Studies of the seismicity, structure and evolution of Sub-Saharan Africa

Ray Durrheim & Andy Nyblade

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

OVERVIEW

Founded in 2005 to:

- DEVELOP HUMAN & INSTITUTIONAL CAPACITY
- CONDUCT RESEARCH
  - NATURAL RESOURCES
  - GEOHAZARDS
  - CURIOSITY

EPOS
EUROPEAN PLATE OBSERVING SYSTEM

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Workshop

14th Annual AfricaArray Workshop

School of Geosciences
University of the Witwatersrand
Johannesburg, South Africa

7 - 12 July 2019

Programme

Monday 24 June to Saturday 13July		***AfricaArray International Field School***
Sunday 7 July	*9h30-16h00*	***AfricaArray station operator course*** *Andy Nyblade (Penn State University, USA),* *Ranto Raveloson (University of the Witwatersrand, SOUTH AFRICA)* ***Diversity of data products available from the ISC website*** *Dmitry Storchak (International Seismological Centre, UK)*
Monday 8 July & Tuesday 9 July	*8h00-20h00*	***AfricaArray Scientific Meeting***
Wednesday 10 July	*9h00-16h00*	***Workshop: Joint Inversion of Gravity & Seismic Data*** *Islam Fadel & Mark van der Meijde (University of Twente, THE NETHERLANDS)*
Thursday 11 July	*9h00-16h00*	***Workshop: MT Acquisition, Processing and Interpretation for Beginners*** *Wesley Harrison (University of Witwatersrand, SOUTH AFRICA)*
Friday 11 July	*9h00-16h00*	***Workshop: Machine Learning in the Geosciences*** *Glen Nwaila (University of Witwatersrand, SOUTH AFRICA)*
Friday 11 July	*9h00-13h00*	***Workshop: how to make the public aware of your research*** *Presented by The Conversation - Africa (PIs Yasuo Yabe, Musa Manzi)*
tbc	*9h00-16h00*	***Workshop: ICDP-DSeis Scientific Drilling & Rock Physics*** *held under the auspices of the Japan/South Africa Joint Science and Technology Research Collaboration Project (PIs Yasuo Yabe, Musa Manzi)*

EPOS EUROPEAN PLATE OBSERVING SYSTEM

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GLT Lecture Theatre, Geosciences Building, Wits — **Monday 8 July 2019**

*Abstract appended

08:00 - 08:30 **REGISTRATION**

08:30 - 08:45 Welcome
Professor Zeblon Vilakazi (*DVC Research, University of the Witwatersrand*)

08:45 - 09:00 AfricaArray status report - network activities and development plan
Andy NYBLADE (*Penn State University USA*)

09:00 - 09:15 Building geophysics talent and opportunity in Africa: experience from the AfricaArray/Wits Geophysics Field School
Susan WEBB (*University of the Witwatersrand SOUTH AFRICA*)

09:15 - 09:30 Training and complementary activities
Ray DURRHEIM (*University of the Witwatersrand & CSIR, SOUTH AFRICA*)

09:30 - 10:00 **INVITED KEYNOTE ADDRESS**
*Issues with producing a more complete and accurate ISC Bulletin for Africa
Dmitry STORCHAK (*International Seismological Centre, UNITED KINGDOM*)

10:00 – 10:30 ***TEA BREAK***

Theme: Structure and tectonics of Africa

10:30 – 10:45 *Investigation of crustal thickness under MDT seismic station using receiver function technique, Morocco
Said BADRANE (*CNRST, MOROCCO*)

10:45 - 11:00 *3D density, thermal, and compositional model of the Saharan Metacraton from integrated geophysical-petrological modelling
Mohamed SOBH (Christian-Albrechts-University, GERMANY & NRIAG, EGYPT)

11:00 - 11:15 *Crustal thickness estimates beneath four seismic stations in Ethiopia inferred from P-wave receiver function studies
Birhana ABERA (*University of Addis Ababa, ETHIOPIA*)

11:15 - 11:30 *Body wave tomography of the Uganda region
Cate Bressers & **Andy NYBLADE** (*Penn State University, USA*)

11:30 - 11:45 *New estimates of seismic anisotropy in eastern Africa from shear wave splitting measurements
Fenitra ANDRIAMPENOMANANA (*Postdoctoral Fellow, University of the Witwatersrand, SOUTH AFRICA*)

11:45 - 12:00 *Crustal thickness beneath the Bushveld Complex from teleseismic receiver functions
Ranto RAVELOSON (*Postdoctoral Fellow & AfricaArray network Manager, University of the Witwatersrand, SOUTH AFRICA*)

12:00-12:30 **INVITED KEYNOTE ADDRESS**
Revealing the geodynamics of Botswana; impact of the 2015 Botswana earthquake
Mark VAN DER MEIJDE, Islam Fadel & Hanneke Paulssen (*University of Twente, NETHERLANDS*)

12h30-12:45 ***GROUP PHOTO***

12:45 - 14:00 ***LUNCH BREAK***

*Abstract appended

14:00-14:15 *Down Under the Volta Basin: Geophysical Evidence for the Birimian Basement
Abigail AYIKWEI (*PhD candidate, University of the Witwatersrand SOUTH AFRICA*)

Theme: Resources

14:15 - 14:45 **INVITED KEYNOTE ADDRESS**
*The value of seismics in mineral exploration and mine safety
Musa MANZI (*University of the Witwatersrand SOUTH AFRICA*)

14:45 - 15:00 *Geomechanical assessment of the potential of induced seismicity for a carbon storage project in the Bredasdorp Basin
Eric SAFFOU (*University of the Western Cape, SOUTH AFRICA*)

15:00 - 15:15 *Carbon injection in fractured crystalline media: investigation of rock physics, mechanics, induced seismicity and a case for engineered geothermal system in SA
Chris SAMAKINDE (*Postdoctoral fellow, University of the Western Cape SOUTH AFRICA*)

15:30 - 16:00 ***TEA BREAK***

16:00 - 16:15 * Constrained Least Squares Spectral Analysis (CLSSA) as a spectral decomposition method in E-BD Oil Field within the Bredasdorp Basin, South Africa
Sbonelo NGCONGO (PetroSA & PhD *candidate, University of the Witwatersrand SOUTH AFRICA*)

16:15 - 16:30 *Using seismics and potential fields to uncover the southern (Bethal) lobe of the Bushveld Complex
Stephanie ENSLIN (*University of the Witwatersrand, SOUTH AFRICA*)

16:30– 16:45 *Reprocessing of the legacy reflection seismic data across the Morokweng crater using a diffraction imaging approach
Michael WESTGATE (*PhD candidate, University of the Witwatersrand, SOUTH AFRICA*)

16:45– 17:00 *Geophysical investigation of the Transvaal Basin in the Boons-Magaliesburg-Hekpoort area
Emmanuel ONYEBUEKE (*PhD candidate, University of the Witwatersrand, SOUTH AFRICA*)

17:00– 17:15 *Integrated geophysical investigations of the Zululand basin
Tamara MAKHATENG (*MSc candidate, University of the Witwatersrand SOUTH AFRICA*)

17:30 - 19:30 **POSTERS & SNACKS IN THE BLELOCH MUSEUM**

GLT Lecture Theatre, Geosciences Building, Wits — **Tuesday 9 July 2019**

*Abstract appended

Theme: Geohazards

08:30 – 09:00 **INVITED KEYNOTE ADDRESS**
*Faults and fault scaling in stable continental regions
Alastair SLOAN (*University of Cape Town, SOUTH AFRICA*)

09:00-09:15 *Optimal consideration constraints of power supply for seismic nodes
Dauda DUNCAN (*Botswana International University of Science & Technology, BOTSWANA*)

