

DAMAGING EARTHQUAKES IN AFRICA

Seismotectonic background & Seismic Hazard Implications

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&

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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



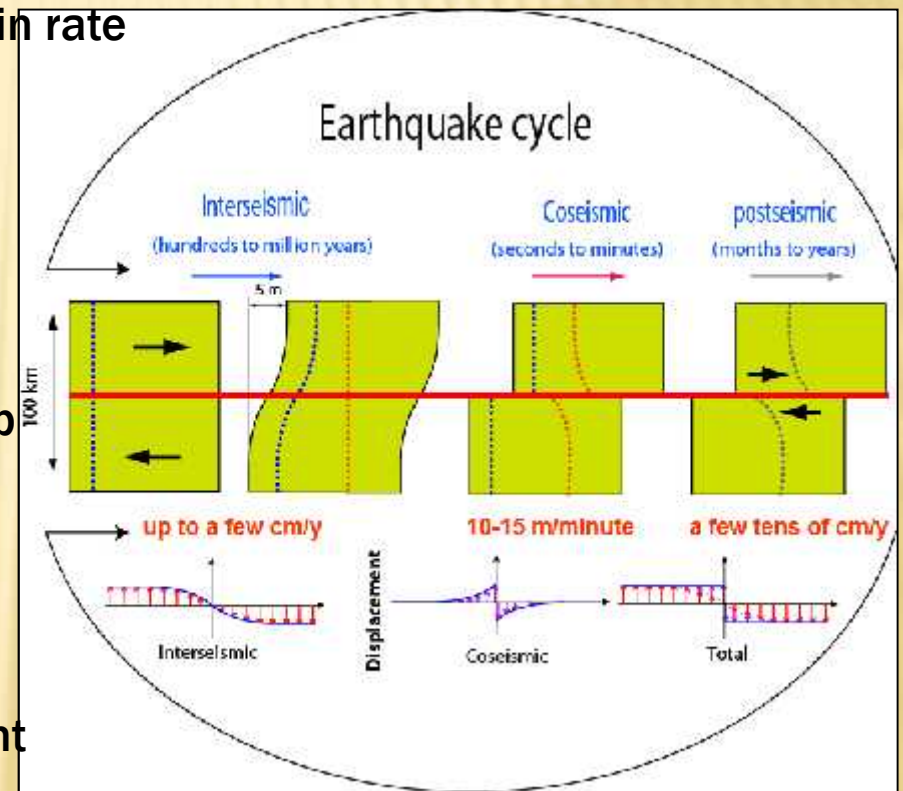
Nicholas AMBRASEYS (1929 – 2012)
Earthquake geology - engineering
Parametric seismicity catalogue

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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

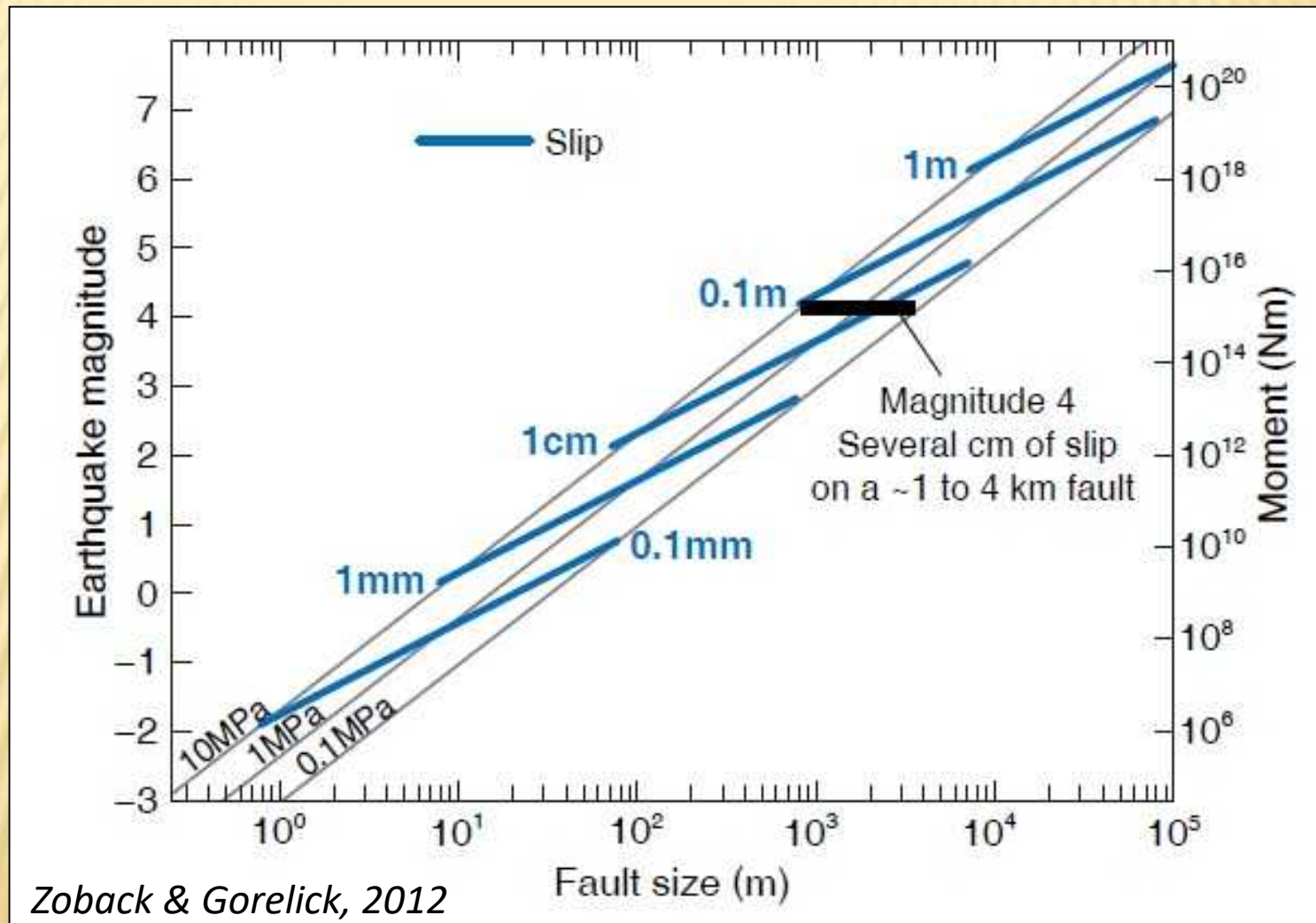


$$M_o = \sim \iint_S U \, dS$$

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

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Earthquake Geology and Seismic Sources



