THE UNESCO IGCP 610/659 Projects

1. Paulina Amponsah & 2. Mustapha Meghraoui

1. School of Nuclear and Allied Sciences
Ghana Atomic Energy Commission
2. Institut Terre et Environnement de Strasbourg (ITES),
CNRS - UMR 7063, France
AUTHORS

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

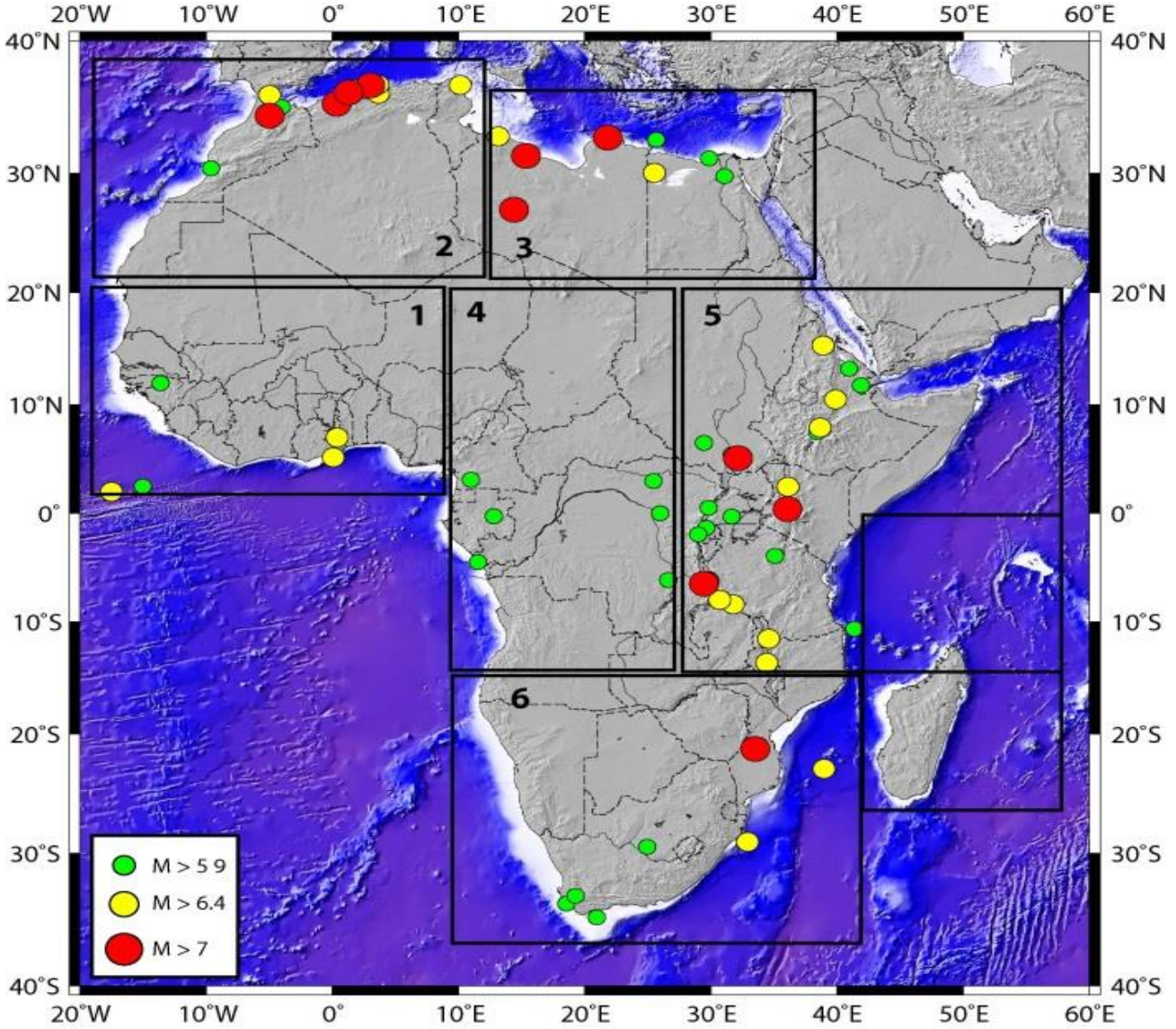
IGCP Project 601
Seismotectonics and seismic hazards in Africa

