

# DAMAGING EARTHQUAKES IN AFRICA

Seismotectonic background & Seismic Hazard Implications

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International Conference on Impact of Natural Hazards in Africa  
Lessons from 1992 Cairo Earthquake - 23-26 October 2017, Cairo, Egypt

# Early earthquake studies in Africa



Jalal Al-Din Al SUYUTI (1445 – 1505)  
Catalogue of 135 earthquakes  
Macroseismic scale



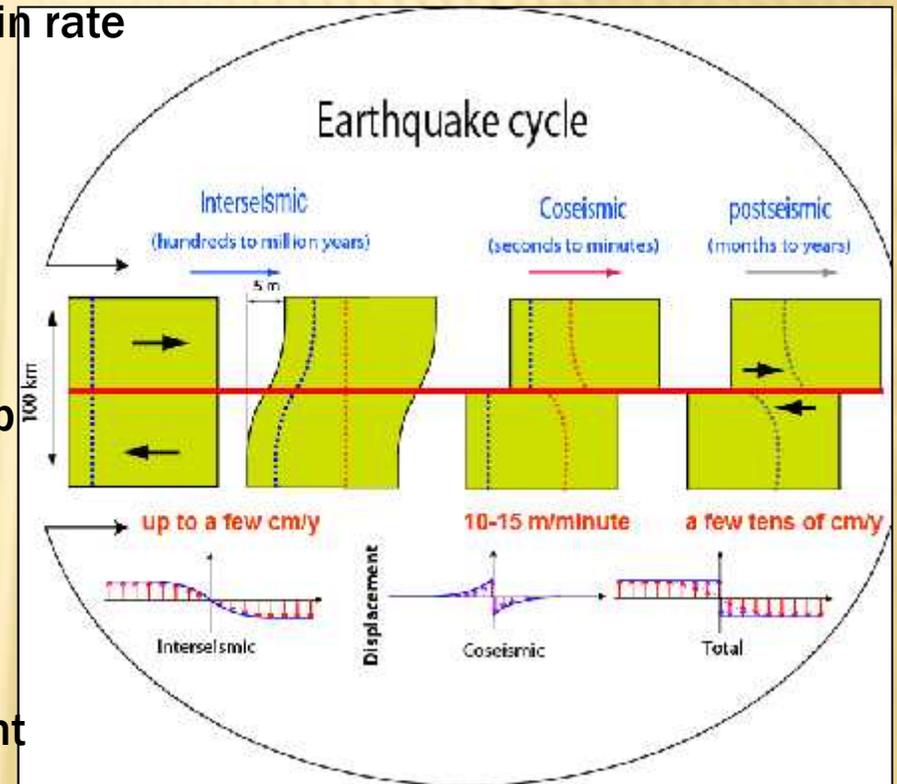
Nicholas AMBRASEYS (1929 – 2012)  
Earthquake geology - engineering  
Parametric seismicity catalogue

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# Damaging Earthquakes in Africa

## Earthquake Geology and Seismotectonics

- How faults generate earthquakes (distribution, kinematic & strain rate)
- Crustal structures, seismogenic layer and strain rate
- Elastic rebound and the 'seismic cycle'
  - preseismic movements
  - co-seismic rupture
  - afterslip and postseismic relaxation
- Interseismic loading, stress and strain build up
  - paleoseismology
- Mechanical models of faulting behaviour
- Regional seismotectonic models
- Seismic zoning for Seismic Hazard Assessment