The Seismotectonic Map of Africa



THE IGCP-601 WORKING GROUP (2011 – 2016)



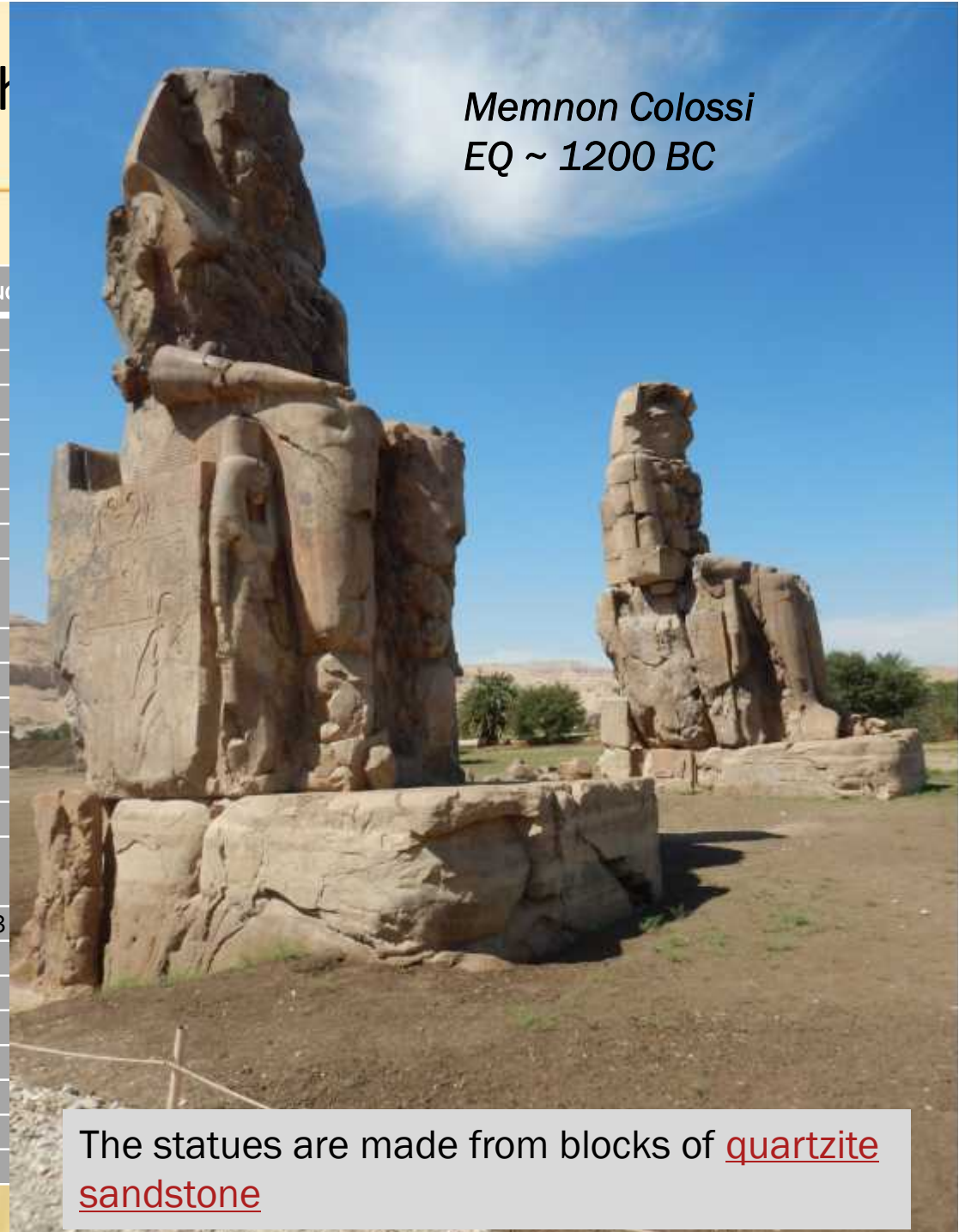
- ❑ Coordinator : Mustapha Meghraoui (IPG Strasbourg, France)
- ❑ Hesham Hussein & Mohamed El Gabry (NRIAG, Egypt)
- ❑ Atalay Ayele (Addis Ababa University, Ethiopia)
- ❑ Ateba Bekoa (Buea University, Cameroun)
- ❑ Vunganai Midzi & Magda Roos (Council for Geoscience, South Africa)
- ❑ Paulina Amponsah (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

