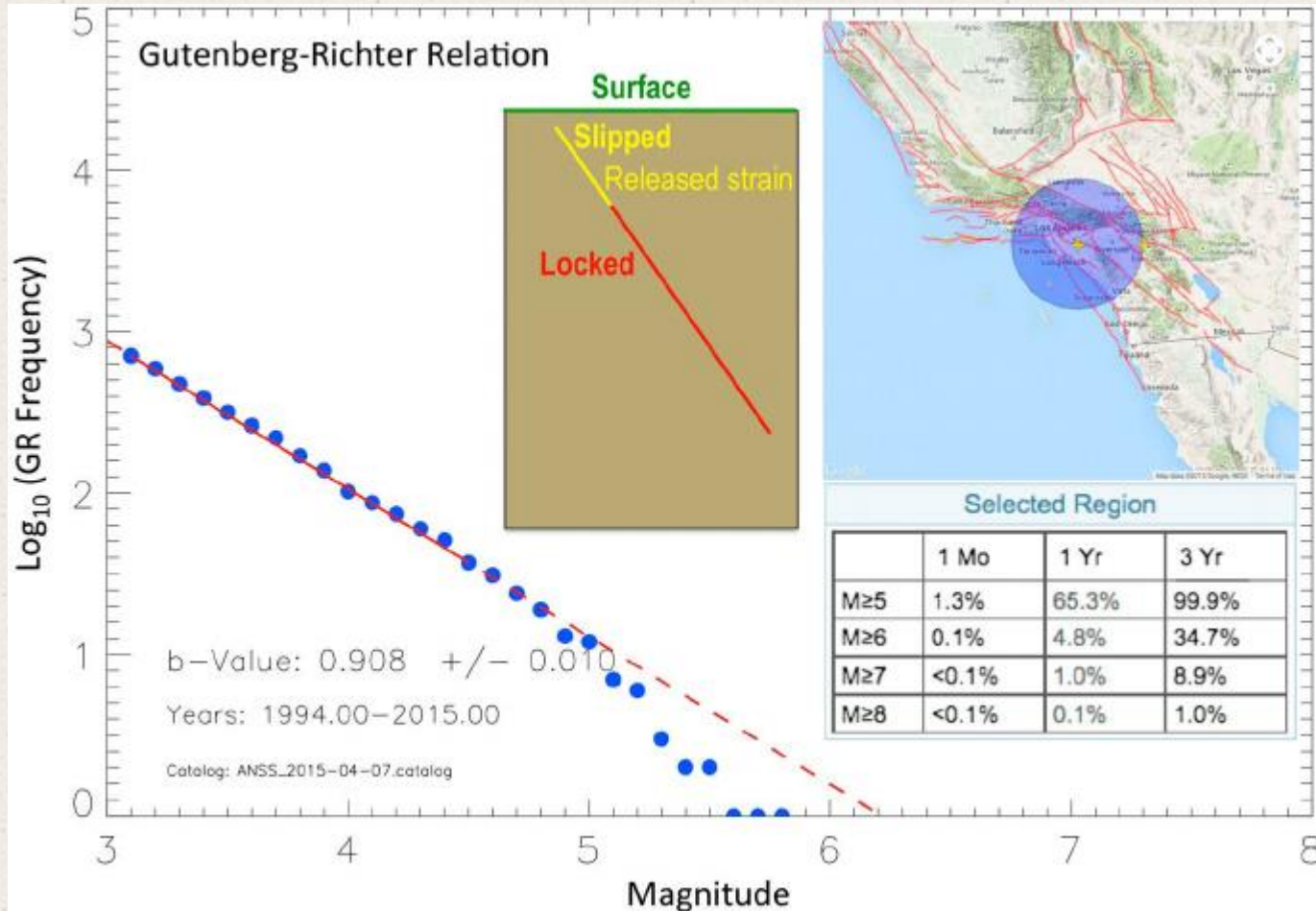




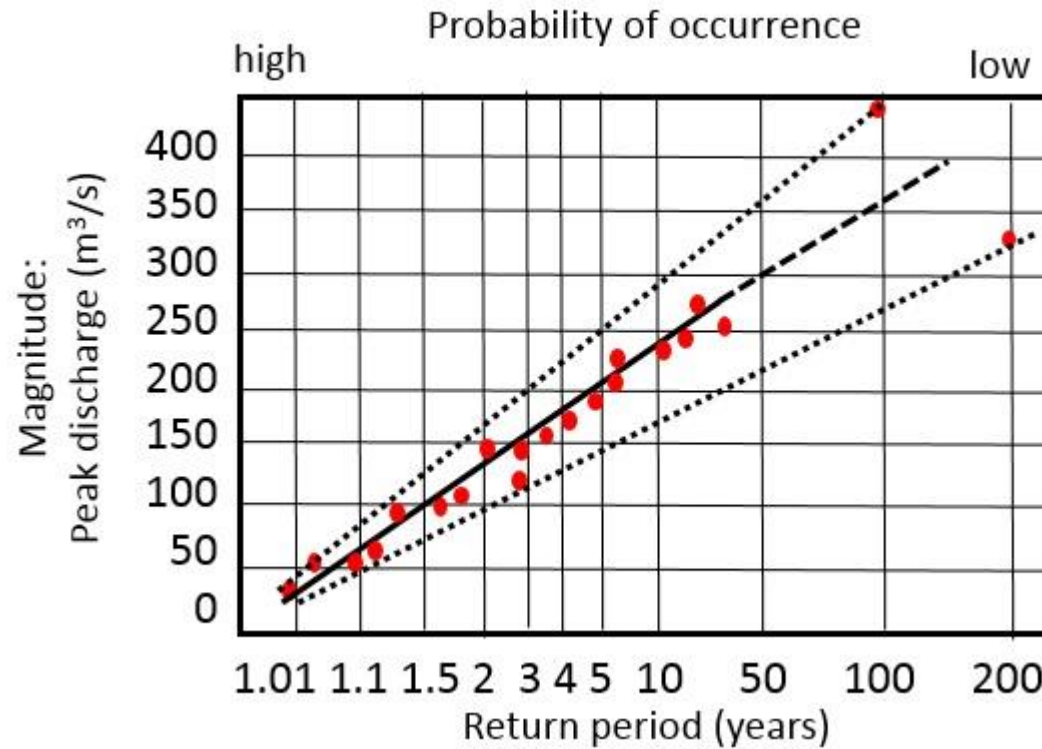
# Deprem büyüklüğü ile belirlenen parametreler

