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## SEISMOTECTONIC MAP OF AFRICA

*A project prepared by:*

Mustapha MEGHRAOUI  
Earthquake Geologist (Ph. D)  
Institut de Physique du Globe  
University of Strasbourg  
5, rue René Descartes

67084 Strasbourg cedex, France

Tel : +33 (0)368 850 111; Fax : +33(0)368 850 125

[m.meghraoui@unistra.fr](mailto:m.meghraoui@unistra.fr)

[http://east.u-strasbg.fr/IPGS/Eq\\_DynGlobale/index\\_DG.php](http://east.u-strasbg.fr/IPGS/Eq_DynGlobale/index_DG.php)

*In cooperation with:*

Bernard INGRAM  
Senior Geologist (M. Sc.)  
Central Regions Unit  
Council for Geoscience  
280 Pretoria Street

Silverton, Pretoria, 0127, South Africa

Tel: +27 (0)12 841 1124; Fax: +27 (0)86 617 5800

[bingram@geoscience.org.za](mailto:bingram@geoscience.org.za)

<http://www.geoscience.org.za>

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## 1. INTRODUCTION

The African continent forms a tectonic plate with diverse geological domains that include seismically active zones. Although some regions of the plate are presumably qualified as stable, several large earthquakes (with  $M > 7$ ) have occurred in the past. Active zones with significant late Pleistocene and Holocene tectonics (last 100 ka) characterize the continental deformation near the plate boundary and its permanent background seismicity. The presence of major active faults that generate destructive earthquakes is among the most important geological and geophysical hazards for the continent.

In its annual meeting held in Algiers (10–12 May 2010), the Organisation of African Geological Surveys (OAGS) decided to launch a project titled “The Seismotectonic Map of Africa” (SeTMA). This project will be conducted by a scientific and technical team of African geologists and geophysicists in collaboration with the geological surveys of each African country. The project will also benefit from the assistance of foreign geologists and geophysicists known for their significant scientific contributions in the field of active tectonics and earthquake studies.

The production of thematic maps in geology and geophysics constitutes an important objective necessary for the social and economic development of Africa. The realistic assessment and mitigation of geological and geophysical hazards requires the characterisation of the main physical parameters and building of a databank at a regional scale. The seismic hazards being among the major threats of the continent, the development of seismotectonic studies is a necessary step for the mitigation of earthquake disasters in Africa.

Promoters of the project are the *Agence National de Geologie et Contrôle Minier* (ANGCM, Algeria) and the *Council for Geoscience* (South Africa). However, the cooperation with existing organizations such as the *Geological Society of Africa* (GSAf), the *Organization of African Geological Surveys* (OAGS), *Commission for the Geological Map of the World* (CGMW), *International Union of Geological Sciences* (IUGS), *United Nations Educational, Scientific and Cultural Organization* (UNESCO), the *International Association of Seismology and Physics of the Earth Interior* (IASPEI), and *International Geological Correlation Program* (IGCP) will help in the map production. Other networks such as the *International Centre of Theoretical Physics* (ICTP, Trieste), *AfricaArray* (Washington) and *Global Earthquake Model* (GEM, Eurocentre Pavia) will help in supporting the project and establishing the link with the seismic hazard assessment.

## 2. FRAMEWORK OF THE PROJECT

Previously, Jean Paul Cadet and Philippe Rossi (CGMW) in cooperation with the Bernard Ingram of the Council for Geoscience, South Africa, have prepared the SeTMA proposal and provided the tectonic framework and technical characteristics on which a seismotectonic map can be realised (a draft map was produced from the world seismotectonic map, see Appendices, Fig. 1). Another initiative was attempted in the frame of the International Council for Scientific Unions - Regional Office for Africa (ICSU-ROA) but it was limited by logistical and organisational difficulties.

The preparation of the seismotectonic map of Africa is a multidisciplinary task that requires the definition of scientific and technical characteristics and the organisation of a working group able to conduct the analysis of existing data. The working group will work on the six different seismotectonic provinces:

- The **East African** Rift (from Malawi to Ethiopia) and Madagascar,
- The **Southern African** shield (includes Mozambique, Namibia and Angola) and the Cape fold belt,
- The **Northwest African** fold-and-thrust belt (Atlas Mountains),
- The **Northeast African** tectonic zones of Libya and Egypt,
- The **Central Africa**-Nigeria fault systems and the Cameroon volcanic line, and
- The **Western-Central Africa** “so called” stable tectonic zones and related islands.