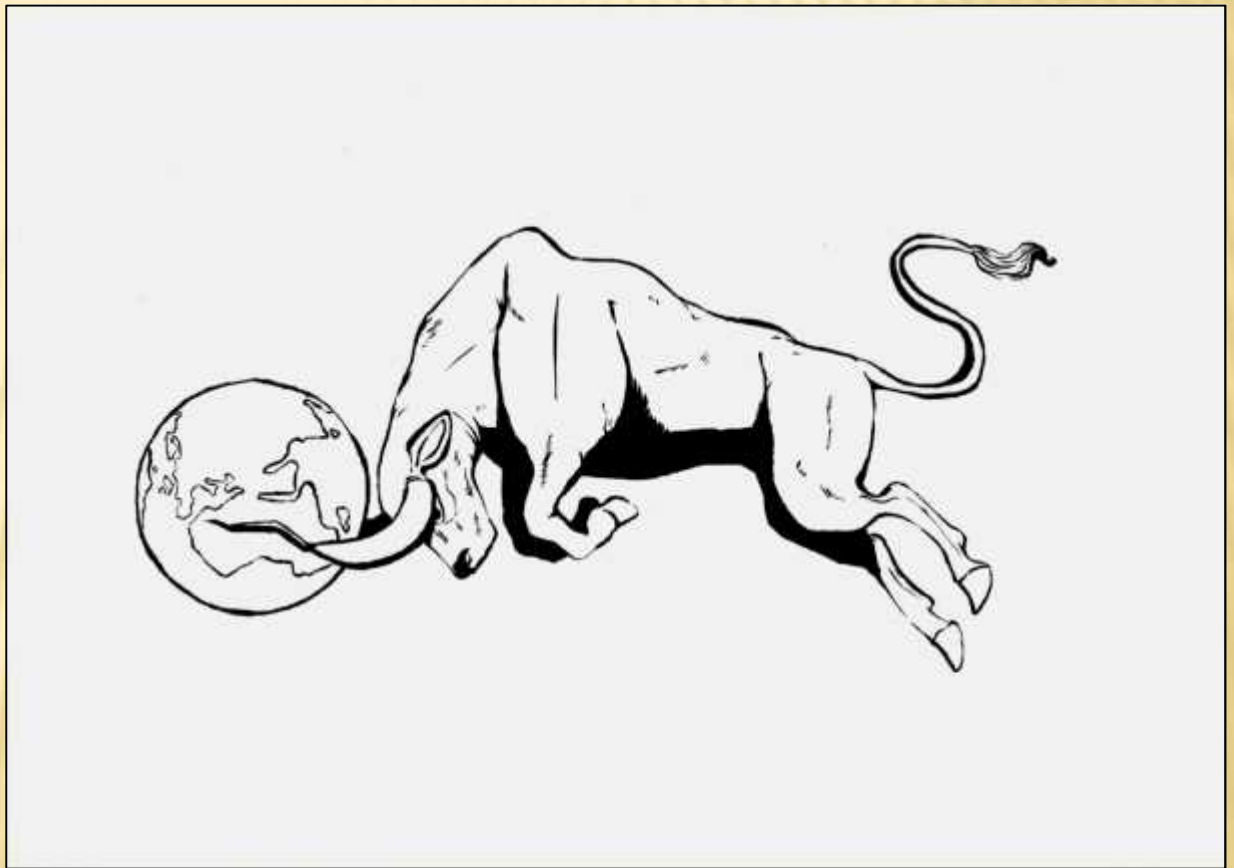
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The mythology

Gnami Gnami



Zelzal el Ferd



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12 October 1992 Cairo earthquake (Ms 5.8)



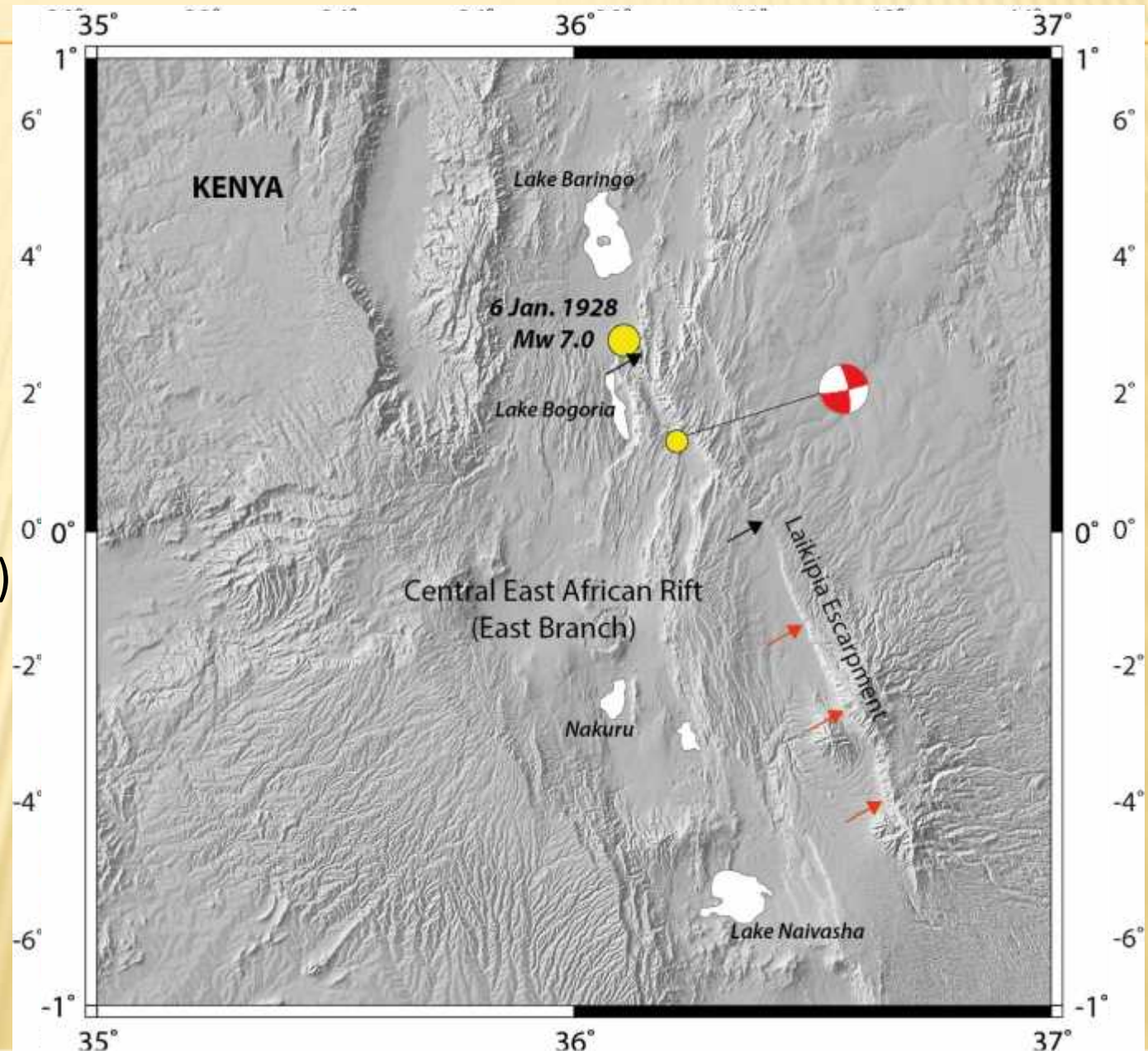
Zemmouri earthquake near Algiers

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)

