A public-private partnership supporting geophysics training and research in Africa
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6th Annual AfricaArray Workshop

School of Geosciences
University of the Witwatersrand,
Johannesburg, South Africa

19-22 November 2010

Programme & Abstracts

A public-private partnership for geoscience training & research in Africa
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6th Annual AfricaArray workshop - Nov 19-22, 2010

School of Geosciences University of the Witwatersrand, Johannesburg, South Africa

November 19, 20 - ***Vetting and revision of science and logistics plan for an expanded AfricaArray***
November 21, 22 - ***Technical workshop with concurrent thematic sessions covering all disciplinary areas (atmospheric science, climate science, geodesy, hydrology, seismology, human dimensions of climate change, ecology and space weather)***

GLT Lecture Theater, Geosciences Building, Wits **Friday 19 November 2010**

08:00 - 08:30	Registration	
08:30 - 08:40	Welcoming remarks	Bozzoli / Gibson
08:40 - 09:10	AfricaArray Overview and Workshop goals	Nyblade

Fundamentals of the science and the state of the discipline in Africa

09:10 - 09:30	Geodesy	Richard Wonnacott
09:30 - 09:50	Atmospheric science	Stuart Piketh
09:50 - 10:10	*Atmosphere research over South Africa and the Indian Ocean*	Siva Venkataraman
10:10 - 10:40	***Tea Break***	
10:40 - 11:10	Climate	Fred Semazzi
11:10 - 11:30	*Statistical analysis and Interpretation in climate science*	Sebastine Francis
11:30 - 11:50	*Spatial and temporal patterns of Intra-seasonal oscillations over Equatorial Africa*	*Lukiya* Tazalika
11:50 – 12:10	Hydrology	Tamiru Abiye
12:10 - 14:00	***Lunch***	

Reviewing & revising the Science & Logistics Plan

14:00 - 14:30	Summary of Science & Logistics Plan for the expanded AfricaArray	Andy Nyblade
14:30 - 16:00	Breakout sessions: Science driven by societal needs (chapter 2)	
16:00 - 16:30	***Tea Break***	
16:30 - 18:00	Report back from breakout sessions	

GLT Lecture Theatre, Geosciences Building, Wits **Saturday 20 November 2010**

08:30 - 08:45	Recap of results from previous day
08:45 - 10:30	Breakout sessions: Science that addresses fundamental questions (chapter 3)
10:30 - 11:00	***Tea break***
11:00 - 11:30	KEYNOTE LECTURE: How did Karabo die? Deciphering a 2 million year old tragedy. **Paul Dirks** (*James Cook University, Australia*)
11:30 - 12:30	Report back from breakout sessions
12:30 - 14:00	***Lunch***
14:00 - 16:00	Breakout sessions: Instrumentation and capacity building, structural organization, funding needs & priorities, stakeholders (chapters 4 - 8)
16:00 - 16:30	***Tea break***
16:30 - 18:00	Report back from breakout sessions

Sunday November 21

Field trip: Cradle of Humankind

08:00	Bus leaves Wits
8h00 - 9h30	Travel to Sterkfontein caves
9h30 - 11h30	Visit Sterkfontein caves and Maropeng
11h30 - 13h00	Return to Wits. ***Eat packed lunch on bus.***

GLT Lecture Theatre, Geosciences Building, Wits

Theme: African seismology

13:30 – 13:45 *15 min*	Ghana's experience in the establishment of a national data centre **Paulina Amponsah** (*Nuclear Energy Commission, Ghana*)
13:45 - 14:00 *15 min*	Interpretation of 3D reflection seismic data covering the West and Far West Rand goldfields **Musa Manzi** *(University of the Witwatersrand, South Africa*)
14:00 - 14:15 *15 min*	Velocity Structure and Source Moment Tensor Studies of the Earthquake swarm in the South East part of Egypt. **Ahmed Hosny** *(National Research Institute for Astronomy & Geophysics, Egypt)*
14:15 - 14:30 *15 min*	Active fault zones along the North Tanzania divergence **Michael Msabi** *(University of Dodoma, Tanzania)*
14:30 - 14:45 *15 min*	**Richard Ferdinand** *(University of Dar es Salaam, Tanzania)*
14:45 - 15:00 *15 min*	Geophysical characterisation of Kalahari sand, Gwayi sandstone and Karoo aquifers in North Matabeleland, Zimbabwe: resistivity and seismic refraction results **Gwavava, Oswald** *(University of Fort Hare, South Africa)*
15:00 - 15:30 pm *30 min*	***Tea break***
15:30 - 15:45 *15 min*	Seismic Activity in Thunduwike, Malawi **Shaba, Pearson** *(Geological Survey, Malawi)*
15:45 - 16:00 *15 min*	The effect of Rift Border Fault: The 2009 Karonga Earthquakes **Chindandali, Patrick** *(Geological Survey, Malawi)*
16:00 - 16:15 *15 min*	Mine-induced seismicity in mine water ingress in the Witwatersrand basin, South Africa **Zhao, Baojin** *(University of Fort Hare, South Africa)*
16:15 – 16:30 *15 min*	The New Configuration of Madagascar Seismic Network; the First Obtained Results: Crustal Velocities **Gerard Rambolamanana** (*Institute and Observatory of Geophysics Antananarivo, Madagascar*)
16:30 – 16:45 *15 min*	Crustal structure beneath central part of Madagascar using the data registered by the Malagasy seismic station ABPO by surface wave analysis **Abdoulkarim, Moussa** (*Institute and Observatory of Geophysics Antananarivo, Madagascar*)
16:45 - 17:00 *15 min*	Lithospheric structure under the SBV seismic station in Vohemar from Receiver Functions **Andriampenomananany Ony, Fenitra Sy Tanjona** (*Institute and Observatory of Geophysics Antananarivo, Madagascar*)
17:00 - 17:15	A study on velocity structure using teleseismic receiver function in central region of Madagascar.

