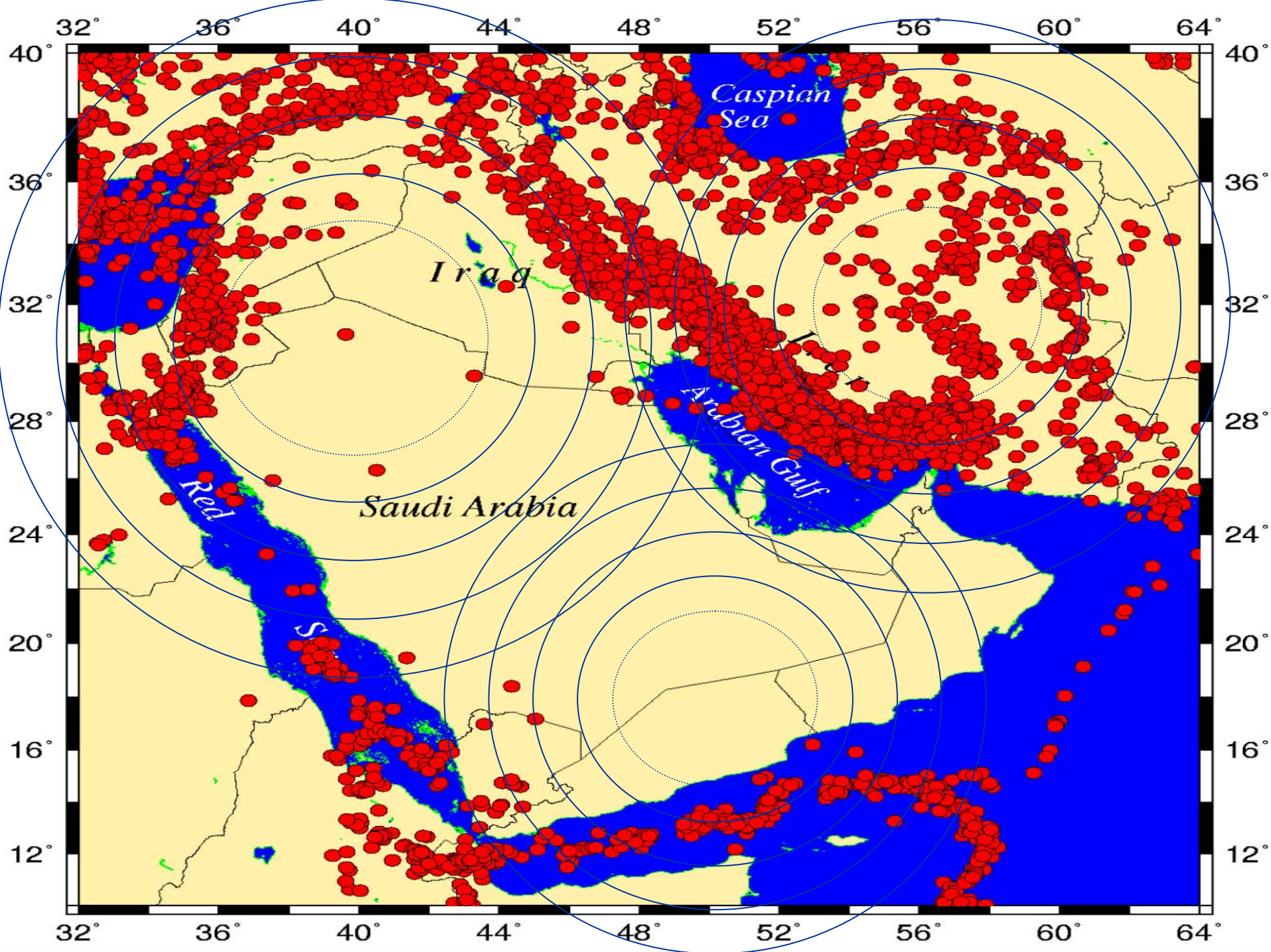
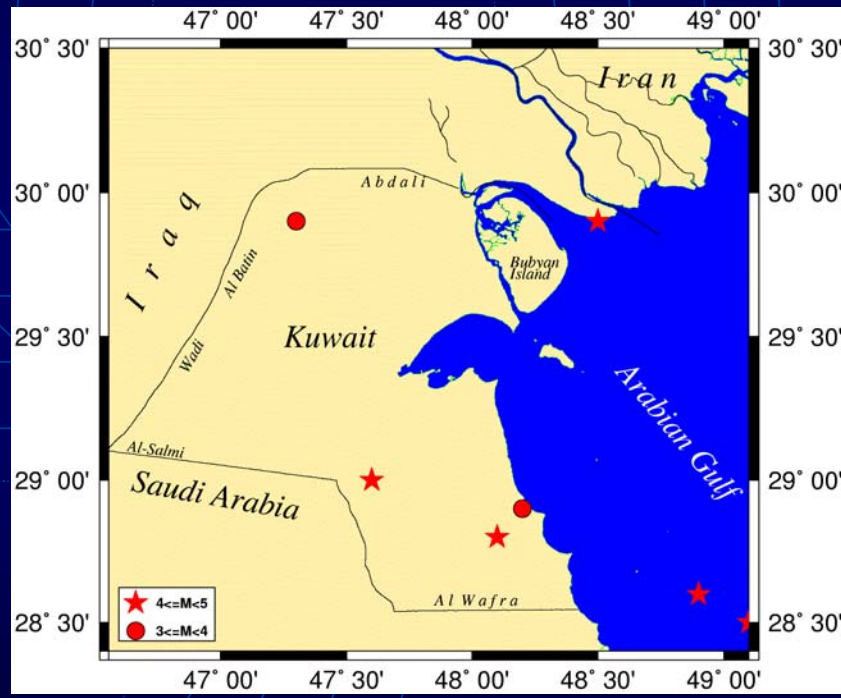
Assessment of Seismic Hazard for the State of Kuwait