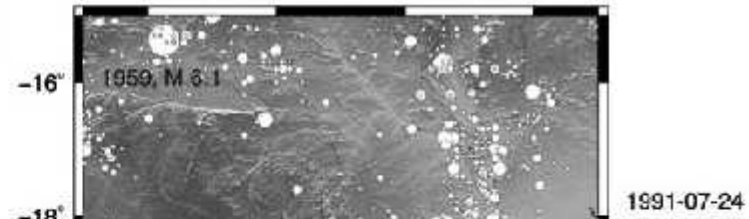


Machaze eq., Mw 7.0, 22 February 2006

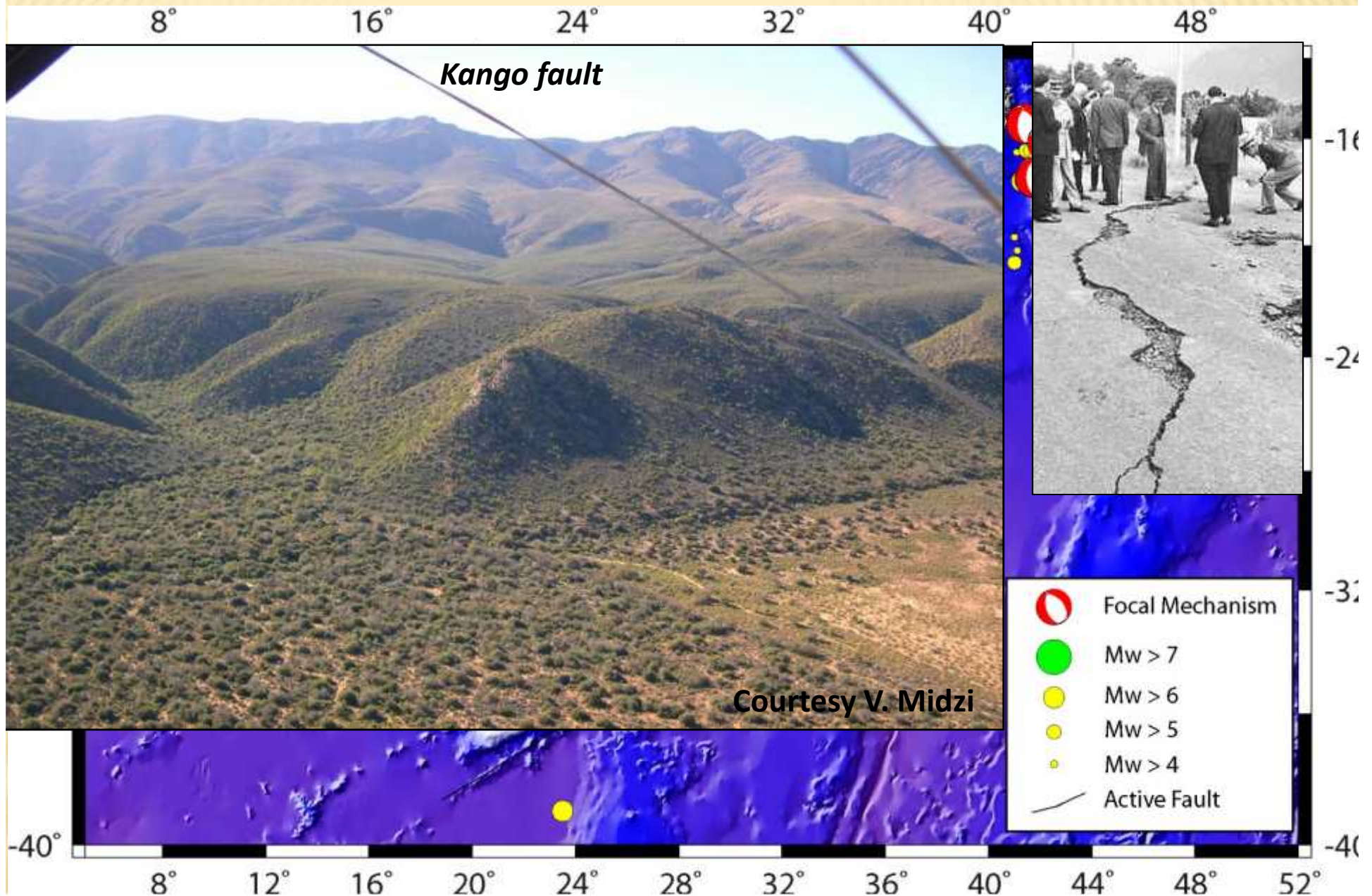
(a)