- Countries involved in the project :
  - Algeria, Belgium, Botswana, Cameroon, DR Congo, Egypt, Ethiopia, France, Ghana, Ivory Coast, Kenya, Libya, Madagascar, Malawi, Morocco, Mozambique, Namibia, Senegal, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zimbabwe.

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

IGCP 601

- The project was initiated at the request of the Organization of African Geological Surveys (OAGS)
- The Commission of Geological Map of the World (CGMW) assisted with the map edition.
- Colleagues from Africa-Array, IASPEI, NAGET, supported during the 4-year preparation of the map.



Seismotectonic provinces and major earthquakes of the African continent

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

Works done

- Harmonization and homogenization of earthquake catalogues
- Digitized Quaternary & active faults, volcanic fields, etc.
- Prepared geodetic solutions for the continent
- Prepared a new map of stress distribution and related analysis in Africa
- Prepared a new map on crustal structures (upper mantle and lithospheric) in Africa.

EPOS EUROPEANPLATEOBSERVINGSYSTEM

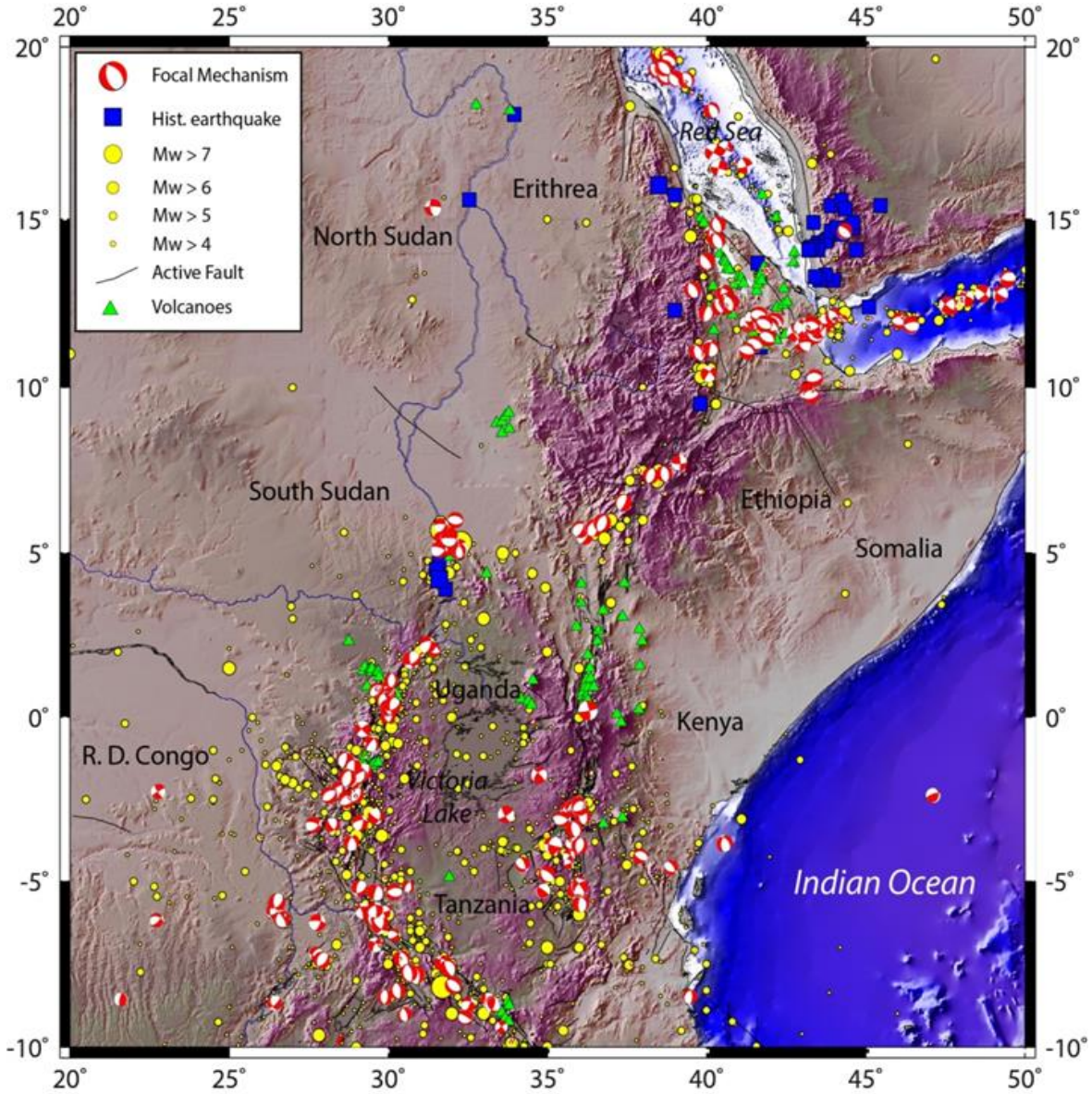
The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