09:15 - 09:30 *The new BSN: developments in monitoring seismic events in Botswana
Onkgopotse NTIBINYANE & **Joseph MARITINKOLE** (*Botswana Geoscience Institute, BOTSWANA*)

09:30 - 09:45 *Seismic hazard assessment of DRC and environs based on GEM-SSA and new source model
Georges MAVONGA TULUKA (*Goma Volcanic Observatory, DRC*)

09:45 - 10:00 *Neo-deterministic seismic hazard assessment at Alexandria, Egypt
Hazem BADRELDIN (*National Research Institute for Astronomy & Geophysics, EGYPT*)

10:00 – 10:30 ***TEA BREAK***

10:30 - 10:45 *Potential risks associated with the occurrence of intraplate earthquakes: a case study in Mopani District, Limpopo Province, South Africa
Barbra NDWAMBI and Milton Kataka (*MSc candidate, Department of Mining and Environmental Geology, School of Earth Sciences, University of Venda, SOUTH AFRICA*)

10:45 - 11:00 *Seismotectonic model for Johannesburg
Brassnavy MANZUNZU (*PhD candidate, University of the Witwatersrand & Council for Geoscience, SOUTH AFRICA*)

11:00 - 11:15 *Probabilistic seismic hazard study for Madagascar
Tsitsi RAKOTONDRAIBE (*University of the Witwatersrand, SOUTH AFRICA*)

Theme: Mining & near-surface

11:15 - 11:30 *Drilling into seismogenic zones of M2.0–M5.5 earthquakes in South African gold mines (DSeis project): 2019 status report
Ray DURRHEIM (*University of the Witwatersrand, SOUTH AFRICA*)

11:30 - 11:45 *Gutenberg-Richter *b*-value analysis of overlapping seismic clusters
Dakalo LIGARABA (*MSc candidate, University of the Witwatersrand, SOUTH AFRICA*)

11:45 - 12:00 *Prediction of brittle shear fracture preparation, nucleation and rupture propagation motion during a seismic slip
Siyanda MNGADI (*PhD candidate, University of the Witwatersrand, SOUTH AFRICA*)

12:00 - 12:15 *The seismic response to mining during the extraction of the Thuthukani shaft pillar, Kloof Operations, South Africa
Richard MASETHE (*PhD candidate, University of the Witwatersrand, SOUTH AFRICA*)

12:15 - 12:30 *The use of ambient seismic noise to quantify and monitor hazards in a mine tailings dam
Thulisile KUNJWA (*MSc candidate, Nelson Mandela University, SOUTH AFRICA*)

12:30 - 12:45 *Investigating the depth of the Pan-African granitic basement using 3D seismic refraction tomography
Mapathe NDIAYE (*University of Thies, SENEGAL*)

12:45 - 14:00 ***LUNCH***

Theme: Geodesy, Space Science and MT

14:00 - 14:15 *Geophysical investigation of groundwater control in the semi-arid Swartland terrane, South Africa
Wesley HARRISON (*PhD candidate, University of the Witwatersrand, SOUTH AFRICA*)

14:15 - 14:30 Velocity field and tectonic strain in Nigeria derived from GPS measurements
Joseph DODO (*National Space Research and Development Agency (NASRDA), NIGERIA*)

14:30– 14:45 *Time series analysis of cGPS surface displacement and meteorology time series in Southern Africa
Sikelela GOMO (*MSc candidate, University of the Witwatersrand, SOUTH AFRICA*)

14:45– 15:00 *A lithospheric magnetic field model over southern Africa at satellite altitude using CHAMP satellite data
Emmanuel NEHAYO (*SANSSA Hermanus Magnetic Observatory & PhD candidate, University of the Witwatersrand, SOUTH AFRICA*)

15:00– 15:15 *Seasonal variability and trends in atmospheric water vapour content from ground-based GPS: results from the regional Africa Array GPS network
Olalekan Adekunle ISIOYE (*Ahmadu Bello University, NIGERIA*)

15:15– 15:30 Flashes of brilliance: studies of lightning
Susan WEBB & Carina SCHUMANN (*University of the Witwatersrand, SOUTH AFRICA*)

15:30 - 16:00 ***TEA BREAK & POSTERS***

Theme: Initiatives allied to AfricaArray

16:00 - 16:15 IASPEI & the African Seismological Commission
tbc

16:15 – 16:30 IUGS Resourcing Future Generations initiative (Africa's Mineral's Fortune)
NAM S&T Centre (Mitigating the Impact of Extreme Natural Events in Developing Countries)
Ray DURRHEIM (*University of the Witwatersrand, SOUTH AFRICA*)

16:30 – 16:45 American Geophysical Union (AGU) & Society of Exploration Geophysicists (SEG)
Susan WEBB (*University of the Witwatersrand SOUTH AFRICA*)

16:45 – 17:00 Informing the public of your research
Candice BAILEY (*The Conversation - Africa*)

17:15 - 20:00 **TASTE OF TECHNOLOGY (with SAGA and the GSSA)**
ATRIUM OF THE BERNARD PRICE BUILDING

EPOS EUROPEANPLATEOBSERVINGSYSTEM

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FIELD SCHOOL

AfricaArray International Geophysics Field School: Diversity and training come together in Africa

Susan Webb[1], Musa Manzi[1], Stephanie Scheiber-Enslin[1], Blessing Chinamora[1], Ansuya Naidoo[1], Sally-Anne Lee[1], Ahmed Isiaka[1], Siyanda Mngadi[1], Keoagile Tshitlho[2], Andy Nyblade[3], and Erica Emry[3]

1230 THE LEADING EDGE October 2015

Figure 7. Gravity data base station on a stable outcrop. From left: Vanessa Nana (Cameroon), Vanessa Eni (USA), and Sally-Anne Lee, instructor, University of the Witwatersrand.

Figure 4. Participants in the 2015 field school celebrate the end of the day with the EM31. From left: Linah Maphanga (South Africa), Hilary Korir (Kenya), Josia Shilunga (Namibia), Rocio Castillo (U.S.A.), Tsitsi Rakotondraibe (Madagascar), and Keoagile (Braza) Tshitlho, instructor (Botswana).