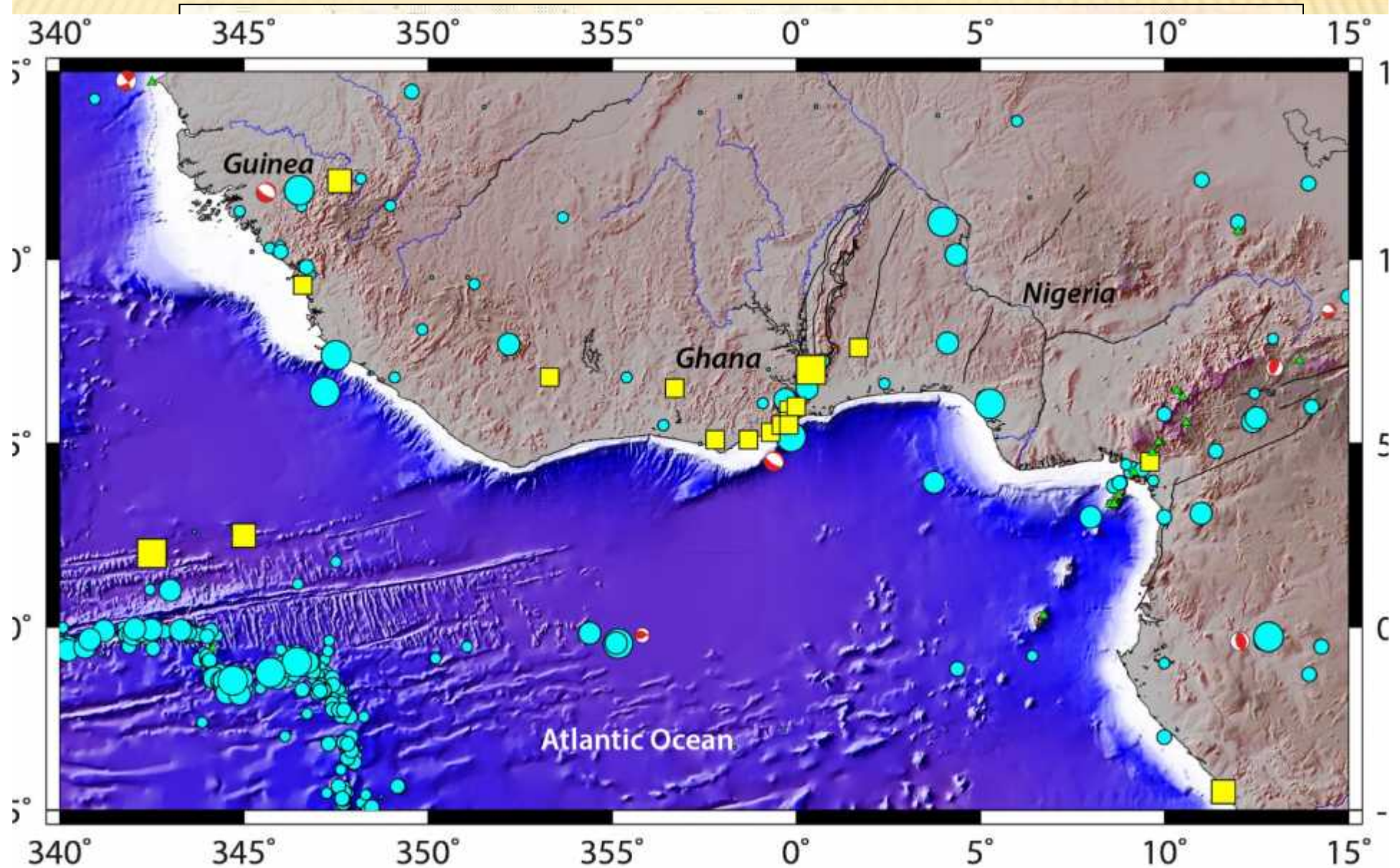
(b)



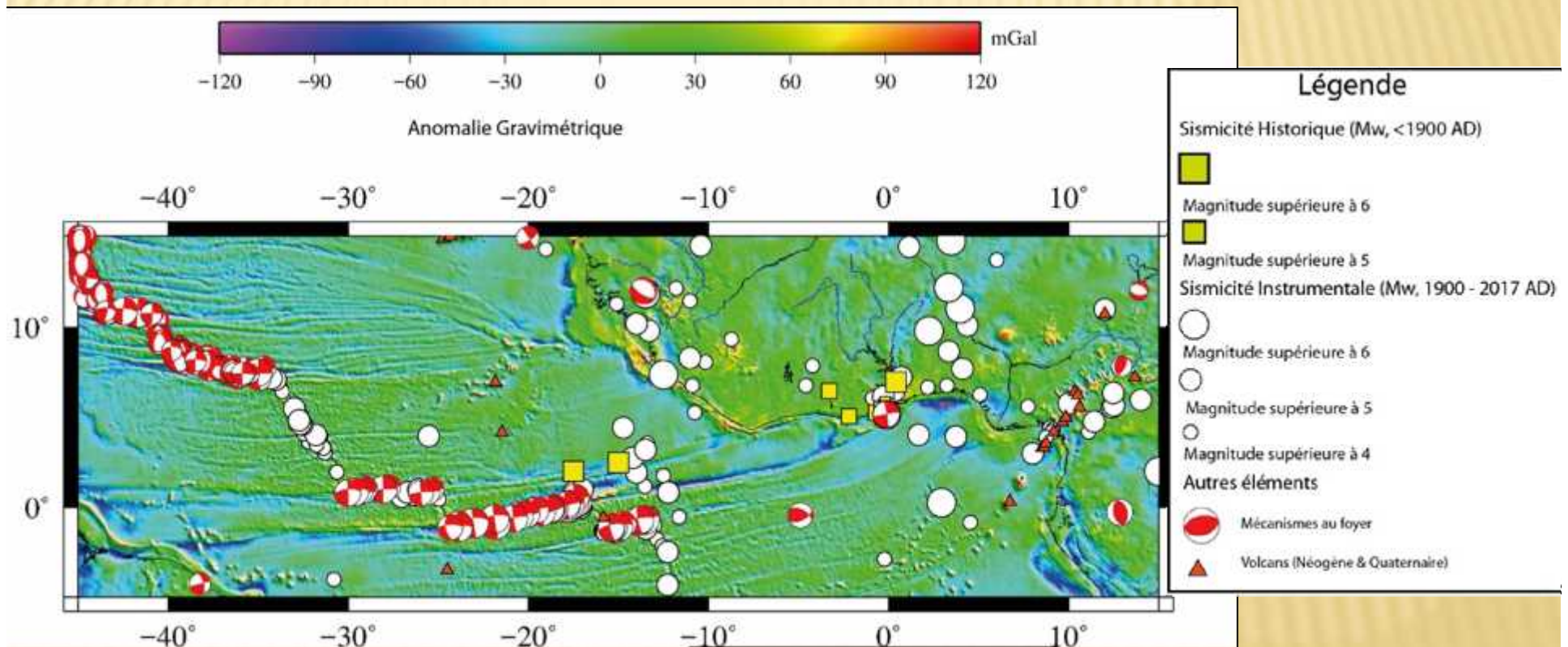
Tulbagh (Ceres) eq. Mw 6.3, 29 Sept. 1969