Map preparation

- Building a homogeneous database of seismic parameters
- Prepare a database of neotectonic structures with Quaternary faulting
- Improving the seismotectonic database in regional gaps,
- Building a GIS interface of geologic and geophysical database,
- Prepare the background for the seismic hazard assessment with scenarios and models.

EPOS EUROPEAN PLATE OBSERVING SYSTEM

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121



Example of regional seismotectonic map. North and central regions of the East African Rift

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

The Seismotectonic Map of Africa

*Mustapha Meghraoui (Coordinator) EOST – IPG Strasbourg. Corresponding author *E-mail: m.meghraoui@unistra.fr*
Paulina Amponsah (GAEC, Accra), Abdelhakim Ayadi (CRAAG, Algiers), Atalay Ayele (Univ. Addis Ababa), Bekoa Ateba (IRGM, Yaounde), Abdunnur Bensuleman (Tripoli Univ.), Damien Delvaux (MRAC-Tervuren); Mohamed El Gabry (NRIAG, Cairo), Rui-Manuel Fernandes (UBI/IDL, Portugal) ; Vunganai Midzi & Magda Roos (CGS, Pretoria),Youssef Timoulali (Univ. Mohamed V, Rabat).

(Received 11/04/2015: Accepted 03/01/2016)
DOI:10.18814/epiiugs/2016/v39i1/89232
Website: http://eost.u-strasbg.fr/igcp601/index.html
Database address: http://sageoscience.maps.arcgis.com/

We present the Seismotectonic Map of Africa based on a geological, geophysical and geodetic database including instrumental seismicity and re-appraisal of large historical events, and harmonization and homogenization of earthquake parameters in the catalogues. Although establishing the seismotectonic framework of the African continent is a difficult task, several previous and ongoing projects provide a wealth of data and outstanding results. The database of large and moderate earthquakes in different geological domains includes the coseismic and Quaternary faulting that reveals the complex nature of the active tectonics in Africa. The map benefits from previous works on local and regional seismotectonic maps that needed to be integrated with the lithospheric and upper mantle structures, seismic anisotropy tomography and gravity anomaly, into a continental framework.

The synthesis of earthquake and volcanic studies obtained from the analysis of late Quaternary faulting and geodetic data will serve as a basis for hazard calculations and the reduction of seismic risks. The map will be useful for the seismic hazard assessment and earthquake risk mitigation for significant infrastructures and their socio-economic implications in Africa. The constant population increase and infrastructure growth in the continent that exacerbate earthquake risk justify the necessity of continuously updating this map.