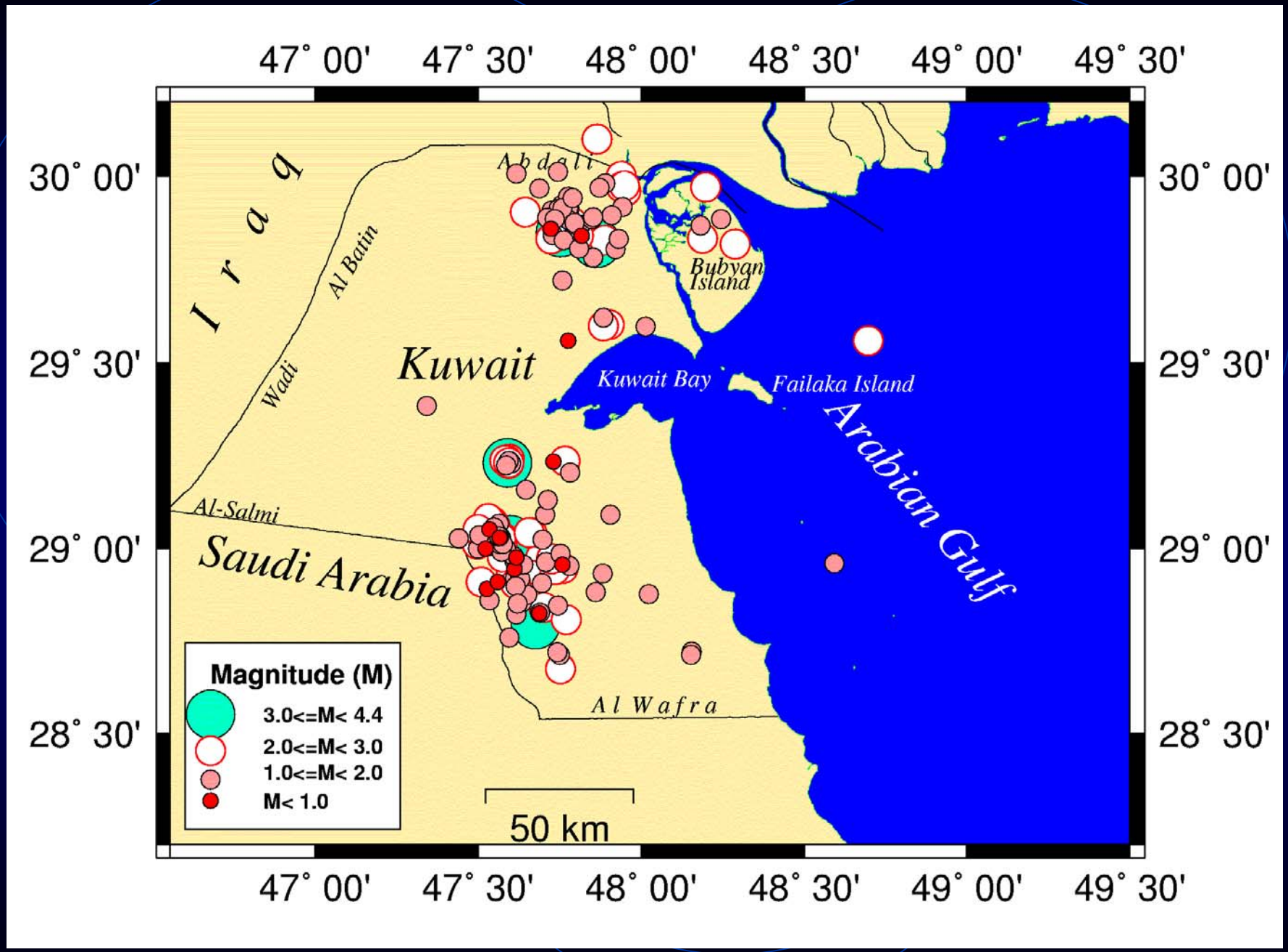
Abdullah Al-Enezi

Why we need to do Assessment of Seismic Hazard for the State of Kuwait ?


Caspian Sea
Iraq
Iran
Arabian Gulf
Saudi Arabia
Red Sea
32°
36°
40°
44°
48°
52°
56°
60°
64°
40°
36°
32°
28°
24°
20°
16°
12°

Date	Lat.	Long.	Depth km	Mag.
1973	28.5	49.1	?	4.6
1976	28.6	48.9	33	4.1
1976	29.9	47.3	33	3.2
1976	28.9	48.2	33	3.8
1977	28.8	48.1	?	4.5
1993	29.0	47.6	10	4.8
1997	28.7	47.5	10	4.3




47° 00'
47° 30'
48° 00'
48° 30'
49° 00'
49° 30'
30° 00'
29° 30'
29° 00'
28° 30'
Iraq
Al Batin
Wadi
Abdali
Bubyan Island
Kuwait
Kuwait Bay
Failaka Island
Arabian Gulf
Al-Salmi
Saudi Arabia
Al Wafra
Magnitude (M)
3.0<=M< 4.4
2.0<=M< 3.0
1.0<=M< 2.0
M< 1.0
50 km

High Rise Building





Oil Facilities



Problems of Assessment of Seismic Hazard for the State of Kuwait

- Incomplete record of large and historical data.

- Low seismic events (less than magnitude 4).