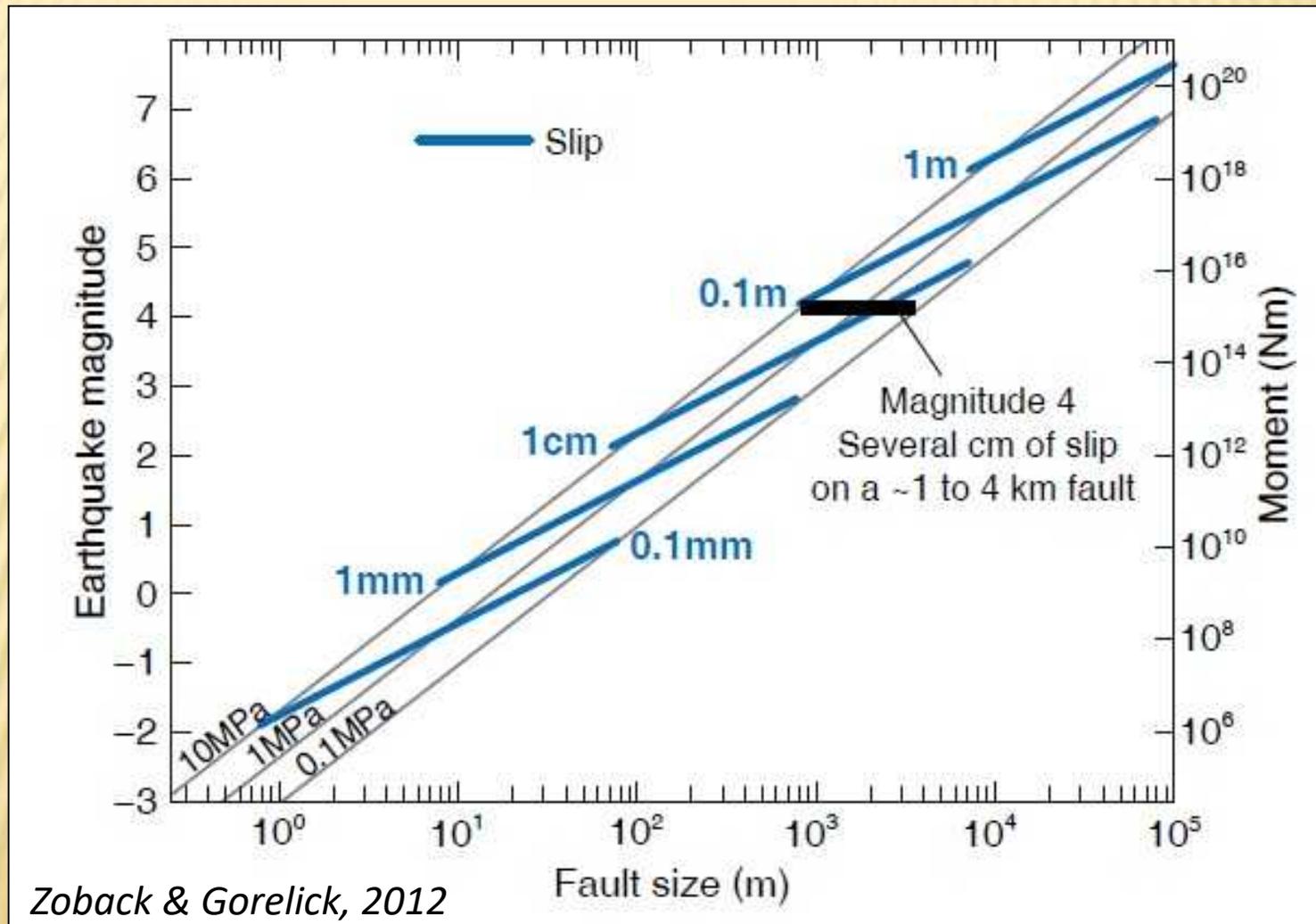


$$M_o = \sim \iint_S U \, dS$$

$$\dot{M}d = \sim \iint_S (\dot{U}_\infty - \dot{U}) \, dS$$

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## Earthquake Geology and Seismic Sources



# The Seismotectonic Map of Africa



## THE IGCP-601 WORKING GROUP (2011 – 2016)

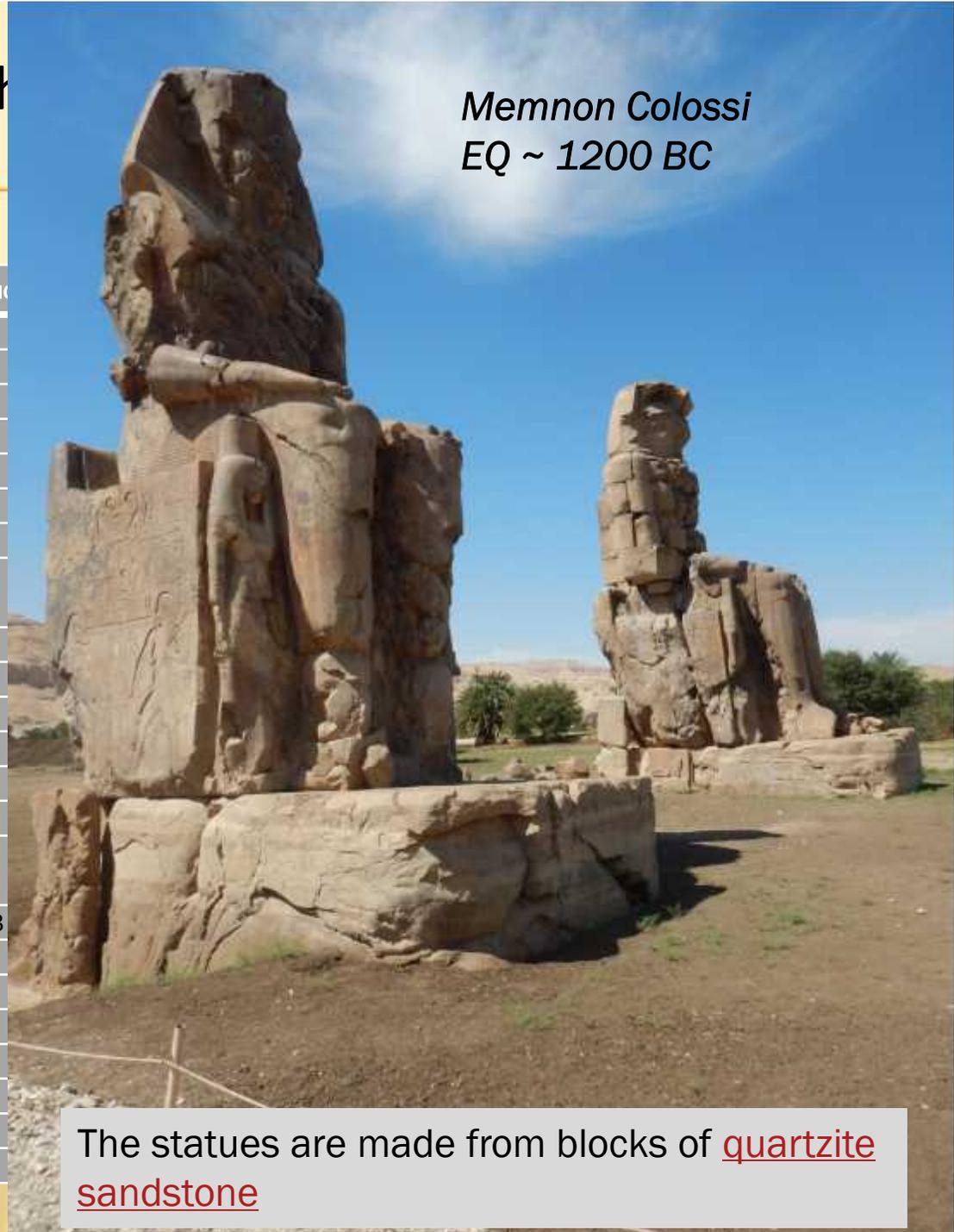
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- ❑ Hesham Hussein & Mohamed El Gabry (NRIAG, Egypt)
- ❑ Atalay Ayele (Addis Ababa University, Ethiopia)
- ❑ Ateba Bekoa (Buea University, Cameroun)
- ❑ Vunganai Midzi & Magda Roos (Council for Geoscience, South Africa)
- ❑ Paulina Amponsah (Ghana Atomic Energy Commission)
- ❑ Djillali Benouar & Abdelhakim Ayadi (USTHB-CRAAG, Algeria)
- ❑ Nacer Jabour & Youssef Timoulali (CNRST, Rabat, Morocco)
- ❑ Abdunnur Bensuleman (University of Tripoli, Libya)
- ❑ Damien Delvaux (Musée Central de l'Afrique, Belgium)
- ❑ Mourad Bezzeghoud & Rui-Manuel Fernandes (FCT, Portugal)



