

# Seismicity trend analysis in and around Pakistan region between 1900 – 2022



PMD

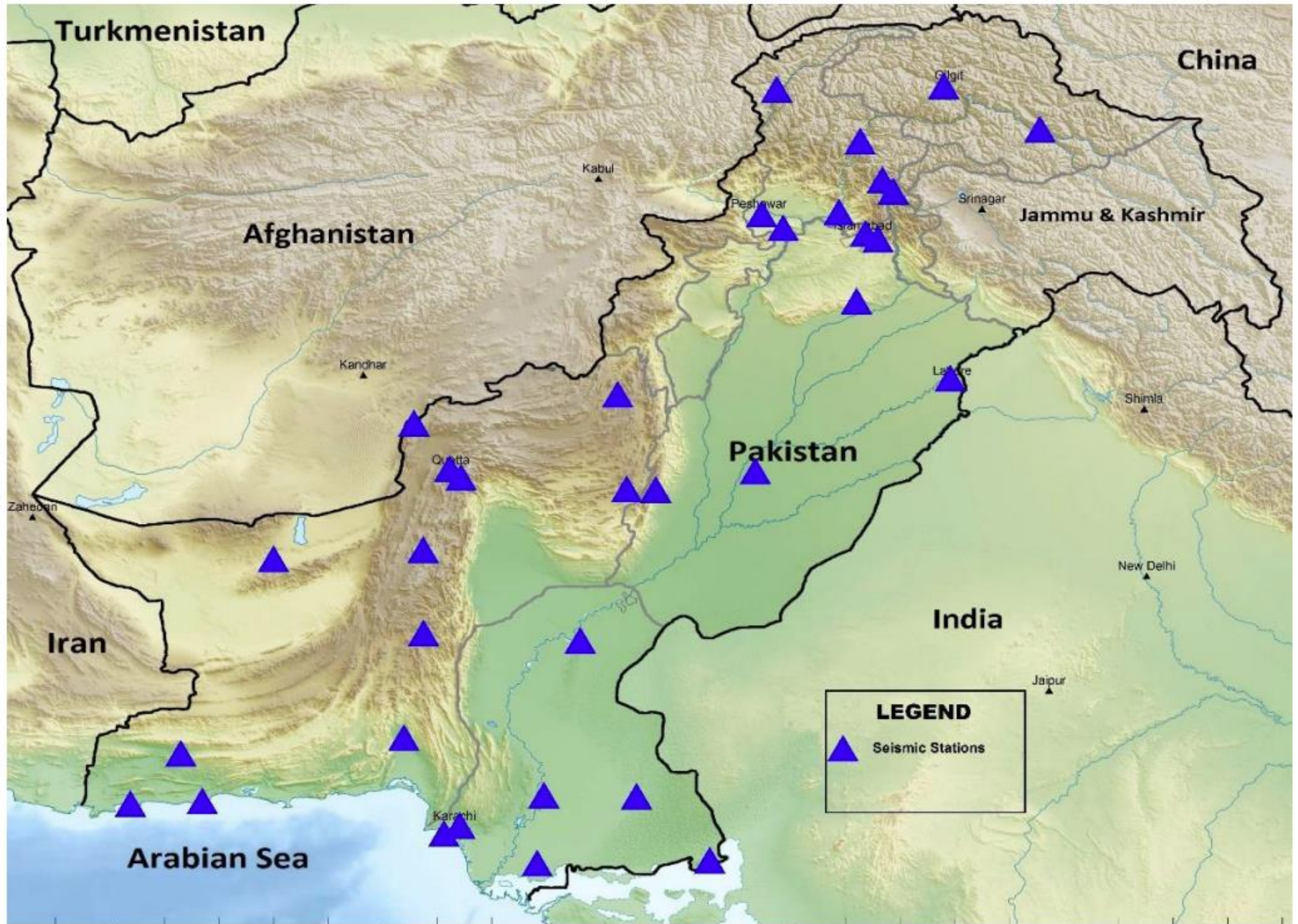
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Pakistan Engineering Congress, Lahore

# **Scheme of the Presentation**

1. Introduction
2. Fault system of Pakistan
3. Seismicity pattern
4. Trend analysis of different areas
5. Conclusion

# Earthquake Monitoring Network of Pakistan





Data Management Center,  
Islamabad



## Introduction

Tectonic settings and past experience of damaging earthquakes in and around Northern Pakistan make it seismically highly prone.

The Major Known faults are ;

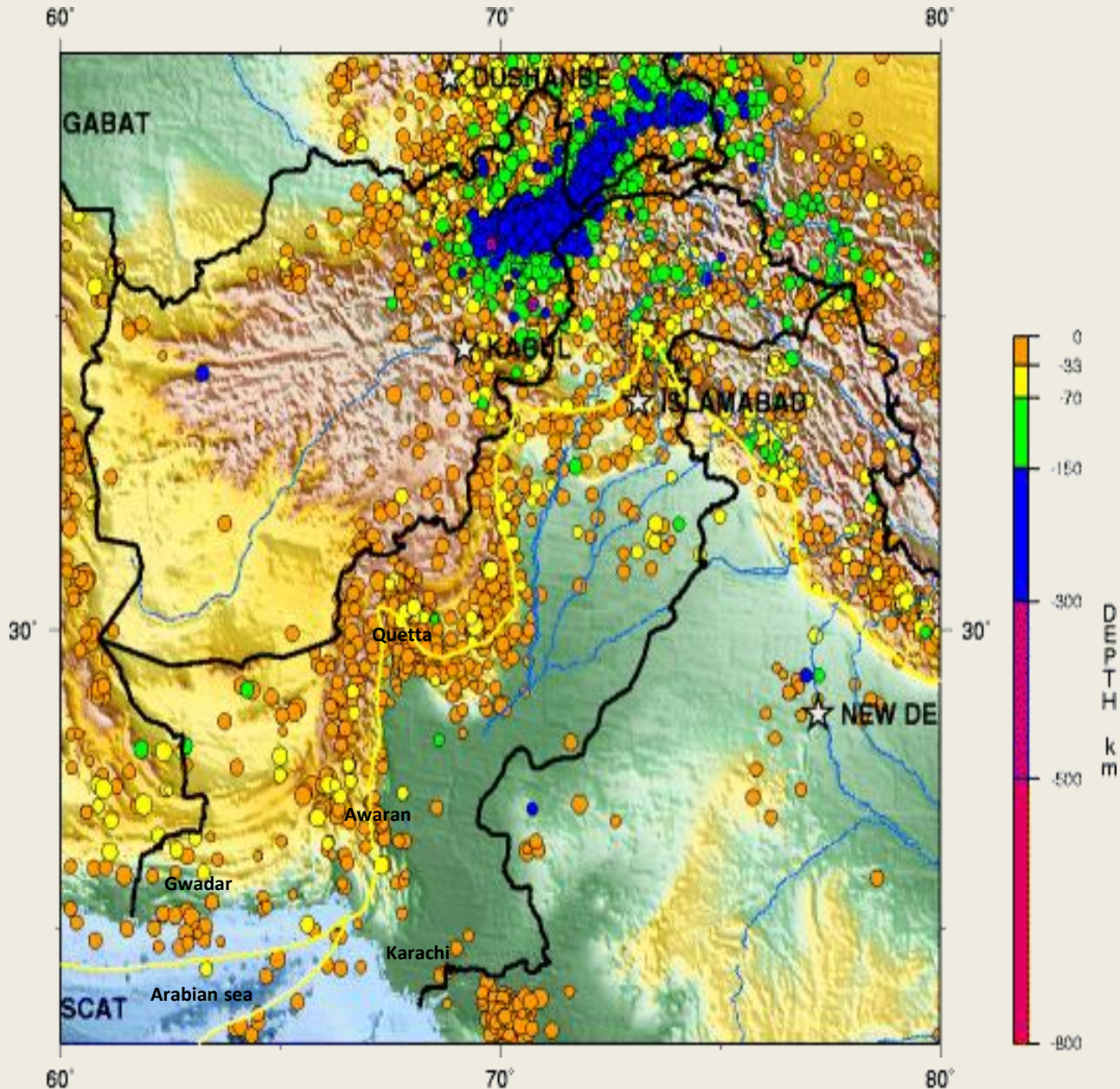
- 1) Main Karakoram Thrust.
- 2) Riasi Thrust.
- 3) Salt Range Thrust.
- 4) Bannu Fault.
- 5) Quetta-Chiltan Fault.
- 6) Allah Bund Fault.
- 7) Hoshab Fault.
- 8) Makran Coastal Fault.

## Plate Boundary





# General Seismicity Pattern of Pakistan & Surrounding Areas

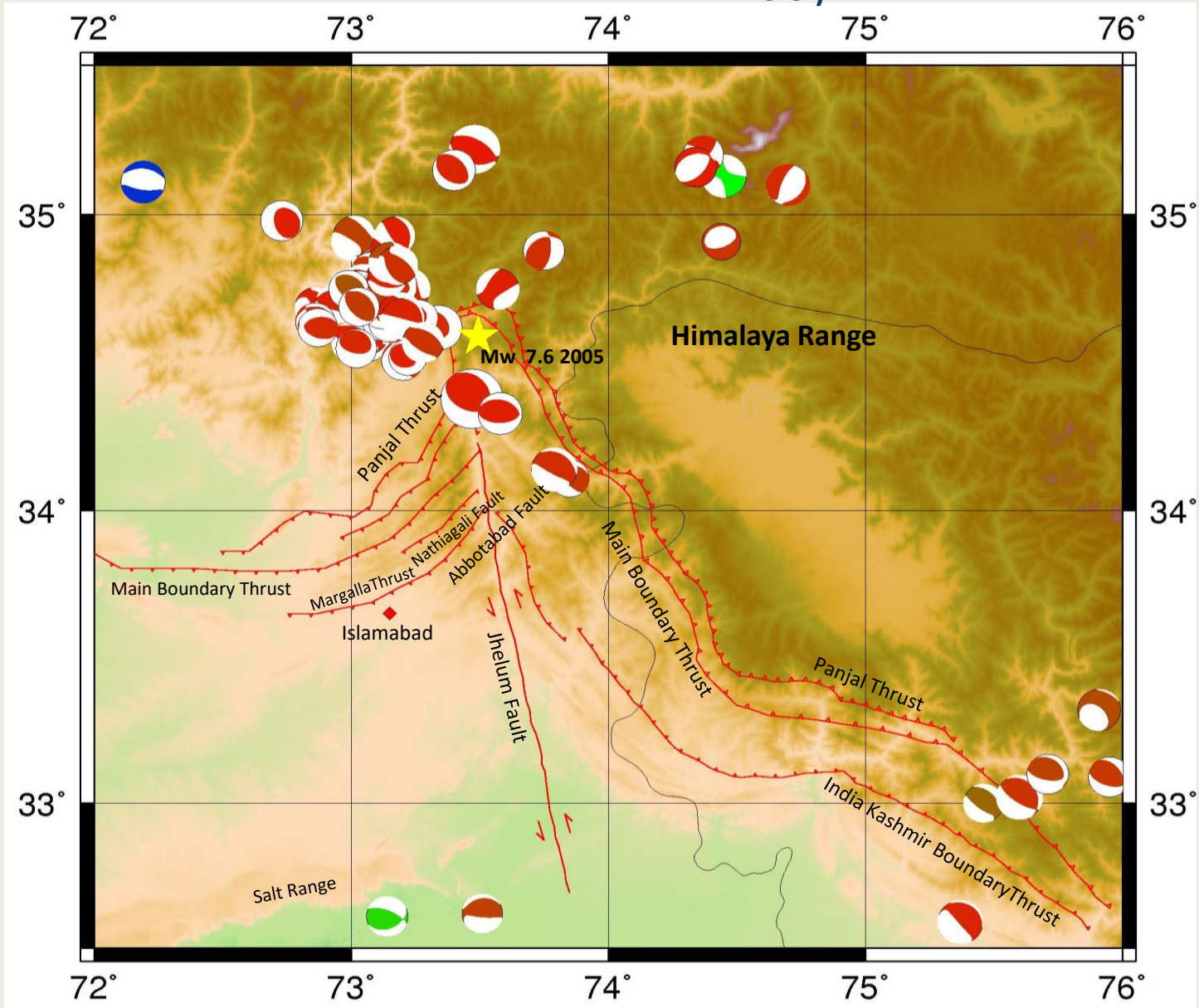


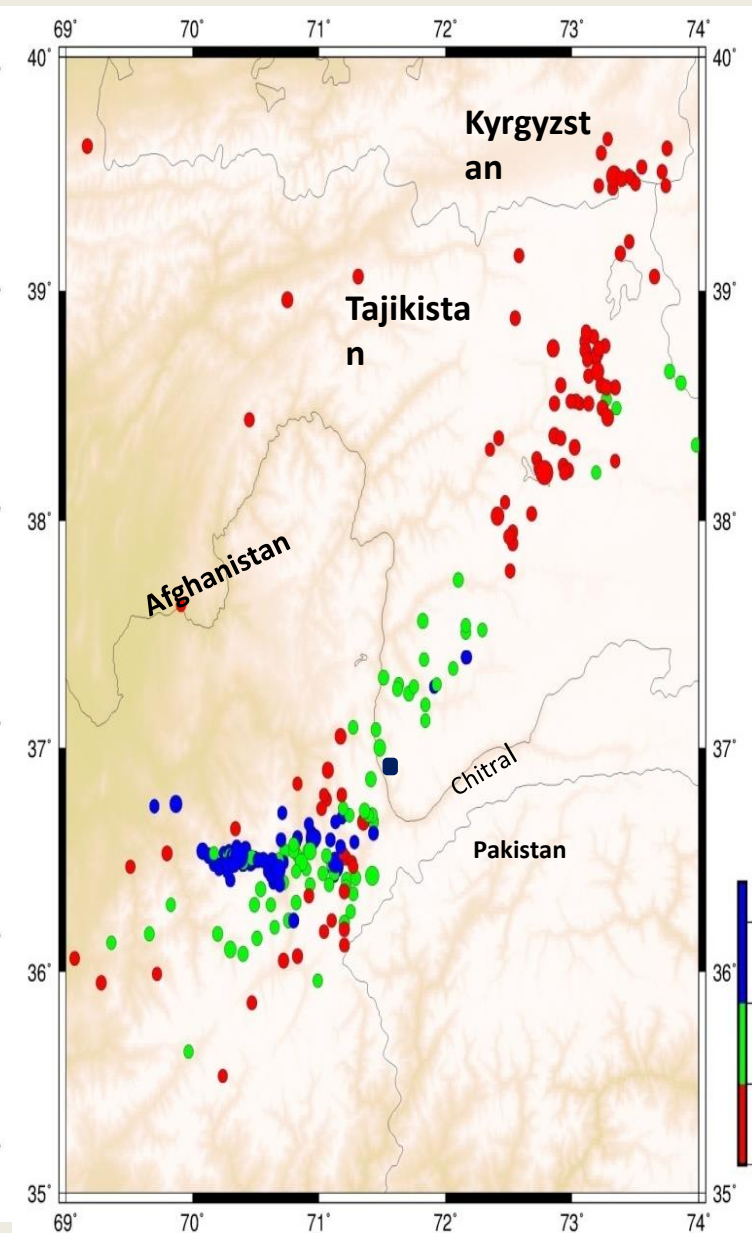
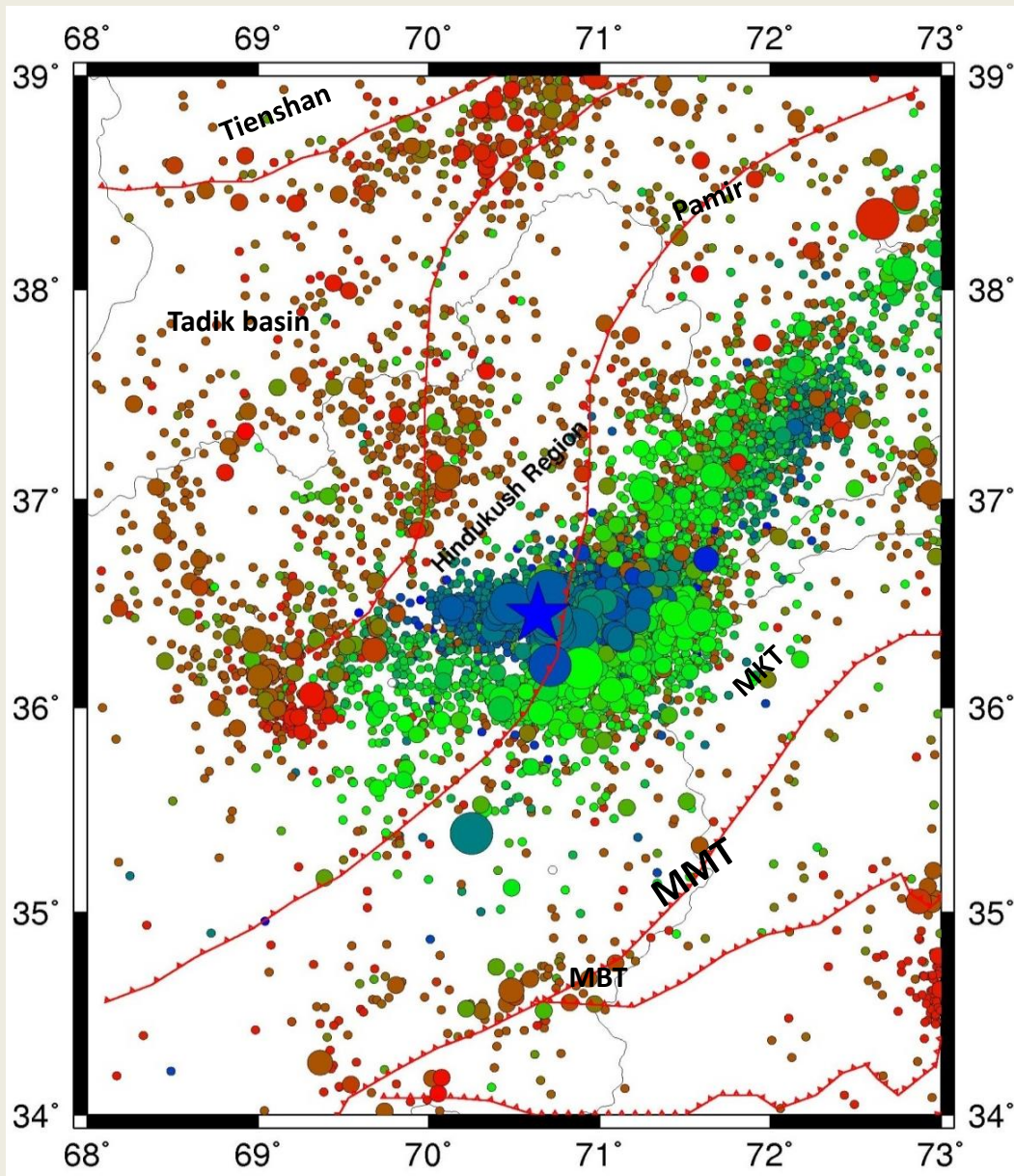
- A Brief Seismicity Analysis of Pakistan & surroundings:
- 1900-2015
- 4.0 to 4.9 64% of the total events,
- 25% from 3.0 to 3.9 and
- 9% from 6.0 to 6.9
- Only 150 events with magnitude  $\geq 6.0$
- 28 events with magnitude range 7.0 to 7.9
- Only 3 events have magnitude  $\geq 8.0$