- Recent Instrumental Observation (Start 1997)

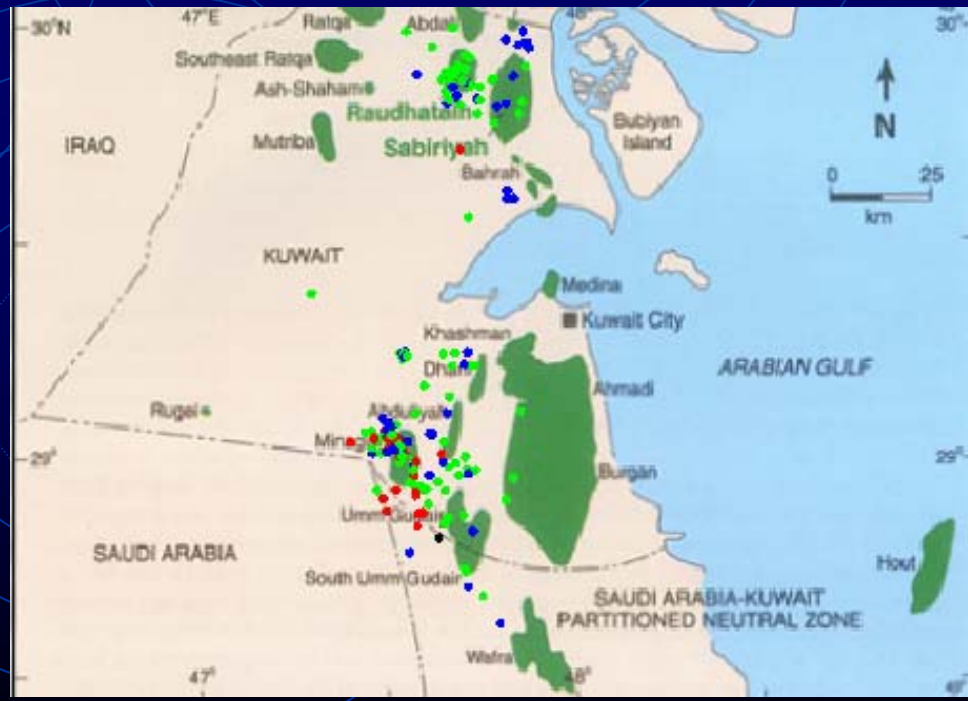
Seismic Activities in Oil Field

- Seismic event located within oil fields.

- Low magnitude of seismic events.

- The magnitude in the northeast (Ml) Range from 0.4 to 2.9. depth range from 3.5 to 28 km.

-The magnitude in the Southwest (Ml) range from 0.3 to 4.3 and depth range from 3.3 to 25 km.



Methodology

HA and MMAX program to Define the:

1- Mmax (maximum regional magnitude)

2- Mean activity rate λ

3- *b*-parameter in the frequency-magnitude

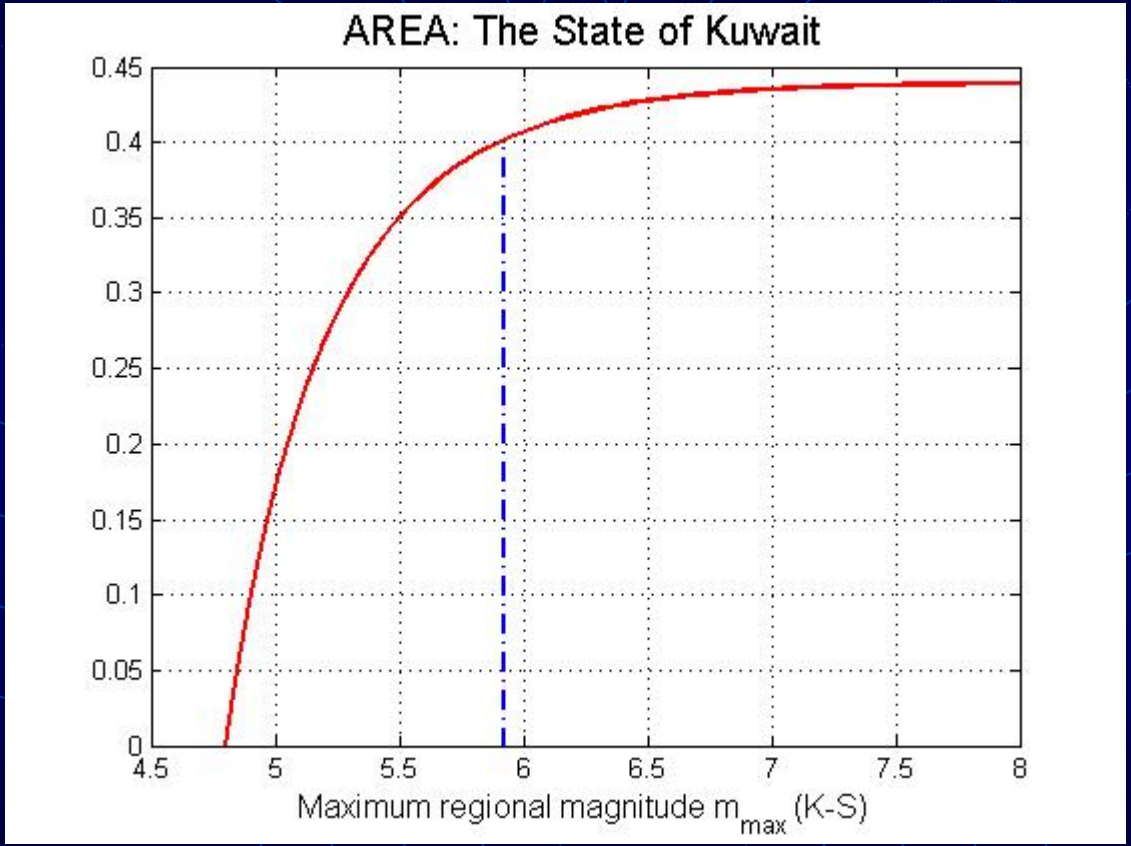
HS program for seismic hazard assessment at the site to Define:

1- maximum site-characteristic value of the PGA.