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# Damaging Earth

Earthquakes	Dates	Latitude	Longitude
Lac Tanganyika	1910 Dec. 13	-6.5	29.5
El-Asnam, Algeria	1980 Oct. 10	36.23	1.32
Nuweiba, Egypt	1995 Nov. 22	28.81	34.80
Juba, South Sudan	1990 Mai 20	5.11	32.18
Subukia, Kenya	1928 Jan. 6	0.4	36.11
Al-Qadahia, Libye	1935 Apr. 19	31.38	15.4
Machaze, Mozambique	2006, Feb. 22	-21.32	33.58
Kalemie, Congo-Tanzania	2005 12 5	-6.25	29.79
Zemmouri, Algeria	2003, May 21	36.83	3.65
Orleansville, Algeria	1954 Sep. 9	36.28	1.47
Salima, Malawi	1989 Mar. 10	-13.71	34.49
Accra, Ghana	1939 Jun. 22	5.18	0.13
El-Hoceima, Morocco	2004, Feb. 24	35.14	-4
Dobi, Ethiopia	1989 08 20	11.75	41.96
Ceres, West Cape, S. Africa	1969 Sept. 29	-33.36	19.31
Kivu, DR Congo	2002 Oct. 24	-1.905	29.013
Karonga, Malawi	2009 Dec. 19	10.108	33.81
Gaoual, Guinea	1983 Dec. 22	11.95	-13.6
Mascara, Algeria	1994 Aug. 18	35.45	0.08
Bukavu, DR Congo	2008Fev. 2	28.74	-2.45
Rukwa, Tanzania	1994 Aug. 18	6.5	29.5
Agadir, Morocco	1960 Fev. 28	30.41	-9.6
Cairo, Egypt	1992 Oct. 12	29.78	31.14



*Memnon Colossi  
EQ ~ 1200 BC*

The statues are made from blocks of quartzite sandstone

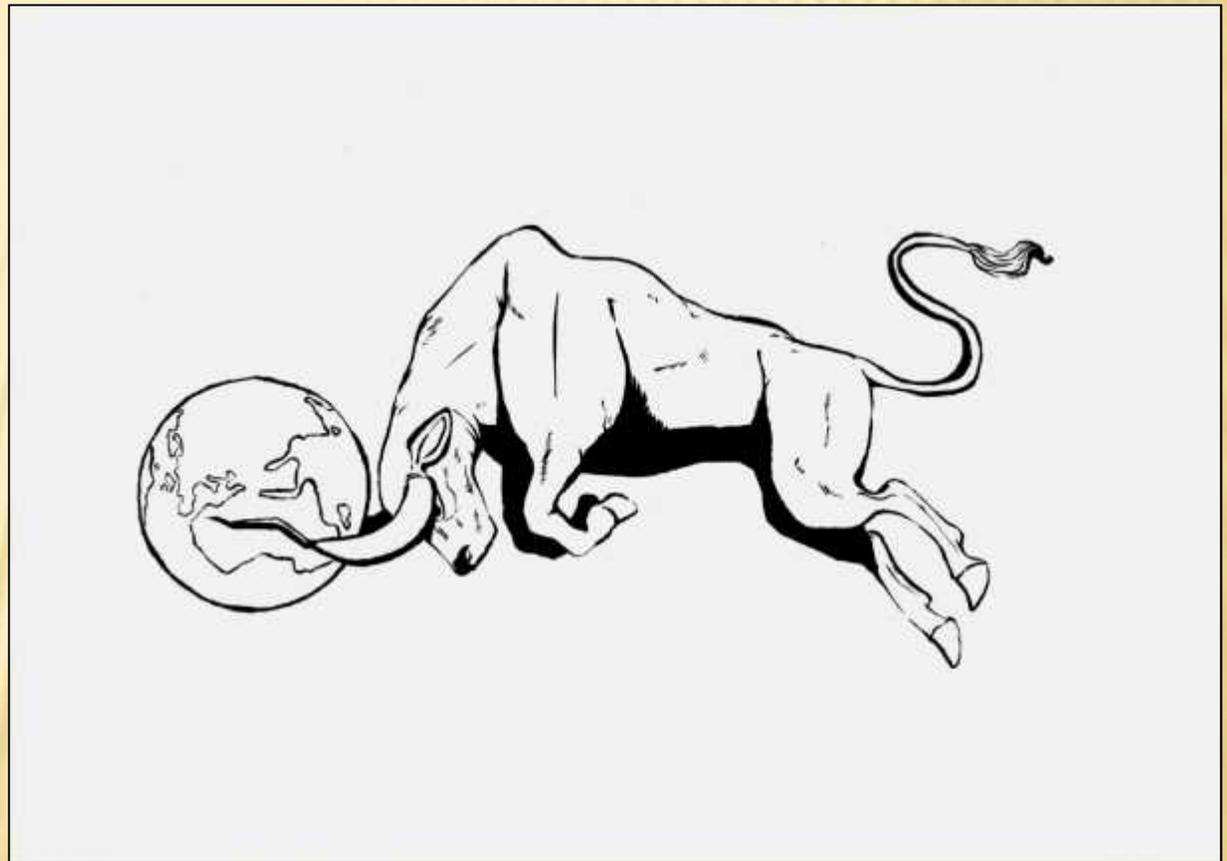
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## The mythology