15 min **Rakotondraibe, Tsiriandrimanana** (*Institute and Observatory of Geophysics Antananarivo, Madagascar*)

17:15 - 18:30 ***Poster session in Bleloch Museum (with snacks and drinks)***

GLT Lecture Theatre, Geosciences Building, Wits **Monday November 22**

08:00 - 08:30 REGISTRATION – Tea and Coffee

08:30 - 08:40 WELCOMING REMARKS
10 min **Dean Faculty of Science / Head of Geosciences** , *Univ. of Witwatersrand*

08:40 - 09:00 AFRICAARRAY STATUS REPORT - network activities and development plan
20 min **Andy Nyblade** *(Penn State Univ., USA)*

09:00 - 09:10 EDUCATIONAL & COMPLEMENTARY ACTIVITIES
– Global Earthquake Model Initiative
– Japan-SA collaboration "Observational studies to mitigate seismic risks in mines"
– 100 Years of rockburst research & IUGG2011
10 min **Ray Durrheim** *(University of the Witwatersrand/CSIR, SA)*

09:10 - 09:20 AFRICAARRAY INTERNATIONAL FIELD SCHOOL
10 min **Sue Webb** *(University of the Witwatersrand, SA)*

09:20 - 9:50 KEYNOTE LECTURE: New seismic images of the African Superplume
30 min **Andy Nyblade** *(Penn State University, USA)*

Theme: Tectonics and Structure of the African Plate

9:50 – 10:10 Evolution of stress in western southern Africa since the breakup of West Gondwana: seismotectonic implications
20 min **Marco Andreoli** (*Nuclear Energy Corporation of South Africa*)

10:10 - 10:30 The IntraCongo Basin: Dynamic topography or failed rift with protracted thermal subsidence?
20 min **Etienne Kadimo Kabongo** (*University of Lumumbashi*)

10:30 - 11:00 ***Tea break***
30 min

11:00 - 11:15 Structure of the crust beneath Cameroon, West Africa, from the joint inversion of Rayleigh wave group velocities and receiver functions
15 min **Alain Pierre Tokam Kamga** (*University of Yaounde 1, Cameroon*)

11:15 - 11:30 Tectonic Settings Of Phanerozoic Sedimentary Basins In Africa
15 min **Kudzanayi Mgodi** (*University of the Witwatersrand, South Africa*)

11:30 - 11:45 Upper crustal structure of the Bushveld Complex using high-frequency Rayleigh wave tomography
15 min **Eldridge Kgaswane** *(Council for Geoscience, South Africa)*

11:45 - 12:00 Middle mantle seismic structure of the African Superplume
15 min **Martin Brandt** *(Council for Geoscience, South Africa)*

12:00 - 12:15 Seismic Velocity Structure of the Crust and Upper Mantle in Sudan
15 min **Nada El Tahir** *(Seismological Research Institute, Sudan)*

12:15 - 12:30 The Geophysicists without Borders Dayspring Project
15 min **David Ngobeni** *(University of the Witwatersrand, South Africa)*

12:30- 14:00 ***Lunch break***
90 min

14:00 - 14:45 KEYNOTE LECTURE: Okavango Delta
45 min **Spike McCarthy** (*University of the Witwatersrand, South Africa*)

Theme: Seismic hazard

14:45 - 15:00 The September 19, 2009 Ml 5.0 earthquake in the Ankober area: lessons for seismic hazard mitigation around Addis Ababa
15 min **Atalay Ayele** *(University of Addis Ababa, Ethiopia)*

15:00 - 15:15 The effects of the 3 February 2008 earthquake in the Lake Kivu basin, Western Rift Valley of Africa
15 min **Mifunu Dieudonne Wafula** *(CRSN, DR Congo)*

15:15 - 15:30 Seismotectonic Models, Earthquake Recurrence and Maximum Possible Earthquake Magnitudes for South Africa
15 min **Mayshree Singh** *(Council for Geoscience, South Africa)*

15:30 - 16:00 pm ***Tea break***
30 min

16:00 - 16:15 Deterministic Properties of Mine Tremor Aftershocks
15 min **Thabang Kgarume** *(CSIR, South Africa)*

16:15 - 16:30 Seismic Damage Mechanism at Impala Platinum
15 min **Lesiba Ledwaba** *(Impala Platinum, South Africa)*

16:30 - 16:45 Seismic hazard and volcanogenic seismicity in the DRC
15 min **Georges Mavonga** *(Goma Volcanic Observatory, DR Congo)*

16:45 - 17:00 Full Moment Tensor Solutions of 'large' (Mw > 3.0) Mine-Induced Events in the Carletonville Mining District, South Africa
15 min **Jordi Julià** *(Penn State Univ., USA)*

17:00 - 18:00 ***Snacks and drinks in Bleloch Museum***

Posters: on display from 19-22 November 2010 in Bleloch Museum

Seismicity and Seismotectonics of Sudan
Babiker, Naila[1], AG Mula[1], AA Sadig[2], AG Faraw[2], M Mirgani[1], S Taha[1], N Ali[1], K Yassin[1], K Abdelaziz[1], A Kamal[1], B Ahamed[1] and N Zein[3]
[1]*Seismological Research Institute, National Centre for Research, Sudan*
[2]*University of Khartoum, Sudan*
[2]*University of Alneelein, Sudan*

Establishing and Validating Empircically0Based Ground Truth Criteria for Seismic Events Located Using Regional Networks
Brazier[1], Richard, KB Boomer[2], Steven Myers[1], Andrew Nyblade[1] and Jennifer Kokoska[2]
[1]*Pennsylvania State University, USA*
[2]*Bucknell University, USA*

Anisotropy of the western branch of the East African Rift – Preliminary shear-wave splitting results
Desser[1], Elizabeth and Andy Nyblade[1]
[1]*Pennsylvania State University, USA*

Constraints from Deep-Imaging Magnetotellurics on the Lithospheric Structure of the Okwa terrain, Botswana

Khoza[1,2,3], David, Alan Jones[1], Mark Muller[1], Marion Miesonpust[1], Pieter-Ewald Share[1,2,4] and the SAMTEX Team
[1]*Dublin Institute for Advanced Studies, Ireland*
[2]*University of the Witwatersrand, South Africa*
[3]*BHP Billiton SA Ltd, South Africa*
[4]*CSIR, South Africa*

Seismicity and Seismic Hazard assessment of the western arid regions of South Africa
Malephane[1], Hlompho, Ray Durrheim[1,2] and Marco Andreoli[3]
[1]*University of the Witwatersrand, South Africa*
[2]*CSIR, South Africa*
[3]*Nuclear Energy Corporation of SA, South Africa*