This subdivision is made according to the geodynamics, neotectonics and seismicity characteristics of each region. For each seismotectonic province, the following tectonic and seismology experts has been nominated by GSAf to contribute to the project:

- The **North-Western African Region** – A. Ayadi (Research Centre of Astronomy and Geophysics, Algeria),
- The **North-Eastern African Region** - A.E.A. Mohamed (National Research Institute of Astronomy and Geophysics, Egypt),
- The **Western African Region** - A.F. Abimbola (University of Ibadan, Nigeria),
- The **Eastern African Region** - A. Abebe (Addis Ababa University, Ethiopia),
- The **Central African Region** - N.J. Metuk (Institute for Geological and Mining Research, Cameroon), and
- The **Southern African Region** - B. Mapani (University of Namibia, Namibia).

### 3. SCIENTIFIC AND TECHNICAL CHARACTERISTICS

In this seismotectonic project, a synthesis of the 1/1 000 000 to 1/5 000 000 scale regional maps will ultimately constitute the 1/10 000 000 scale map. The *International Geological Map of Africa* at 1:5 000 000 (1985–1990) and the *International Tectonic Map of Africa* at 1:5 000 000 (in press, 2010) prepared in the frame of the CGMW projects will serve as a basis of this mapping project.

As already set in the previous SeTMA proposal the seismotectonic map will have the following parameters:

- **Projection:** Transverse Mercator (Mo: 16° East, Latitude: 0°).
- **Limits:** To be adjusted according to the format envisaged for the map, which will be similar to the *Tectonic Map of Africa* (i.e., North: 40° N, South: 42° S, East: 60° E, West: 25° W).

The primary objective will be the preparation of a databank represented by means of a ArcGIS sub-project. The databank includes the following items:

- Satellite images (Landsat, SPOT, ...),
- Digital Elevation Models (SRTM3+, Alos prism products),

- The major faults with tectonic activity during the Quaternary period,
- The major faults with tectonic activity during the Holocene,
- The major faults with recently recorded coseismic activity,
- The major faults of the oceanic domains,
- Characteristics of active volcanoes,
- Geodetic maps (conventional geodesy, GPS data, InSAR)
- The background seismicity from 1960 up to the present-day,
- The historical seismicity up to 1960,
- Major tsunamis and their impact on the African coastlines,
- The focal mechanisms of earthquakes and related stress distribution, and
- Geophysical maps (gravity, magnetic, seismic profiles and tomography).

A careful study will be devoted to each significant historical or recent large earthquake and its surface faulting and deformation. The data compilation is complemented by a detailed study of the related scientific literature and an analysis of the seismotectonic characteristics at a regional level. This information can be distributed as:

- A leaflet that supplements the map includes the detailed legend with explanations of the seismotectonics of each province. Tectonic cross sections joined with geophysical profiles and kinematic models will illustrate the geodynamic structure at the crustal and lithospheric level.
- Tables of tectonic and seismic parameters (fault dimensions and mechanism, physical properties) follow a specific format that can be useful for subsequent seismic hazard and risk studies.

#### **4. TIMETABLE OF THE PROJECT**

The seismotectonic map needs a minimum of 3 years for its realisation. The pre-project can be launched during the 23<sup>rd</sup> Colloquium of African Geology (CAG 23) - South Africa 2011 - held at the University of Johannesburg during 8–14 January 2011. Representatives of the African geological and geophysical surveys and the African and foreign scientists will meet for a workshop and discuss the scientific content of the project and the timetable.

Further discussion and preparation of scientific and technical aspects with the official launching of the project can be during the annual meeting of the OAGS that will be held in May 2011 in Windhoek (Namibia). Official representatives from all geological surveys of Africa will probably attend the meeting and decisive scientific topics as well as logistical and organisational issues can be discussed.