The database and related map are prepared in the framework of the IGC Project-601 "Seismotectonics and 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).

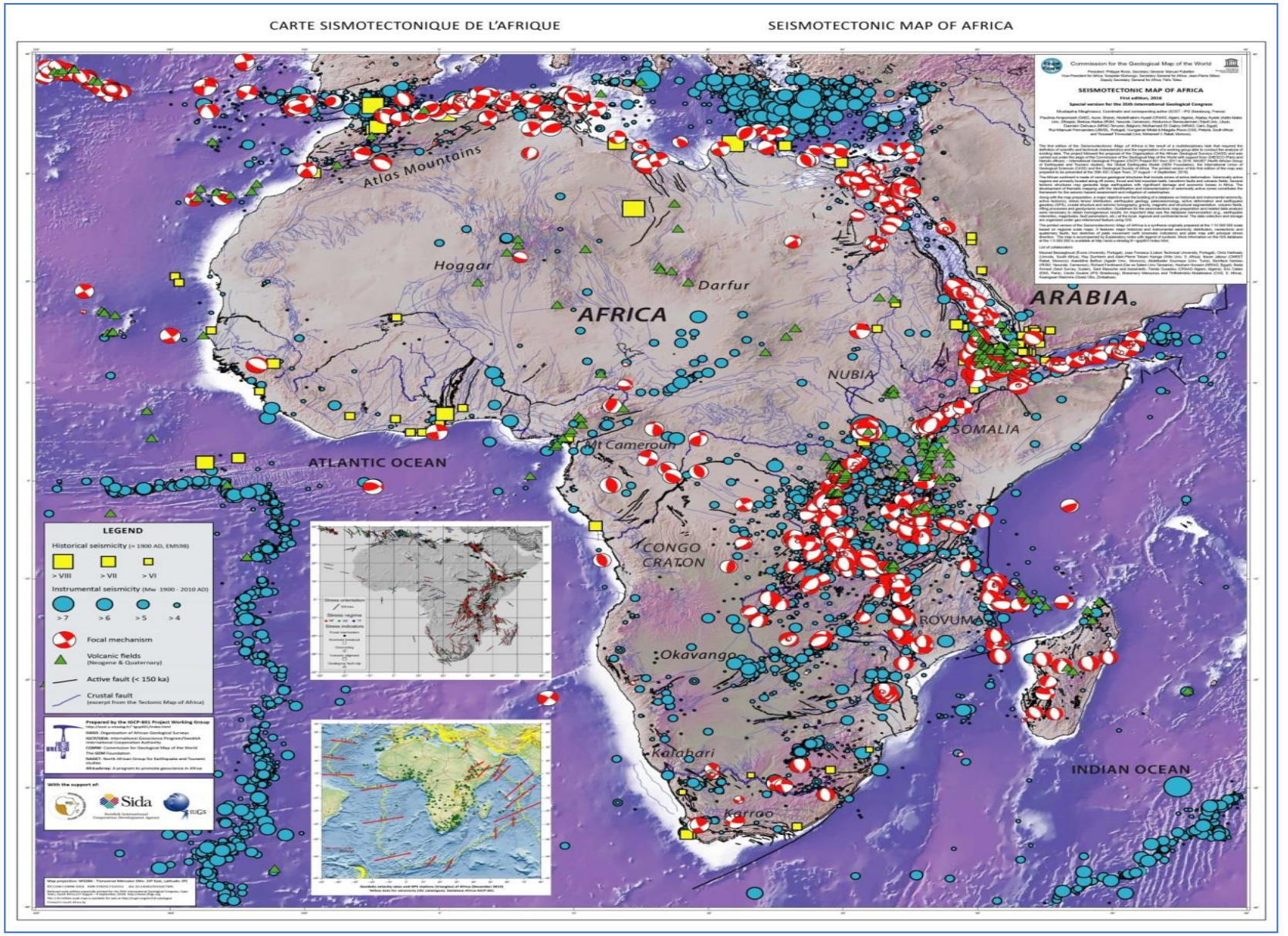
Introduction

The African plate has been the site of numerous large and destructive earthquakes, the most recent events being the 2009 Karonga earthquake (M 6.2) in Malawi, the 2008 Bukavu earthquake (M 6.0) in D.R.Congo, the 2006 Machaze earthquake (M 7.0) in Mozambique, the 2003 Zemmouri-Boumerdes earthquake (M 6.8) in Algeria, and the 1990 Juba earthquake (M 7.1) in South Soudan. Seismically active regions are primarily located along rift zones and related volcanic activity, thrust and fold mountain belts, and along mainly offshore transform faults. Several seismotectonic structures may generate large earthquakes in densely populated regions causing severe damage and significant economic losses in Africa.

Seismotectonic regions in Africa are poorly known in terms of the current faulting activity, crustal deformation, and their geodynamic causes. The North Africa thrust and fold belt and the East African Rift system are the most obvious areas of ongoing tectonic deformation experiencing large earthquakes (Yang and Chen, 2010; Meghraoui and Pondrelli, 2012). However, other regions like the Cameroon Volcanic Line and the Congo Basin in Central Africa, the West Africa and Southern African plateau are also seismically active. The presence of major active faults that generate destructive earthquakes is among the most important geological and geophysical hazards in the continent.

The development of a thematic map with the identification and characterization of seismically active zones constitutes the framework for seismic hazard assessment and mitigation of catastrophes. This subject was discussed in a session during the 23rd Colloquium of African Geology in Johannesburg (CAG 23, 8 – 14 January 2011) and was a concern expressed during the Algiers meeting of the Organisation of African Geological Surveys (OAGS, May 2010) which requested the preparation of the Seismotectonic Map of the African continent and assessment of the seismic hazard and risk implications. A Working Group* addressed these issues in the framework of the IGC Project-601 "Seismotectonics and seismic 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