Seismic and Structural Interpretation using 3D Reflection Seismic Data from the West and Carletonville Goldfields, Witwatersrand Basin
Manzi, Musa[1]
[1]*University of the Witwatersrand, South Africa*

Hydrogeological Monitoring and Modelling in the Crocodile-Marico Catchment Basin: a Tool for Implementing National Integrated Water Resource Management Programmes and for Sustaining Company Profits
Mophatlane, Tshegofatso[1]
[1]*Anglo American Platinum Division, South Africa*

Establishing and Validating Empircically0Based Ground Truth Criteria for Seismic Events Located Using Regional Networks
Mulibo[1], GD, AA Nyblade[1] and RW Ferdinand[2]
[1]*Pennsylvania State University, USA*
[2]*University of Dar es Salaam, Tanzania*

Constraints from Deep-Imaging Magnetotellurics on the Lithospheric Structure of the Okwa terrain, Botswana
Muller, Mark[1], Alan Jones[1], Rob Evans[2] and the SAMTEX Team
[1]*Dublin Institute for Advanced Studies, Ireland*
[2]*Woods Hole Oceanographic Institution, USA*

Investigating the Origin and Evolution of the Karoo Basin using 3D modelling
Scheiber, Stephanie[1], Sue Webb[1] and Jörg Ebbing[2]
[1]*University of the Witwatersrand, South Africa*
[2]*Geological Survey of Norway*

Constraints from Deep-Imaging Magnetotellurics on the Lithospheric Structure of the Okwa terrain, Botswana
Share[1,2,4], Pieter-Ewald, Alan Jones[1], Mark Muller[1], Marion Miesonpust[1], David Khoza[1,2,3], Sue Webb[2], H Tunehead[5] and the SAMTEX Team
[1]*Dublin Institute for Advanced Studies, Ireland*
[2]*University of the Witwatersrand, South Africa*
[3]*BHP Billiton SA Ltd, South Africa*
[4]*CSIR, South Africa*
[5]*Geovista AB, Sweden*

The Seismic Network in Sudan
[1]Sidahmed, Abdelkhalig
[1]*Geological Research Authority of Sudan*

Crustal Modeling in Africa: towards high resolution models using GRACE and GOCE satellite gravity data
Tedla[1,2], GE, M van der Meijde[1], AA Nyblade[2] and FD van der Meer[1]
[1]*University of Twente, The Netherlands*
[2]*Pennsylvania State University, USA*

Establishing and Validating Empircically0Based Ground Truth Criteria for Seismic Events Located Using Regional Networks
Tugume[1], Fred, Andy Nyblade[1], Jordi Julià[1] and Gabriel Mulibo[1]
[1]*Pennsylvania State University, USA*

Seismic activity in Zimbabwe and Station Status in Zimbabwe from 1959 to Present
Shumba, Blessing[1]
[1]*Goetz Observatory, Zimbabwe*

Analysis of guided elastic waves at a periodically joined interface of two half spaces
Yenwong Fai[1]**, Alfred and Ray Durrheim**[1,2]
[1]*University of the Witwatersrand, South Africa*
[2]*CSIR, South Africa*

Shear-wave velocity structure in the central part of Madagascar by surface waves analysis

Abdoulkarim Moussa[1], Andriampenomanana Ny Ony Fenitra[1], Rakotondraibe Siriandrimanana[1], Rambolamanana Gérard[1]

1. Institute and Observatory of Geophysics of Antananarivo, PO Box 3843
101 ANTANANARIVO - MADAGASIKARA

Seven teleseismic events recorded from January to April 2010 by the broadband seismic station SBV were used to determine the crustal velocity structure of the north-eastern part of Madagascar by the inversion of receiver function. Initially, the receiver functions were calculated, using SEISAN, SAC and GSAC softwares. Subsequently, the inversion of receiver functions was performed, based on a criterion of selection used quite generally in the receiver function inversion method, with the CPS software. This method consists in a selection of receiver function with ray parameter values equal or nearly equal to be reversed. This reduces the differences in calculations during the inversion and refines the velocity model obtained after inversion.

The velocity model is characterized by three layers: a first layer having 19 km thickness with an S-wave velocity equal to 3.40 km/s, followed by a second layer having a thickness of 22 km in which the S-wave velocity is 3.75 km/s and finally comes the last layer which extends from 41 km depth and forms the border with the Moho. For the last layer, the S-wave velocity increases from 3.75 km/s to 4.4 km/s. The Moho discontinuity has been approximately located at a depth of 41 km. This result is in agreement with previous works in Madagascar.

Keywords: Madagascar, Receiver function, inversion, crustal structure.

Ghana's Experience in the Establishment of a National Data Centre

Paulina Ekua **Amponsah**[1]

1. Ghana Atomic Energy Commission, P.O.Box LG 80, Legon, Accra, Ghana .

The Government of Ghana in a bilateral agreement with the Preparatory Commission for the Comprehensive Nuclear Test - Ban Treaty Organisation have established a National Data Centre in Ghana with the aim of monitoring the testing of nuclear explosions. Seismic, hydroacoustic, radionuclide and infrasound methods are used for the monitoring. The National Data Centre was commissioned on the 3rd of February, 2010 at the Ghana Atomic Energy Commission. At present Ghana does not have any operational, centralised data (seismic, hydroacoustic, radionuclide and infrasound) acquisition system with the capability of accessing data from other international stations. Hence, the importance of setting up the National Data Centre which would enable us constantly monitor, manage and coordinate both natural and man-made seismic activities in the country and around the globe , upload data to the International Data Centre (IDC) as well as receive and use International Monitoring System(IMS) data and IDC products for treaty verification and compliance. Apart from these, the Centre also accesses and analyzes seismic waveforms relevant to its needs from the International Data Centre; makes data available to its stakeholder Institutions for earthquake disaster mitigation; reports on all aspects of disasters related to seismic to relevant government agencies that deal with disasters; makes recommendations to the government of Ghana on earthquake safety measures; provides information to assist government Institutions develop appropriate land and building policies. The Centre in collaboration with stakeholder agencies periodically organises public lectures on earthquake disaster risk mitigation.