*Gnami Gnami*



*Zelzal el Ferd*



*12 October 1992 Cairo earthquake (Ms 5.8 )*

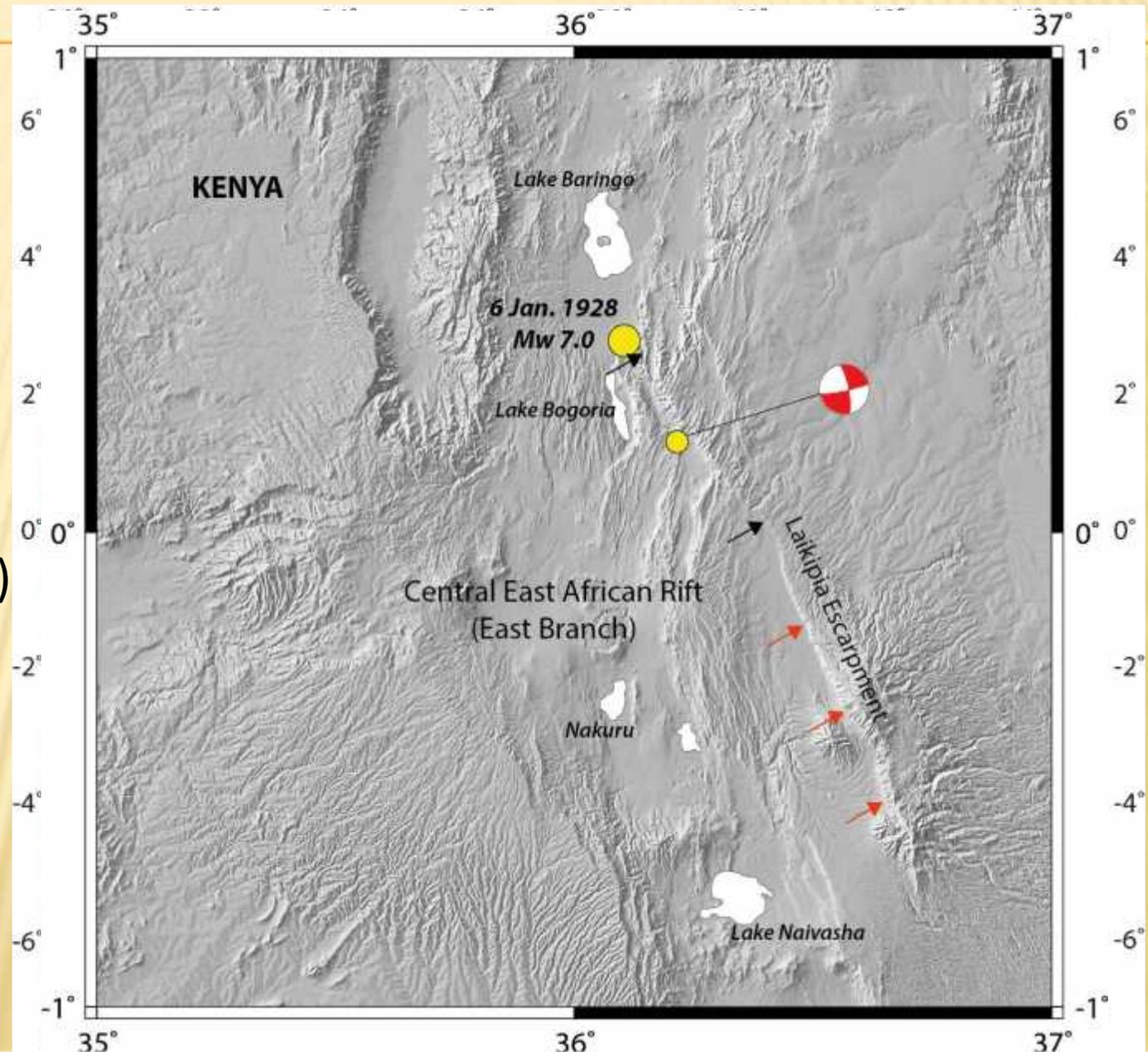


# Zemmouri earthquake near Algiers 23/05/2003, Mw 6.8



## *Subukia earthquake, 6 January 1928 Mw 7.0*

38-km-long fault  
2.4 m throw on  
normal fault  
(Ambraseys, 1991)

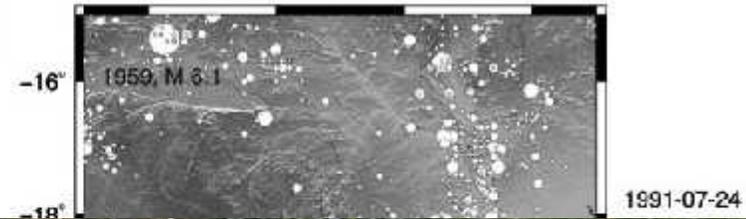


# *Machaze eq., Mw 7.0, 22 February 2006*

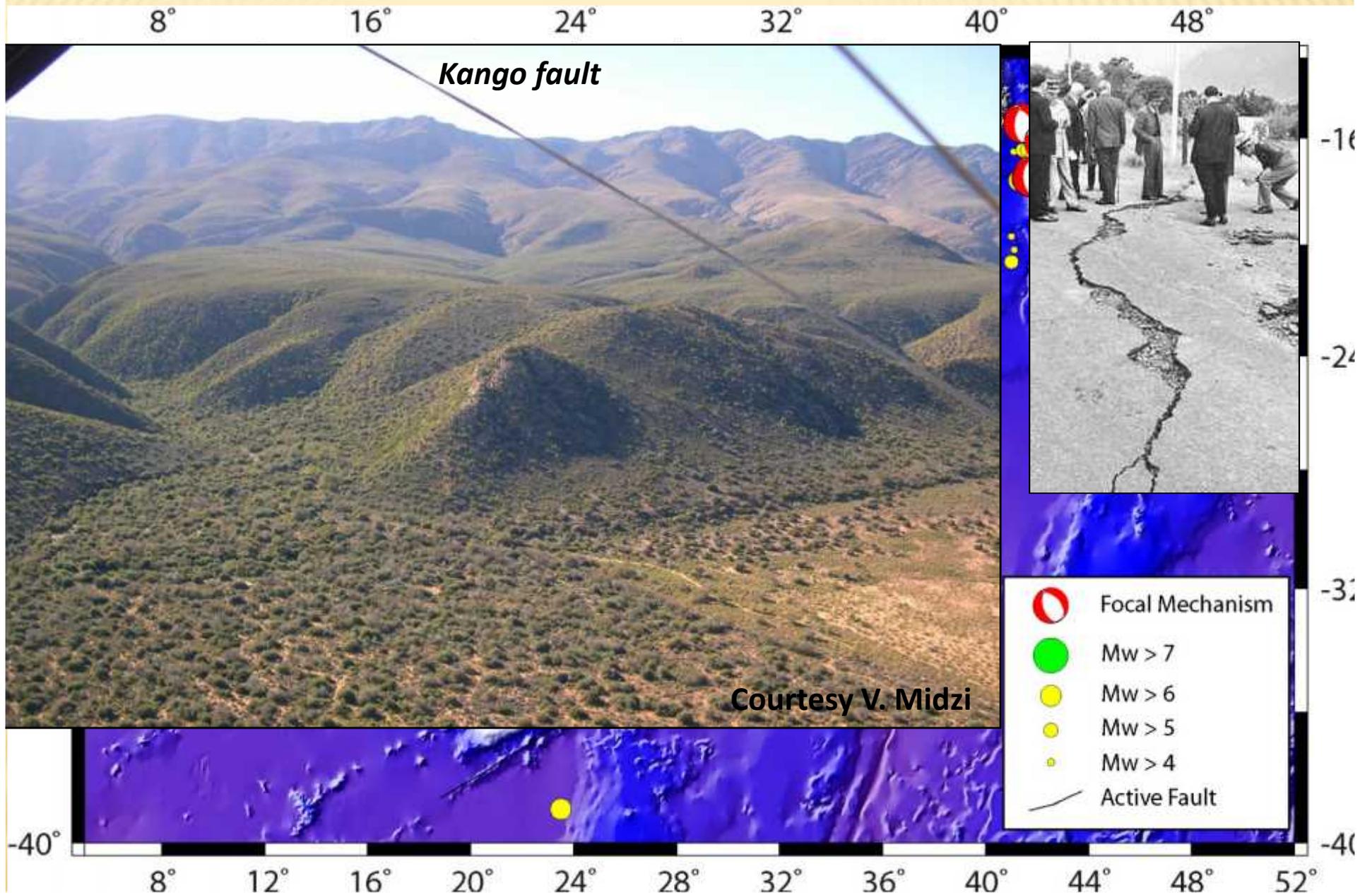
(a)