## 1. Gutenberg-Richter ilişkisi

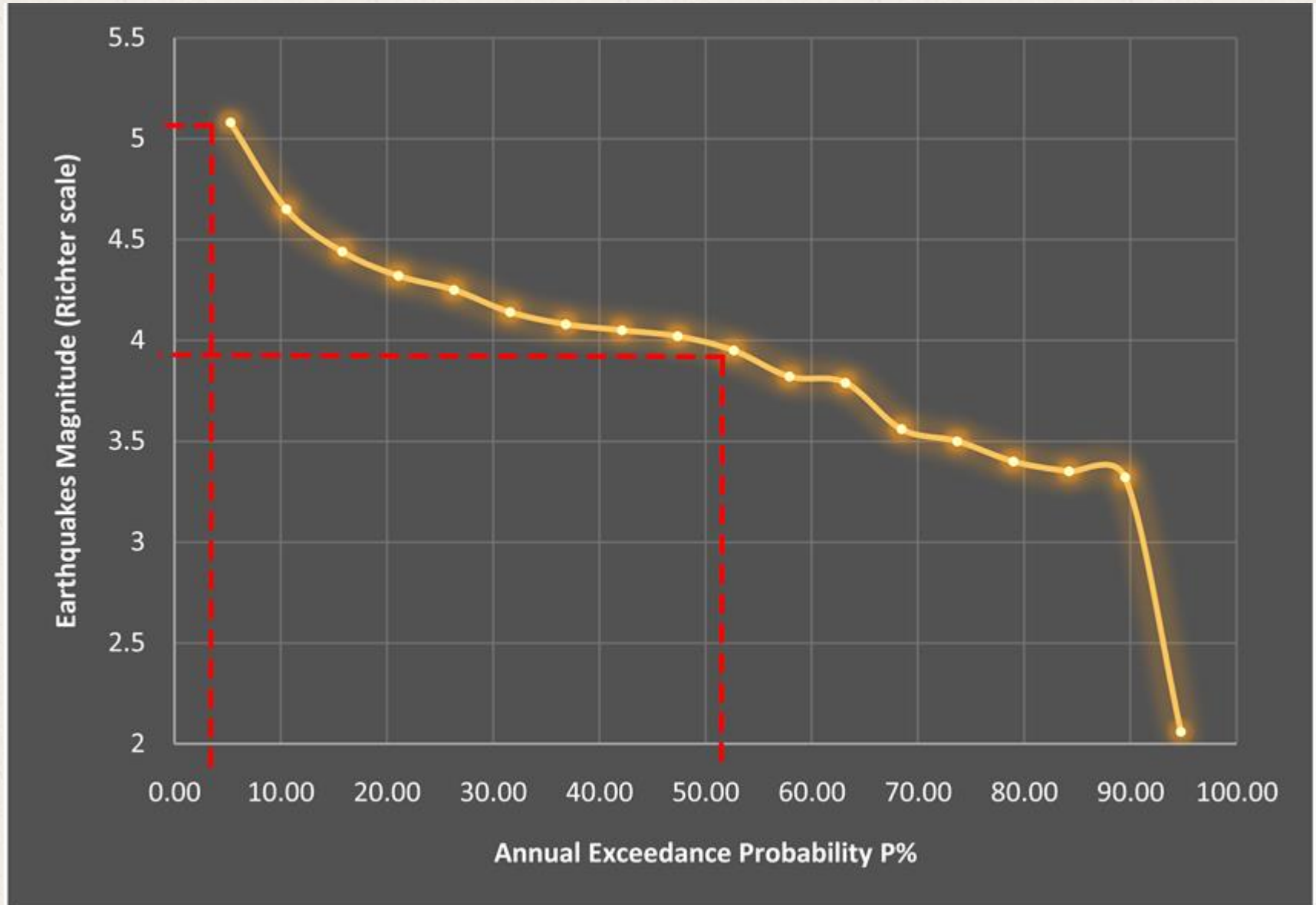
$$\log N = a - bM$$



## 2. Belli büyüklükteki depremin tekrarlanma aralığı (Return Period)



### 3. Limit değerlerin aşılma olasılığı (Probability of Exceedance)



# Jeolojik ve Jeoteknik İnceleme Esasları

- Jeolojik haritalama
  - Yüzey ve yeraltı araştırmaları
  - Laboratuvar deneyleri
  - Jeolojik ve mühendislik analizleri
  - Rapor
- 
- Proje türü
  - Topoğrafik durum
  - Jeolojik malzeme karakterizasyonu
  - Jeolojik ve sismik afet
  - Sahaya ulaşım
  - Yerel idare ve özel koşullar