A mid-term date for a first draft presentation of the seismotectonic map can be the 34<sup>th</sup> Session of the International Geological Congress (IGC 34), in Brisbane, Australia, during 5–10 August 2012.

A final version of the seismotectonic map of Africa will be officially presented during the 35<sup>th</sup> International Geological Congress in South Africa in 2016.

## 5. THE SCIENTIFIC WORKING GROUP

The scientific content of the seismotectonic map will be the result of a close collaboration between the African scientists. Ideally, geological and geophysical surveys from each African country will have to delegate a scientific in charge of the data collection and analysis.

A steering committee formed by leading African scientists (1 colleague for each seismotectonic province) assisted by foreign scientists in active tectonics, seismology and geodesy (3 to 5 colleagues).

The survey delegates and the steering committee will have to meet at least twice a year in an African country. Discussion sessions and business meetings will be conducted by a moderator.

**Project leaders:** Mustapha Meghraoui (IPG Strasbourg, France)  
Bernard Ingram (CGS, South Africa)

### **African Scientists (tentative list):**

Abu El-Ela Amin Mohamed (National Research Institute of Astronomy and Geophysics, Egypt), Akinlolu Festus Abimbola (University of Ibadan, Nigeria), Atalay Abebe (Addis Ababa University, Ethiopia), Benjamin Mapani (University of Namibia, Namibia), Nnange Joseph Metuk (Institute for Geological and Mining Research, Cameroon), Ateba Bekoa (Geophysical Observatory, Cameroon), Kadiri Umar Afegbua (Centre for Geodesy and Geodynamics, Nigeria), Semch-Eddine Guelai (ANGCM, Algeria), Abdelhakim Ayadi (CRAAG, Algeria), Assia Harbi (CRAAG, Algeria), Djillali Benouar (USTHB, Algeria), Nacer Jabour (Seismological Centre of Rabat, Morocco), Taoufik Mourabit (University of Tanger, Morocco), John Agyei Duodu (Geological Survey of Ghana), Yousif Elsamani Ali (Geological Research Authority of Sudan), Salah Mahmoud (National Research Institute of Geophysics, Egypt), Abdunnur Suleiman (Libya), Gerhard Graham (Council for Geoscience, South Africa), Marco Andreoli (NECSA, South Africa), Coenie de Beer (Council for Geoscience, South Africa), Mark Goedhart (Council for Geoscience, South Africa), Michelle Grobbelaar (Council for Geoscience, South Africa), Vunganai Midzi (Council for Geoscience, South Africa) ...

### **Possible foreign Scientists:**

Eric Calais (Dept. of Earth & Atmospheric Sciences, Purdue University, USA), Mourad Bezzeghoud (Evora University, Portugal), Rui Manuel Fernandes (Lisbon University, Portugal), Damien Delvaux (Africa Museum, Belgium), ...

## 6. RESOURCES AND SUPPORTS

Different African and foreign institutions are already interested in the production of the seismotectonic map of Africa. However, their financial contributions are related to specific proposals related with meetings, scientific research or the map preparation. The resources can be organised as following:

- The OAGS (with ANCGM and CGS in particular) will support the map preparation and regional meetings for scientific discussions on seismotectonic provinces.
- The UNESCO and CGMW will support expenses of the African scientists and the map publication.
- The CGMW proposed to aid in the contribution of the establishment of the legend and the inventory of the complementary relevant information to be provided on the map (i.e. GPS data, stress etc.). A latest version of the new Tectonic Map of Africa has been supplied by the CGMW to assist with the project (Appendices, Fig 2).
- The IGCP (International Geoscience Programme) and IUGS (International Union of Geosciences) may fund projects on geohazards in Africa (Deadline for submission: 15 October 2010) (<http://www.unesco.org/science/earth/doc/igcp/Projects2010.pdf>).
- The Office of External Activities of the ICTP (Trieste) provides funding for scientific programmes dedicated to Africa (<http://oea.ictp.it/>).
- The European Science Foundation provides funding for conferences in the frame of the Europe-Africa Frontier Research Conference Series (<http://www.esf.org/activities/esf-conferences/partnerships/europe-africa-frontier-research-conference-series.html>).
- The GEM network offers support for the sub-Saharan African scientists that will attend the workshop at the 23<sup>rd</sup> CAG meeting.