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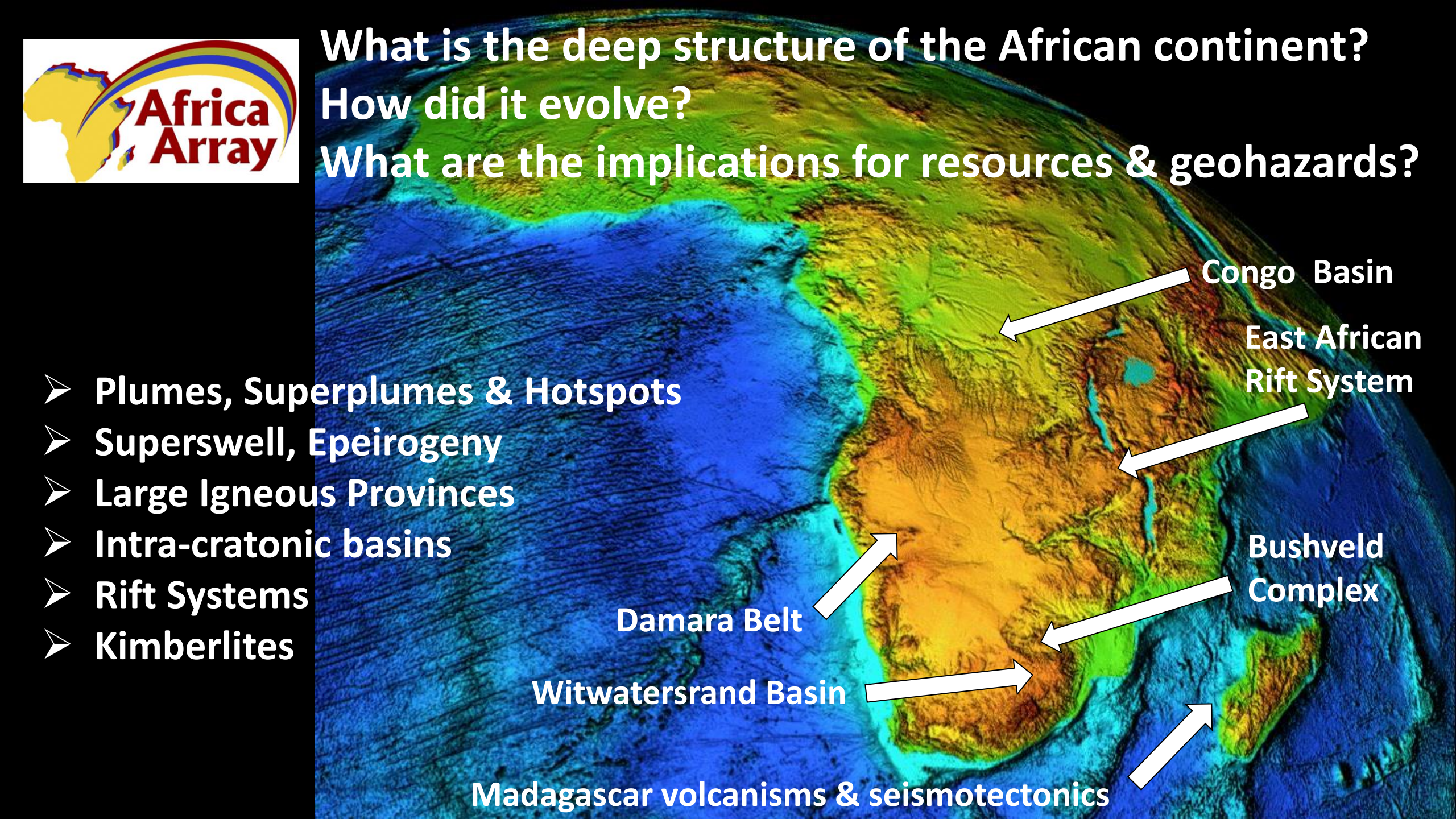
Africa Array
What is the deep structure of the African continent?
How did it evolve?
What are the implications for resources & geohazards?
Plumes, Superplumes & Hotspots
Superswell, Epeirogeny
Large Igneous Provinces
Intra-cratonic basins
Rift Systems
Kimberlites
Congo Basin
East African Rift System
Bushveld Complex
Damara Belt
Witwatersrand Basin
Madagascar volcanisms & seismotectonics

TOOLBOX

- Broadband seismology
  - Receiver functions
  - Body wave tomography
  - Surface wave tomography
  - Ambient noise
- Reflection Seismics
- Gravity, Magnetics & MT
- Joint inversion

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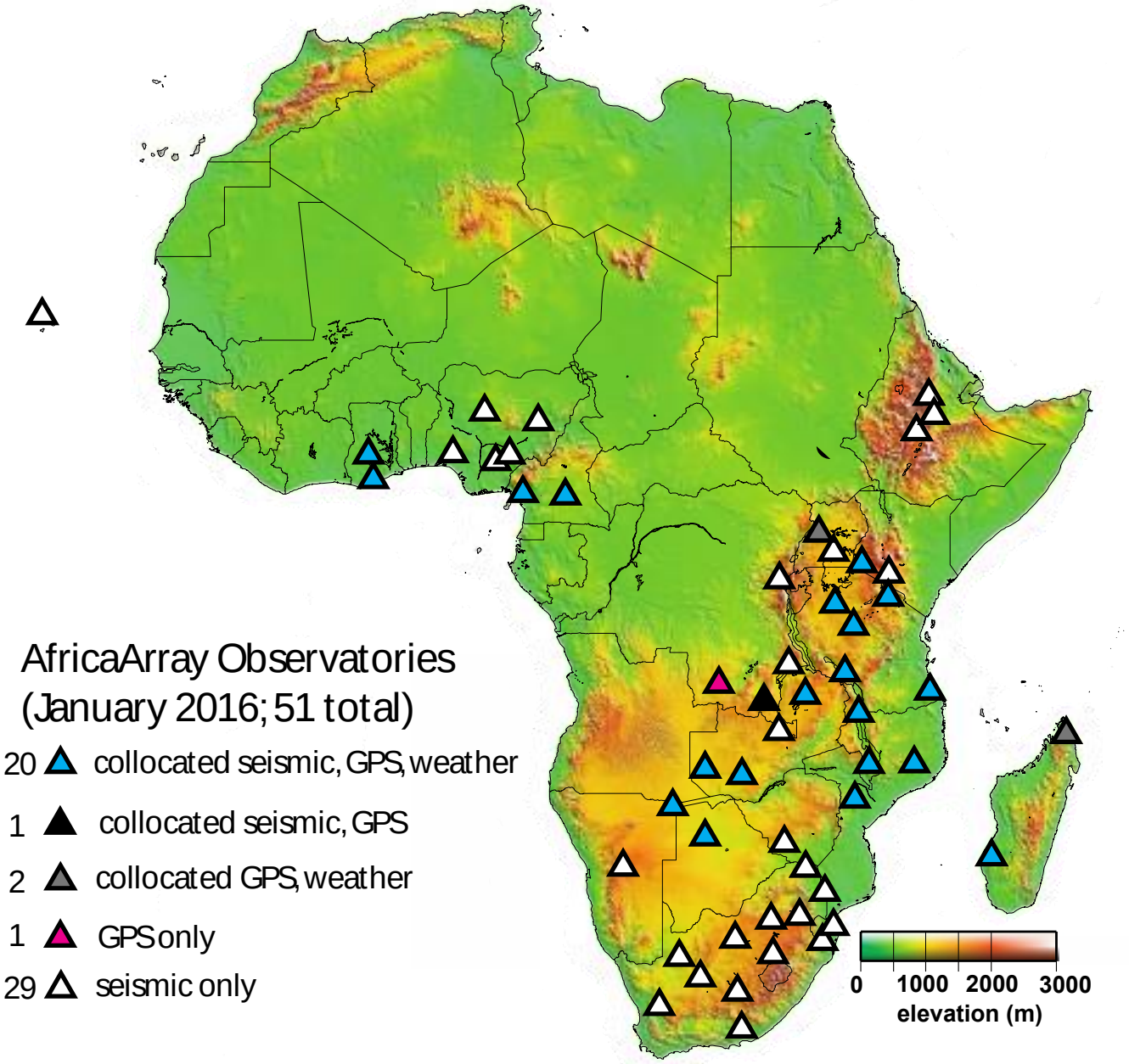
‘Backbone’ Network

- 53 stations
- 50 seismic stations
- 24 GPS/met stations
- 17 countries
- Continuous recording
- Data recovery 70-80%
- Data availability: IRIS and UNAVCO
- Data retrieval:
  - A few countries - real-time using cell modems
  - Elsewhere - monthly