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

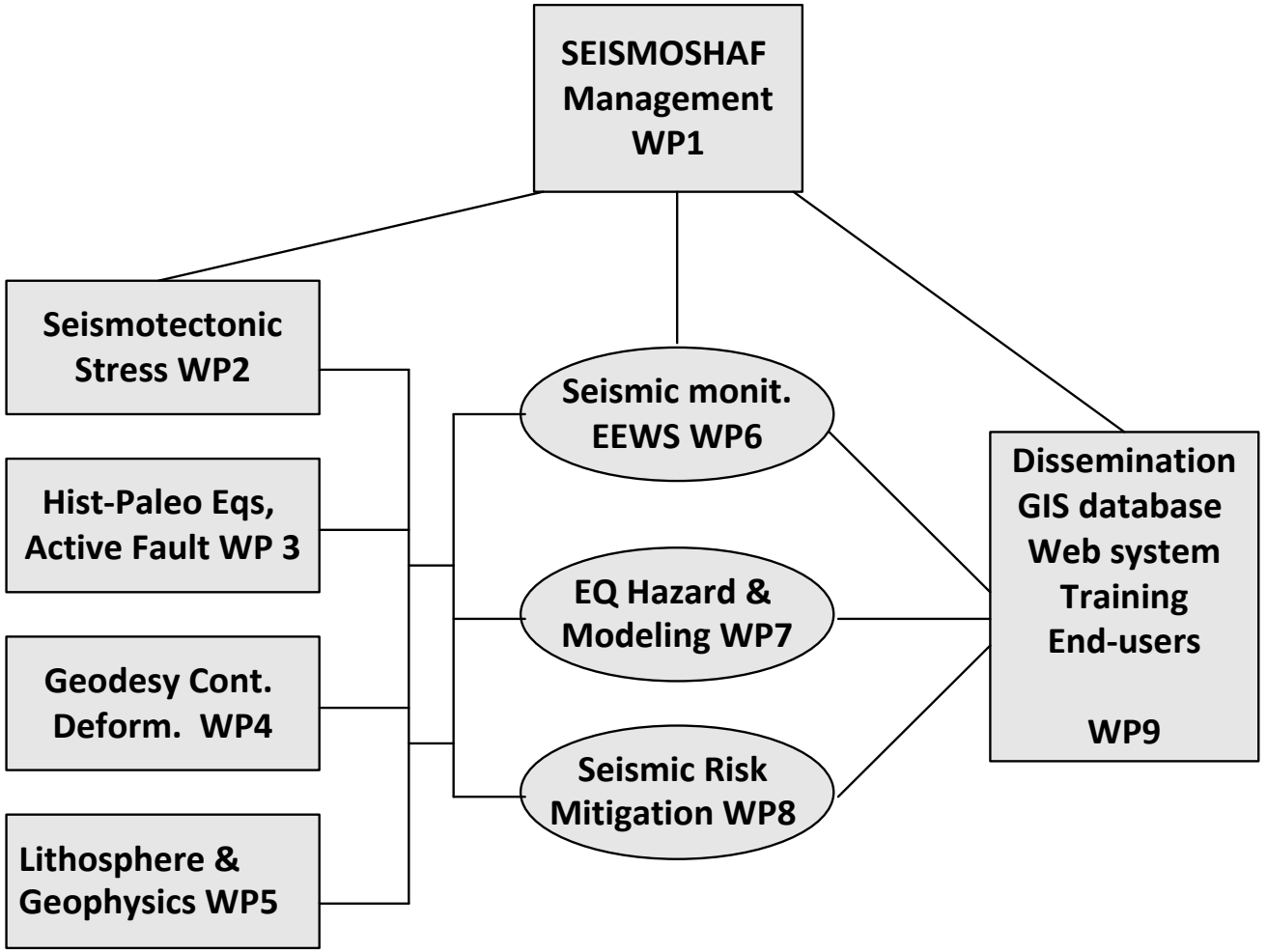


The Seismotectonic Map of Africa (CGMW 2016)

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

IGCP Project 659 (SEISMOSHAF)

IMPROVED REGIONAL SEISMOTECTONIC MAP IN AFRICA: A KEY COMPONENT FOR THE SEISMIC HAZARD AND RISK ASSESSMENT



THE EPOS SP PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT N° 871121

Aim of project

- To update the database developed in the Seismotectonic Map of Africa
- To improve regional seismotectonic maps for application in a multidisciplinary approach to seismic hazard and risk assessments.
- To explore the feasibility of real-time seismic risk mitigation, such as Early Earthquake Warning Systems in selected pilot-sites.
- Encourage collaboration and training

EPOS EUROPEANPLATEOBSERVINGSYSTEM

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

The SEISMOSHAF project : IGCP – 659

Expected results and output/deliverables	Output/deliverables
Capacity building in hazard and risk assessment: workshops and summer schools	Lectures and practical classes
Seismic hazard analysis	Regional maps and zoning
Risk analysis and mitigation plans	Assessment maps in selected sites (large cities)
Outreach and dissemination	Conferences, meetings, articles, video courses

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

Expectations

- Develop deterministic and/or probabilistic models for all the provinces.
- Each province planned the preparation of specific local projects for the inventory of earthquake faulting, and earthquake recurrence time.
- Develop geodynamic analysis using geodetic data with slip rates along with the selection of test sites for the hazard and risk assessment.