Key words: Ghana, Preparatory Commission for the Comprehensive Nuclear Test-Ban Treaty Organization, National Data Centre, seismic data

Shear-wave velocity structure in the central part of Madagascar by surface waves analysis

Andriampenomanana Ny Ony Fenitra[1], Rakotondraibe Siriandrimanana[1], Abdoulkarim Moussa[1], Rambolamanana Gérard[1]

1. Institute and Observatory of Geophysics of Antananarivo, PO Box 3843
101 ANTANANARIVO - MADAGASIKARA

The fundamental mode of Rayleigh wave generated by 14 earthquakes were analysed to estimate the shear-wave velocity distribution with depth along 26 paths of seismic waves. These events occurred in western and eastern of Madagascar between 2007 to 2010 and recorded by the broadband seismic station ABPO (Ambohimpanompo / Madagascar). The multiple filter technique (Diewonski et al., 1969) was applied to obtain the dispersion curves of the fundamental modes of Rayleigh wave between 10 sec to 65 sec of period which correspond roughly to sensitivity between 0 km and 80 km of depth. These dispersion curves were inverted, using Herrmann software package (1987) : Computer Programs in Seismology, but only upper 60 km were considered to get the shear-wave velocity structure of the crust and the lithospheric mantle. For all the dispersion curves, the group velocity of Rayleigh wave increases with period. Generally, the inversion of the dispersion curve shows 3 layers where the shear-wave velocity structures increase with depth.

Keywords: Madagascar, Rayleigh waves, fundamental mode, multiple filter technique, dispersion curve, inversion, shear-wave velocity structure.

Geodynamic implications of the recent earthquakes felt in Central Cameroon

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2. Institute of Geological and Mining Research, branch for Geophysical and Volcanological Research; P.O. Box 370 Buea, Cameroon.
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The geological setting of Cameroon, in central Africa is characterized in the south by the Congo craton, a stable zone of Archean age; while the centre and north of the country lie over the Pan-African (orogeny). Cenozoic volcanism is represented by a series of islands in the Atlantic Ocean and mainland volcanic centres stretching over a distance of over 1500 km. Many faults are identified across the country; the most important group being associated with Central African shear zone and Sanaga fault system. The annual seismicity correlates mostly with volcanic provinces but ever since 2005 the most important earthquakes felt in the country since 2005 are located in Centre Cameroon region. They are studied from short period data of Mount Cameroon permanent seismic network, temporary broad band stations and macroseismic survey. Two main earthquakes with m¬b ~ 5 were recorded. Their focal mechanisms are strike slips which agree with the results of structural studies carried earlier in the region. A tentative interpretation of this recent seismicity is given with respect to the proposed geodynamic model of central Africa.

The September 19, 2009 Ml 5.0 earthquake in the Ankober area: lessons for seismic hazard mitigation around Addis Ababa

Atalay **Ayele**[1]

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The Ankober-Fentale-Dofen area is the most seismically and volcanically active area close to Addis Ababa, the capital of Ethiopia in a distance range of ~ 150 km. The area comprises the southern extension of the Red Sea rift and the junction where the main Ethiopian rift funnels out to the Afar Depression. It is so common to record characteristic earthquakes from the Ankober region in the campus of Addis Ababa University frequently, in most cases as sequences and sometimes single shocks. The area was shaken by 6.0 maximum magnitude earthquake in 1938 otherwise the tectonic stress is mostly released by smaller magnitude shocks.

On September 19, 2009 an earthquake of magnitude 5.0 Ml ruptured in an area 25 km northeast of the Ankober town at 17:56:07 GMT. The residents of the Ankober town were terrified by the shaking and this event was felt as far as Addis Ababa. As the event origin time was about 9:00 PM local time many people were at home and it was widely felt in Addis specially residents who live on multistory buildings. The strong motion data was also captured by Altus K2 accelerometer placed in Addis Ababa at about 160 km from the epicenter. However, this event has never been reported by international data centers like NEIC and many others which shows that many damaging earthquakes pass unnoticed in regions of the world with spare distribution of monitoring facilities. This is a good justification for improving the distribution of seismic stations in Africa by AfricaArray and others that work closely in the region. This earthquake is considered as a warning signal for residents, decision makers and construction engineers in Addis Ababa as other eminent earthquake damage is possible in the future. Addis Ababa is the seat of the African Union (AU), Economic Commission for Africa (ECA) and many others international organizations plus the city is currently in a strong spirit of change but the idea of erecting earthquake resistant structure doesn't seem to get the due consideration.

Seismicity and Seismotectonic of the Sudan

N. Babiker[1]**,** A.G. Mula[2], A.G. Farwa[2], M. Mirgani[1], S. Taha[1], N. Ali[1], K. Yassin[1], K. Abdalaziz[1], A. Kamal[1] and N. Zein[3]

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2. University of Khartoum, Faculty of Science, Department of Geology
3. University of Alneelein, Faculty of Science, Department of Geology

Earthquake data collected from international seismological stations were compiled in order to produce a seismicity map for the Sudan. The seismicity map was superimposed on the tectonic map of the Sudan in order to identify the relationship between the distribution of earthquake and active structures. The study showed that Sudan lies within seismically-active area which can be divided into four major zones namely the Southern Zone, the Red Sea Zone, the Central African Fault Zone and a zone related to volcanic activity. The Southern Zone is bounded by the latitudes 3º 0̀0 and 10°0̀0 N and longitudes 22º 0̀0 and 36°0̀0 E. The seismic activity associated with this zone is attributed to the extension of the western branch of the East African Rift System into southern Sudan. The Red Sea Zone is located in the northeastern part of the Sudan where the seismic activity is high due to the spreading process along the axial trough of the Red Sea. Seismicity related to the Central African Fault System (CAFZ) is thought to have been triggered by rejuvenation of this structure in response to the opening of the Atlantic and the subsequent formation of the interior rift basins of central Sudan. The seismic activity related to volcanicity is confined to Darfur region (J. Marra area) and Bayuda Desert.