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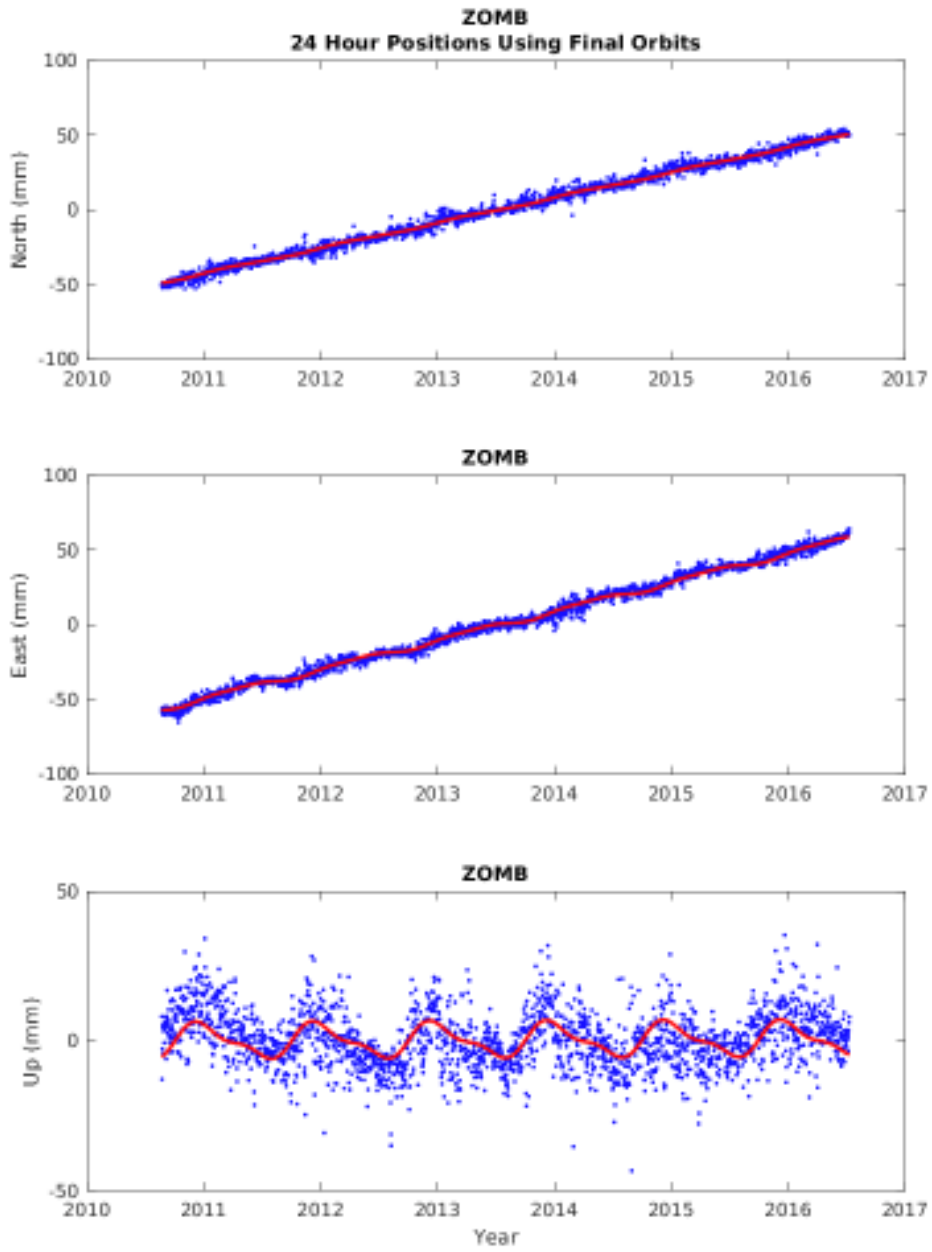
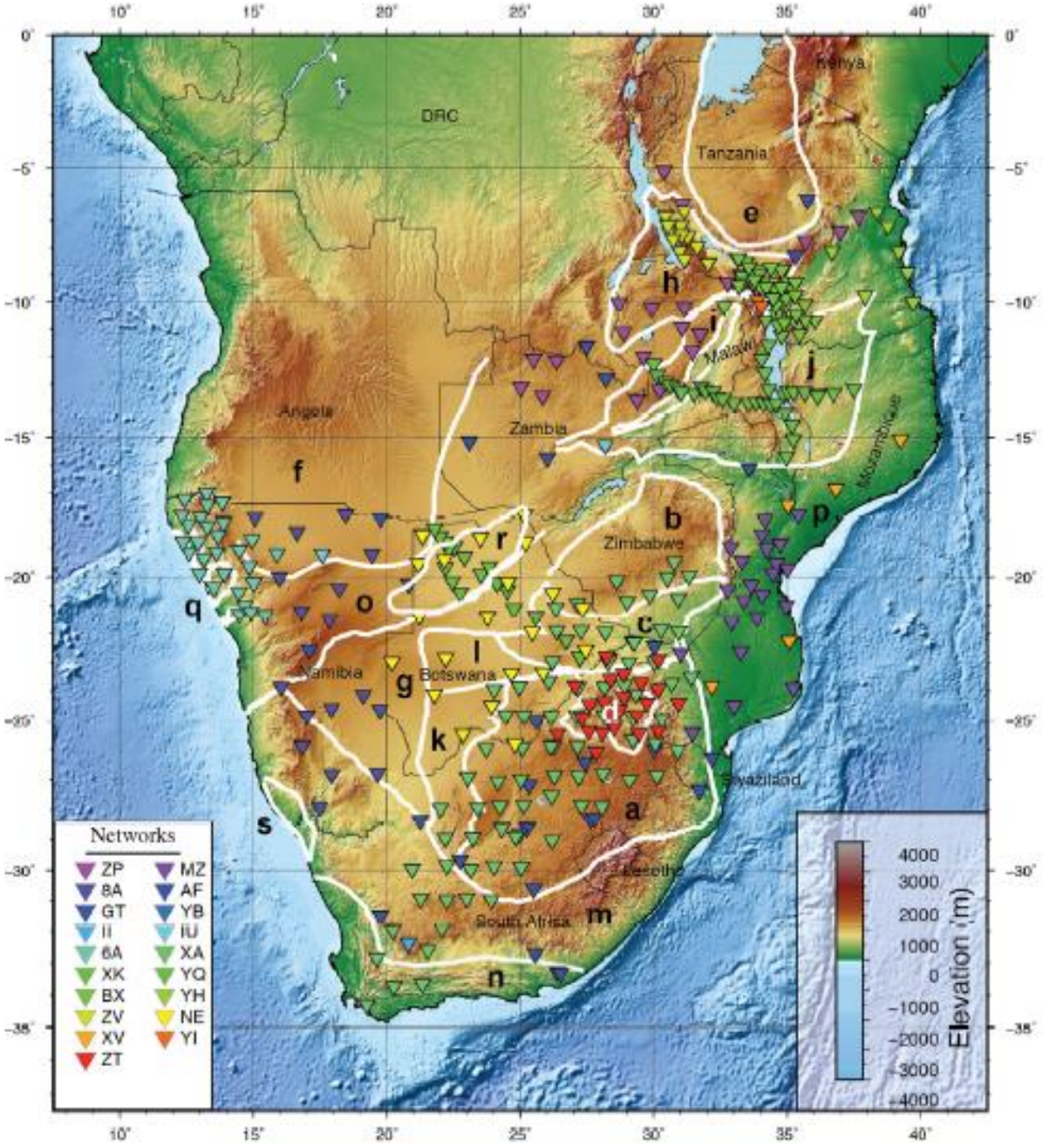
Zomba
MALAWI

Station: ZOMB



last data on 09-Jul-2016
Processed and Plotted by the Nevada Geodetic Laboratory on 08-Aug-2016



Recent temporary broadband seismic deployments

2013-2017 Botswana – 20 stations
Botswana Geosciences Institute & University of Twente

2015-2018 Northern Namibia – 10 stations
2017-2018 Southern Namibia – 10 stations
(Namibian Geological Survey & De Beers)