EPOS EUROPEAN PLATE OBSERVING SYSTEM

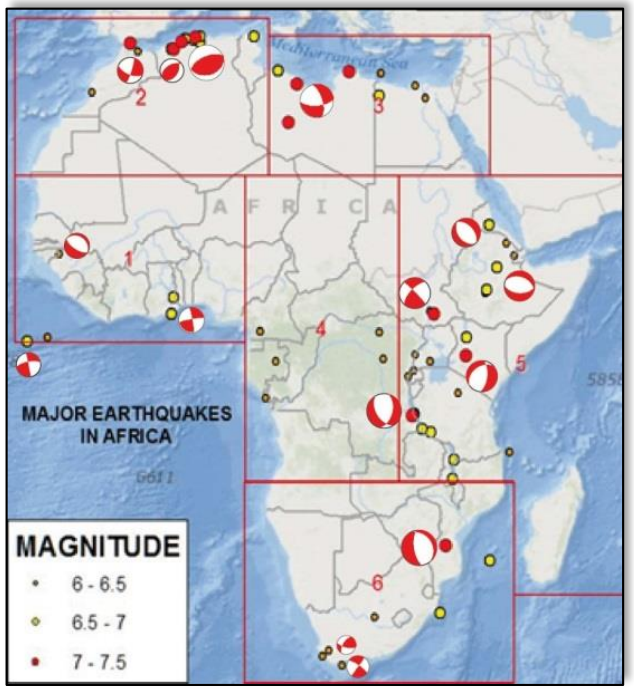
The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