The Malawi Rift and 2009 Karonga earthquakes

Patrick Rafiki N. **Chindandali**[1]

1. Geological Survey Department, Seismology Section, Box 27, Zomba, Malawi

Karonga lies within the Malawi rift which is an extension of the Western arm of the East African Rift System (EARS) where rifting is believed to have been initiated ~12-10 Ma. GPS data for the region indicate an E-W extension of ~3.2 mm/yr (Chu and Gordan, 1999; Stamps et al., 2008) which further suggests an influence of stress accumulation within the dominant geomorphology. The dominant feature bounding the Karonga region on the eastern side is the Livingstone rift boundary fault while on the western flanks of the lake, is a series of many smaller faults and it is where a total of 26 earthquakes of magnitude M≥4.0 occurred between December 6th, and 19th of 2009. All earthquakes were within a depth range of 0-30 Km. The occurrences of these events on the western flanks of the lake demonstrate that the hanging wall of the Livingstone Fault is unstable hence the release of stresses within it. The rupture of one of the synthetic W-dipping faults within the district is evident of an area under continued seismic activity which requires further research to constrain fault geometries in the region by employing Geophysical methods since accurate structural and kinematic models are very useful in understanding seismo-tectonics of any region.

Key words: Karonga earthquakes, Seismicity of Malawi, Northern Province, Malawi rift, Faulting, Rift Boundary fault

Middle mantle seismic structure of the African Superplume

Martin **Brandt**[1]

1. Council for Geoscience, South Africa

We present the results of statistical hypothesis testing on Grand's global tomography model of three-dimensional shear velocity variations for the middle mantle underneath eastern- and southern Africa. We apply a F-test to evaluate the validity of the inverted model where the tilted, slow velocity anomaly at the core-mantle boundary and deep mantle under southern Africa, known as the African Superplume, extends into the slow velocity anomaly in the upper mantle under eastern Africa. This null hypothesis is tested against alternative hypotheses where various "obstruction volumes" in the middle mantle are constrained to the average slowness during the tomographic inversion. The result is an equal probability of accepting an alternative hypothesis with a thin volume at 850-1000 km depth whereas volumes at other depths are rejected. We conclude the African Superplume rises to at least 1150 km depth and the upper mantle slow velocity anomaly continues from the surface to below the mantle transition zone. We interpret the "obstruction volume" as a thermal boundary layer at the same base depth of other plumes that originate near the 670 km discontinuity.

Key words: Global Tomography, African Superplume, Shear-wave, Hypothesis testing

Seismic Velocity Structure of the Crust and Upper Mantle in Sudan

N.B. El Tahir[1]**,** A.A. Nyblade[2], R.J. Durrheim[3,4] and J. Julià[2]

1. Seismological Research Institute, Sudan
2. Penn State University, USA
3. University of the Witwatersrand, South Africa
4. CSIR, South Africa

Crustal structure of Khartoum has been investigated by using H-K stacking of receiver functions and a joint inversion of P -receiver functions and Rayleigh wave group velocities for 3 long periods seismic stations distributed in a radius of 40 km within and around Khartoum. We obtained consistent results from the two methods yielding Moho depth estimates of 36-38 km (H-k stacking) and 37 km (joint inversion). As Sudan is considered one of the large Precambrian terrains,

both results from the two methods were expected. The 1-D shear wave velocity models obtained from the joint inversion method show relatively simple structure which contains gentle crust-mantle boundaries with a change in velocity from about 3.5 to 4.2 km/sec.

These preliminary findings support previous studies showing that crust away from the rift in the eastern and southern part of Sudan has not been modified by Cenozoic rifting and magmatism. However, the influence of the central Africa Shear zone which passes north Khartoum has not been fully studied.

Key words: receiver function, inversion and crustal structure

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Monitoring Of Flood for Information Dissemination in Nigeria: Operational Challenges for Flood Early Warning System

Regina **Folorunsho**[1]J

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Flooding usually occurs as a result of severe storms, either at sea or on land and from tsunamis. In Nigeria, flooding occurs as a result of intense rainfall along river banks, cities and from ocean storm surges which result in massive flooding low lying coastal areas. Though Nigeria is located in the passive Gulf of Guinea which is not highly tectonic, the Chain and Charcot fracture zones which emanate from the Mid-Atlantic ridge and extending to the Nigerian continental margin could be reactivated causing movements which could generate tsunamis. Considering the magnitude of the occurrence of floods in Nigeria there is the need for the establishment of an integrated early flood warning system. The essential links or components of the integrated flood forecasting warning and response system should consist of a data source, communications, forecasts, decision support, notification (often referred to as dissemination) and coordination, and actions (or responses). In Nigeria there is no coordinated monitoring of floods or early warning system. Most rivers do not have water level gauges, while those that have are not integrated into a coordinated system. The Global Level of the Sea Surface (GLOSS 259) tide gauge in Nigeria located at the Nigerian Institute for Oceanography and Marine Research (NIOMR) Lagos is the only station that has long time series of data. A flood Early Warning System (EWS) design for Nigeria can be addressed in two components, (i) EWS for flooding in the river basins and (ii) EWS for flooding due to meteorological and seismically induced flooding. These integrated flood early warning systems must be integrated into national disaster reduction plan with clear definition of roles, with responsibilities at all levels incorporating community-oriented programs..

Full Moment Tensor Solutions of 'Large' (Mw > 3.0) Mine-Related Events in the Carletonville Mining District, South Africa Zone

Jordi Julià[1], Andrew A. Nyblade[1], and Ray J. Durrheim[2,3]

1. Penn State University
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Determination of source mechanisms of mine-related seismicity is important to further understand the rock mass response to mining and improve the safety of mining practices. Seismic events result from the relaxation of seismic stresses induced in the rock mass by the extraction of large volumes of rock from underground and the closure of the corresponding voids at depth. The details of the relaxation mechanisms are encoded in the seismic radiation patterns, so analysis of the seismic events helps constrain those details. Previous studies in deep, hard rock gold mines in South Africa have shown that stresses are relaxed through a combination of normal faulting and co-seismic volumetric closure. Some studies have further suggested that the volumetric closure-shear slip distribution could be bimodal, for 'large'-magnitude events. This observation, however, is based on a small number of events and more need to be analyzed in order to improve its statistical significance. We have inverted spectral amplitudes (with polarity assigned) for15 large events (Mw > 3.0) in the Carletonville mining district of South Africa and determined full moment tensor solutions for each of them. The spectral amplitudes have been measured on high-frequency geophones from three in-mine seismic monitoring networks at Savuka, Mponeng, and TauTona mines, operated by Integrated Seismic Systems

International. The seismic radiation patterns for the 'large' events are not ideally constrained by the in-mine networks and the volumetric-shear mix could not be robustly constrained for most of them. For a few better-constrained source mechanisms, however, the results show consistency with the previously reported bimodality.