2015-2017 Bushveld Complex, S. Africa - 5 stations
2017-2019 Bushveld Complex, S. Africa - 25 stations
(South African Council for Geoscience)

2017-2018 NE Uganda - 9 stations
(Uganda Department of Mines)

AGU ADVANCING EARTH AND SPACE SCIENCE

Geochemistry, Geophysics, Geosystems

Lithospheric Boundaries and Upper Mantle Structure Beneath Southern Africa Imaged by *P* and *S* Wave Velocity Models

A. L. White-Gaynor[1], A. A. Nyblade[1], R. Durrheim[2], R. Raveloson[2], M. van der Meijde[3], I. Fadel[3], H. Paulssen[4], M. Kwadiba[5], O. Ntibinyane[5], N. Titus[6], and M. Sitali[6]

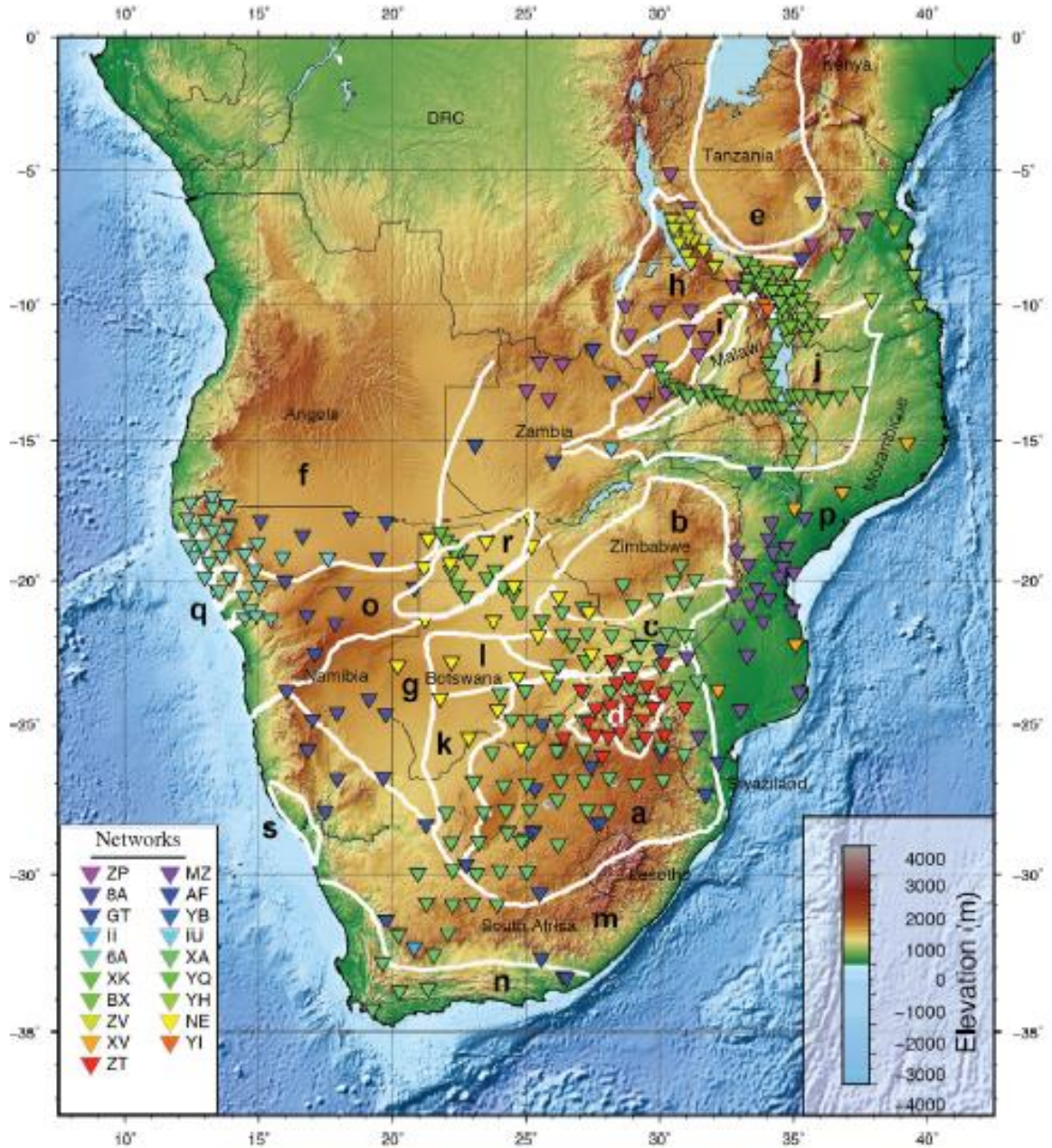
Geophysical Research Letters

Shear-Wave Velocity Structure of the Southern African Upper Mantle: Implications for Craton Structure and Plateau Uplift

A. L. White-Gaynor[1], A. A. Nyblade[1], R. J. Durrheim[2], R. Raveloson[2], M. van der Meijde[3], I. Fadel[3], H. Paulssen[4], M. Kwadiba[5], O. Ntibinyane[5], N. Titus[6], and M. Sitali[6]

Crustal and Upper Mantle Shear Wave Velocity Structure of Botswana: The 3 April 2017 Central Botswana Earthquake Linked to the East African Rift System

Islam Fadel[1,2], Hanneke Paulssen[3], Mark van der Meijde[1], Motsamai Kwadiba[4], Onkgopotse Ntibinyane[4], Andrew Nyblade[5,6], and Raymond Durrheim[6]



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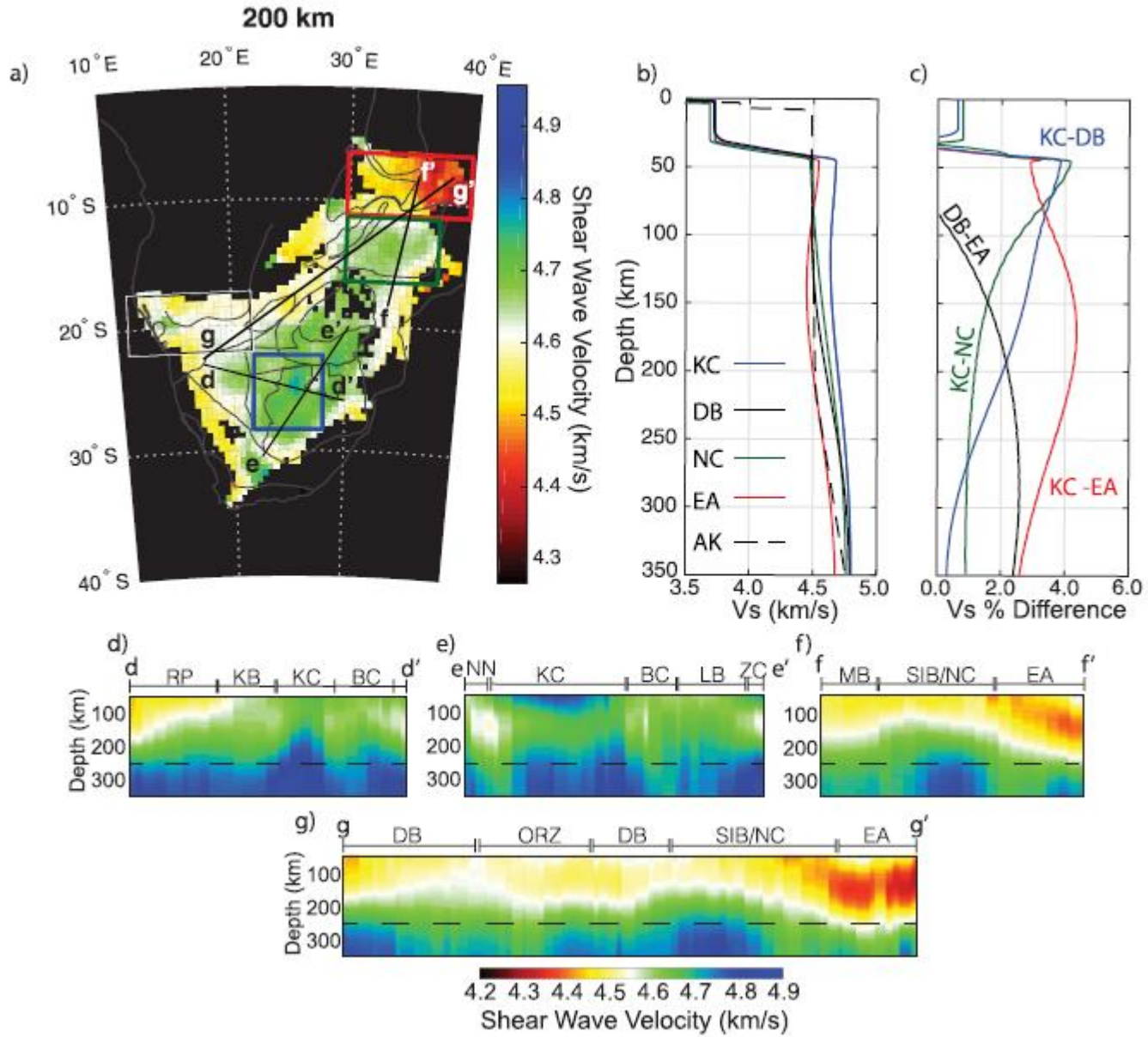