## 7. ANNEX

### Insets

- Plate movement sketch (with kinematic indicators).
- Plate sketch map with principal stress direction.
- Explanatory notes (including a more comprehensive description of the oceanic area).

### Accompanying products

In addition to the seismotectonic map, the following will be prepared:

- An accompanying Compact Disc with the digital seismotectonic map on 1:5 000 000-scale to be accessed with easily readable Geographic Information System (GIS) software. The GIS software is already being developed within the CGMW.



8. APPENDICES

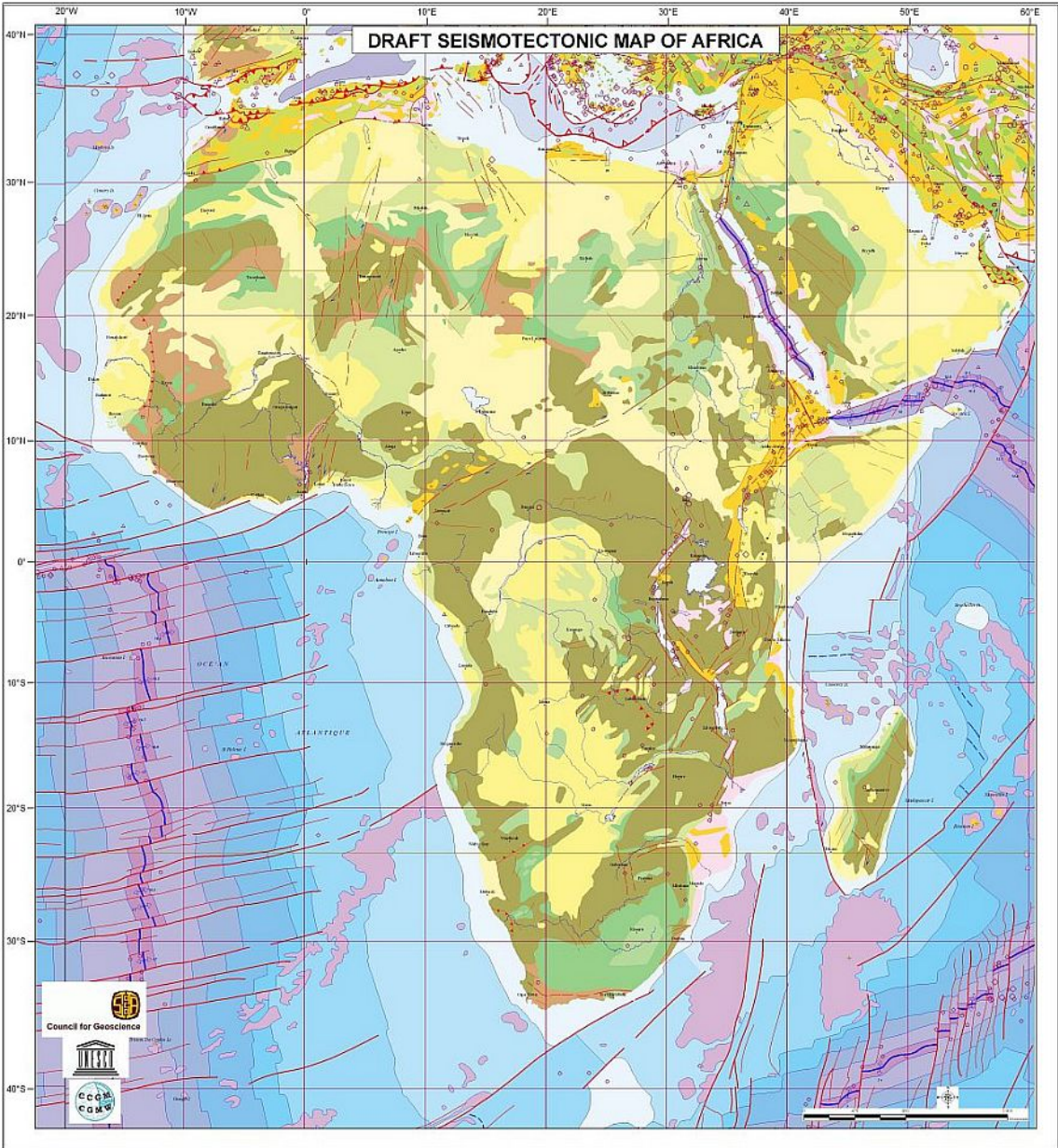
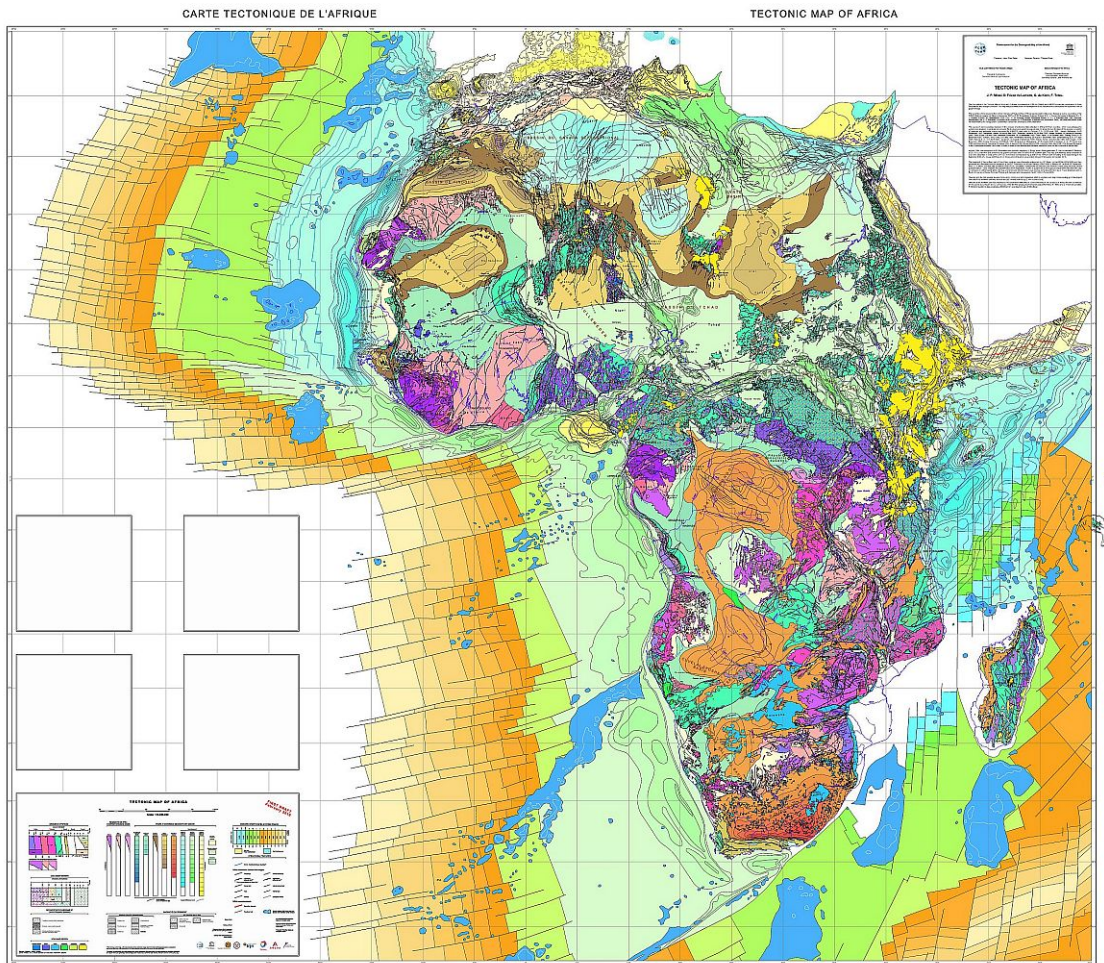


Figure 1. Draft Seismotectonic Map of Africa (2009).



**Figure 2. Draft Tectonic Map of Africa (February 2010).**