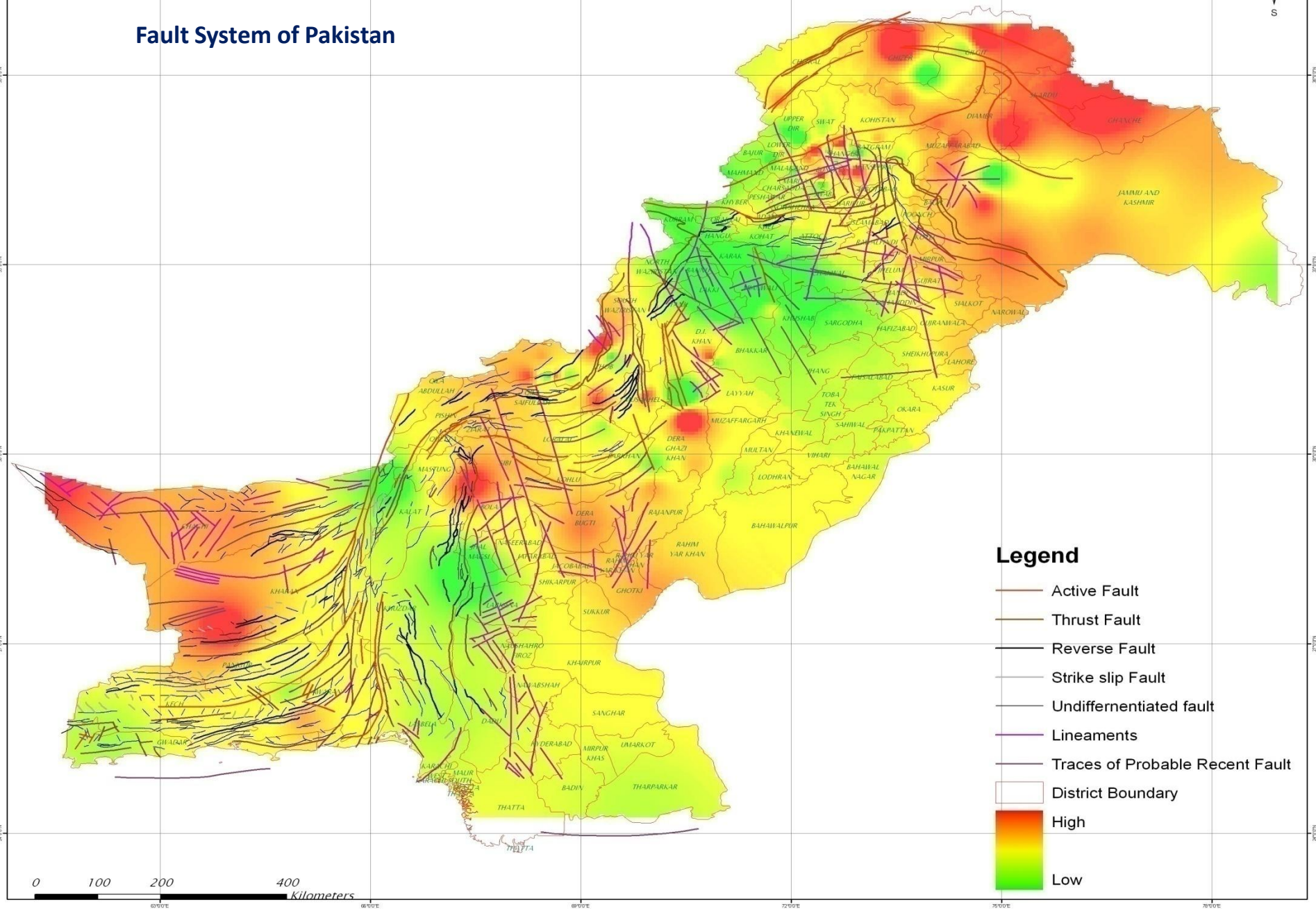
# Active Faults and Mechanism of Earthquakes

M > 5.5 )

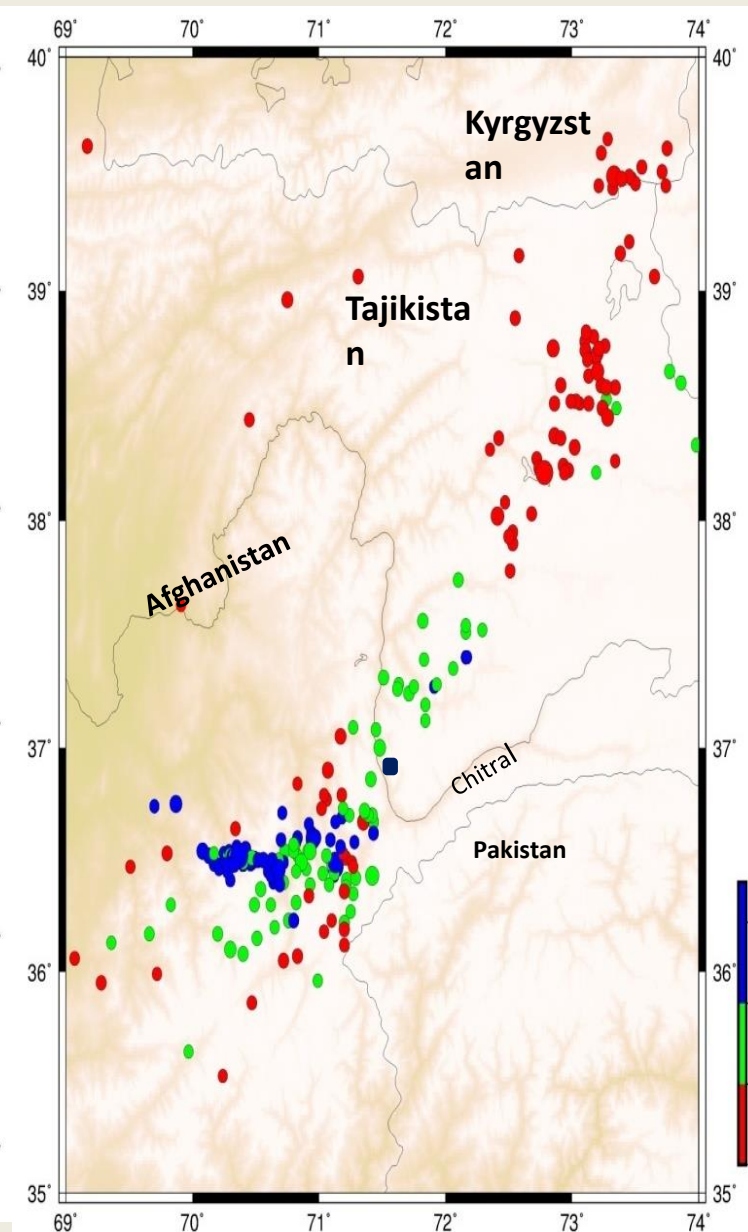
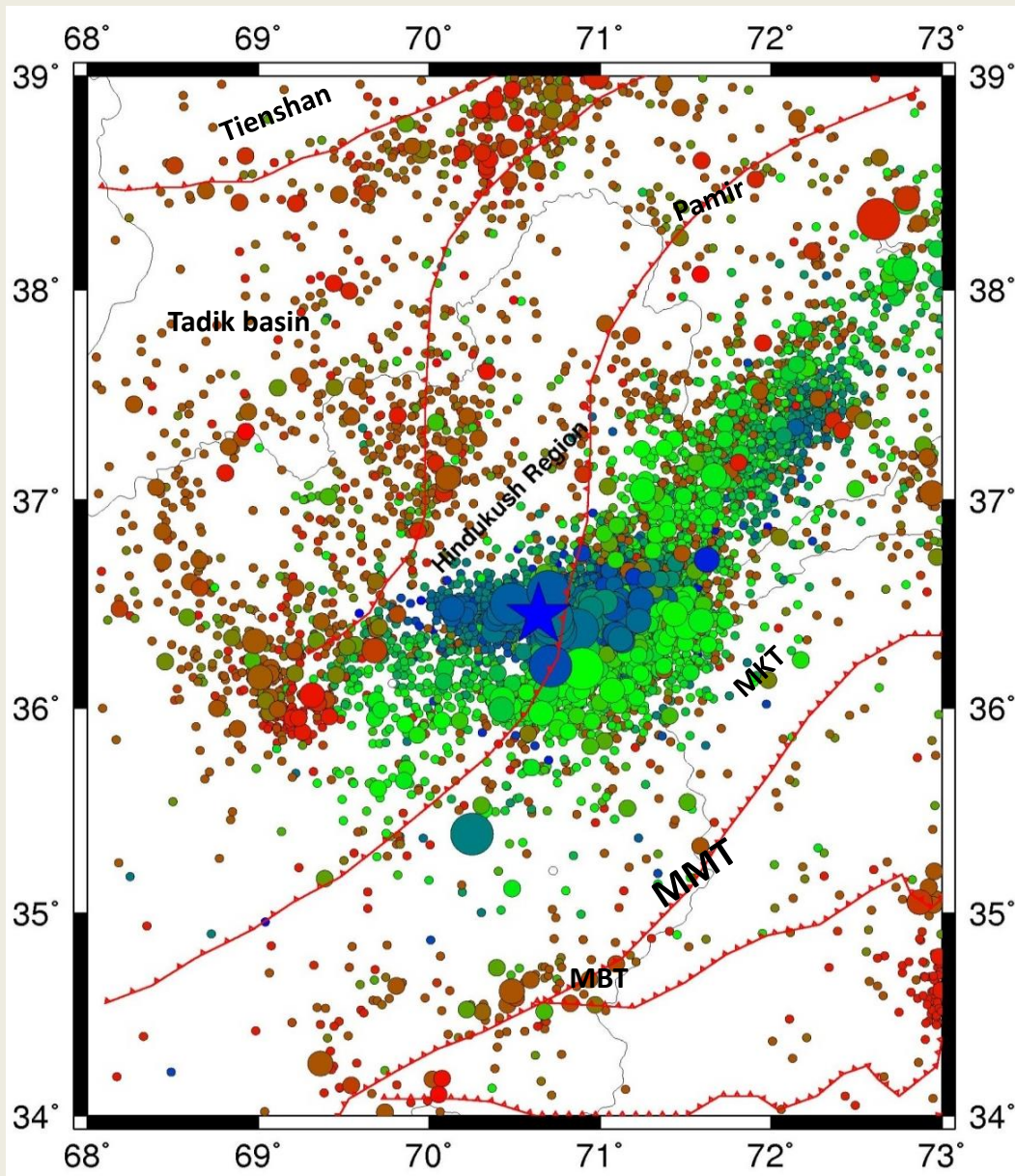