Accra earthquake of 22nd June, 1939 (M_w 6.5)



Seismogenic faulting : Bathymetric Magnetic and Gravity Data



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The Seismotectonic Map of Africa (IGCP – 601)

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

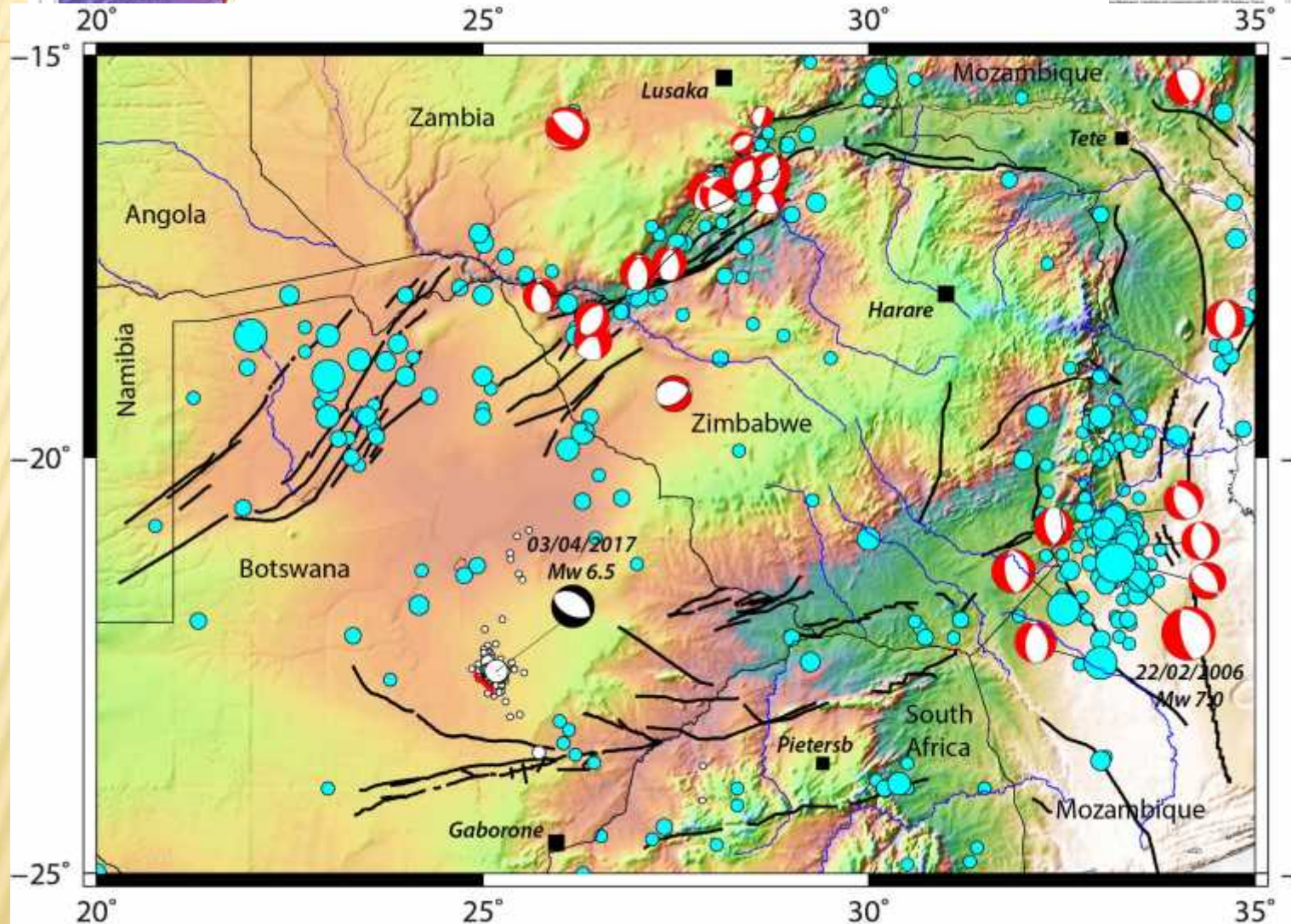


by Mustapha Meghraoui and the IGCP-601 Working Group*

The Seismotectonic Map of Africa



Contribution to the Seismotectonic Map of the World
 Prepared by the IUGS Working Group on Seismotectonics
 International Geophysics Year (IGY) 1982
 SEISMOTECTONIC MAP OF AFRICA
 1st edition, 1982
 World Center for the 200th Anniversary of the Birth of Albert Einstein