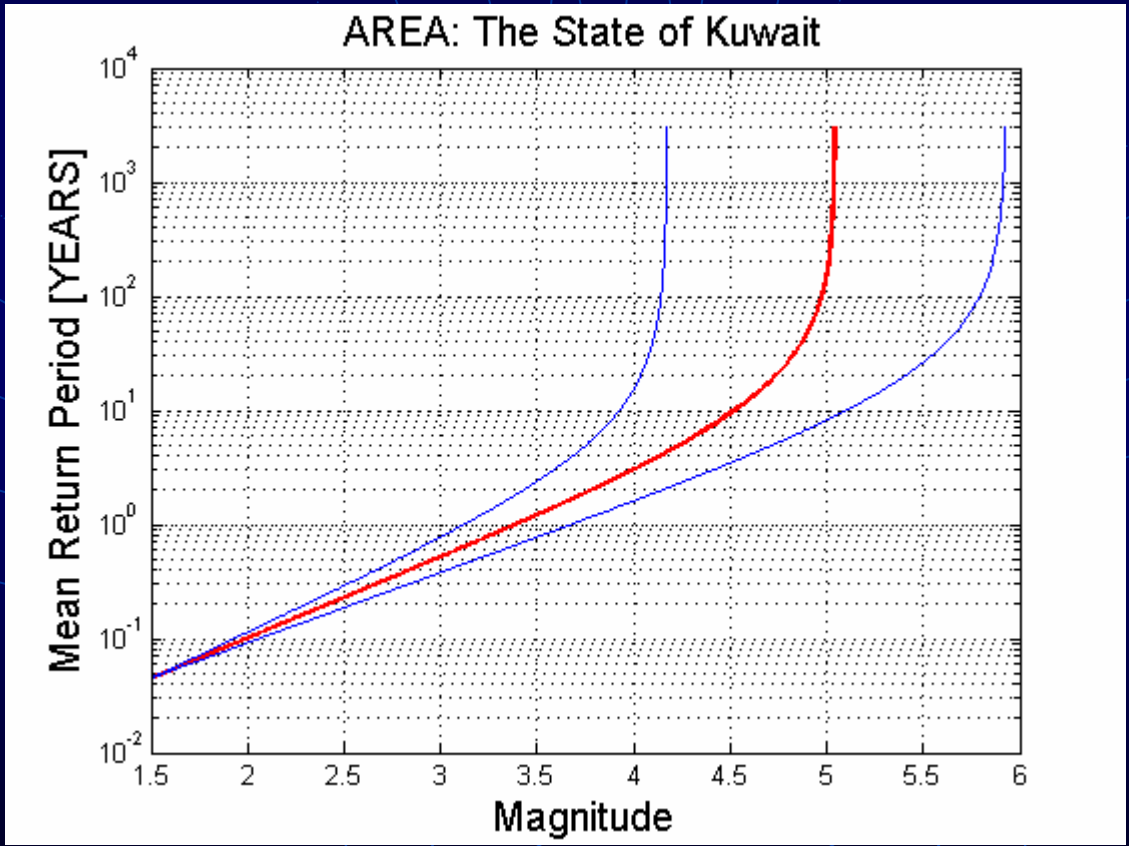
2- mean seismic activity rate λ.

3-γ-parameter in the frequency-PGA distribution.

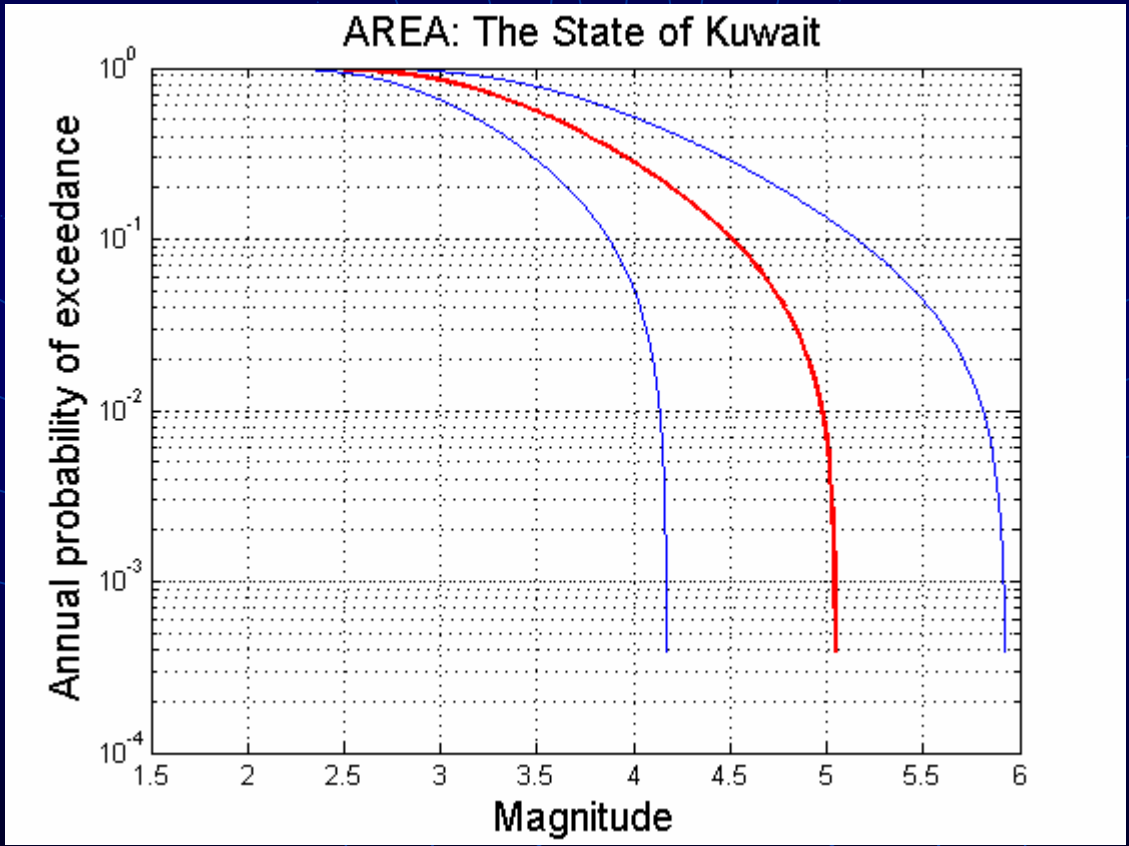
Maximum Magnitude (*m*max)