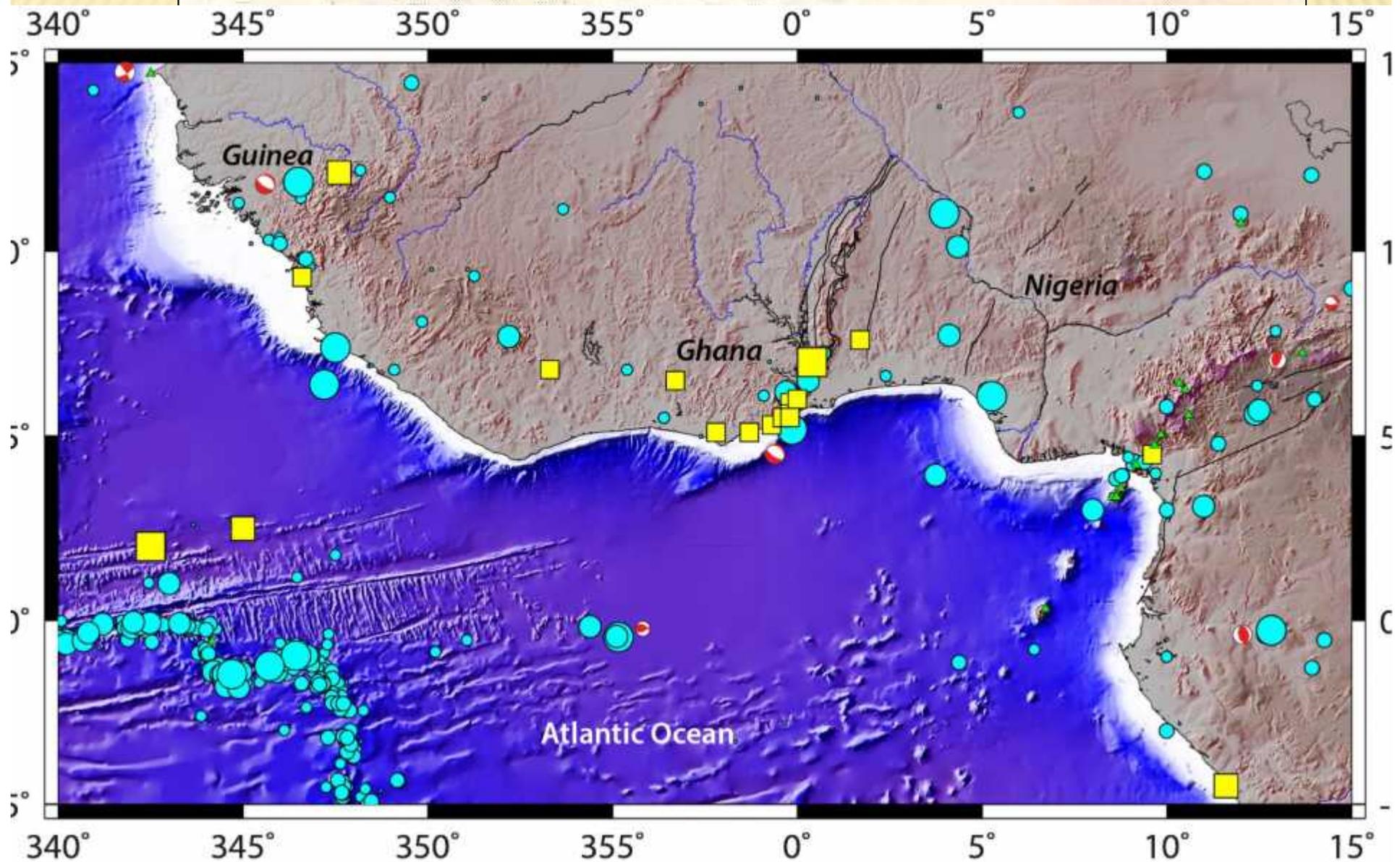
(b)



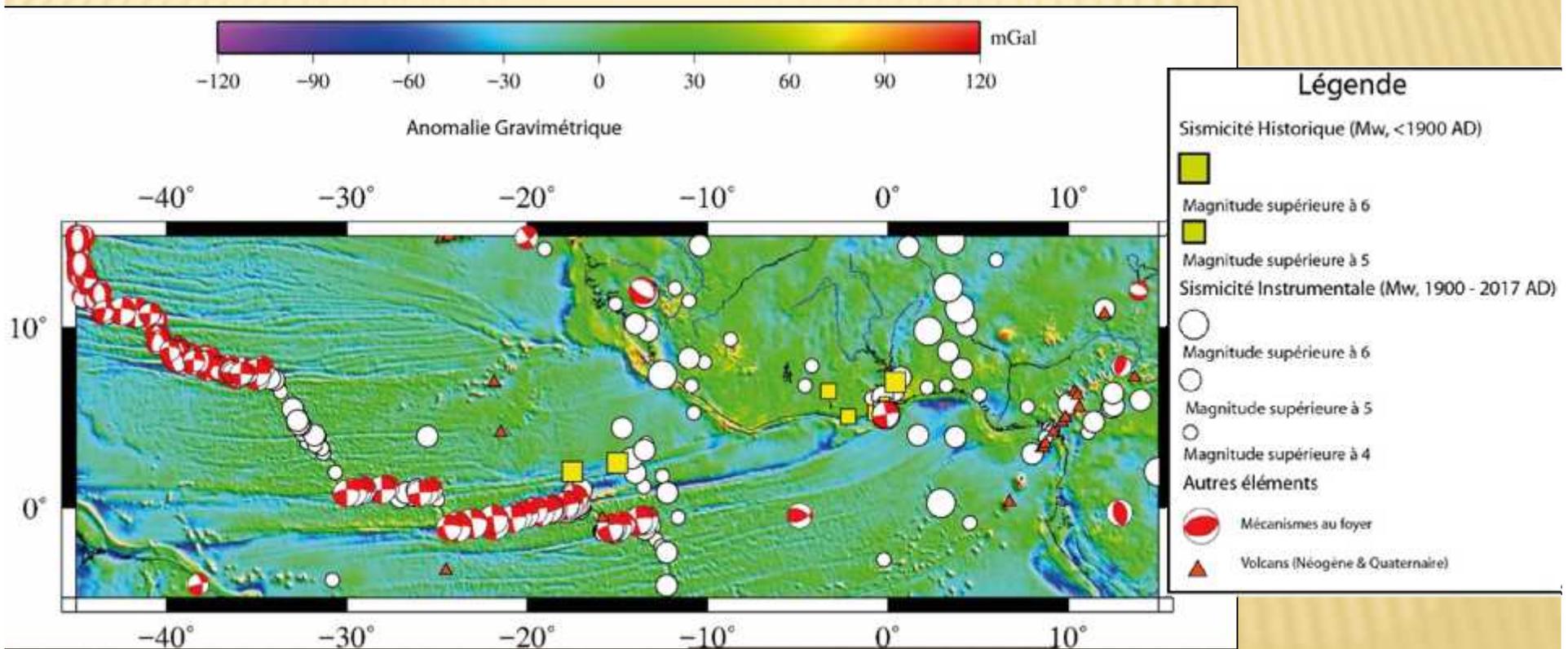
# Tulbagh (Ceres) eq. Mw 6.3, 29 Sept. 1969