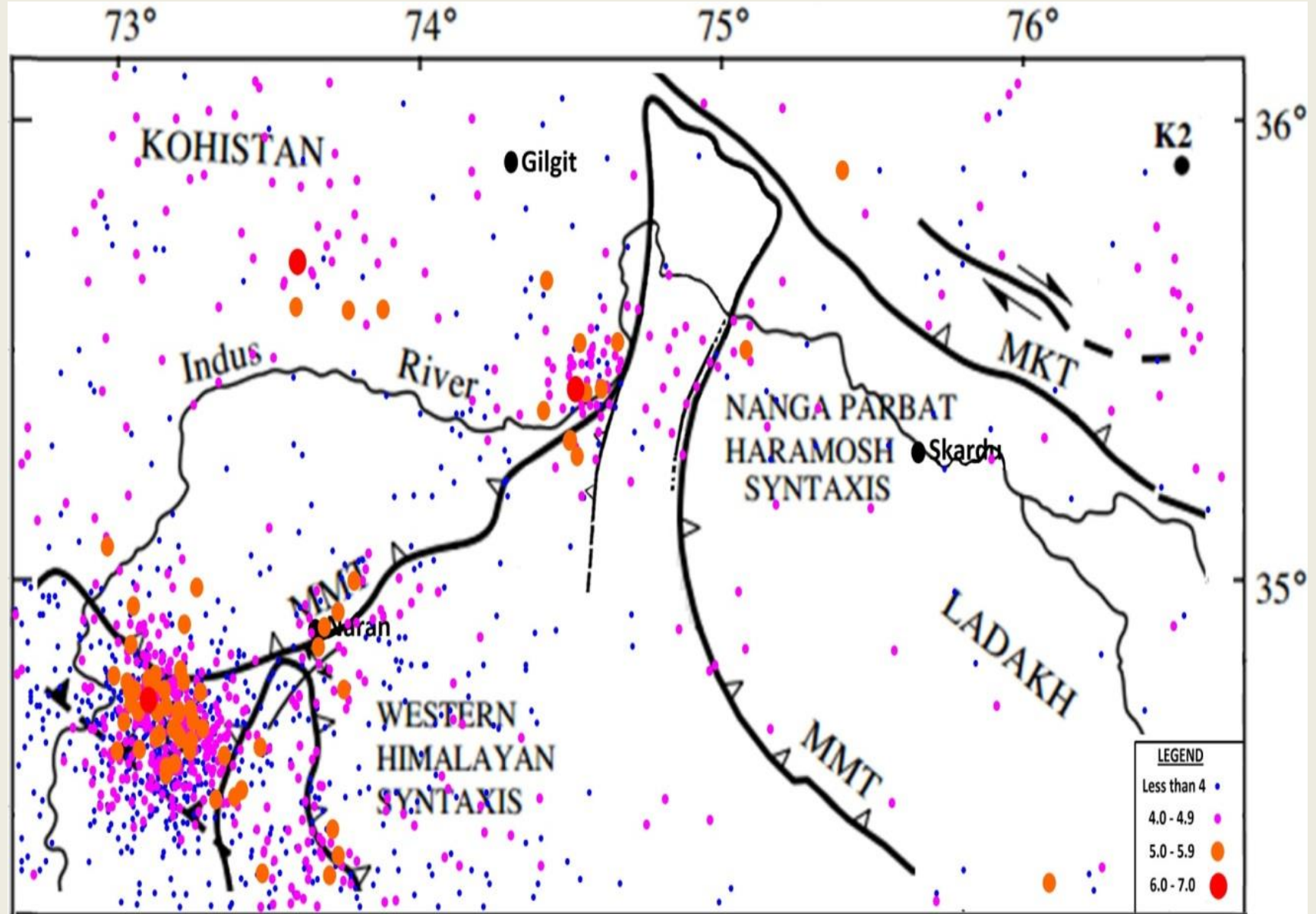




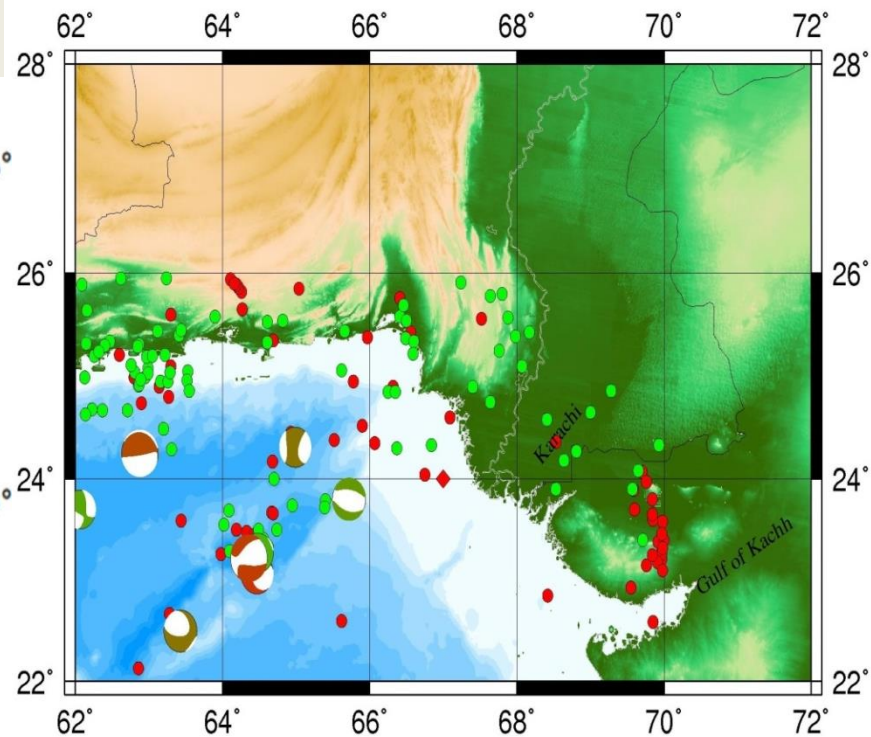
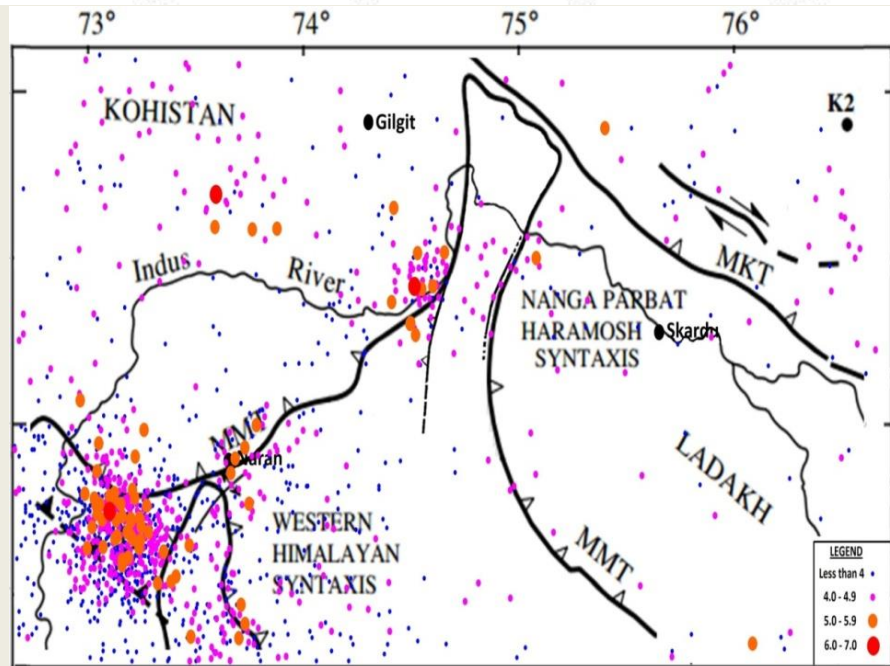
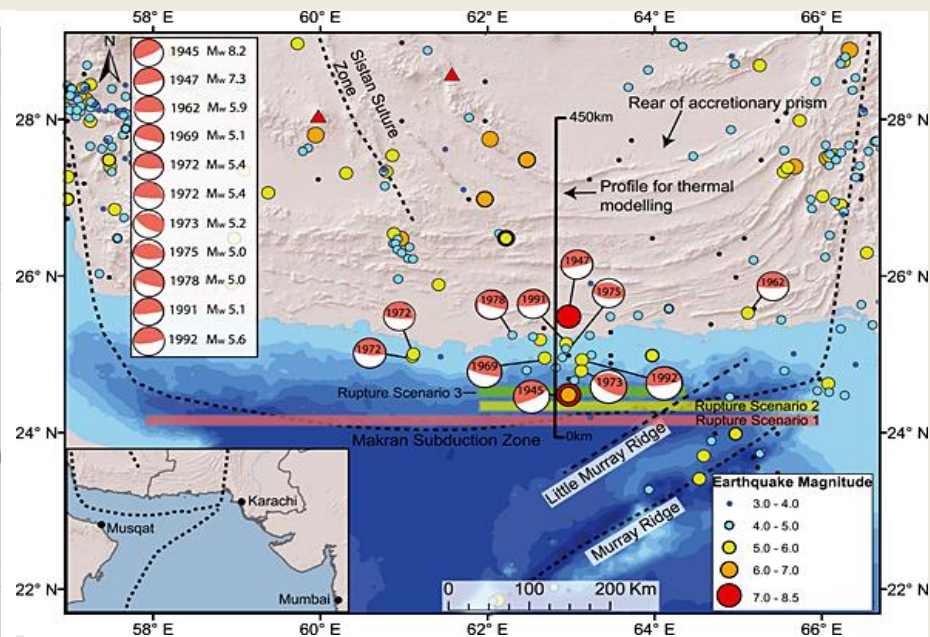
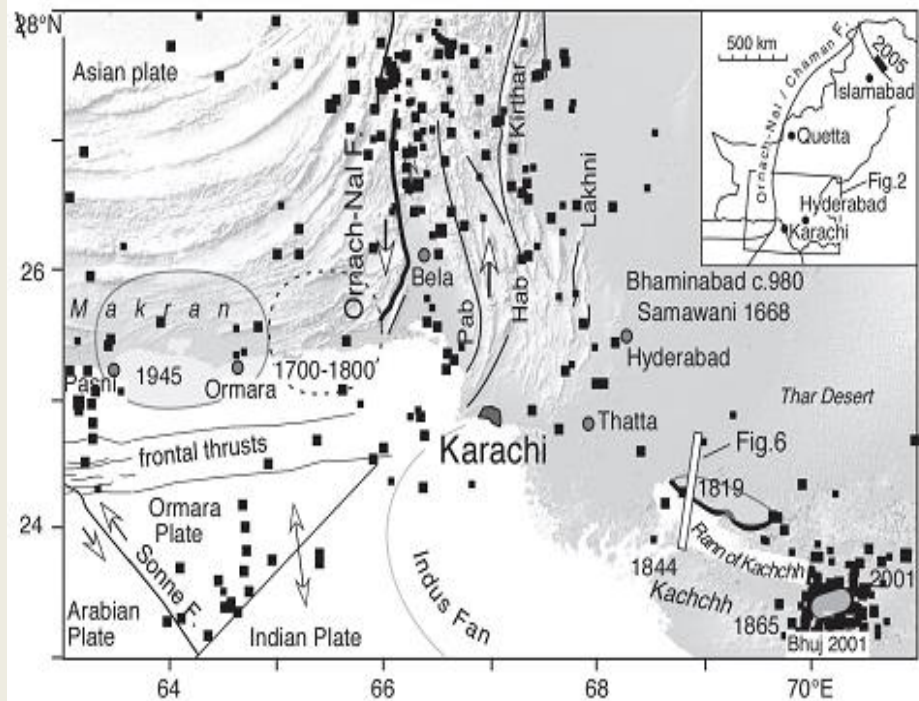




The seismicity along the western side of Main Mantle Thrust (MMT) and associated with seismicity of Hazara syntaxis. The maximum seismicity is located along the western side of Nanga Parbat.