Rank ↕	Date ↕	Location ↕	Event ↕	Magnitude ↕
1	May 22, 1960	<a href="#">Valdivia, Chile</a>	<a href="#">1960 Valdivia earthquake</a>	9.4–9.6
2	March 27, 1964	<a href="#">Prince William Sound, Alaska, United States</a>	<a href="#">1964 Alaska earthquake</a>	9.2
3	December 26, 2004	<a href="#">Indian Ocean, Sumatra, Indonesia</a>	<a href="#">2004 Indian Ocean earthquake</a>	9.1–9.3
4	March 11, 2011	<a href="#">Pacific Ocean, Tōhoku region, Japan</a>	<a href="#">2011 Tōhoku earthquake</a>	9.1 <sup>[3]</sup>
5	November 4, 1952	<a href="#">Kamchatka, Russian SFSR, Soviet Union</a>	<a href="#">1952 Kamchatka earthquakes</a>	9.0 <sup>[4]</sup>
6	August 13, 1868	<a href="#">Arica, Chile (then Peru)</a>	<a href="#">1868 Arica earthquake</a>	8.5–9.0 (est.)
7	January 26, 1700	<a href="#">Pacific Ocean, USA and Canada (then claimed by the Spanish Empire and the British Empire)</a>	<a href="#">1700 Cascadia earthquake</a>	8.7–9.2 (est.)
8	April 2, 1762	<a href="#">Chittagong, Bangladesh (then Kingdom of Mrauk U)</a>	<a href="#">1762 Arakan earthquake</a>	8.8 (est.)
9	November 25, 1833	<a href="#">Sumatra, Indonesia (then part of the Dutch East Indies)</a>	<a href="#">1833 Sumatra earthquake</a>	8.8 (est.)
10	January 31, 1906	<a href="#">Ecuador – Colombia</a>	<a href="#">1906 Ecuador–Colombia earthquake</a>	8.8 <sup>[5]</sup>
11	February 27, 2010	<a href="#">Offshore Maule, Chile</a>	<a href="#">2010 Chile earthquake</a>	8.8 <sup>[5]</sup>
12	August 15, 1950	<a href="#">Assam, India – Tibet, China</a>	<a href="#">1950 Assam–Tibet earthquake</a>	8.7
13	October 28, 1707	<a href="#">Pacific Ocean, Shikoku region, Japan</a>	<a href="#">1707 Hōei earthquake</a>	8.7–9.3 (est.)
14	July 8, 1730	<a href="#">Valparaíso, Chile (then part of the Spanish Empire)</a>	<a href="#">1730 Valparaíso earthquake</a>	8.7 (est.) <sup>[6]</sup>
15	November 1, 1755	<a href="#">Atlantic Ocean, Lisbon, Portugal</a>	<a href="#">1755 Lisbon earthquake</a>	8.5–9.0
16	February 4, 1965	<a href="#">Rat Islands, Alaska, United States</a>	<a href="#">1965 Rat Islands earthquake</a>	8.7
17	October 28, 1746	<a href="#">Lima, Peru (then part of the Spanish Empire)</a>	<a href="#">1746 Lima–Callao earthquake</a>	8.6 (est.)
18	March 28, 1787	<a href="#">Oaxaca, Mexico (then part of the Spanish Empire)</a>	<a href="#">1787 Mexico earthquake</a>	8.6 (est.)
19	March 9, 1957	<a href="#">Andreanof Islands, Alaska, United States</a>	<a href="#">1957 Andreanof Islands earthquake</a>	8.6 <sup>[5]</sup>
20	March 28, 2005	<a href="#">Sumatra, Indonesia</a>	<a href="#">2005 Nias–Simeulue earthquake</a>	8.6 <sup>[5]</sup>
21	April 11, 2012	<a href="#">Indian Ocean, Sumatra, Indonesia</a>	<a href="#">2012 Aceh earthquake</a>	8.6
22	December 16, 1575	<a href="#">Valdivia, Chile (then part of the Spanish Empire)</a>	<a href="#">1575 Valdivia earthquake</a>	8.5 (est.)