Towards an Integrated Disaster Monitoring in Nigeria-Review of Disaster Prone Zones

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Nigeria is not situated where major seismic activities are observed in the world; but pockets of tremors have been experienced in some parts of the country comprising of body wave magnitudes ranging from 4.3 to 4.5, and local magnitudes between 3.7 and 4.2, as well as surface wave magnitudes of 3.7 and 3.9. Most of these events were recorded in the South Western Nigeria where a major fault-the Ifewara-Zungeru fault exists. Despite these recorded events, effective monitoring for possible prediction and early warning scheme in Nigeria is non-existent. Beyond the recorded seismic activities in Nigeria, preliminary geo-hazard map developed by the Centre for Geodesy and Geodynamics shows the susceptibility of some zones to subsidence, landslides, and volcanoes. With the obvious knowledge of earth's dynamism, the need to adopt proactive measures on disasters monitoring and possible prediction is being seriously considered with the help of seismological and geodetic equipment in Nigeria. This paper examines prospects of integrated disaster monitoring in Nigeria.

Key words: Nigeria, Recorded tremors, Ifewara-Zungeru fault, fault lines, integrated monitoring scheme, disaster-prone zones

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The Intracratonic Congo Basin: Dynamic topography or Protracted thermal subsidence?

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The intracratonic Congo Basin is a broad and long-lived intracratonic depression of Central Africa filled with up to 9 km of Neoproterozoic to recent sediments. Its formation is still debate because old geophysical and geological studies do not provide clear images of the deep basin and the underlying basement.

The deep structure is also not well resolved. Some shear-wave tomography studies (Priestley et al., 2008) suggest a more than 200 km thick lithosphere, while others (Pasyanos and Nyblade, 2007) conclude on the absence of keel. Admittances studies support a large strength, thick and cold lithosphere (EET ≈ 100 km; Pérez-Gussinyé et al., 2009; Downey and Gurnis, 2009). Based on this large strength, Hartley and Allen (1994) though that there is no reasonable density contrast related to a rift origin that can explain isostatic anomalies and proposed a dynamic subsidence related to a downward flow in the mantle as a more likely alternative. Heine et al. (2008) discussed the same idea as a general mechanism to reactivate intracratonic basins and Downey and Gurnis (2009) support it for the cratonic Congo basin. Thermal relaxation following an unknown geometry and structure post-Cambrian or Cambrian rifting was proposed early by Daly et al. (1992) and recently by Crosby et al. (2010). To perform a residual gravity signal, we developed a combined analysis of subsidence and gravity. From a 3 sedimentary units separated by two regional unconformities, a 3D geometry model was defined and a residual gravity signal and sediment load flexure were computed using the thin elastic plate model. The obtained residual anomaly shows a prominent NW-SE positive trend that can be related to a possible rift prior to basin subsidence. The associated crustal structure is defined assuming that the post rift subsidence is flexural (EET = 100 km) and the rift isostasy is governed by a depth of necking (DON = 10 km). The defined rift

below the Congo basin is in the continuity of some predefined failed rift basins; the Sembe-Ouesso basin to the NW, the Mbuji-Mayi basin to the SE; the Sangha aulacogen and Inkisi basin to the West.

Deterministic properties of mine tremor aftershocks and rate of mine aftershocks and the implications for Seismic Hazard Assessment

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Mine tremor aftershock sequences from two deep mines in the Far West Rand goldfield, South Africa, were analysed in order to determine the influence of geological and mining parameters on the risk posed by aftershocks. Mainshocks were stacked in time and space and the aftershock productivity was calculated for various subsets. Contrary to our working hypothesis, no significant differences were found between the aftershock productivity of mainshocks located in high stress areas and those located in low stress areas, or between mainshocks located in high strain-rate areas and those located in low strain-rate areas, or between mainshocks located near to geological features and those located further away from geological features. Thus, while the incidence of mainshocks may be affected by stress, strain rate and proximity of geological features, these factors do not have significant influence on aftershock productivity. Consequently, guidelines governing the time period and distance from the mainshock in which hazard is considered to be elevated need not take variations in these geological and mining parameters into account.

Seismicity and Seismic Hazard Assessment of the arid western regions of South Africa: a Neotectonic Perspective

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There are two nuclear reactors in South Africa, a research reactor at Pelindaba near Pretoria and a power-generating reactor at Koeberg near Cape Town. High level radioactive waste (HLW) in the form of spent fuel is currently stored in the designated spent-fuel pools on the Koeberg site. The shorter lived, low- and intermediate-level waste (half-life ≤31 years) is sent to the Vaalputs National Radioactive Waste Disposal Facility in the Northern Cape Province, currently managed by the South African Nuclear Energy Corporation (Necsa). In addition, the South African government is currently formulating plans to construct additional nuclear power stations to meet future demands for energy. According to the Radioactive Waste Management Policy and Strategy for the Republic of South Africa it is prudent to begin gathering the data needed to assess future HLW disposal sites, and explore other options like the reprocessing of spent nuclear fuel.

Site selection criteria for a nuclear waste disposal site include proximity to settlements, agricultural potential of land, geological stability and seismic activity. This study will make a detailed investigation of the seismic activity in the arid western region of South Africa, as this region is likely to prove suitable, in principle, for the disposal of radioactive waste. It is planned to expand and link the existing seismic network at Vaalputs to the National Seismograph Network stations which should improve the sensitivity and location accuracy of the Bushmanland region.
The current Necsa seismic database shows that the Vaalputs site is seismically stable, yet there has been sporadic seismic activity in Namaqualand with swarms in 1996, 2001, and again (near Augrabies) in 2010. The network will be used to assess the reliability of the reported magnitudes, to define active faults and seismotectonic zones, and to derive seismic source mechanisms. This will yield more accurate seismic hazard assessments.

Key words: nuclear waste disposal, South Africa, seismicity, neotectonics, seismic hazard assessment.

Tectonic settings of Phanerozoic sedimentary basins in Africa

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Tectonics and specifically the development and disintegration of continents (which is also related to mantle plumes) influence the formation of sedimentary basin. The Phanerozoic sedimentary basins of Africa have been classified according to their periods of formation and also according to their tectonic setting. The development of sedimentary basins on the African continent have been influenced by the formation of Gondwana, the formation of Pangaea, the breakup of Pangaea, the breakup of Gondwana and the rifting in East Africa. Most of the basins on the continent are rift basins and sag basins.