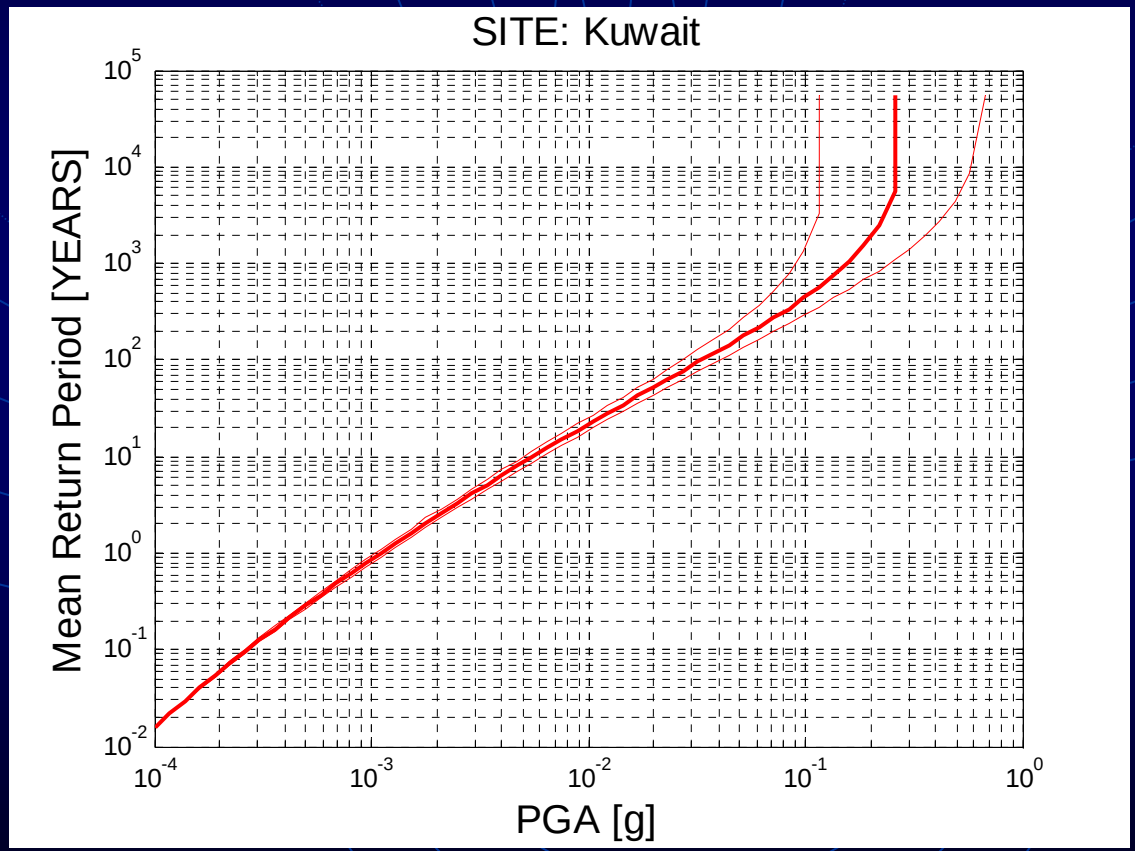
Mean Return Periods for Earthquake of magnitude 1.5 to 5.8



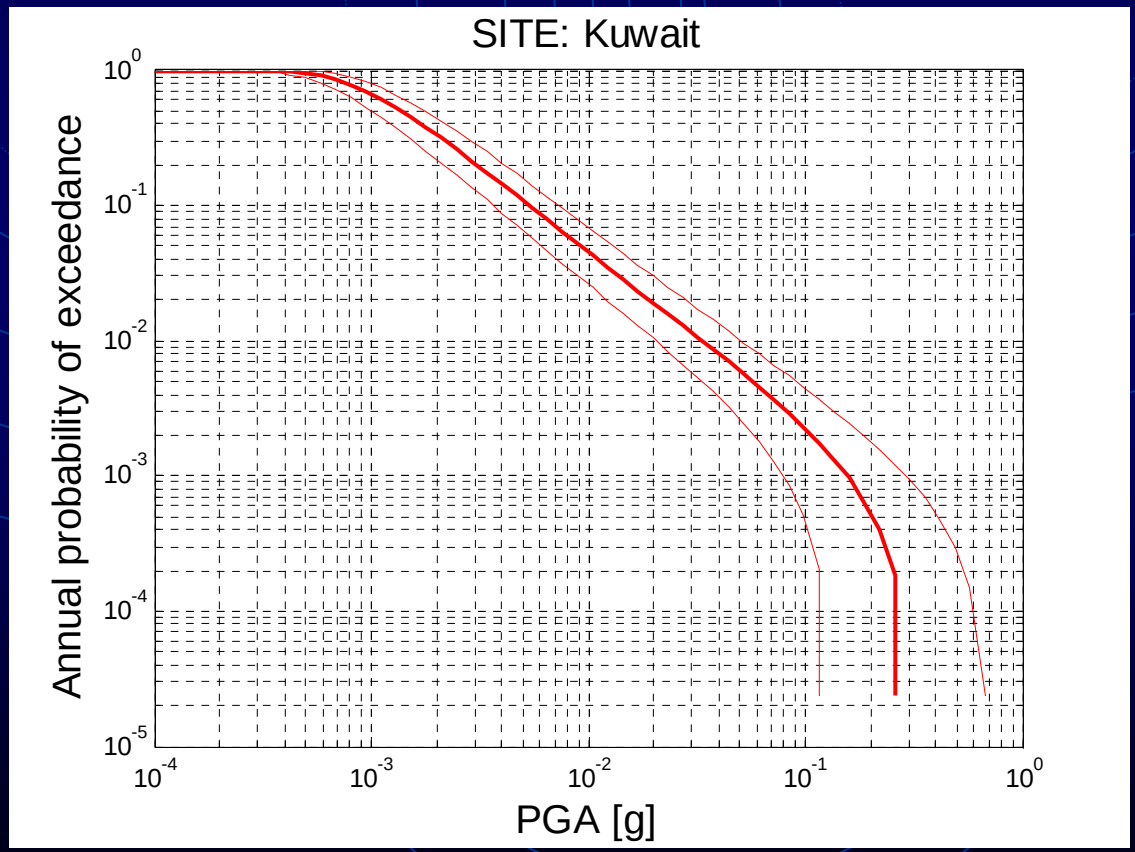
Annual Probabilities of Exceeding the Specified Magnitude