# Accra earthquake of 22nd June, 1939 (Mw 6.5)



# Seismogenic faulting : Bathymetric Magnetic and Gravity Data



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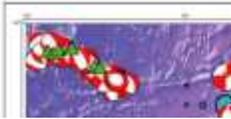
# The Seismotectonic Map of Africa (IGCP – 601)

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- 4745 instrumental earthquakes  $M > 4$  1900 to 2012
- ~ 100 historical (pre-1900 damaging earthquakes)
- ~ 155 active (seismogenic) faults
- 211 volcanoes (~ 43 presently active)

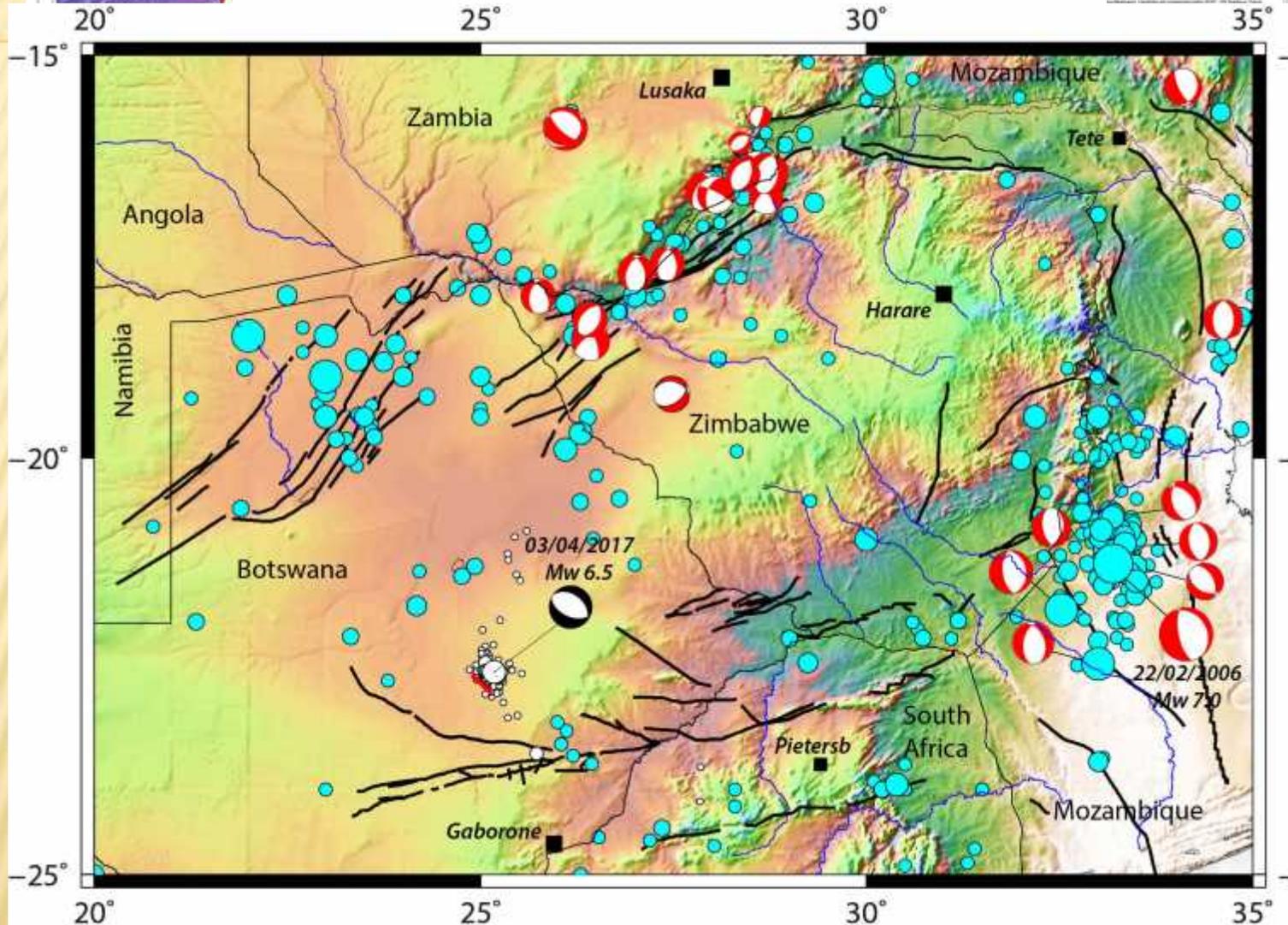


by Mustapha Meghraoui and the IGCP-601 Working Group\*



# The Seismotectonic Map of Africa

Contribution to the Seismotectonic Map of the World  
SEISMOLOGICAL MAP OF AFRICA  
1st edition, 2012  
© 2012 UNESCO for the IUGS International Geophysics Project