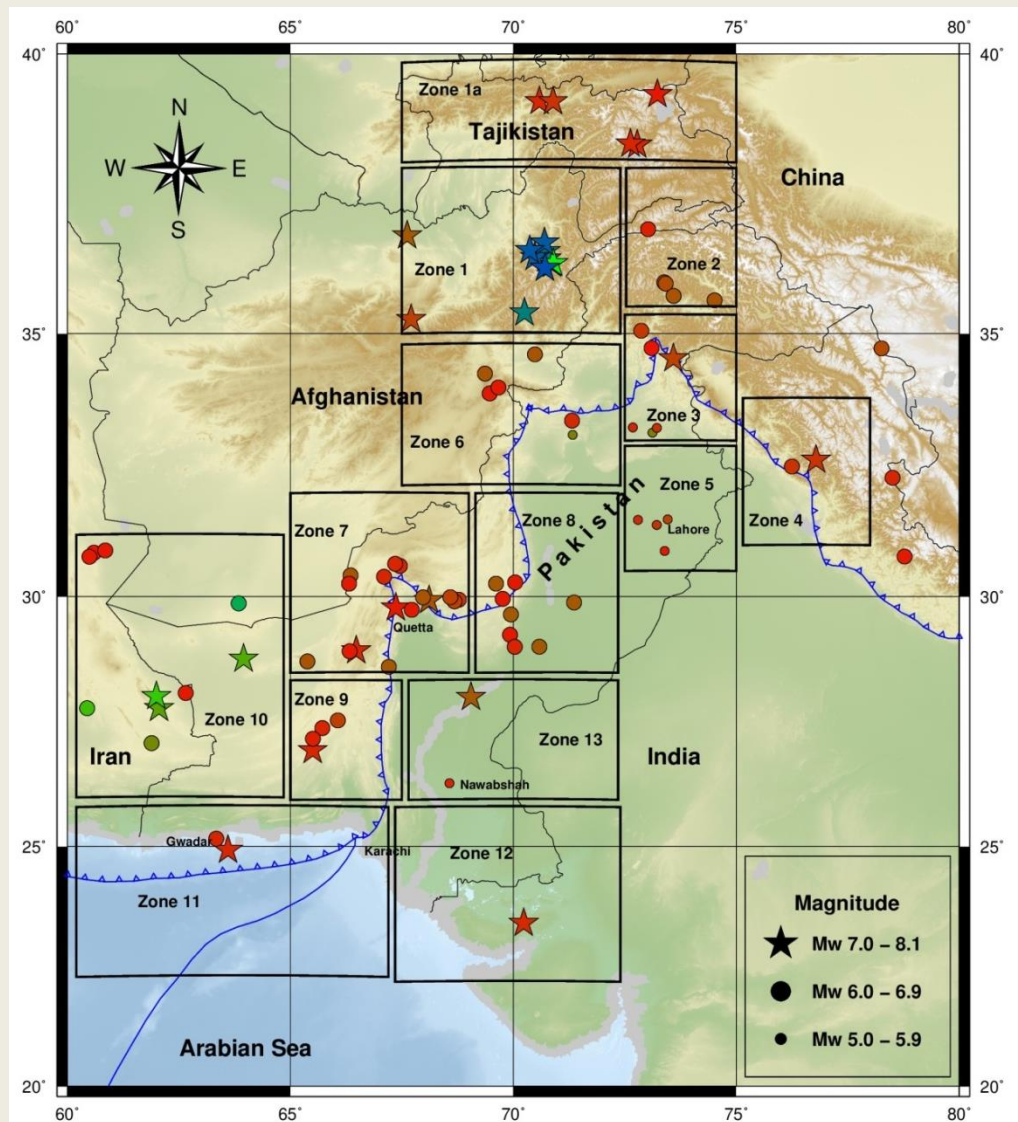




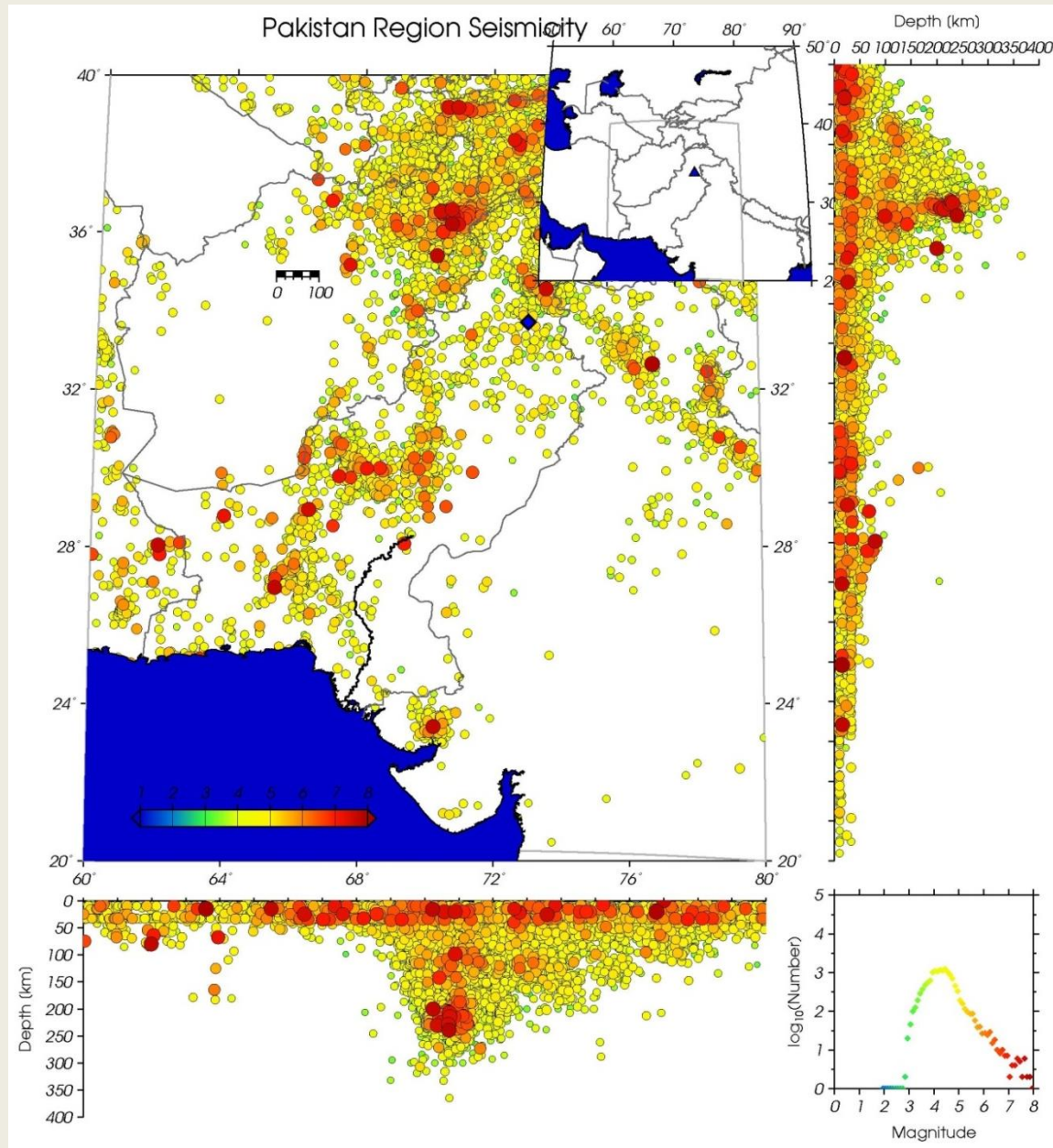




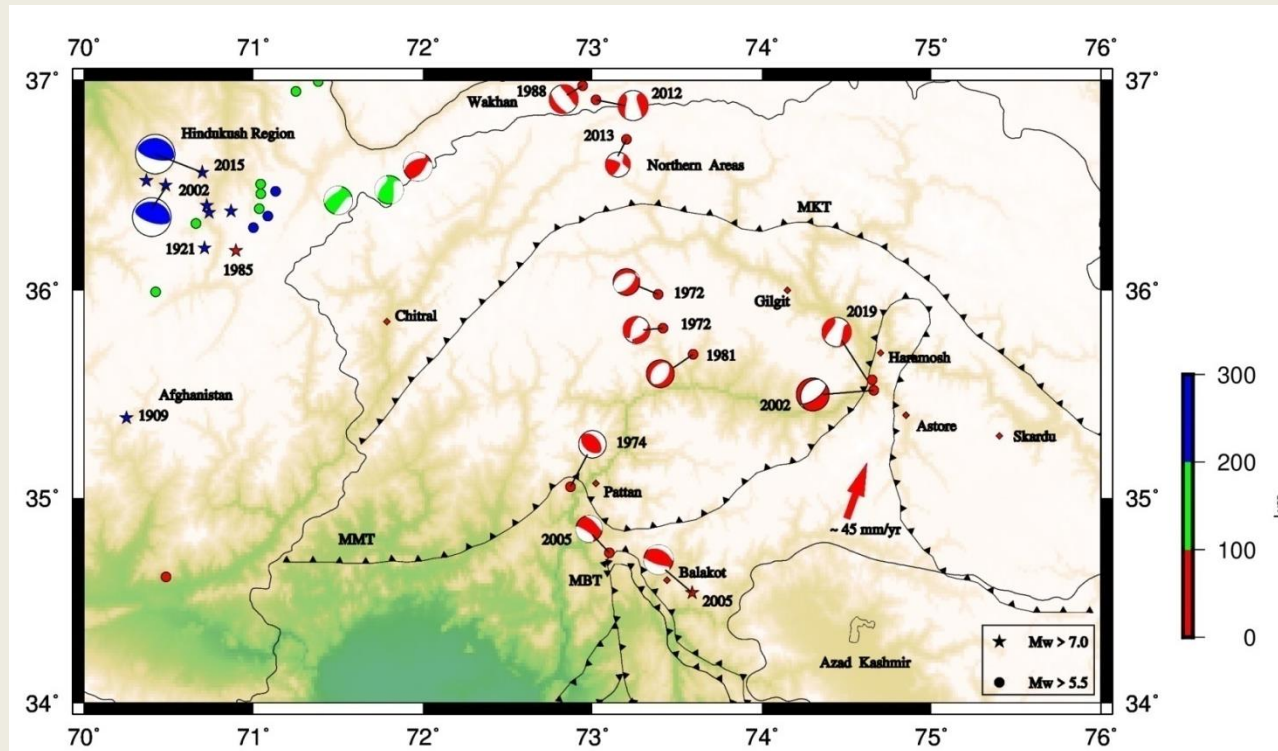
# Major Seismicity Zones Distribution: based on PMD Earthquake catalogue between 1900 - 2022



# Seismicity Profile over Pakistan Region:



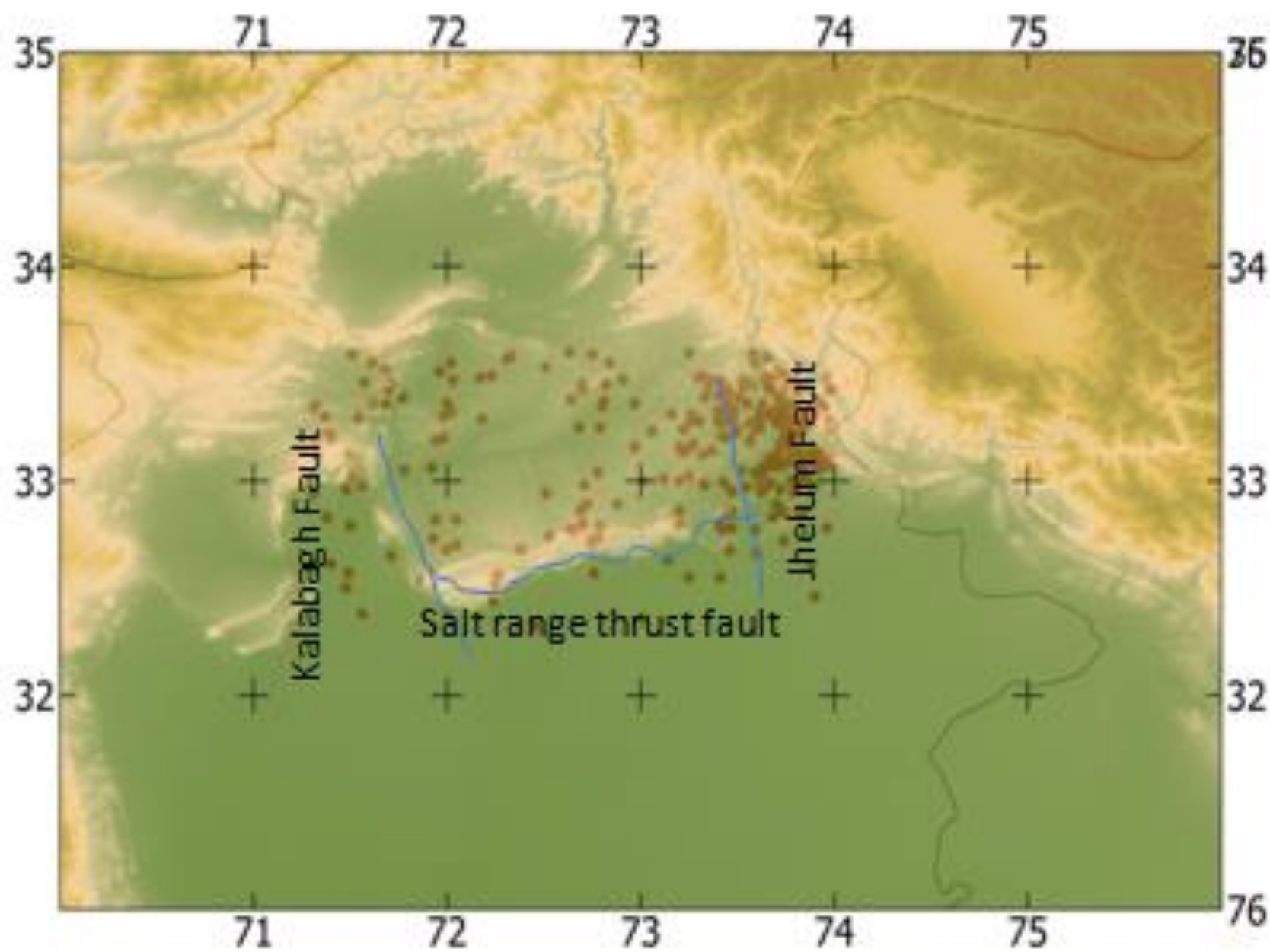
# Northern Areas Pakistan: Seismicity Trend



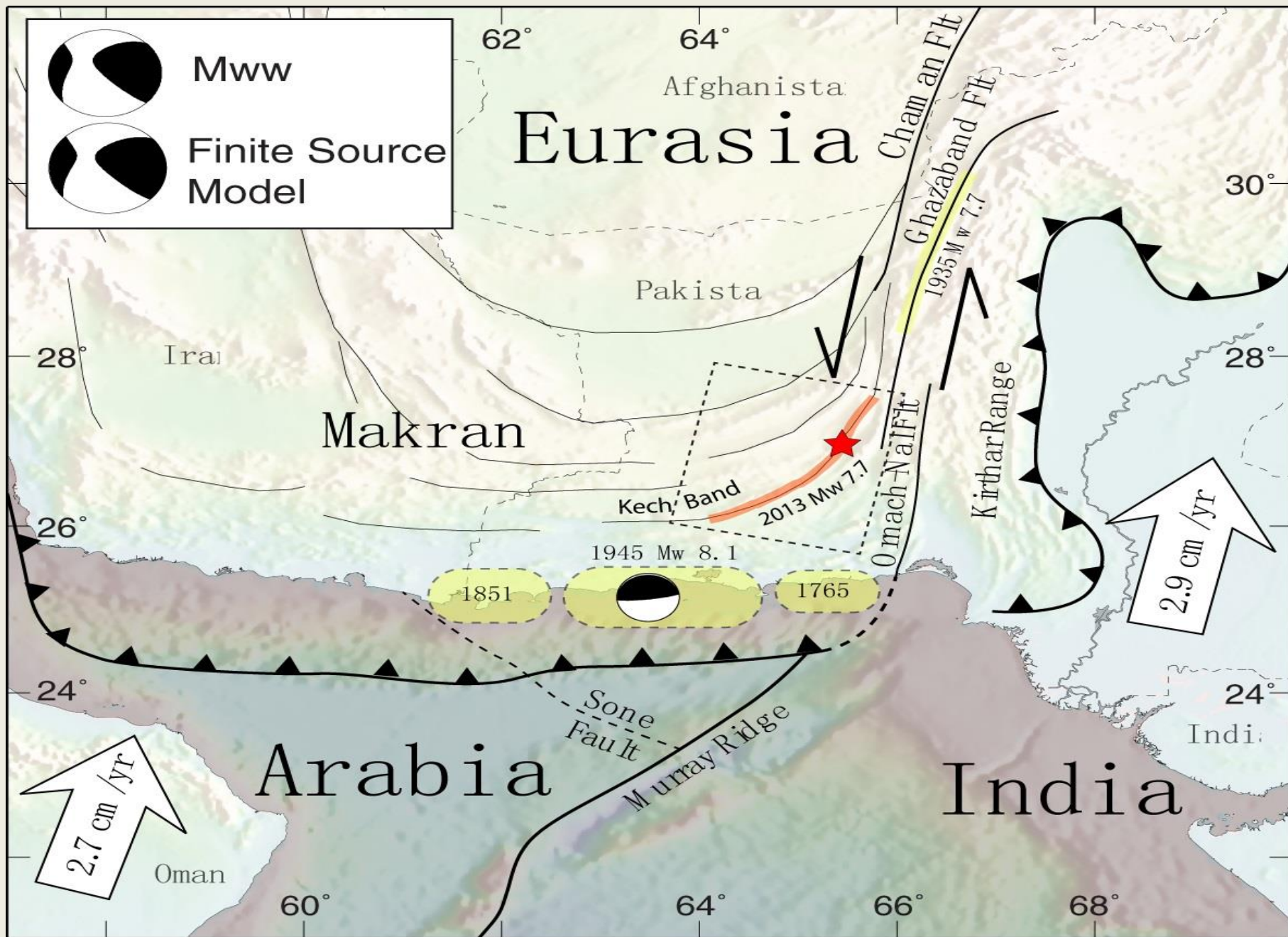
## Significant Earthquakes

Date	Lat (°N)	Long (°E)	Depth (km)	Mw	Epicentre
2005-10-08	34.54	73.59	26	7.6	22 km NE of Muzaffarabad, AJK
2015-10-26	36.52	70.37	213	7.5	Hindu Kush Region, Afghanistan
2002-03-03	36.51	70.48	225	7.4	Hindu Kush Region, Afghanistan
2002-11-20	35.42	74.51	33	6.3	58 km SE of Gilgit, Pakistan