The Mean Return Period of Specified Value of PGA



Annual Probabilities of Exceeding The Specified PGA

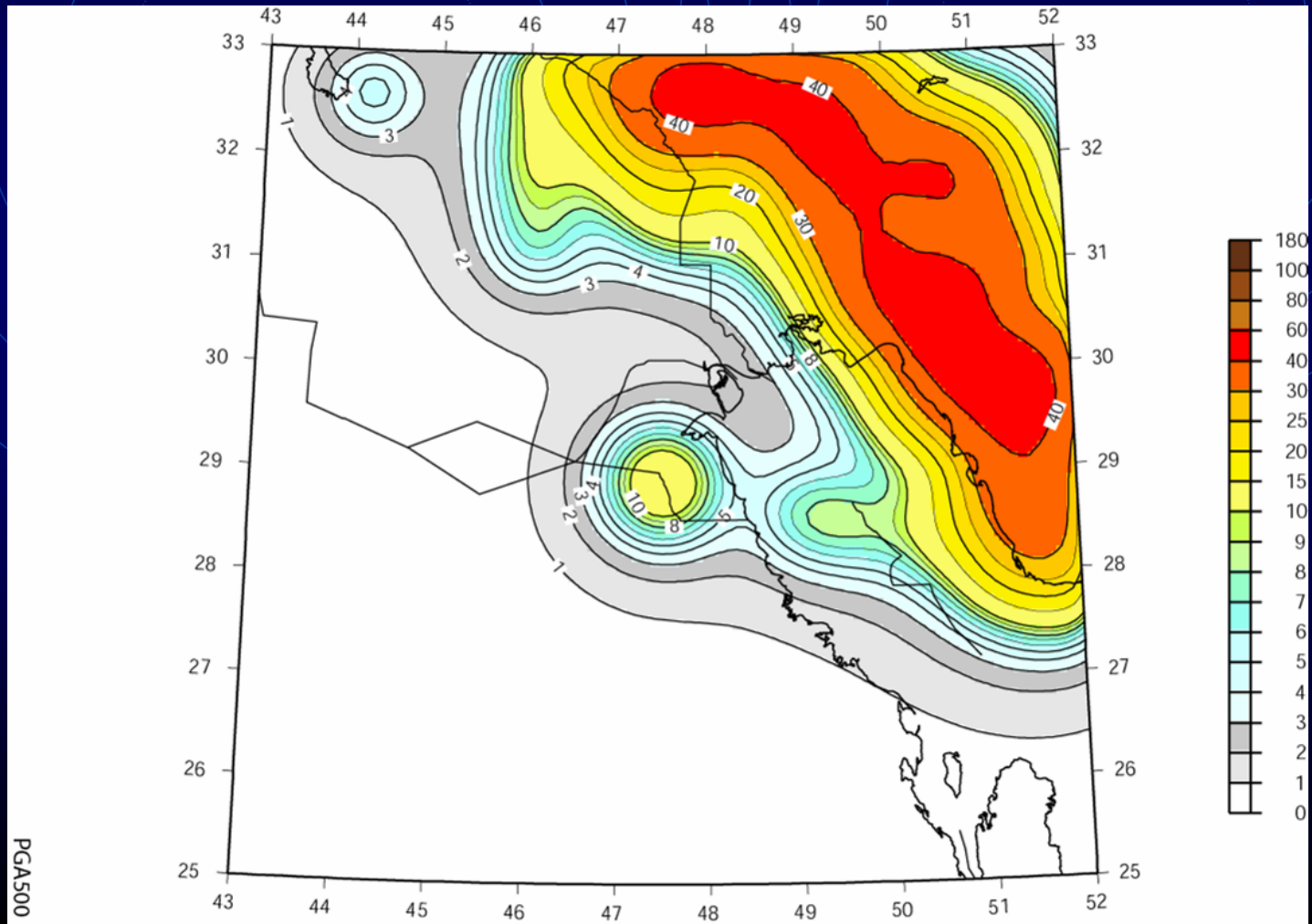


Probabilistic Seismic Hazard Map

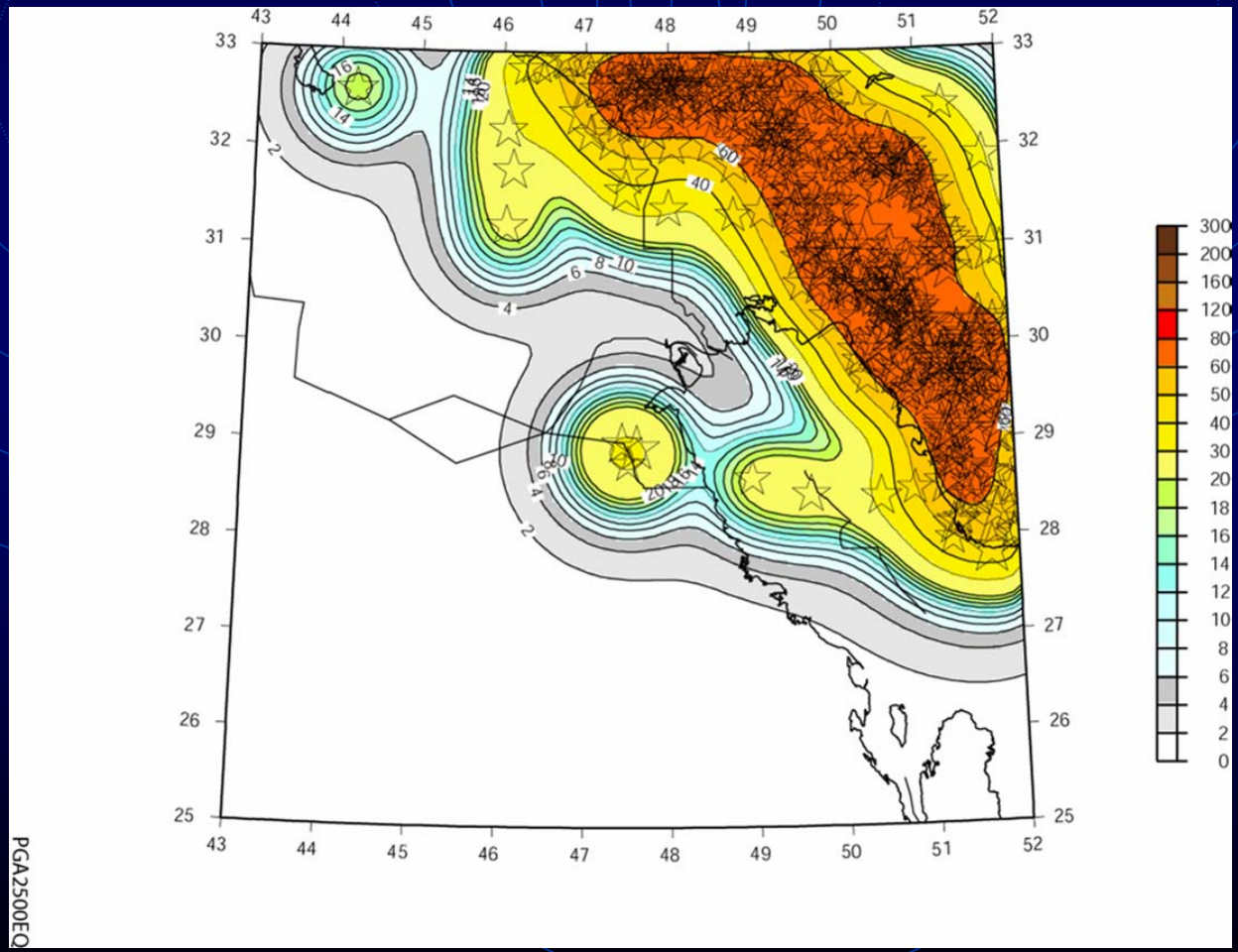
- It developed by USGS as part of Joint project with KISR.

- Earthquake hypocenters and magnitudes from the USGS PDE catalog from 1973-2004 for Zagros mountains area and Kuwait.

Probabilistic Seismic Hazard Map: Peak Ground Acceleration (PGA) With 10% Probability of Exceedance in 50 years (i.e., 475 years return period)



Probabilistic seismic hazard map: Peak Ground Acceleration (PGA) with 2% probability of exceedance in 50 years (i.e., 2475 years return period)