Active fault zones along the North Tanzania divergence

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Results on the study of active fault mapping and characterisation of seismic sources along the North Tanzania Divergence (NTD) are hereby reported. The study involved fault identification, testing of their activeness and characterisation. By using aeromagnetic data, the study has uncovered new faults within the Manyara basin. The uncovered faults are mainly trending NE-SW oblique to the Manyara main border fault, forming a fault zone. Based on well located earthquakes within NTD, three active faults were delineated. Two are located within the Natron basin, i.e., the NE-SW trending Gelai fault and E-W trending fault under Lake Natron, and one in Eyasi basin, i.e., NW-SE trending fault almost perpendicular to the Eyasi border fault. The located earthquakes have also marked four blocks of high seismic activity. The marked blocks are Manyara basin, Balangida, Kondoa and KwaMtoro. Based on criterion for seismic source characterisation, such as fault lateral extent and orientation, earthquake focal depths, stress orientation and maximum observed magnitude, the study have characterised seismic sources along NTD into two. These are three faults in Natron and Eyasi basins, and four fault zones in Manyara basin, Balangida, Kondoa and KwaMtoro.

Use of Isotope Tracer Techniques to Investigate Groundwater Interaction with Lake Victoria

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The Lake Victoria is the second largest lake in the world. It is recognized as an immense geographical and economic entity covering a surface area of 68,800 km^2. The Lake is believed to support about 30 million people within and around its catchment. The scientific phenomenon of water mass balance of Lake Victoria is still lacking. Several attempts of establishing the water mass balance of the lake have been done. The most recent one was done in 2001 under the Lake Victoria Environmental Management Project, where lake water inputs and outputs used in the equation were precipitation, river flows, and evaporation, evapotranspiration and the Nile river outflows respectively. The groundwater contribution was not considered in the equation and was assumed to zero. However, additional methods in this case, isotope techniques were used to justify the groundwater input into the lake. This study therefore demonstrates the use of this technique to affirm groundwater interaction with the lake in contributing to the water balance of Lake Victoria.

Hydrogeophysical investigation of the impact of invasive tree species on groundwater at the Dayspring Children's Village, South Africa

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The Dayspring School, which is located about 66 km northwest of Johannesburg, has been experiencing a chronic shortage of water for over 30 years. Five out of seven boreholes that are scattered within the school property are dry and there is also evidence of contamination from one of the two wells that are producing water. The presence of bluegum and yellow wattle trees is suspected to be the principal cause for the depletion of the aquifer(s) because of their documented high rates of transpiration. Geophysical feasibility studies have shown that the subsurface is dry below the bluegum trees down to the bedrock. Hydrological feasibility studies have shown that the two wells draw water from different aquifers. The purpose of this project is to determine the complex interaction between the plants and structural elements of the various aquifers, site wells for clean water, and assist with explaining the existing contamination. Several geophysical methods including 3D DC resistivity, seismic reflection and refraction, ground penetrating radar, time domain electromagnetics, and gravity will be used to map lithologies, faults, root patterns and the distribution of groundwater. Measurements will be taken before and after the rainy season, and before and after the trees are removed.
Keywords: Fault linkages, border faults, SRTM (DEM)-aeromagnetic data, electrical resistivity.

Determination of the Velocity Structure beneath the Seismic Station Abpo of Madagascar by Receiver Function Inversion

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The seismic station ABPO has been operational since 2007, it is situated in the central part of Madagasikara in Ambohimpanompo-Arivonimamo. Receiver function analysis is a method to look at the discontinuities in the crust and upper mantle.We analyze teleseismic P wave receiver function to obtain the crustal shear wave velocity structure and the Moho depth beneath the seismic station ABPO by using iterative time domaine deconvolution (Gurrola et al.1995, Bostock and Sacchi, 1997; Ligorria and Ammon, 1999).The data used are in tenth, distant events which have epicenters in outside of Madagasikara. Followed by the inversion of the receiver function obtained that reasonable parameters value are almost equal. The modeling results represent that the layers beneath seismic station ABPO composed three layers, the Moho was found at depths between 38 and 42 km.

Keywords: Receiver function, deconvolution, Moho, seismic station ABPO.

Spatial and Temporal Patterns of Intra-seasonal oscillations over Equatorial Africa

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Today Climate Change is the greatest threat to socio-economic development the world over. The poorest of the poor in any community are the most vulnerable to the impacts of climate change. Scientific evidence reveals that the frequency and intensity of extreme weather events such as floods, droughts and variations within the seasons have increased with increasing climate change.

Traditionally, climate research in Africa has tended to focus on monthly area-average rainfall guided partly by available data and by a desire to diagnose the large-scale relations as a first step. However, it is clear that optimum predictive utility requires knowledge of spatial and temporal variability within a season. A dry rainy season may mean famine, but too much rain at the wrong time can impact heavily on the economic development of most African countries.

Intra-seasonal variability during the rainy season is an integral part of each season's character. These oscillations can be viewed as the link between individual weather events and the seasonal climate anomaly; hence the dynamics of intra-seasonal variations can be instrumental in setting up the seasonal anomalies.

The objective of this study is to assess the interaction of continental convection with the regional circulation at intra-seasonal scales. Spatial and temporal structures of Intra-seasonal oscillations over Equatorial Africa are investigated using 21 years of pentad CMAP (CPC Merged Analysis of Precipitation) rainfall from climate prediction centre (CPC). NCEP 700 hPa wind data is also analyzed.

Results show that the first three Principal Components account for about 71% and 37% of the total variance of CMAP rainfall and 700hPa zonal wind respectively. Convection reveals a larger intra-seasonal signal for standing modes, whilst the wind systems are less coherent and may propagate.

The dominant mode of intra-seasonal rainfall is over the northern Congo reflecting low-pressure and uplift throughout the year. The second and third modes are over the southwest Congo / Angola and East African highlands respectively. Zonal wind modes are over the Gulf of Guinea, West Indian Ocean and Southeast Atlantic Ocean respectively. Cross correlation of rainfall and zonal wind modes at intra-seasonal scale reveals that wet spells over the Congo and eastern Africa are triggered by increased westerly flow over the Atlantic. These start to develop a few pentads before the rainfall event over equatorial Africa.