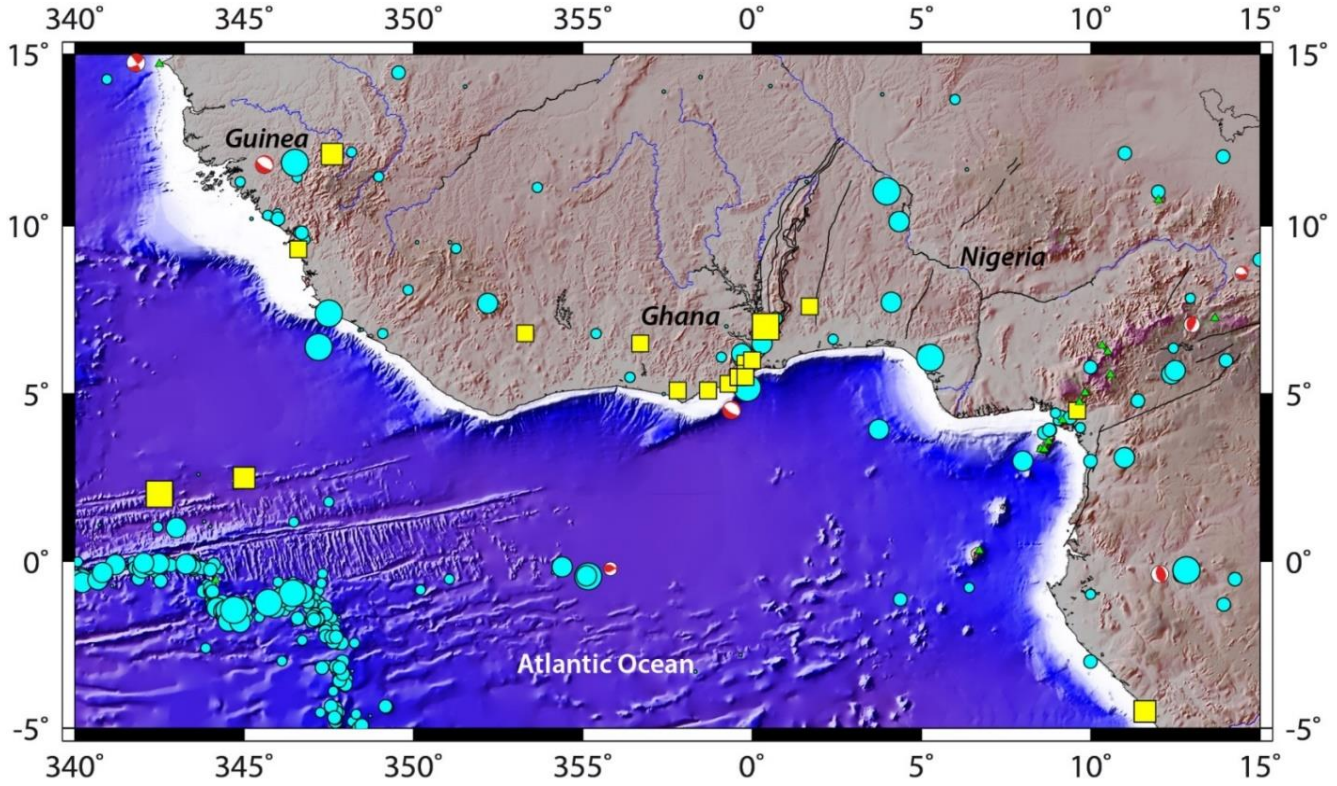
Activities include

- Early Warning System in Africa in cooperation with the NRIAG Cairo (Egypt, workshop in Aswan Dam in December 2022), EOST Strasbourg (France), and the University of Naples (Italy).
- Investigations on active faults, seismotectonics and crustal tectonics in cooperation with different institutions (NAGET, ESRWEG, AfricaArray, IASPEI, ...).
- Investigations on tsunami hazard along African coastlines in cooperation with CGS Pretoria, ONM Tunisia, NRIAG Cairo, Accra Ghana, Buea University Cameroun.
- Develop seismic hazard and zonation model; cooperation between the CGS Pretoria, EOST Strasbourg, NRIAG, Egypt, CRAAG Algiers and Khartoum University, Sudan.
- A seismic risk programme with evaluation of building stock in Accra (Ghana), Tunis (Tunisia) and Nairobi (Kenya).

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

Damaging Earthquakes





Accra earthquake of 22nd June, 1939 Mw 6.5

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

Publications include

- Asefa, J. and Ayele, A., 2021, Deep Rupture Process of the April 2017 Mw 6.5 Botswana Earthquake.IGCP-659 Special Issue, Arab Journal of Geoscience.
- Kariche, J., Meghraoui, M., 2020, Stress transfer and poroelasticity associated to major earthquakes in Africa, IGCP-659 Special Issue, Arab Journal of Geoscience https://doi.org/10.1007/s12517-021-07132-0
- Bagdi-Issaad, S., Meghraoui, M., and Nedjari, A., 2021, Active folding in the Tenes region (Tell Atlas, Algeria). Modelling of the 1922 earthquake fault-related fold (Mw 6.2), Journal of Seismology,https://doi.org/10.1007/s10950-021-10005-4
- Mulabisana, T. and 9 coauthors, 2021. Seismotectonics of the 2017 Moiyabana earthquake (Botswana), Insights from field investigations, aftershocks and InSAR studies, Journal of African Earth Science. 182, https://doi.org/10.1016/j.jafrearsci.2021.104297