23	November 24, 1604	<a href="#">Arica, Chile (then part of the Spanish Empire)</a>	<a href="#">1604 Arica earthquake</a>	8.5 (est.)
24	May 13, 1647	<a href="#">Santiago, Chile (then part of the Spanish Empire)</a>	<a href="#">1647 Santiago earthquake</a>	8.5 (est.)
25	May 24, 1751	<a href="#">Concepción, Chile (then part of the Spanish Empire)</a>	<a href="#">1751 Concepción earthquake</a>	8.5 (est.)
26	November 19, 1822	<a href="#">Valparaíso, Chile</a>	<a href="#">1822 Valparaíso earthquake</a>	8.5 (est.)
27	February 20, 1835	<a href="#">Concepción, Chile</a>	<a href="#">1835 Concepción earthquake</a>	8.5 (est.)
28	February 16, 1861	<a href="#">Sumatra, Indonesia</a>	<a href="#">1861 Sumatra earthquake</a>	8.5
29	May 9, 1877	<a href="#">Iquique, Chile (then Peru)</a>	<a href="#">1877 Iquique earthquake</a>	8.5 (est.)
30	November 10, 1922	<a href="#">Atacama Region, Chile</a> <a href="#">Catamarca Province, Argentina</a>	<a href="#">1922 Vallenar earthquake</a>	8.5 <sup>[7]</sup>
31	February 1, 1938	<a href="#">Banda Sea, Indonesia (then part of the Dutch East Indies)</a>	<a href="#">1938 Banda Sea earthquake</a>	8.5 <sup>[5]</sup>
32	October 13, 1963	<a href="#">Kuril Islands, Russia (USSR)</a>	<a href="#">1963 Kuril Islands earthquake</a>	8.5 <sup>[5]</sup>
33	October 20, 1687	<a href="#">Lima, Peru (then part of the Spanish Empire)</a>	<a href="#">1687 Peru earthquake</a>	8.5 (est.)
34	October 17, 1737	<a href="#">Kamchatka, Russia</a>	<a href="#">1737 Kamchatka earthquakes</a>	8.5 (est.)
35	June 15, 1896	<a href="#">Pacific Ocean, Tōhoku region, Japan</a>	<a href="#">1896 Sanriku earthquake</a>	8.5 (est.)



## Tipik Yapısal Hasarlar



Loma Prieta earthquake damage in San Francisco. The soft first story is due to construction of garages in the first story and resultant reduction in shear strength. (Photo from: <http://earthquake.usgs.gov/bytopic/photos.html>)

Yumuşak kat ve makaslama deformasyonu



## Zayıf kat/kolon Makaslama

Mid-story collapse, Kobe earthquake. (Photo from: The January 17, 1995 Kobe Earthquake: An EQE Summary Report. April 1995, <http://www.eqe.com/publications/kobe/kobe.htm>)



## Kolon Yenilmesi, Kolonlara Aşırı Yük Bindirilmesi



*Collapsed section of I-10 (Santa Monica freeway), West Los Angeles. The freeway had been built across relatively soft soils (drained wetlands), the probable reason for the structural failure. This section of freeway was repaired and made serviceable in three months time. Photograph by Kerry Sieh.*



Column failure on interstate highway overpass, Northridge earthquake. (Photo from: <http://earthquake.usgs.gov/bytopic/photos.html>)





**1995 Kobe Depremi,  
Taşıyıcı Kolonlarda  
Makaslama/Burulma  
Yenilmesi**

約600年にわたって修復しなかった阪神高速道路。  
建設省によると、1964年の新神戸開港以降、地震によ  
る損傷はなかったのだという。安全神話。はも  
ろくも崩れた(17日、神戸市東灘区)



# Kolon Yenilmesi Yakın Plan Görüntüsü