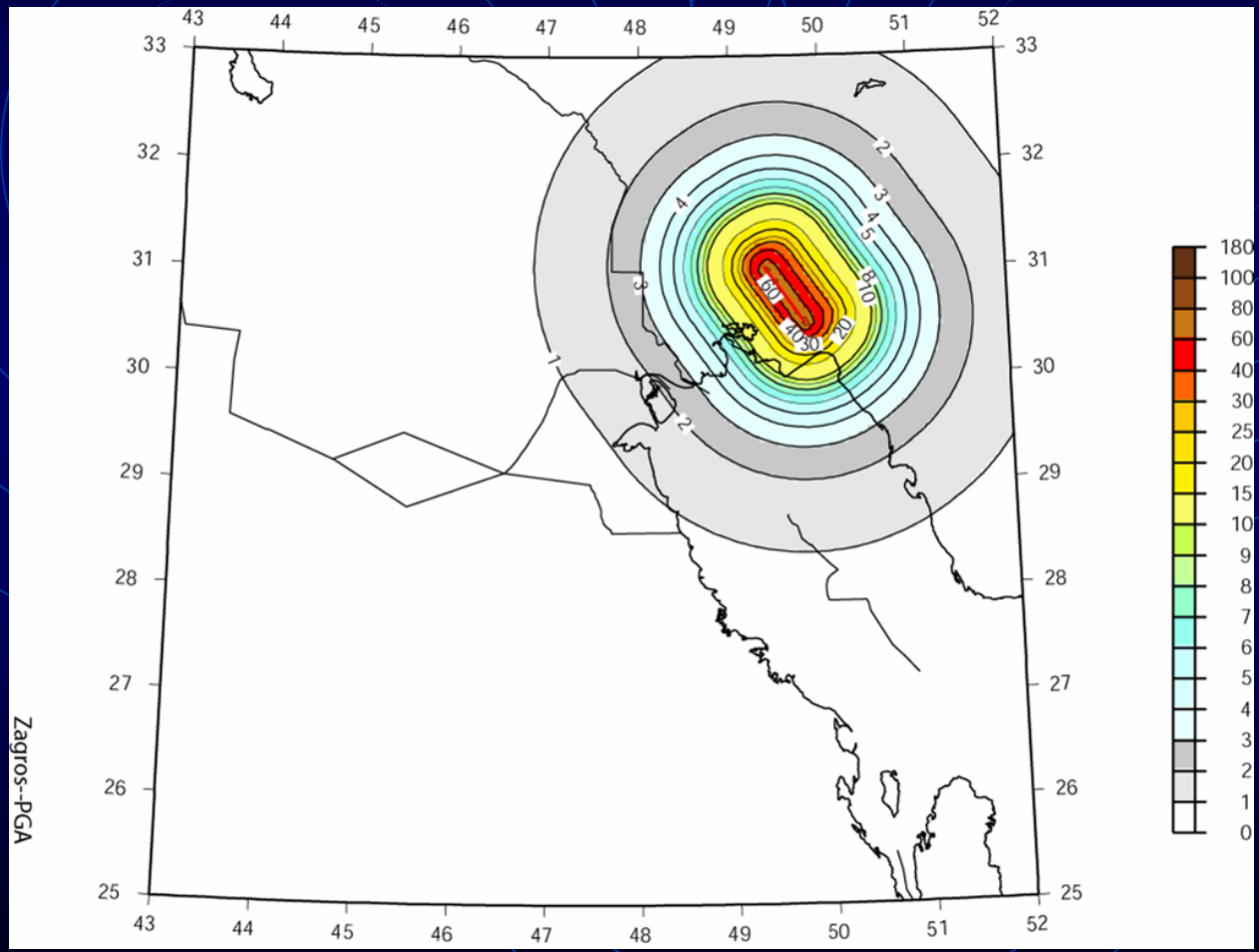
Deterministic Seismic Hazard Map

-We use Mmax a magnitude of 7.5 for zone of Zagros Mountains.

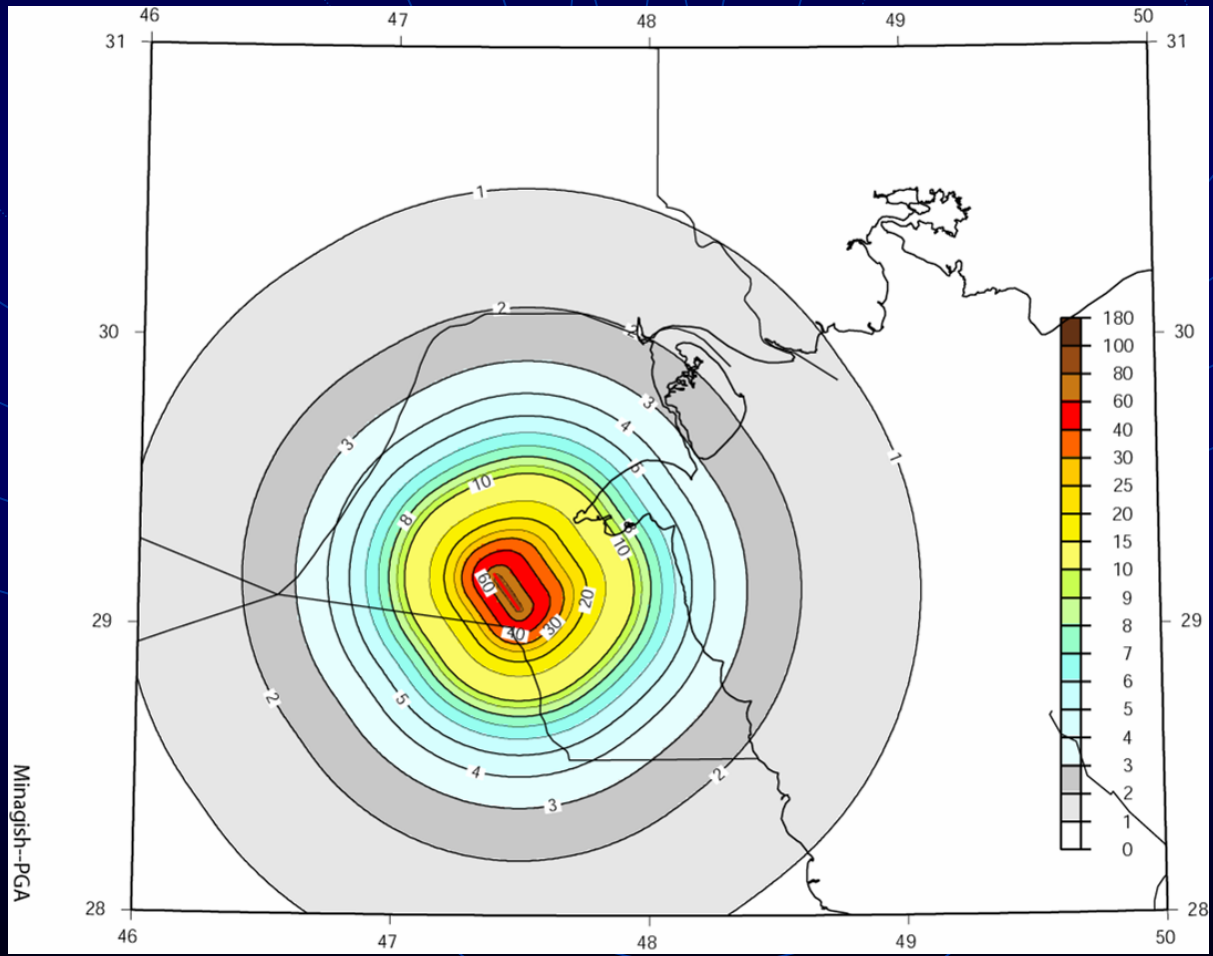
- This Mmax zone was delimited on the southwest by a line drawn between 33 N, 45 E and 26 N, 52 E, which approximately parallels the strike of the Zagros zone of seismicity.

-For the area of Kuwait, Mmax of 6.5 was assigned and delimited in Minagish oil field area.

Deterministic seismic hazard map for a M=7.5 Zagros earthquake: Peak Ground Accelerations (PGA)



Deterministic seismic hazard map for a M=6.5 Minagish earthquake



Conclusion

1- Two possible sources of seismic hazard, Zagros mountains and oil fields.

2- Seismic activities in Kuwait is low and clustered within oil fields.

3- The Mmax for Kuwait reach magnitude 5.8

4- Large Magnitude of earthquake in Zagros Mountains have limit effect in Kuwait city

5- Large Magnitude of earthquake in Minagish oil field may effect Kuwait city and oil field facilities