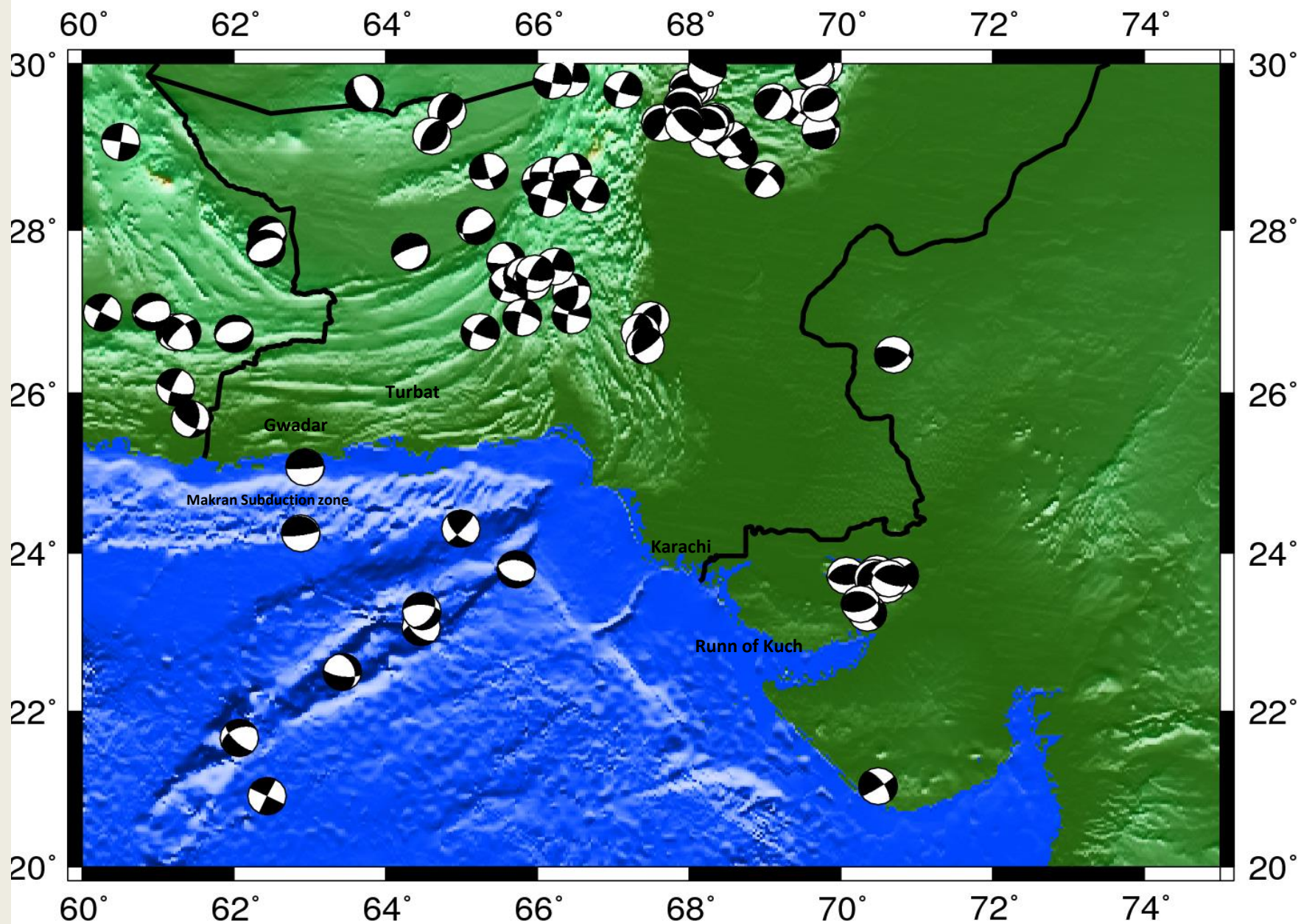




# Southern Fault System

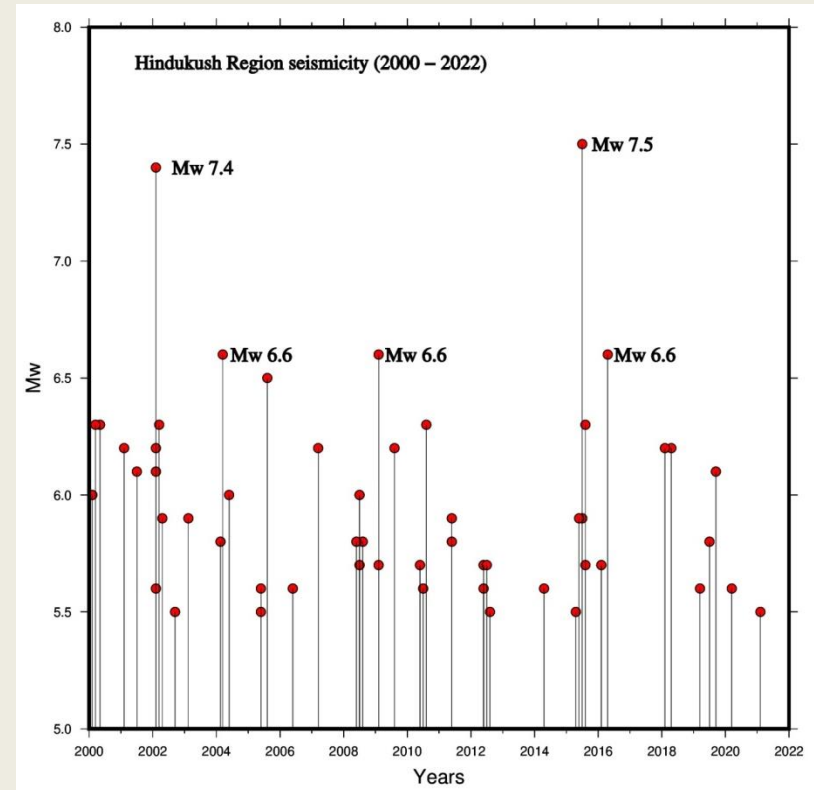
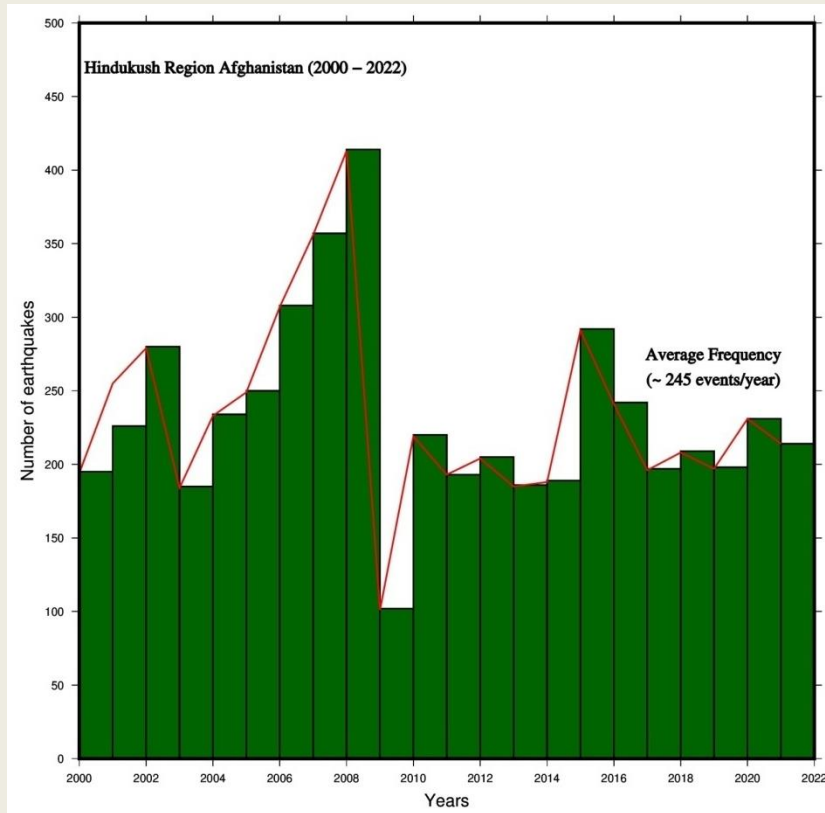




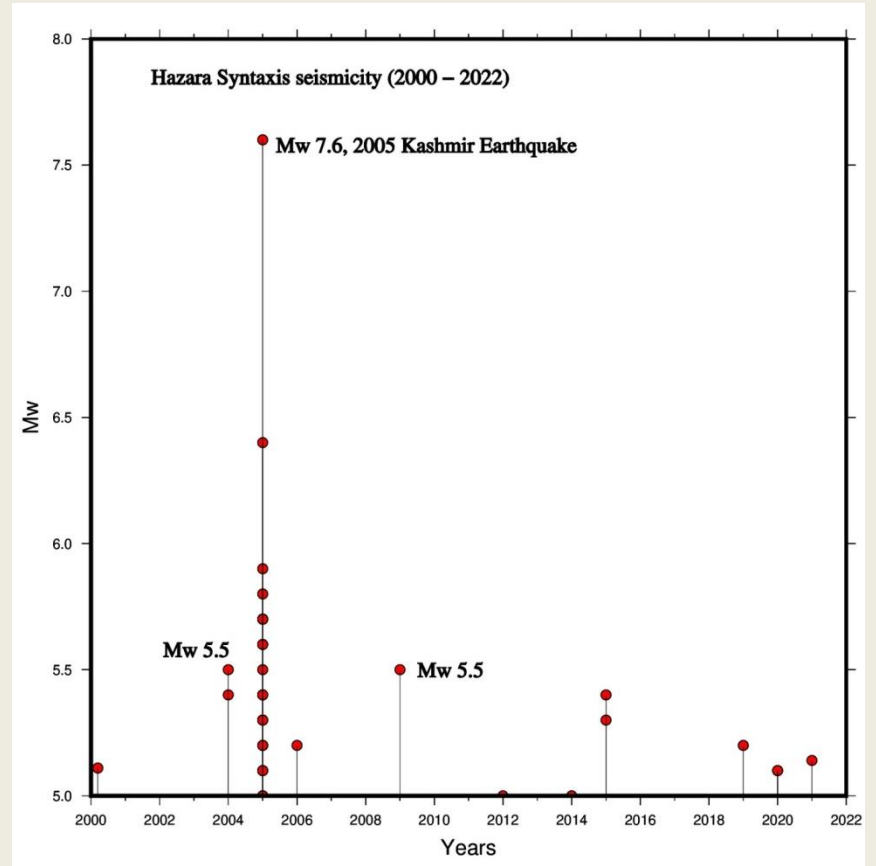
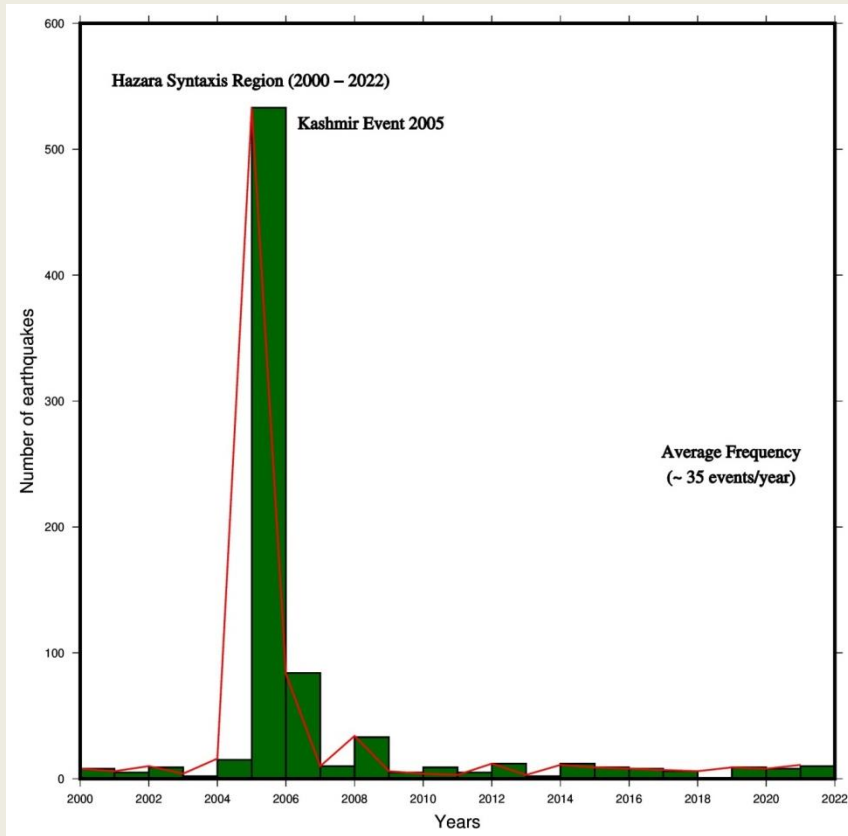




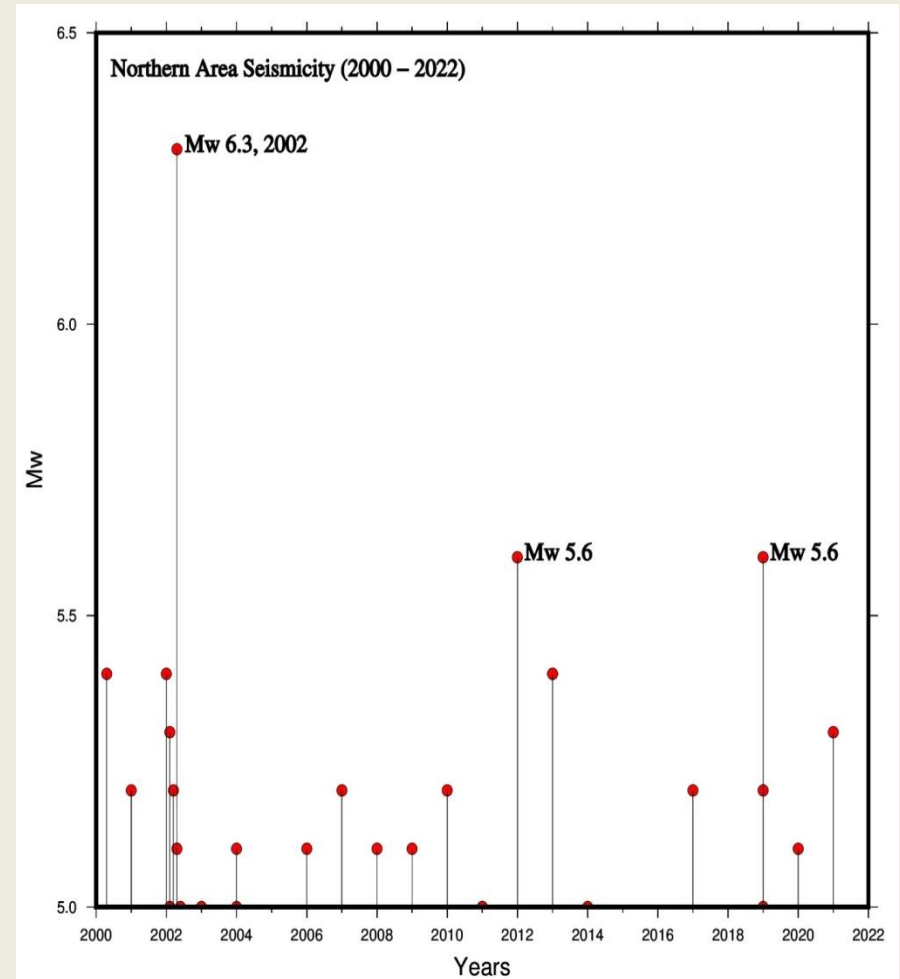
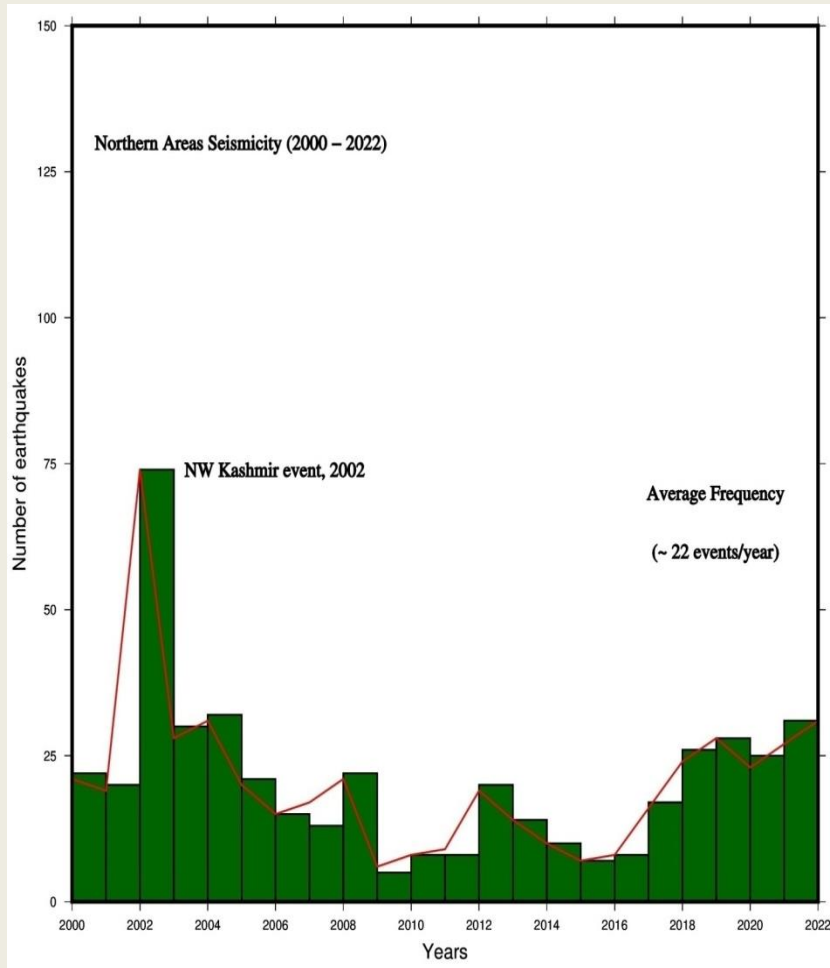
# Hindukush Seismic Zone:



# MBT and Kashmir Boundary Thrust Zone:

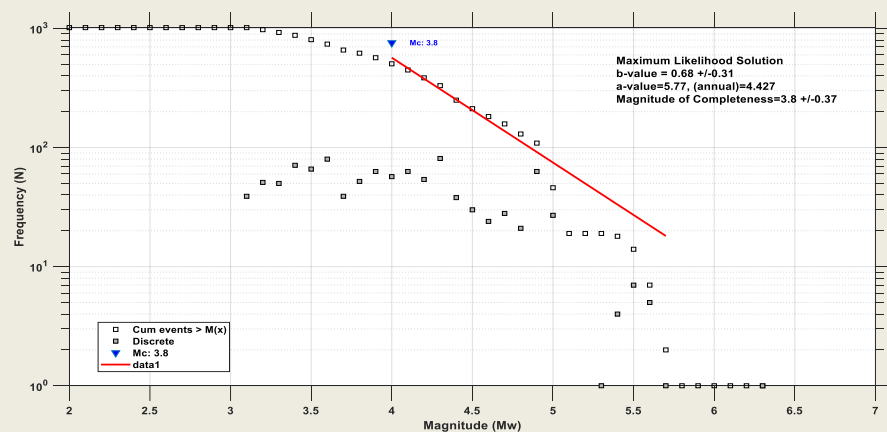
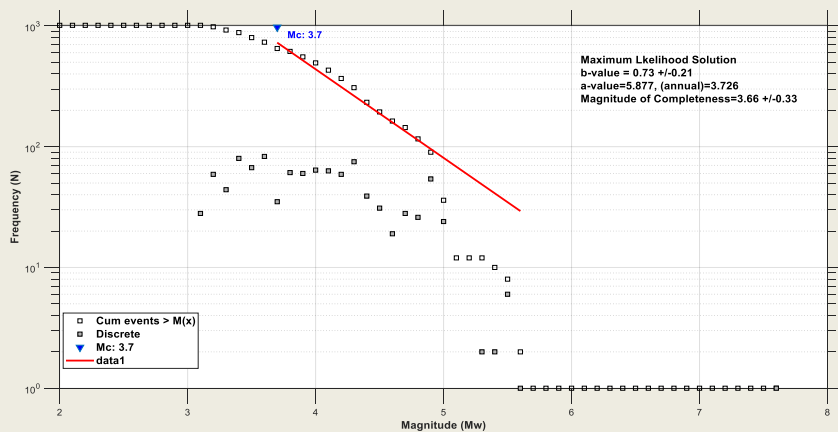
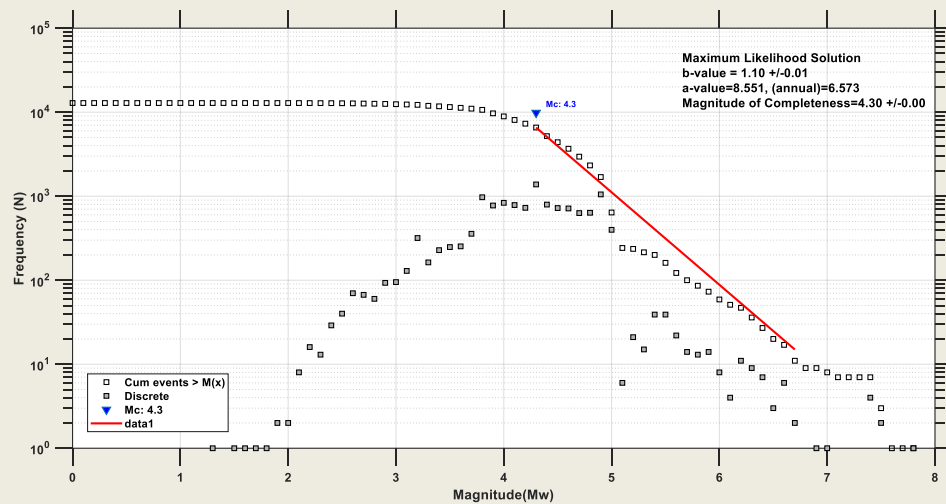


# MMT and MKT Seismic Zone: Northern Areas Pakistan



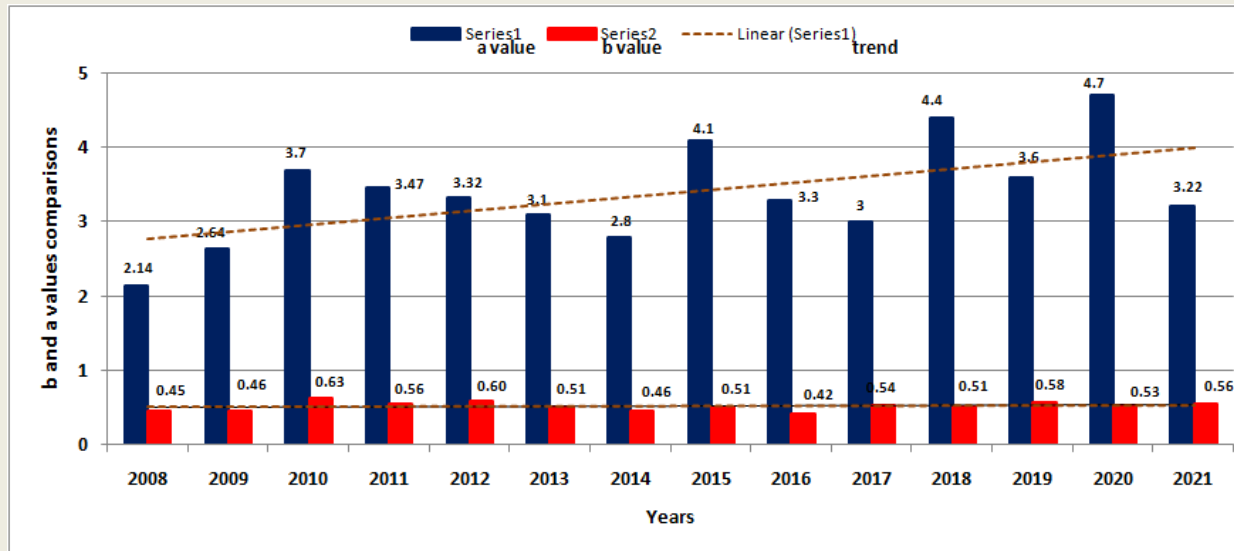


# b-value estimate for Hindukush Region and North Pakistan



**Higher b-value is observed along Hindukush Region ( > 1.0 )**

## b and a value variation for North Pakistan

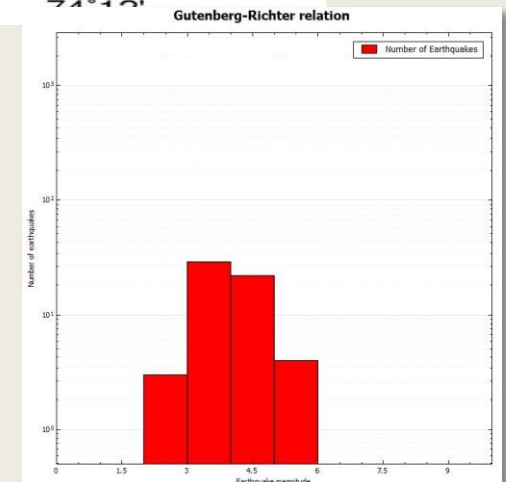
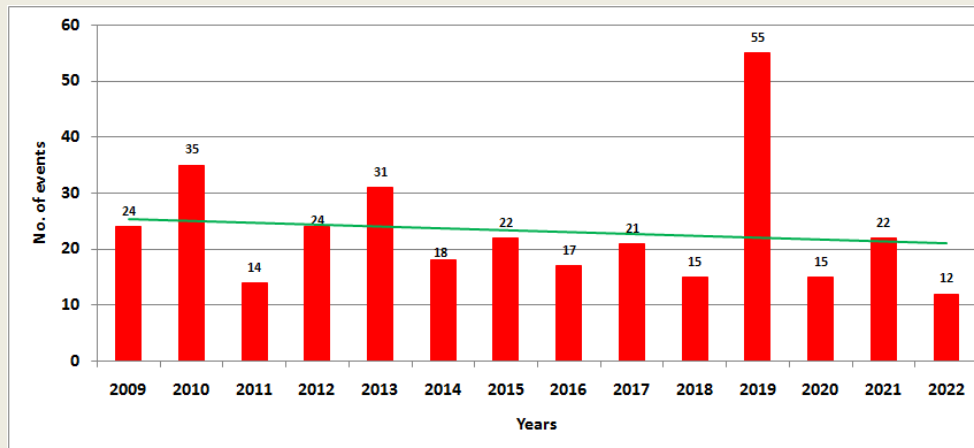
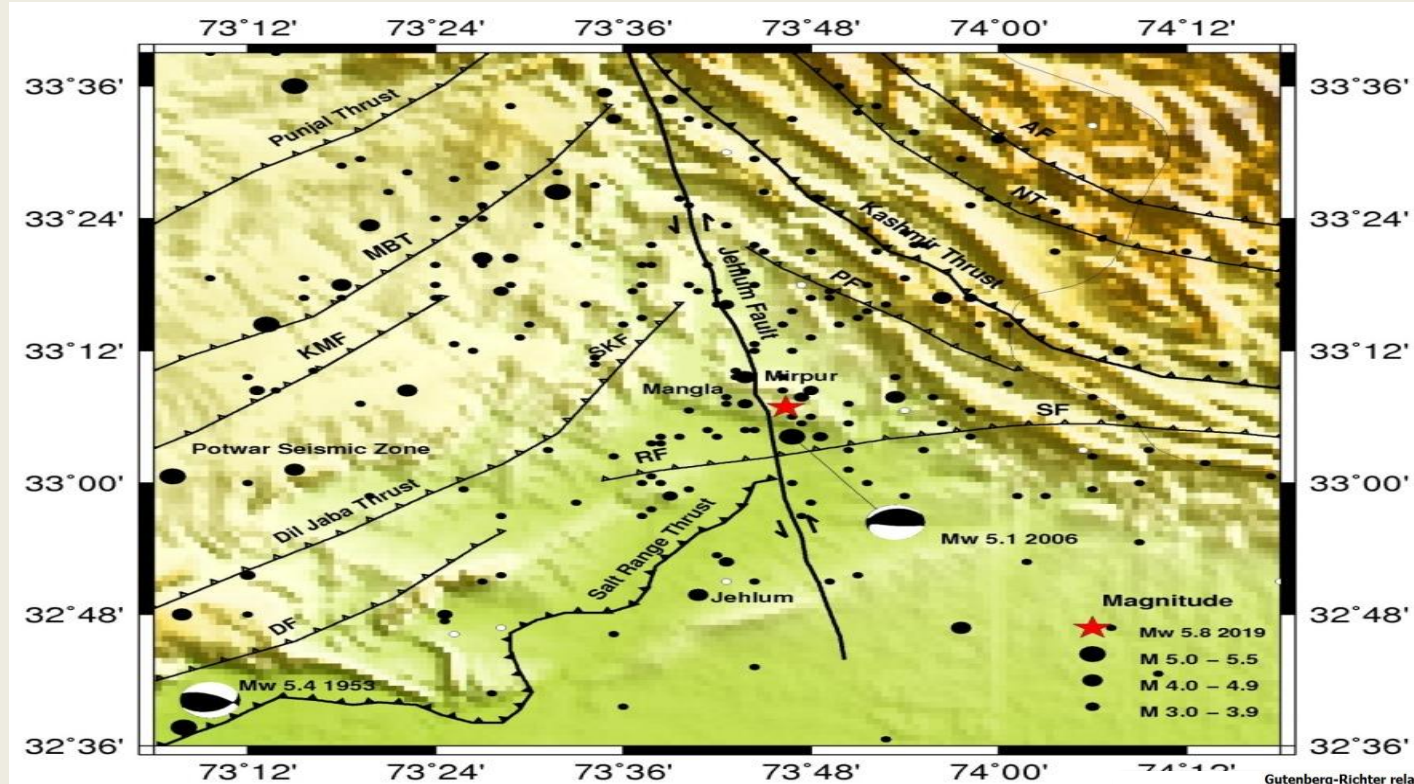


## Significant Earthquakes

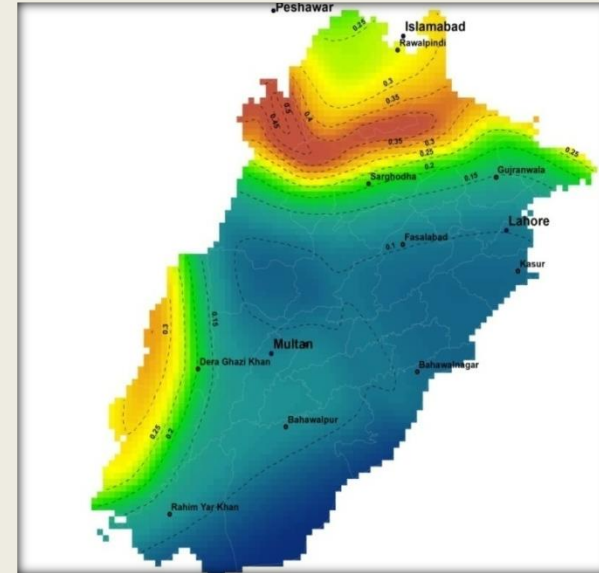
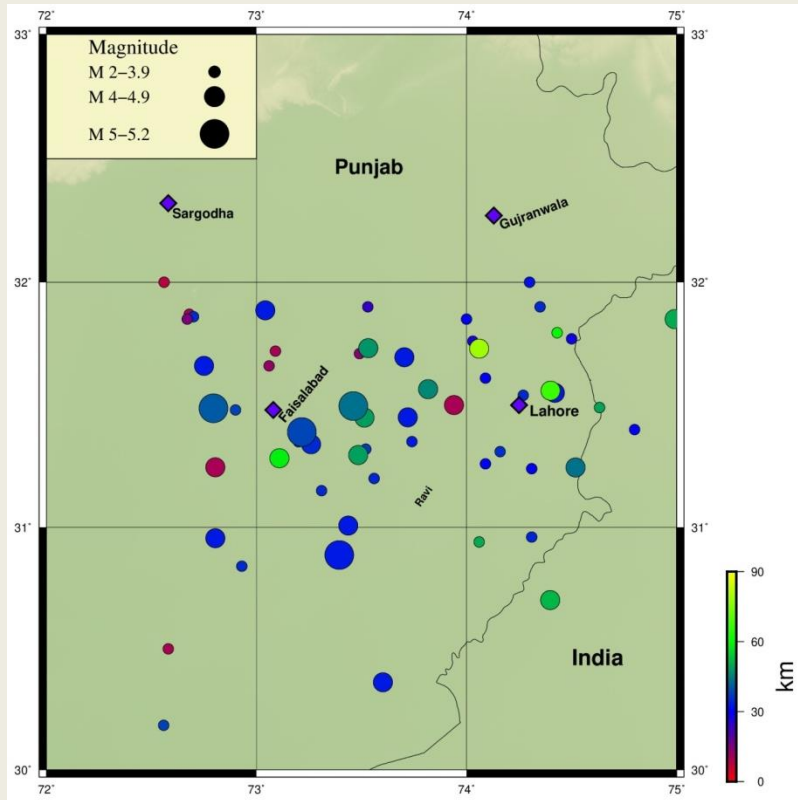
Date	Time	Latitude	Longitude	Depth(km)	Mw	Region
04/04/1905	00:49:59	32.64	76.79	20	7.9	Himachal Pradesh, India
07/07/1909	21:37:47	35.39	70.25	200	7.7	Hindu Kush region, Afghanistan
15/11/1921	20:36:43	36.20	70.71	240	7.8	Hindu Kush region, Afghanistan
04/03/1949	10:19:31	36.56	70.70	229	7.5	Hindu Kush region, Afghanistan
14/03/1965	15:53:07	36.41	70.72	208	7.4	Hindu Kush region, Afghanistan
03/09/1972	16:48:29	35.92	73.42	30	6.2	Northwestern Kashmir
28/12/1974	12:11:44	35.05	72.87	22	6.2	Pakistan
12/09/1981	07:15:54	35.69	73.59	33	6.2	Northwestern Kashmir
20/05/1992	12:20:33	33.38	71.32	16	6.3	Pakistan
20/11/2002	21:32:31	35.41	74.52	33	6.3	Northwestern Kashmir
08/10/2005	03:50:41	34.54	73.59	26	7.6	Muzaffarabad, AJK
26/10/2015	09:09:43	36.52	70.37	231	7.5	Hindukush Region, Afghanistan
24/09/2019	11:18:57	33.11	73.78	11	5.8	Mirpur, AJK