Structure of the crust beneath Cameroon, West Africa, from the joint inversion of Rayleigh wave group velocities and receiver functions

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The Cameroon Volcanic Line (CVL) consists of a linear chain of Tertiary to Recent, generally alkaline, volcanoes that do not exhibit an age progression. Here we study crustal structure beneath the CVL and adjacent regions in Cameroon using 1-D shear wave velocity models obtained from the joint inversion of Rayleigh wave group velocities and P-receiver functions for 32 broadband seismic stations deployed between January 2005 and February 2007. We find that crustal structure beneath the CVL and the Oubanguides Belt is very similar to Pan African crustal structure in the Mozambique Belt, and therefore appears not to have been modified significantly by the magmatic activity. The crust beneath the coastal plain was probably thinned during the opening of the southern Atlantic Ocean, while the crust beneath the Garoua rift was likely thinned during the formation of the Benue Trough in the early Cretaceous. We suggest that the thickened crust and the thick mafic lower crustal layer beneath the northern margin of the Congo Craton may be relict features from a continent-continent collision along this margin during the formation of Gondwana. We expect to improve these results adding measurements of Love wave group velocities to our inversions.

Key words: Inverse theory; Body waves; Surface waves and free oscillations; Cratons; Crustal structure

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Is the 2 January 2010 eruption the rejuvenation of the 27 November 2006 eruption of volcano Nyamuragira in eastern Democratic Republic of Congo?

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As part of an effort to monitor the active volcanoes Nyamuragira and Nyiragongo, we gathered and analyzed seismic data. In order to investigate volcanic processes in the Virunga area, a local seismic velocity model was derived and used to relocate earthquake hypocenters. It was found that swarm-type seismicity, composed mainly of long-period earthquakes, preceded both the 2004 and 2006 eruptions of Nyamuragira. A steady increase in seismicity was observed to commence few months prior to the eruption, which is attributed to the movement of magma in a deep conduit to a shallow reservoir. In the last stage (1 or 2 months) before the eruption, the hypocenters of long-period earthquakes became shallower.

The volcano Nyamuragira erupted again on 02 January 2010. Its lava flows overlapped those of the 27 November 2006. It was not preceded by any significant increase of long-period seismicity before eruption. Based on the spatial and temporal distribution of hypocenters for the period preceding the 2006 and 2010 eruptions, it is believed that the shallow magma reservoir responsible of the 02 January 2010 eruption coincided with that of 27 November 2006 eruption of volcano Nyamuragira.

Lessons from structural failures: case study of the seismic event at Stilfontein 2005

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An earthquake measuring 5.3 on the Richter scale struck the small mining town of Stilfontein at midday Wednesday 9th March 2005. The epicenter was estimated to be 2400 m below the surface (Earthquake in Stilfontein, 2005) in the region where mining activity is dense. Although the residents of Stilfontein are used to regular ground shakings which they describe as "mine bumps", the event of March 2005 was at a level of intensity that was never experienced or expected. Following the seismic event a team of investigators from Wits University went to investigate the structural response of buildings in the town. The main casualties were miners. Of the 3200 miners which were in the mines when the tremors struck. About 24 were injured and two men died in the mines. Above ground in the nearby town of Stilfonten, up to 20% of the buildings were damaged by the tremors. Luckily there were no reported human casualties in the town. This paper describes characteristics of seismic events in Southern Africa based on records and presents the findings of the field study of the Stilfontein 2005 event.

The effects of February 3rd, 2008 earthquake in the Lak Kivu Basin, Western Rift Valley of Africa

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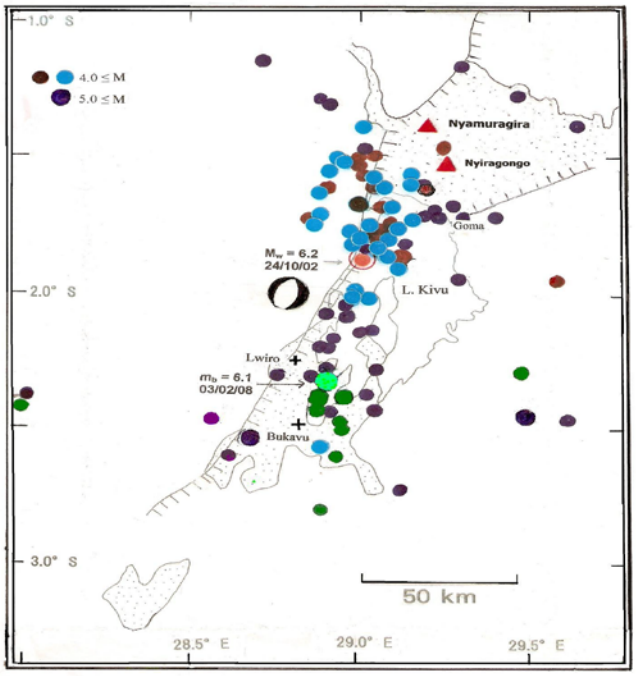
The Lake Kivu basin had experienced an earthquake of local magnitude ml= 6.1 on February 3rd, 2008 at 7h34' UT, in its south-western part. Many phenomena were generated in the Lake Kivu and on the shorelines. At several places were observed land subsidence on the shoreline where several children were killed in D.R. Congo and Rwanda sides. At other places land uplift was observed. According to the fishermen, small tsunami was generated and attacked the coast lines. The highest level accessed by the tsunami was estimated to 4 m at Ibindja Island. The small gas escaping generated by the tsunami was observed at several places in the Lake Kivu. Many damages were recorded in Bukavu city and surrounding areas in D.R. Congo and Rwanda, characterized by the fissures on the walls or collapse of houses. Total 49 people were killed by the earthquake and aftershocks, more precisely 10 in D.R.C. and 39 in Rwanda. This event was preceded by many foreshocks and followed by a long duration of felt aftershocks. The focal mechanism of this event indicates a normal fault. The maximum intensity was recorded close to the epicentre area and estimated to VIII-IX.



The seismicity of Lake Kivu basin for earthquakes with magnitude ≥ 4.0, for the period from 1960 to 2008.