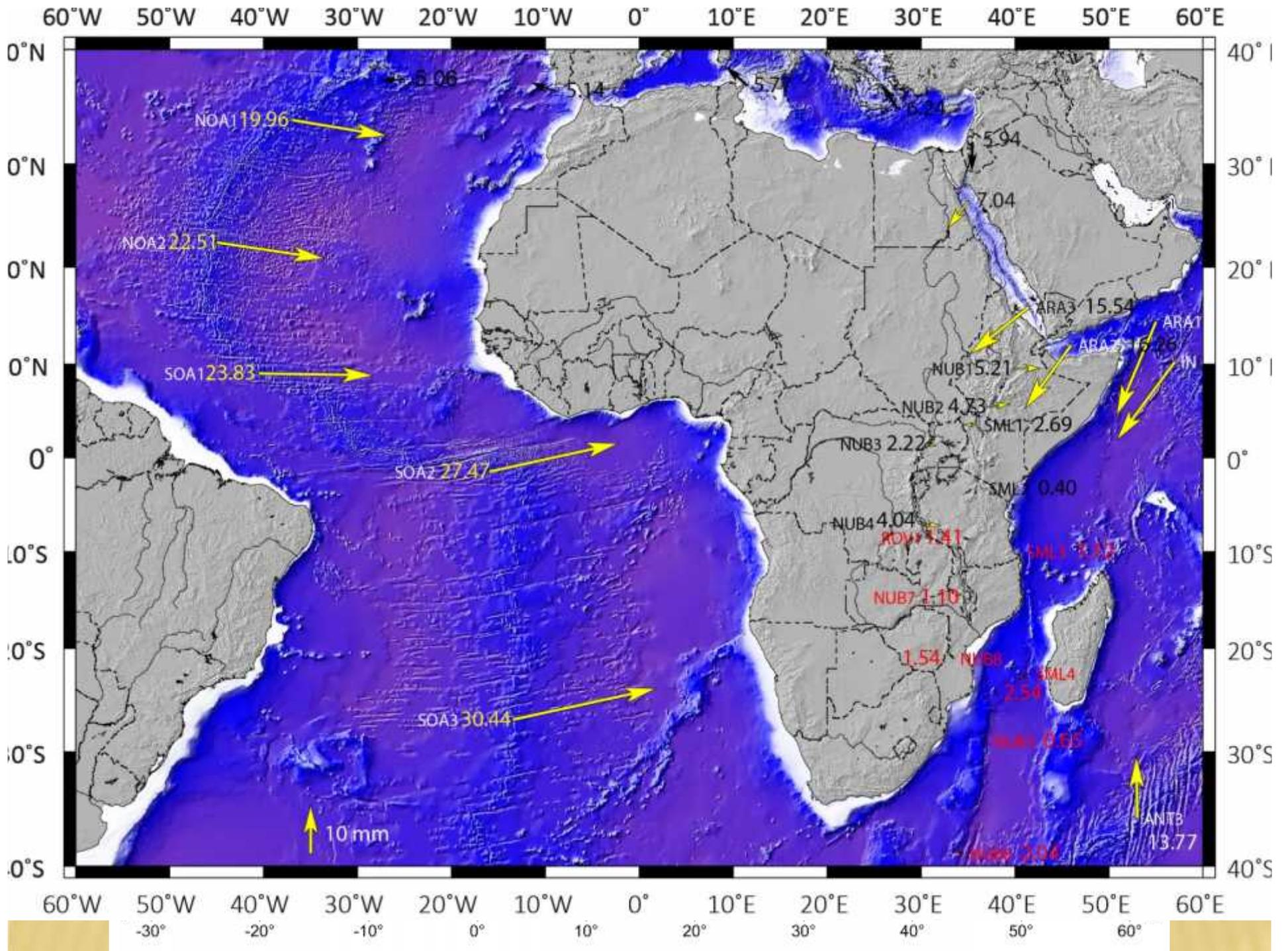


*Seismic Hazards in Africa* of UNESCO-IUGS, funded by the Swedish International Development Agency and UNESCO-Nairobi for a period of 4 years (2011 – 2014, now extended to 2016).