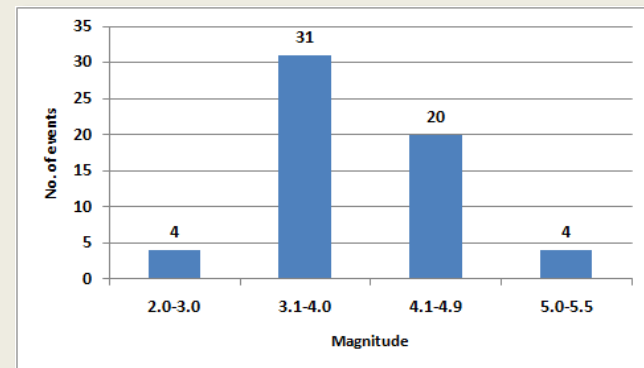
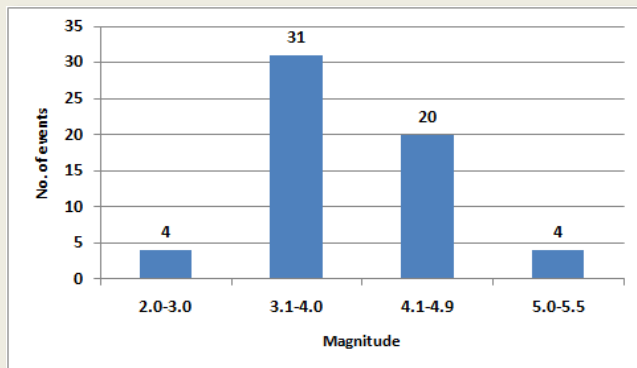
## Mirpur AJK area and Salt Range Seismicity Zone:



# Punjab Plain Seismicity Trend:

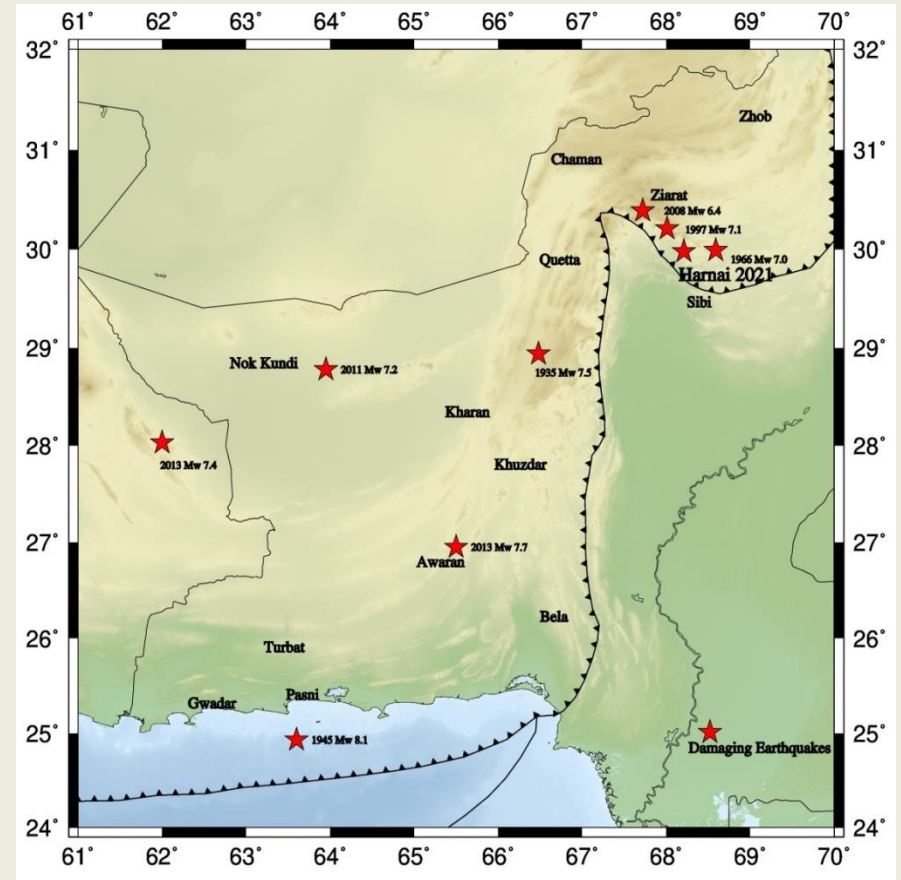
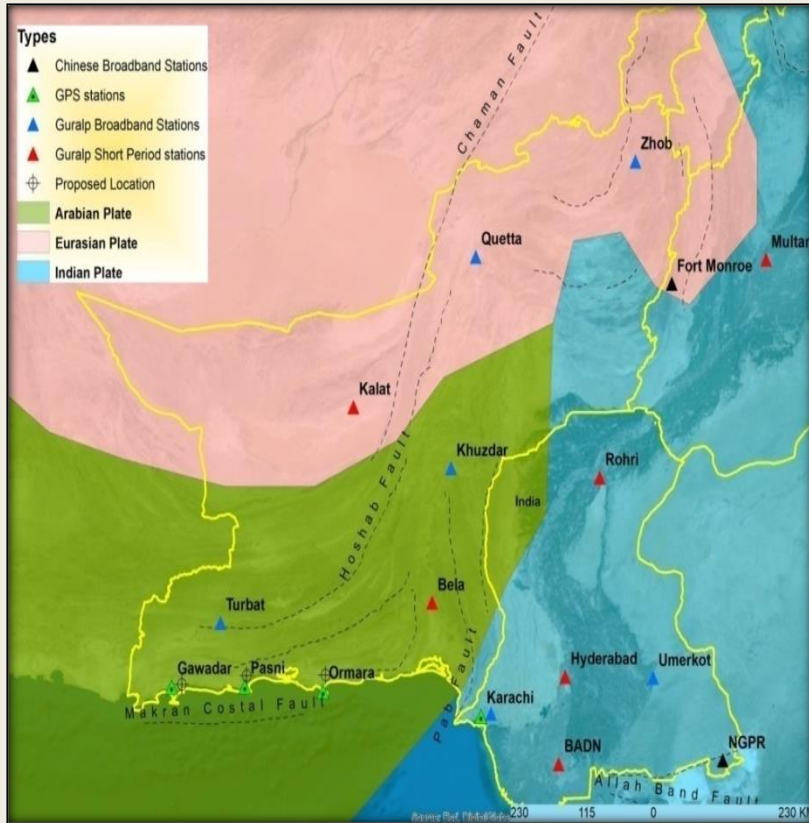


**A low seismicity zone**

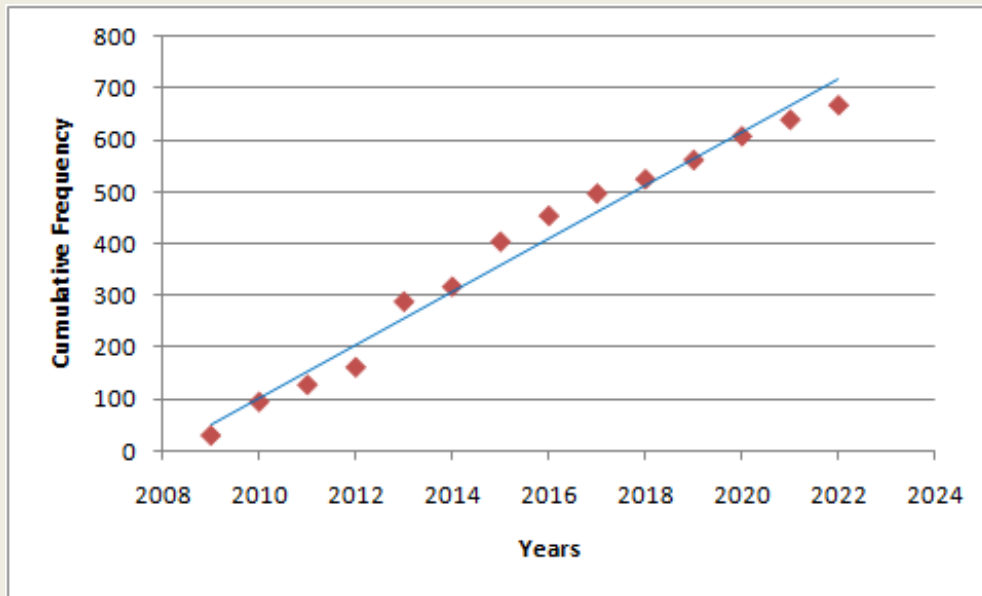




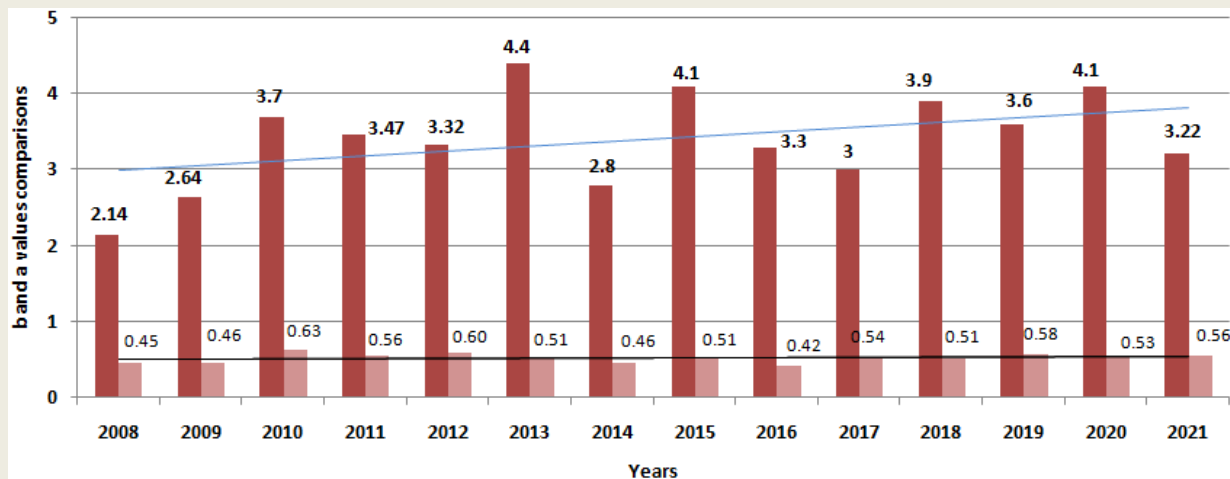
# South-western Pakistan Major Seismic Zones and Seismicity



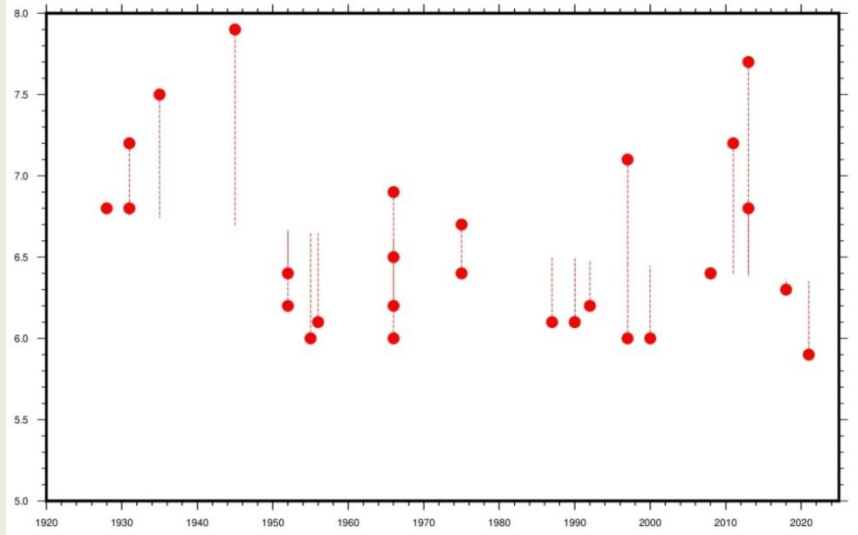
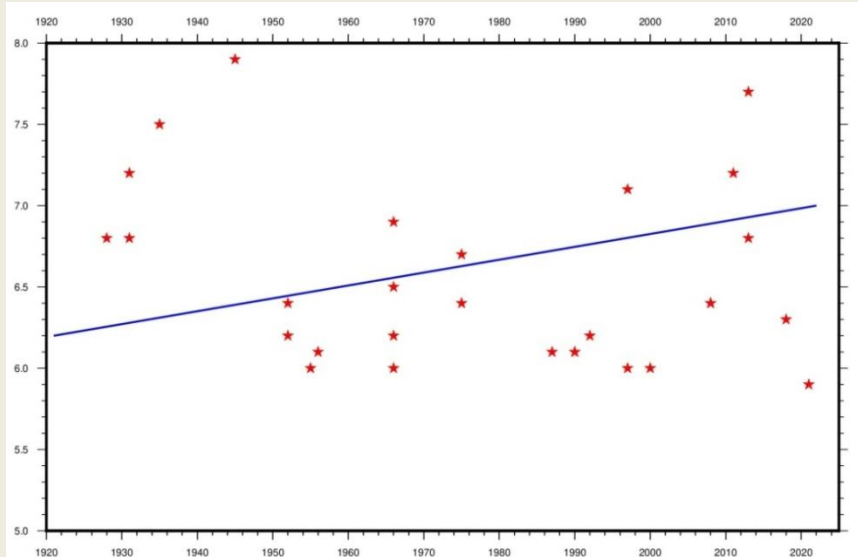
## Recent Seismicity Trend b & a value comparison for South-western Pakistan



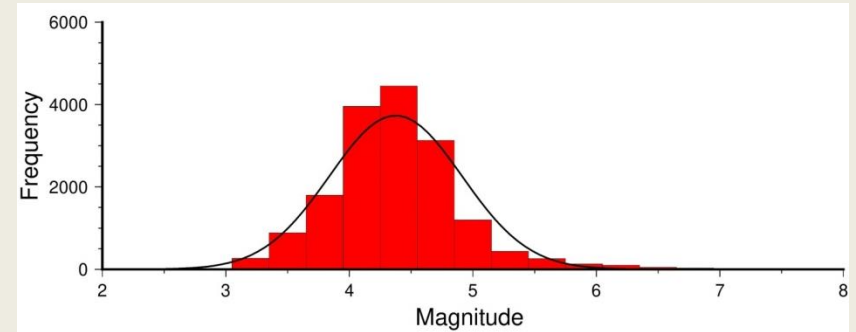
An increasing trend over b – value is observed due to better seismic monitoring in Baluchistan



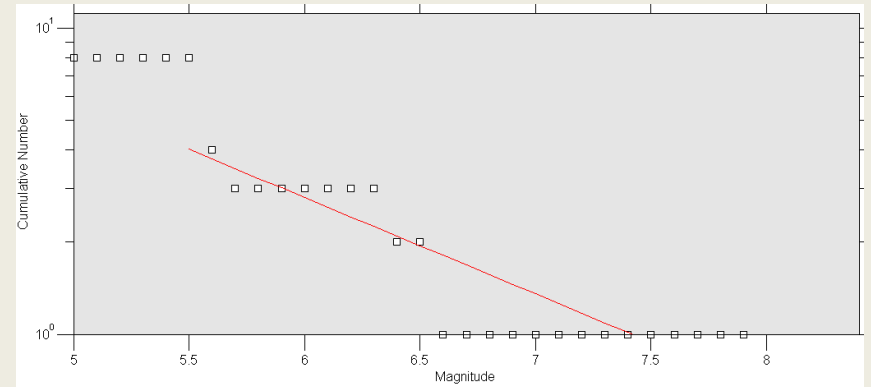
# Seismicity Trend over South-western Pakistan:



## Magnitude trend

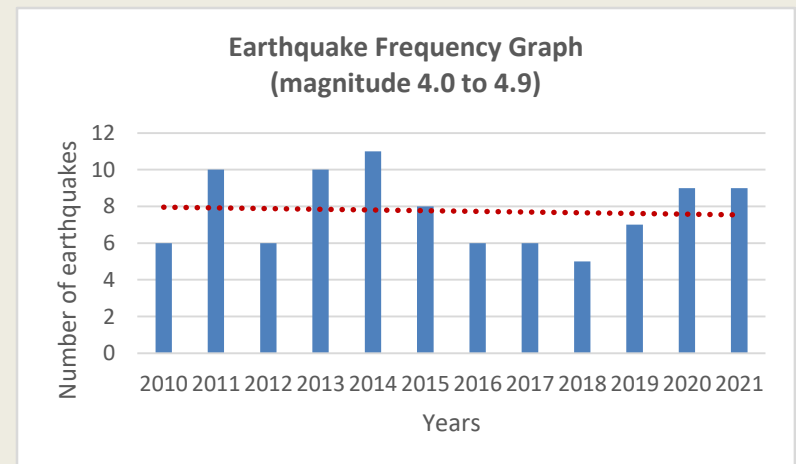
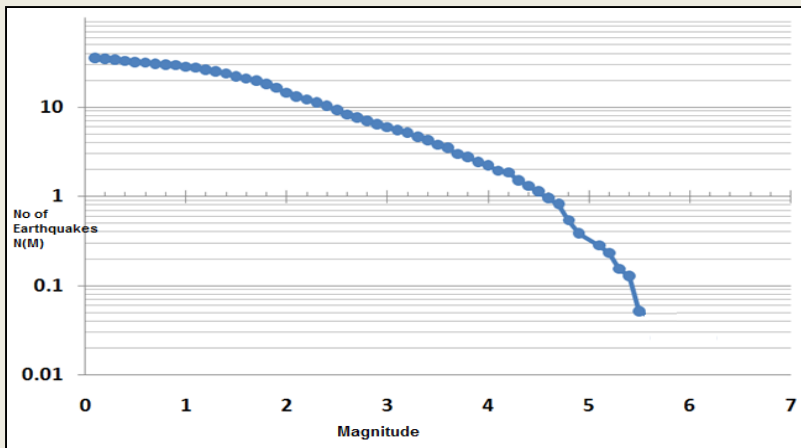
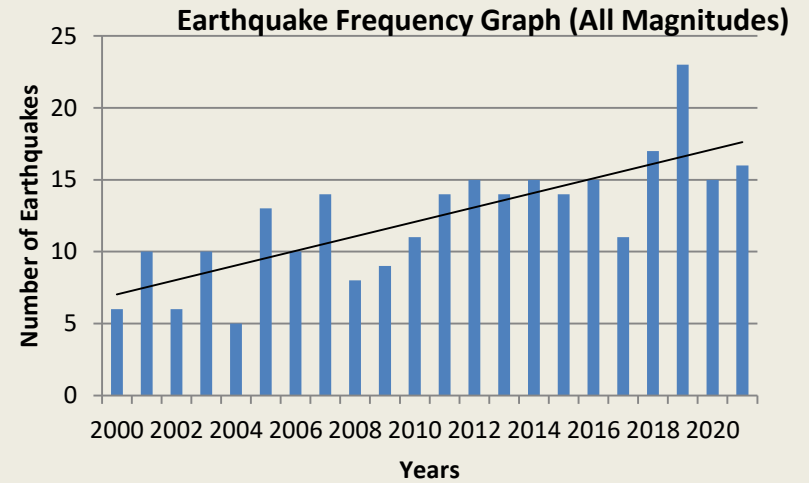
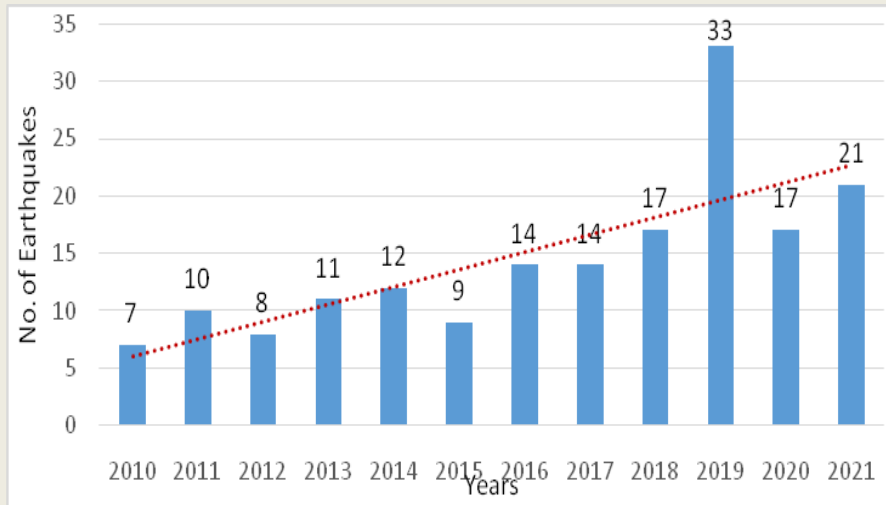


## b-value estimate

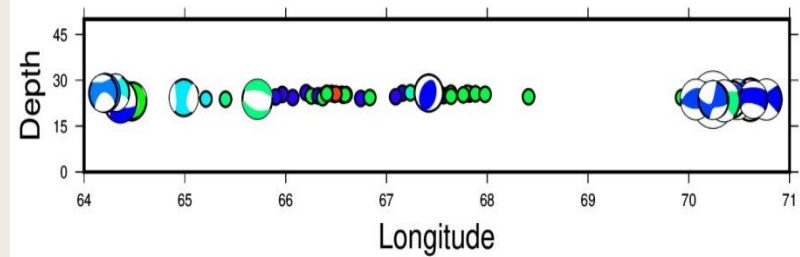
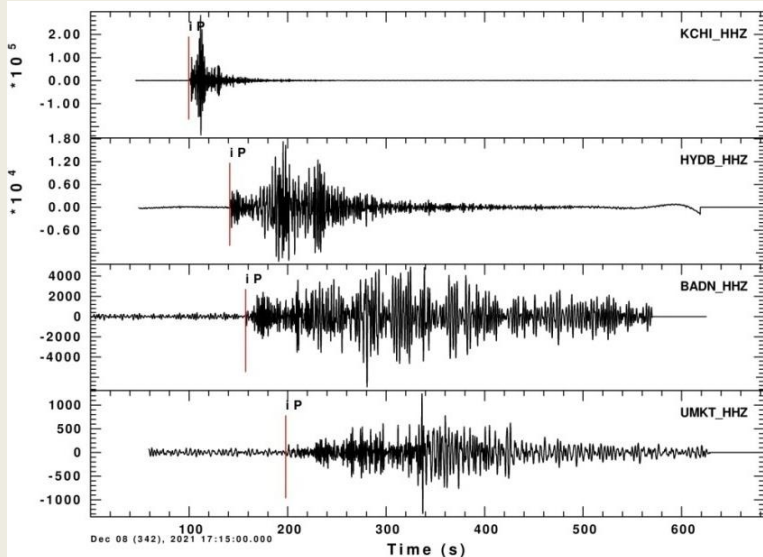
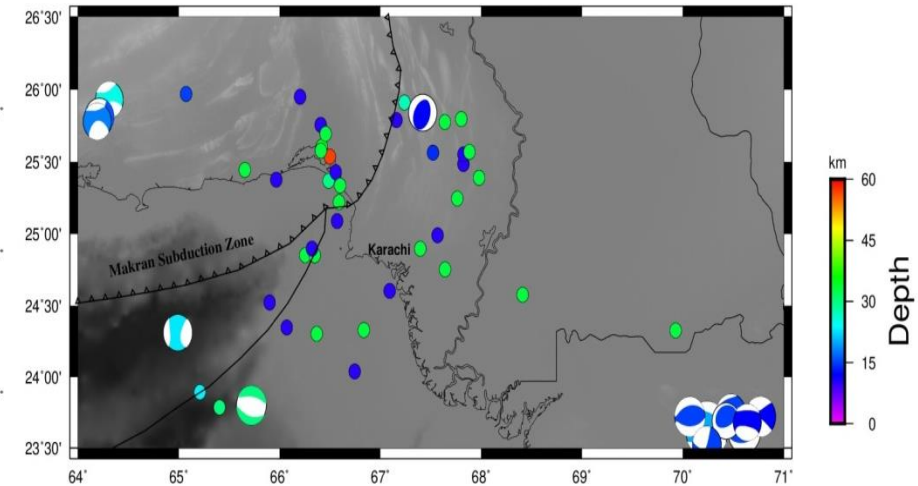
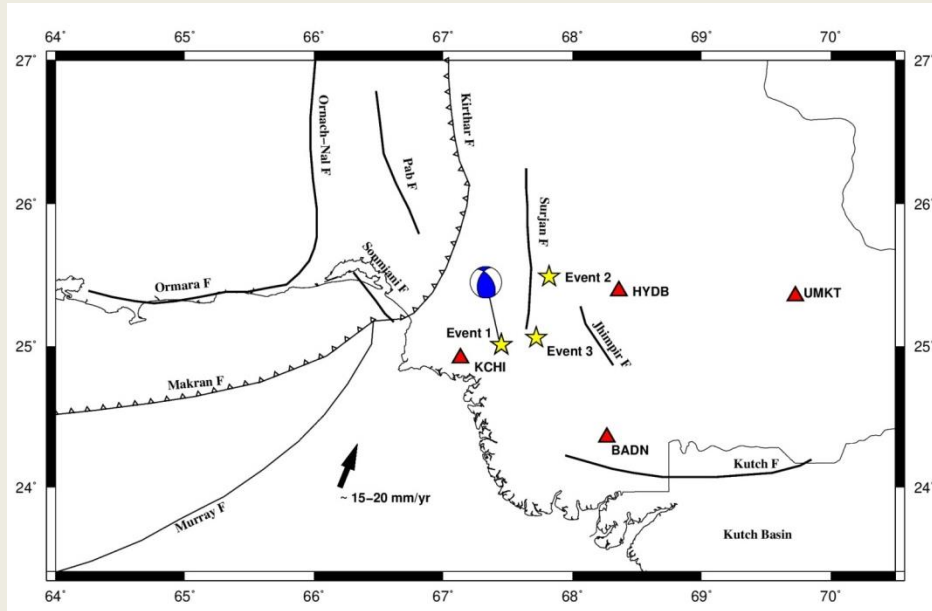




## Yearly basis seismicity trend in Makran and Dalbandin Zone:

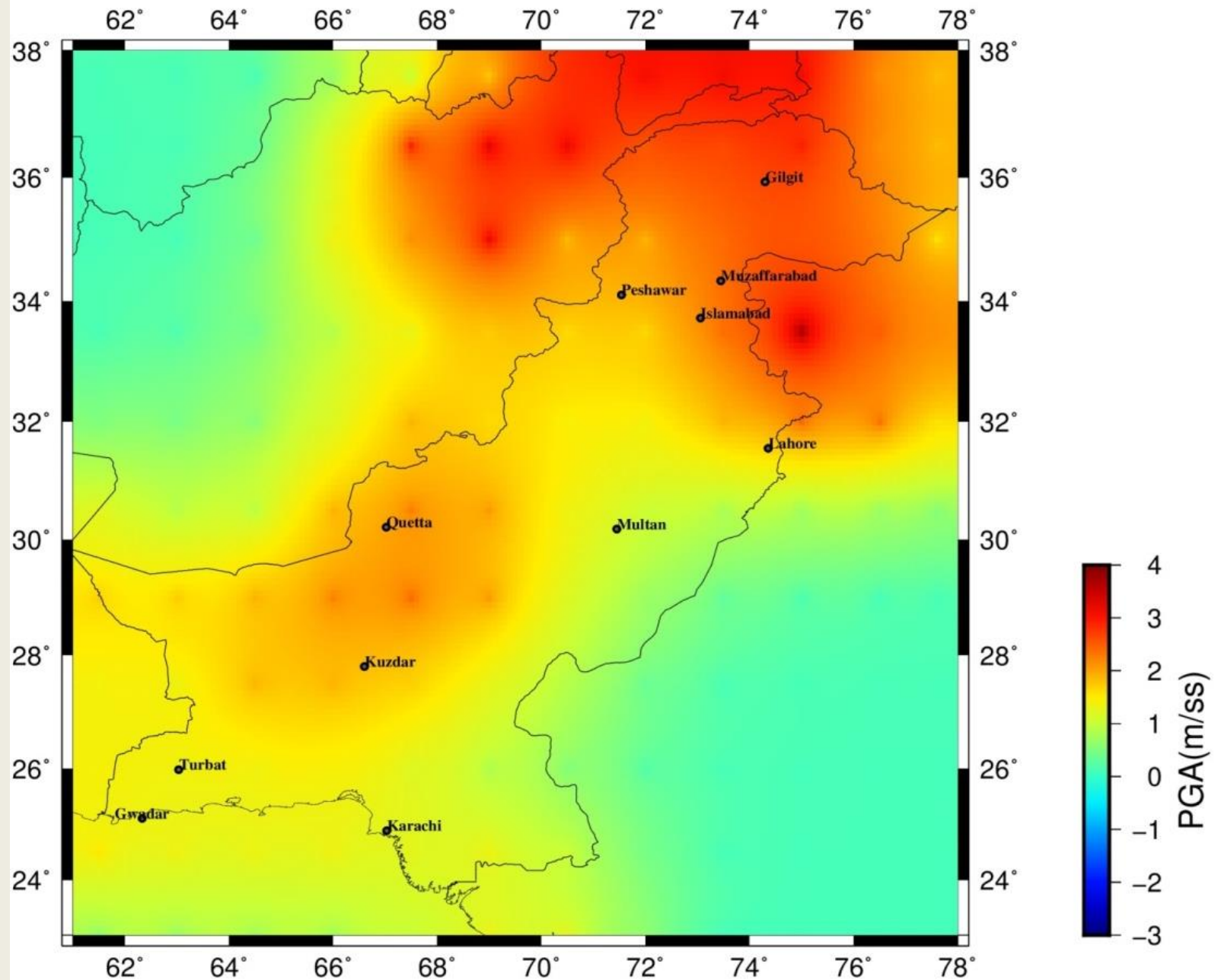


# Major Faults and Recent Seismicity near Karachi:



**3 closer event observed  
near Karachi since 2021: as  
an example**

# Seismic Hazard Map of Pakistan





# Results and Conclusions

1. The results of seismicity trend analysis indicate that more than 15000 earthquakes occurred between 2000-2022.
2. Higher frequency of earthquakes is in the Hindukush region as compared to rest of the areas in Pakistan.
3. An increasing annual seismicity trend is observed , however b value is nearly same.
4. Hazara Kashmir Syntaxis, Northern Pakistan and south-western Pakistan Chaman Fault zone are seismically active regions which produce shallow earthquakes.
5. The maximum earthquake magnitude potential observed in the Hindukush region is  $M_w > 7.0$  with a probability of occurrence 10-15 years and  $M_w > 6.5$  in 5 - 7 years period from the recent earthquake patterns.
6. Hazara-Kashmir Syntaxis region has potential of  $M_w > 7.0$  earthquakes but it takes about 100 years longer time. Northern Pakistan region has potential of  $M_w > 6.0$  with a probability of occurrence 20-30 years. Higher b-values, annual seismicity rate (a-value) show high tectonic stress release.
7. Chaman Fault Zone also has potential of  $M_w > 7.0$  earthquakes but it takes about 100 years or more while Makran Subductuon zone has higher potential of large earthquakes but slow plate movement rate is present.

Thank you