FINDINGS

- **High velocities (~4.7–4.8 km/s)** occur **at depths of 50–250 km** beneath the **Archean nucleus** and several surrounding **Paleoproterozoic and Mesoproterozoic terranes**
- The **margin of the greater Kalahari Craton** is placed along the southern boundary of the Damara Belt and the eastern boundaries of the Gariep and Namaqua-Natal belts.
- At **depths ≥250 km**, there is **little difference in velocities beneath the craton and off-craton regions**, suggesting that the cratonic lithosphere extends to depths of about 200–250 km.
- Upper mantle velocities beneath uplifted areas of southern Africa are higher than the global average and significantly higher than beneath eastern Africa, indicating there that is **little thermal modification** of the upper mantle present today beneath the Southern African Plateau**.**
- **Buoyant support for the plateau** therefore likely resides in the mid- to lower mantle.

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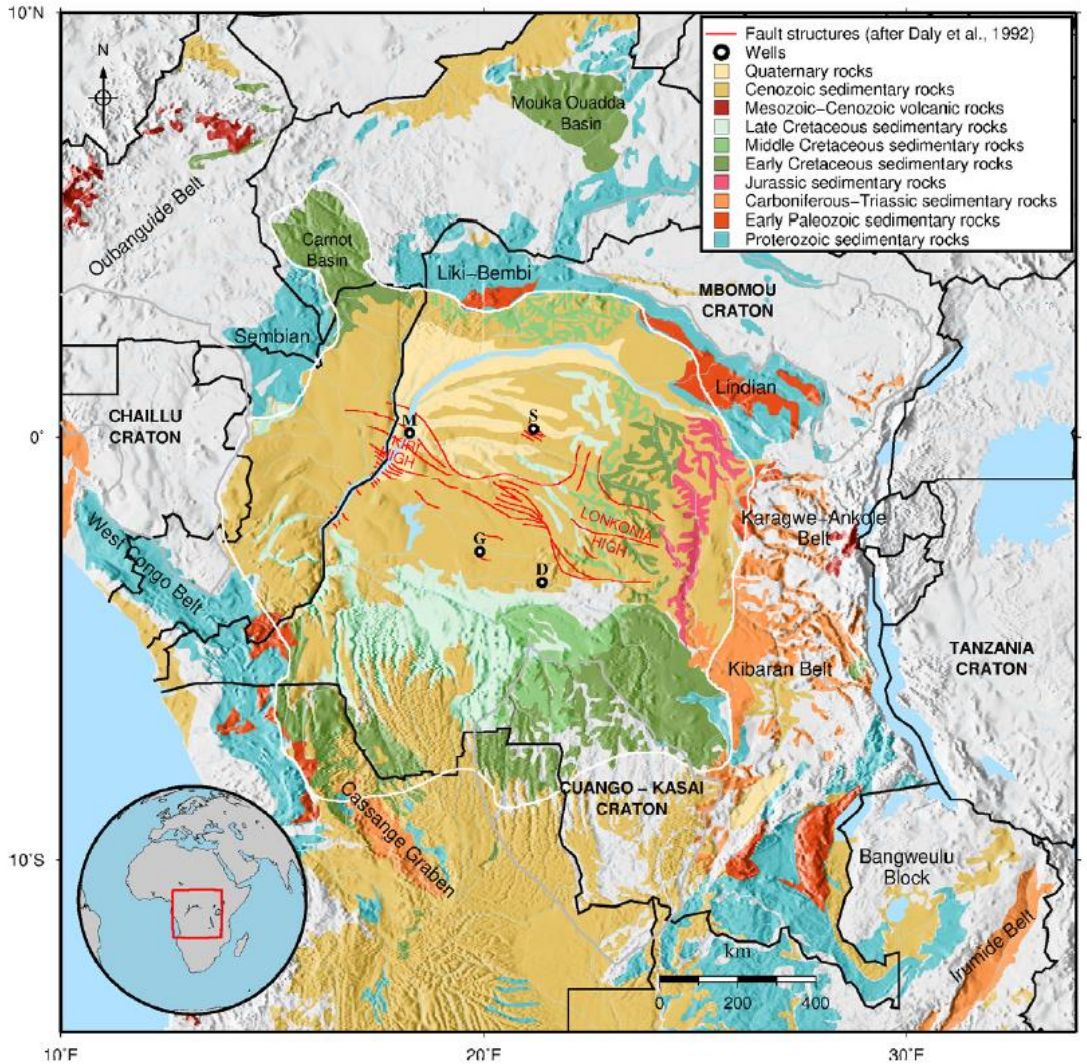
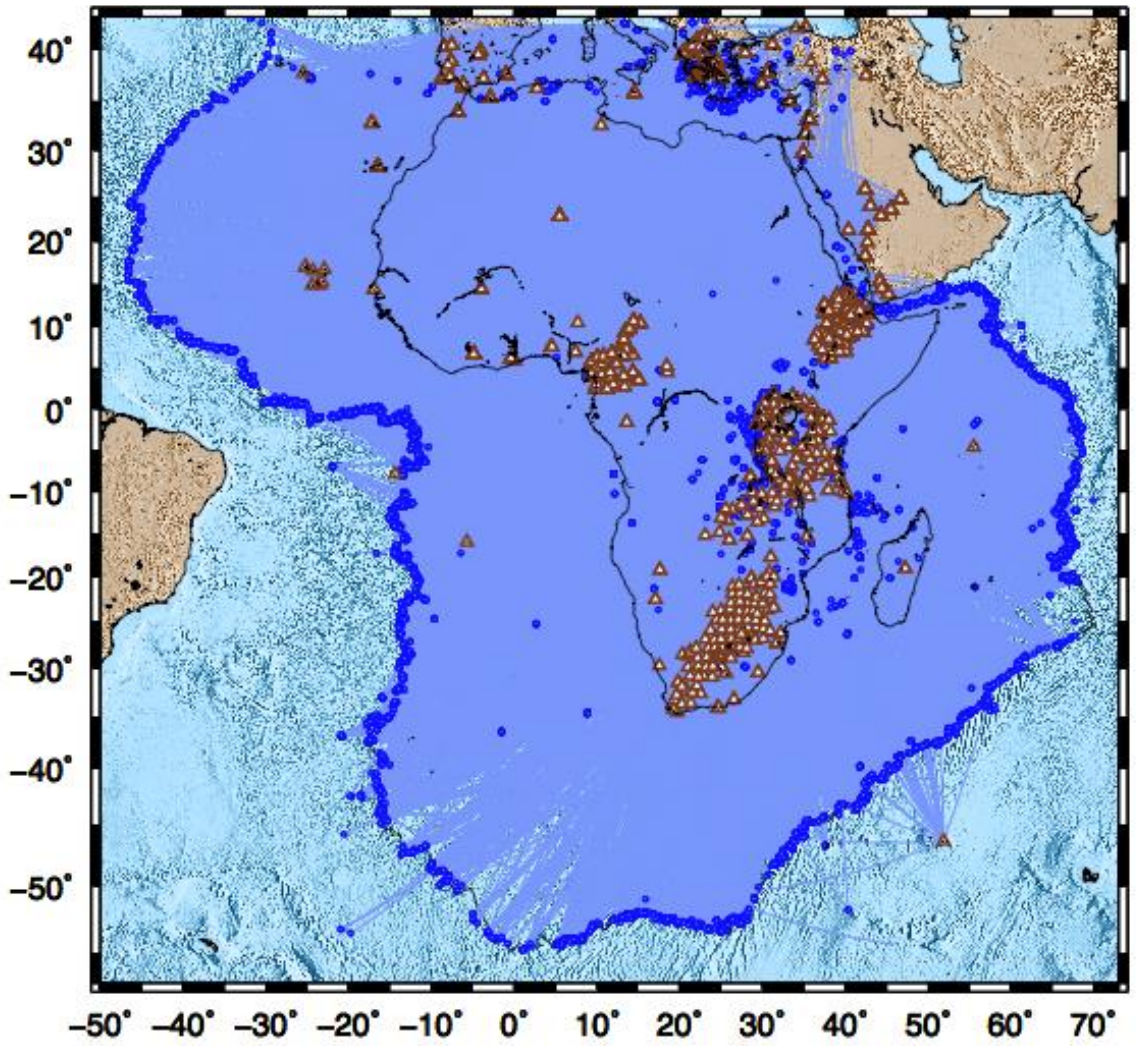
GEOLOGY | THE GEOLOGICAL SOCIETY OF AMERICA®