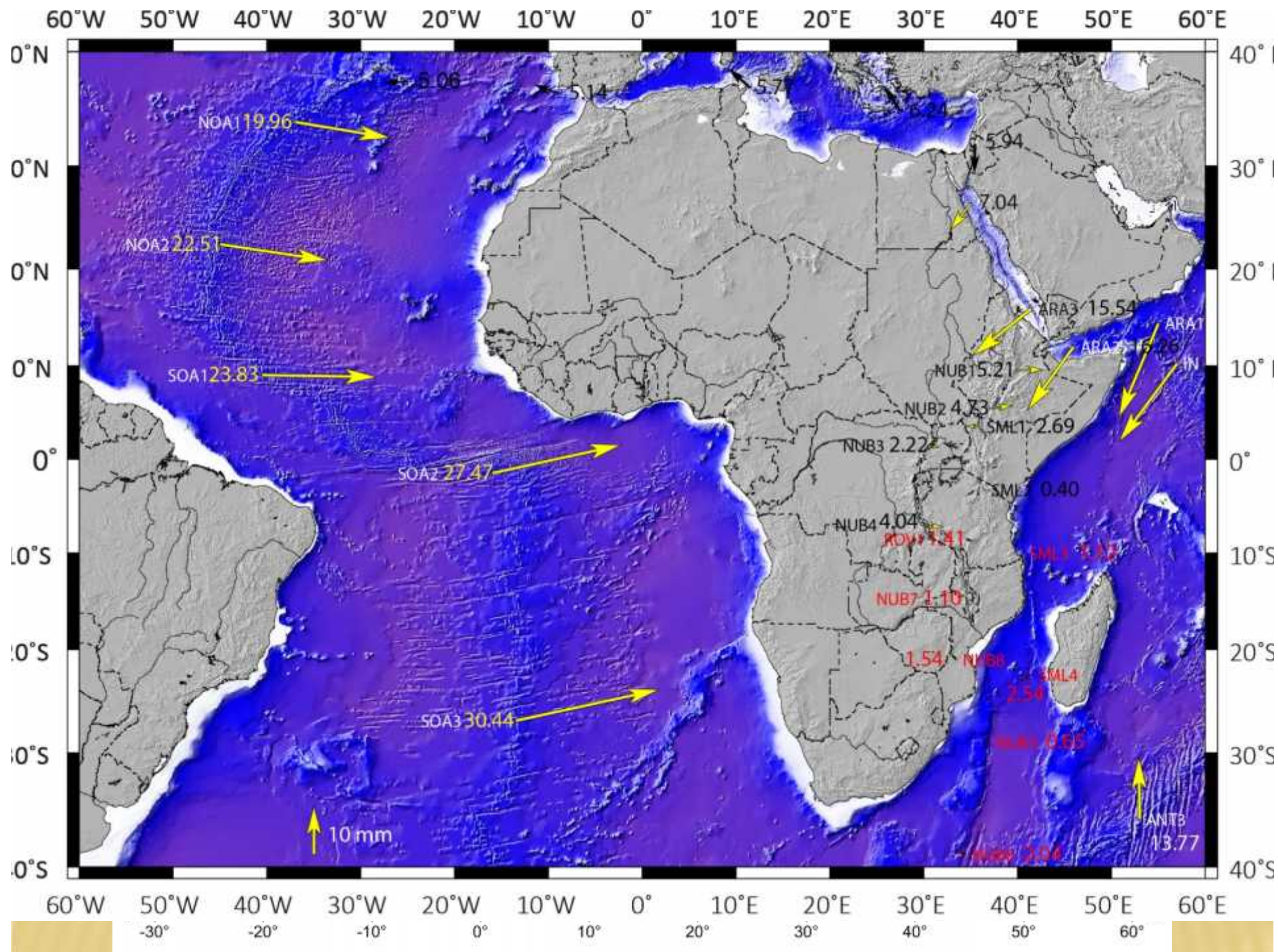


"Seismic Hazards in Africa" of UNESCO-IUGS, funded by the Swedish International Development Agency and UNESCO-Nairobi for a period of 4 years (2011 – 2014, now extended to 2016).