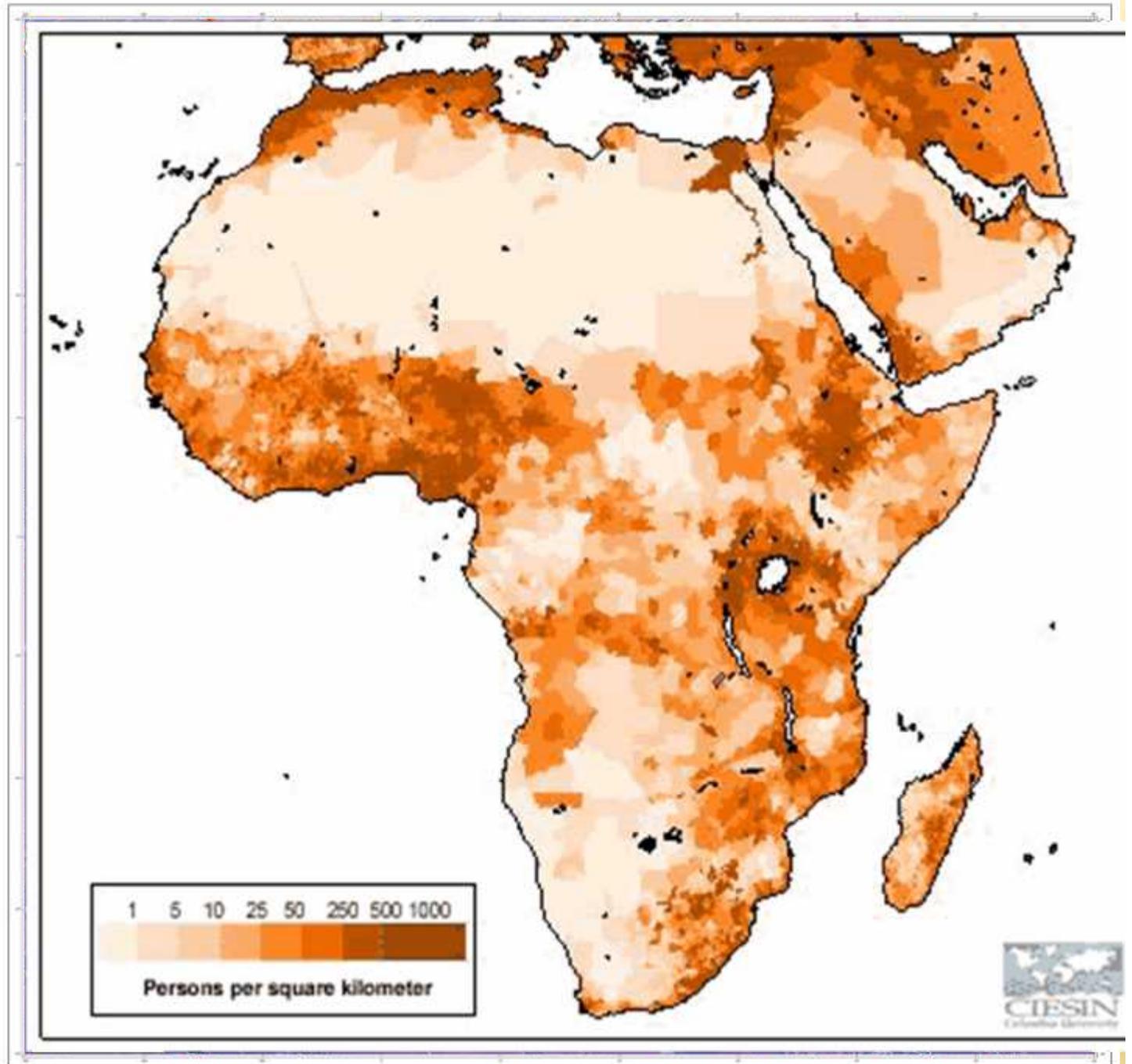
Episode 1, 20, no. 1

hazards in Africa". The seismotectonic map was prepared by geoscientists (mostly from African academic and research institutions) who conducted several scientific projects in earthquake geology, seismology, seismotectonics, geodesy and geophysics in Africa. This contribution reports the scientific programme, procedure and

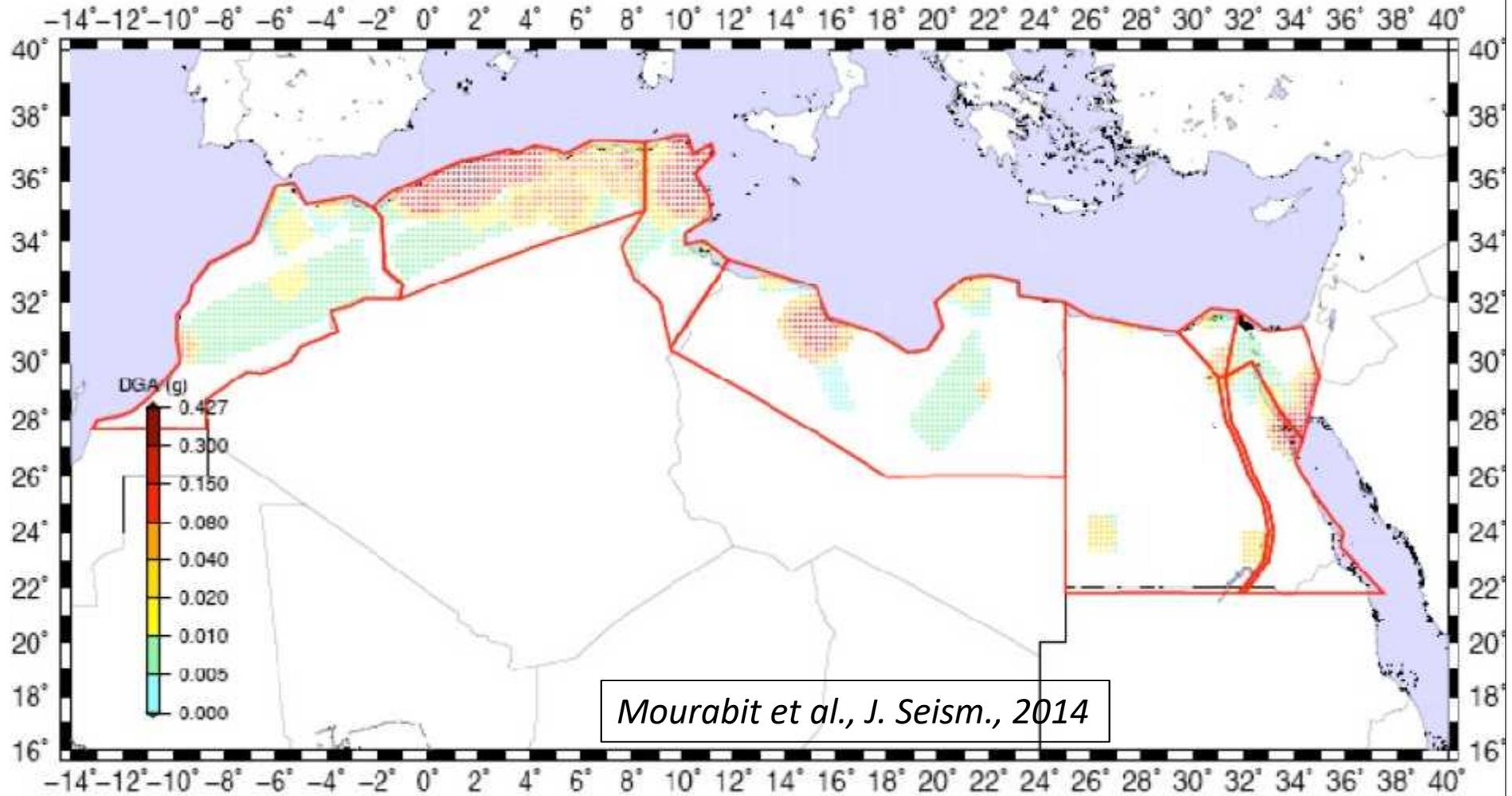




Seismotectonic  
Seismic Hazard  
Seismic Risk



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*Algiers*



*Nairobi*



*Addis Ababa*



*Accra*





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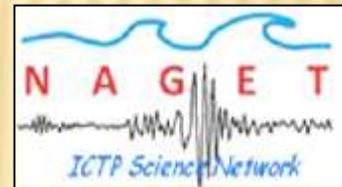
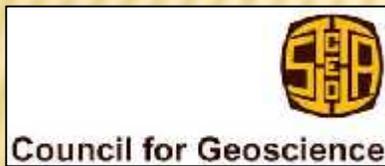
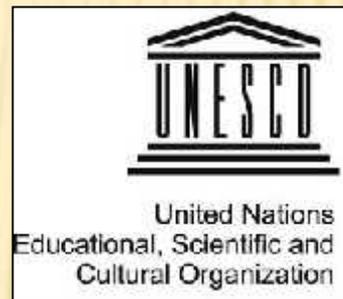
## Conclusive remarks

- ❑ Projects on active - earthquake faults
- ❑ Projects on active deformation (GPS, InSAR)
- ❑ Building of realistic seismic hazard and risk assessments
- ❑ Early warning system for large cities
- ❑ Earthquake data centre for Africa

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## *Supporting institutions (IGCP-601)*



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*Thank you!*

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