Joint inversion of surface wave and gravity data reveals subbasin architecture of the Congo Basin

A. Raveloson[1], A. Nyblade[1,2] and R. Durrheim[1]





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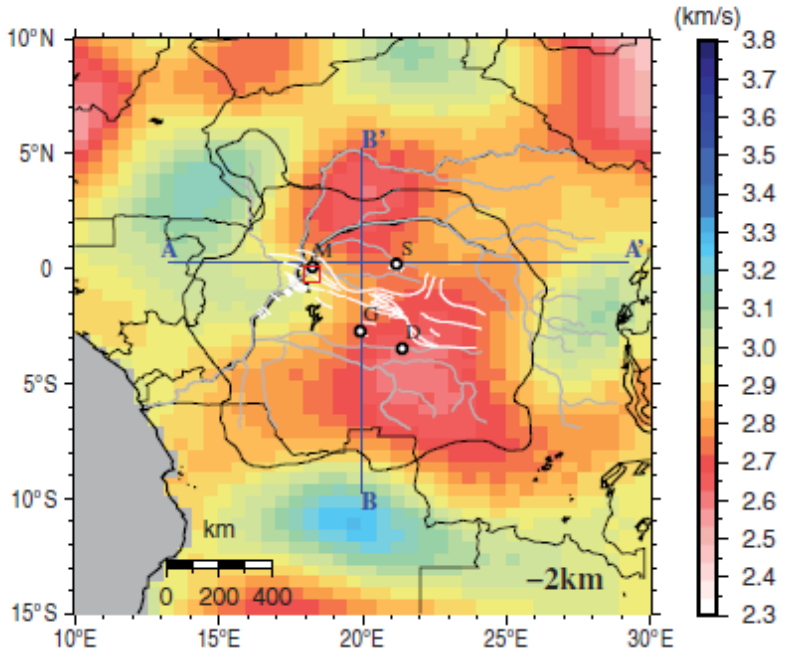