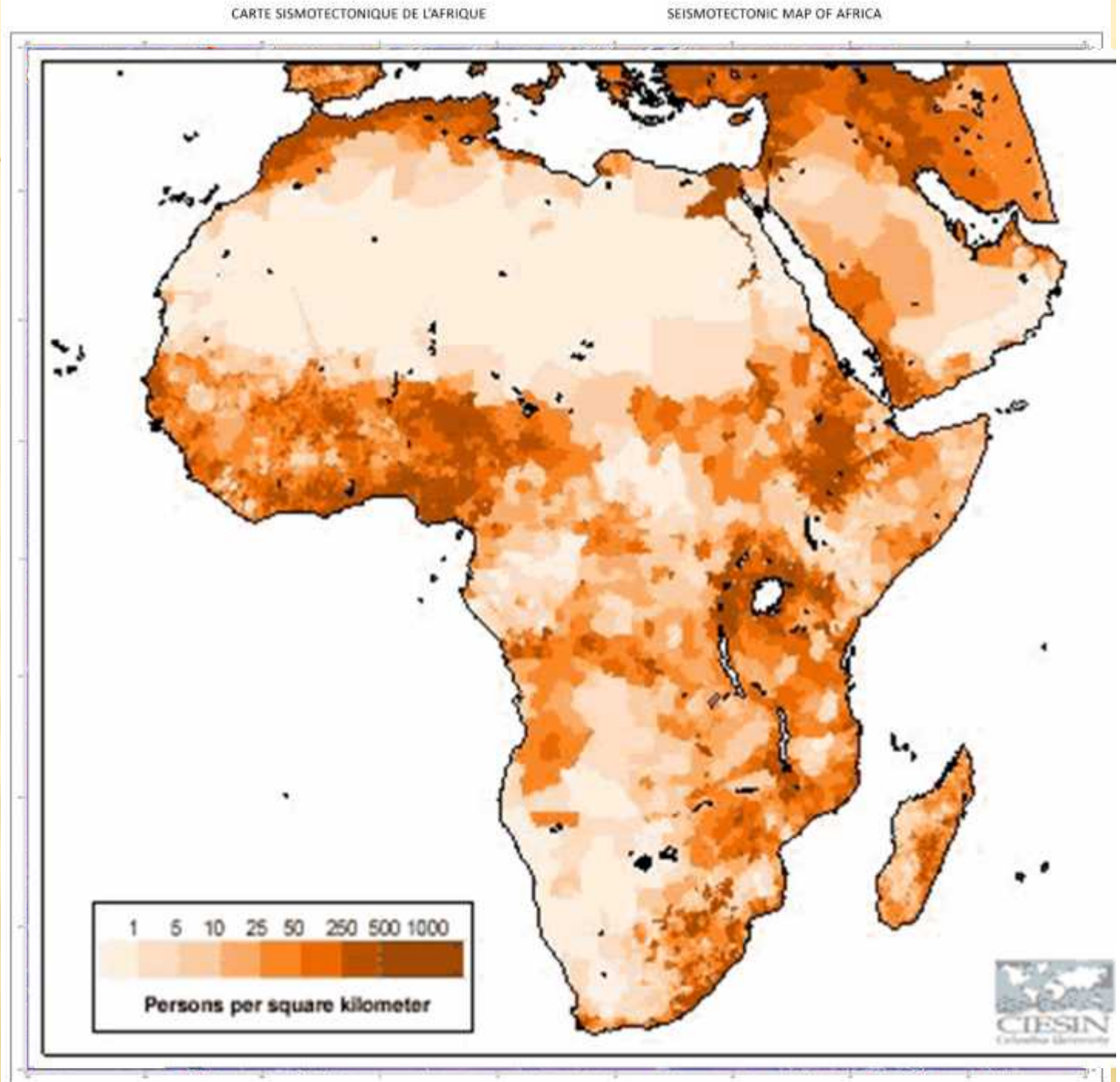
Episode Vol. 29, no. 1

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

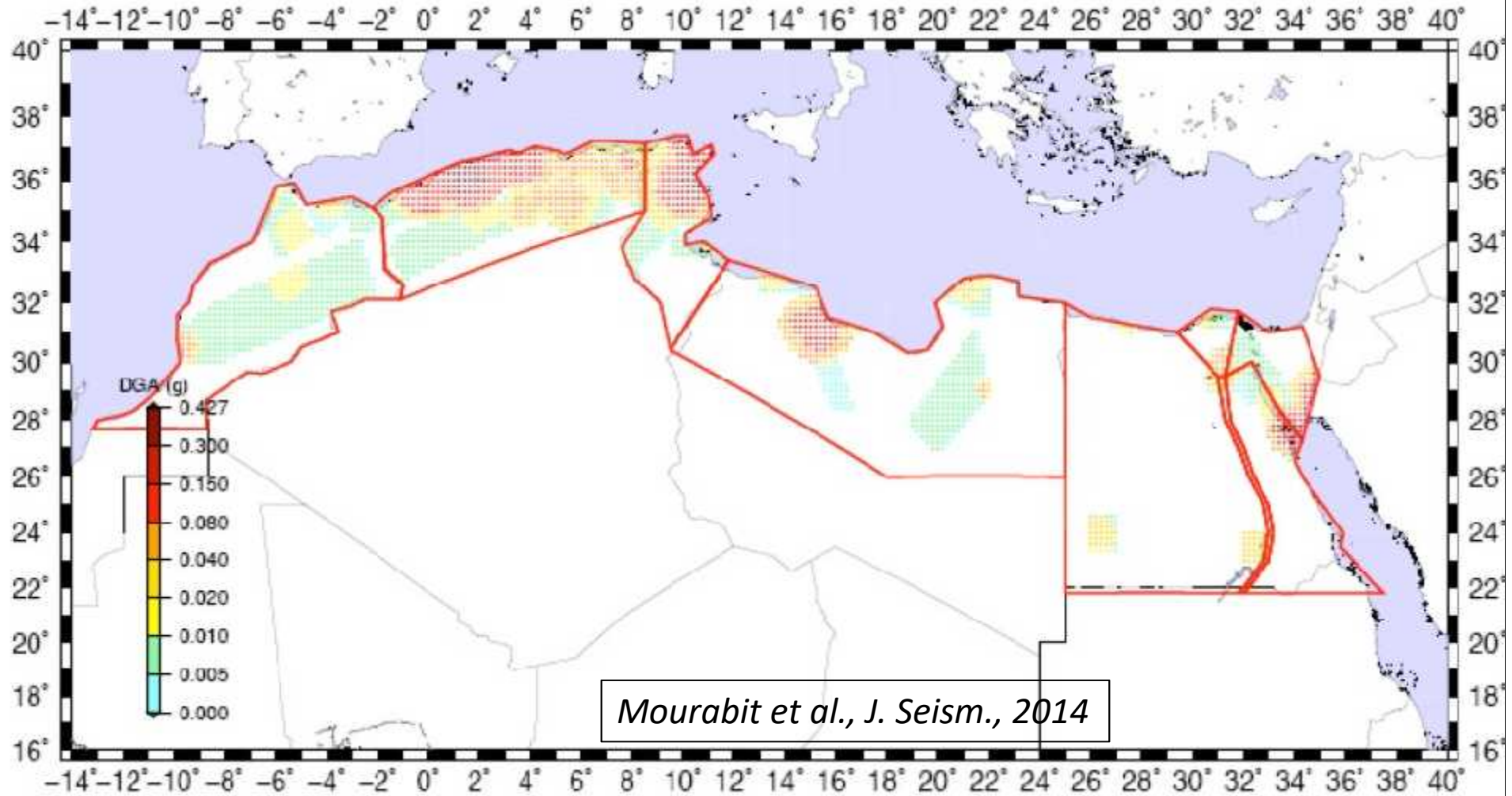




Seismotectonic
Seismic Hazard
Seismic Risk



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Algiers



Nairobi



Addis Ababa



Accra





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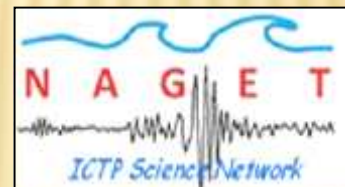
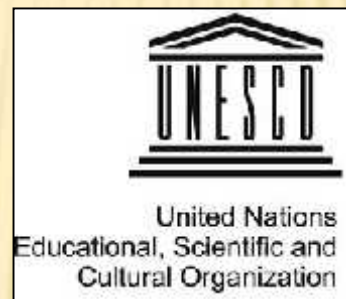
Conclusive remarks

- ❑ 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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A photograph of a savanna landscape. In the foreground, several giraffes are standing on dry, yellowish-brown grass. Some are looking towards the camera, while others are looking away. In the background, a large, conical volcano rises against a blue sky with scattered white clouds. The volcano's peak is slightly hazy. The overall scene is a mix of natural beauty and potential hazard.

Thank you!

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