- Meghraoui, M., P. Amponsah, P. Bernard and B. Ateba, 2019, Active Transform Faults in the Gulf of Guinea: Insights from geophysical data and implications for the seismic hazard, Canadian Journal of Earth Sciences 56: 1398–1408 (2019) dx.doi.org/10.1139/cjes-201

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

Challenges

- The IGCP-659 project activity was drastically reduced due to the Covid-19 pandemic.
- We have been constrained to limit our activity to mainly Skype or Zoom meetings
- Building projects with the AfSC continental wide on a seismological Center in Africa
- Focus on publications
- Training in seismology and seismotectonics for African students (mainly Master & PhD)

EPOS EUROPEAN PLATE OBSERVING SYSTEM

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

Conclusion

- The seismotectonic map of Africa is based on a completed re-appraisal of the historical-instrumental seismicity catalogue with harmonization-homogenization of EQ parameters.
- The database of large and moderate EQs include the coseismic and Quaternary faulting that reveal the complex nature of the active tectonics in continental Africa.
- The seismotectonic database also include geophysical and volcanic results integrated with the lithospheric and upper mantle structures from tomographic anisotropy and gravity anomaly into a continental framework.
- The IGCP projects 601 and 659 and related database represent the framework for a realistic seismic hazard and risk assessment in Africa

EPOS EUROPEANPLATEOBSERVINGSYSTEM

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121

Thank you

Cape Town - IGC 2016

The EPOS SP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 871121