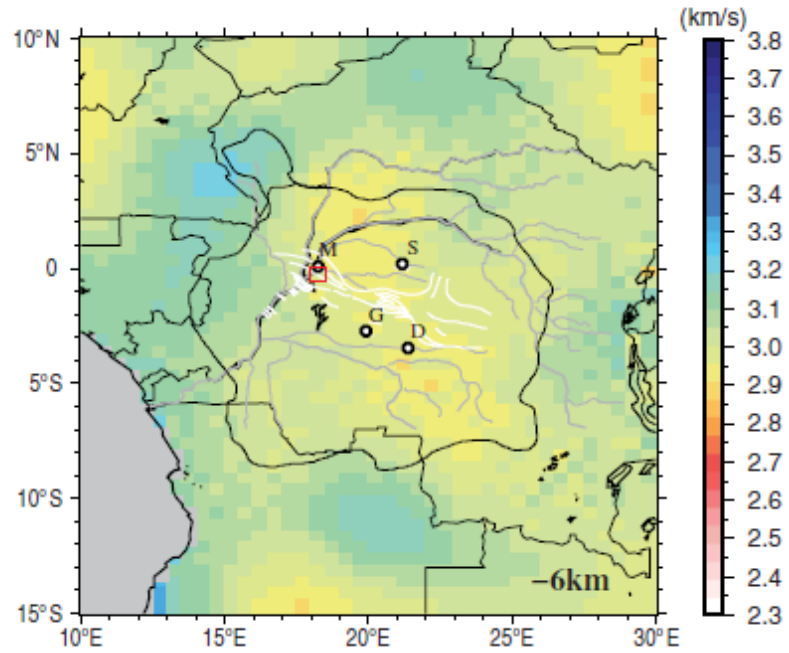

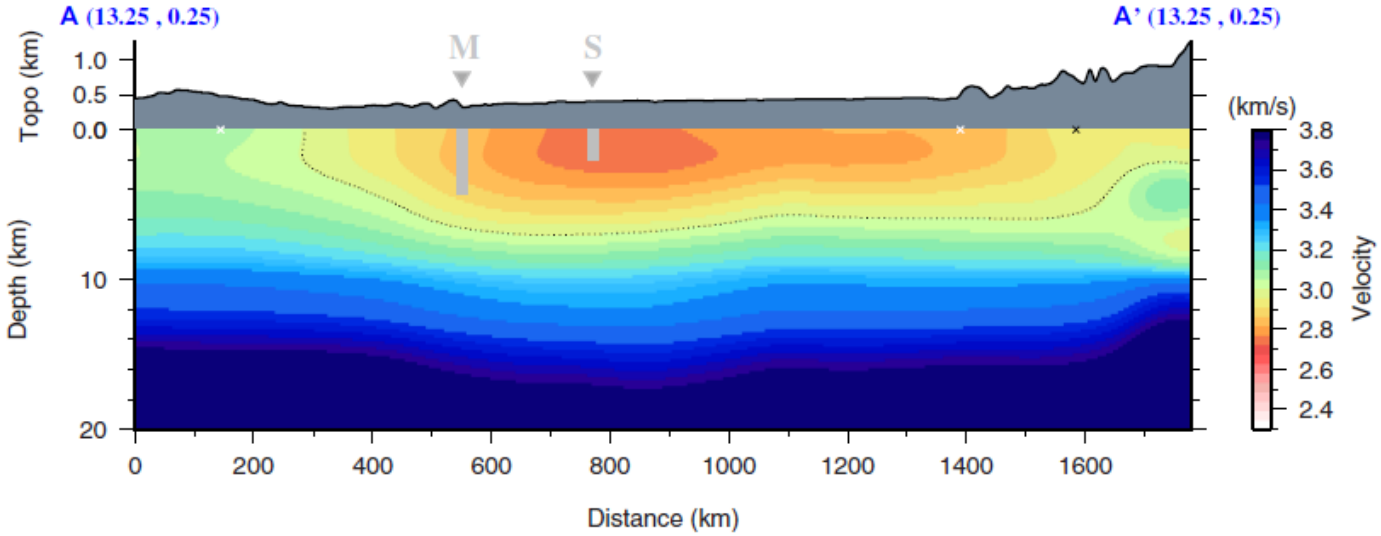

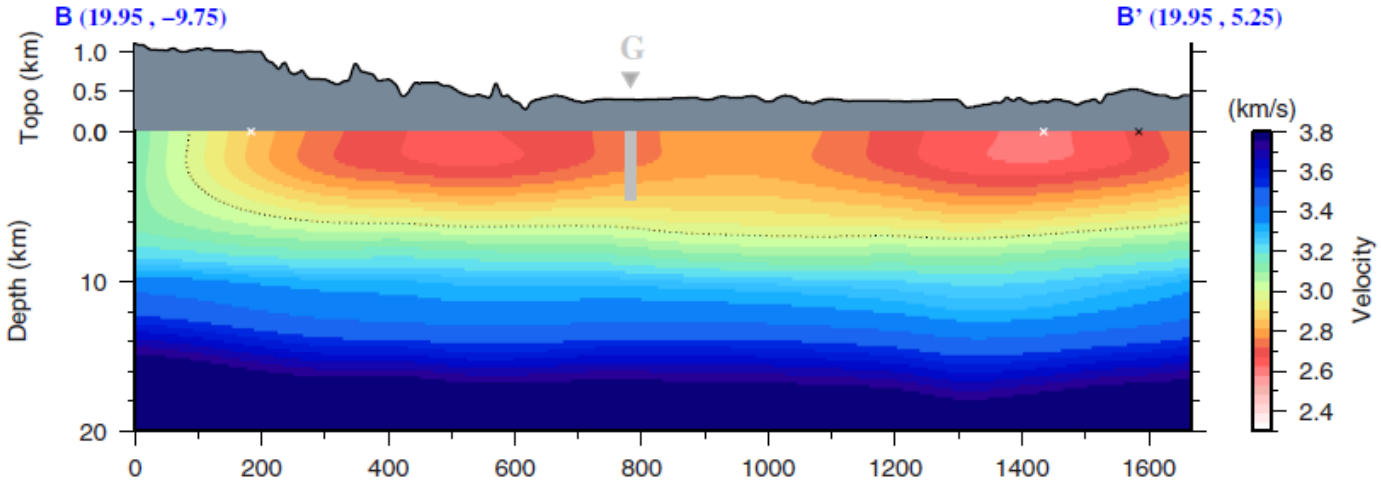

FINDINGS

- 2 ca. 8 km deep sub-basins
- E-W structure likely due to salt tectonics

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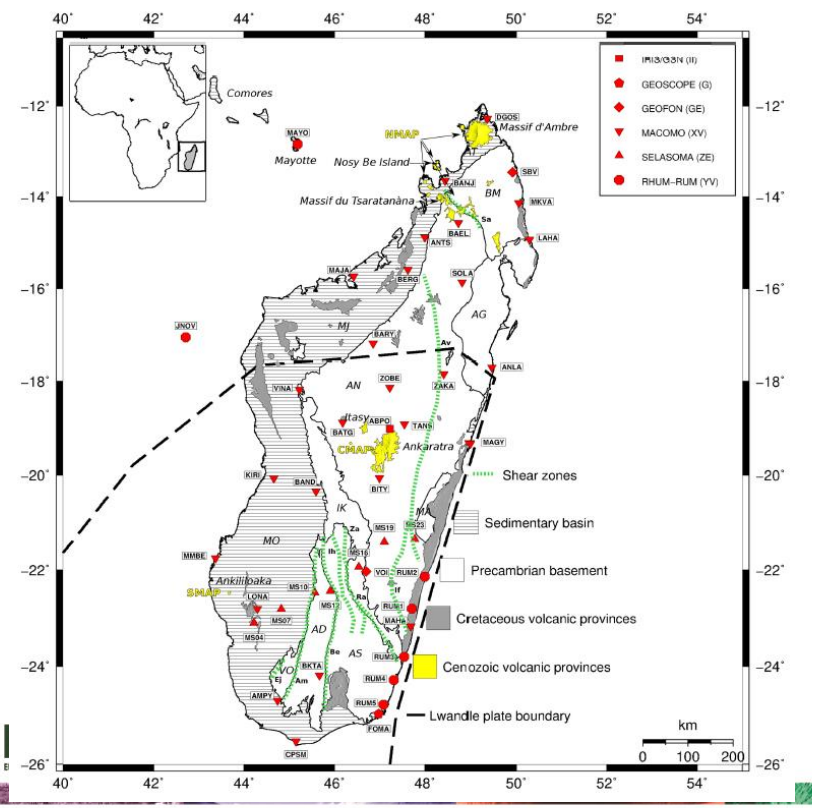
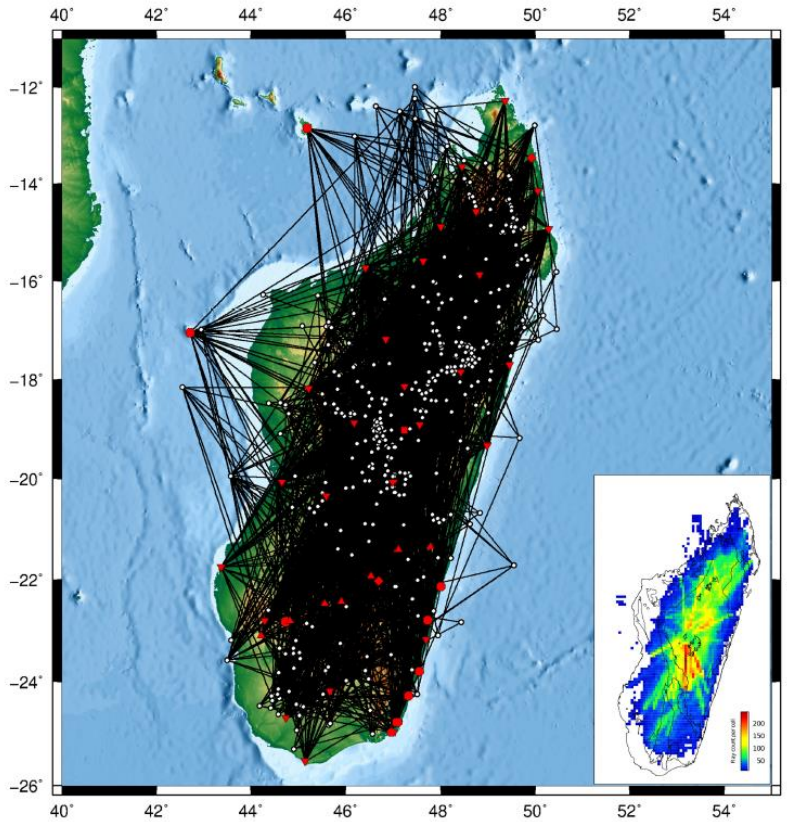
Geophysical Journal International

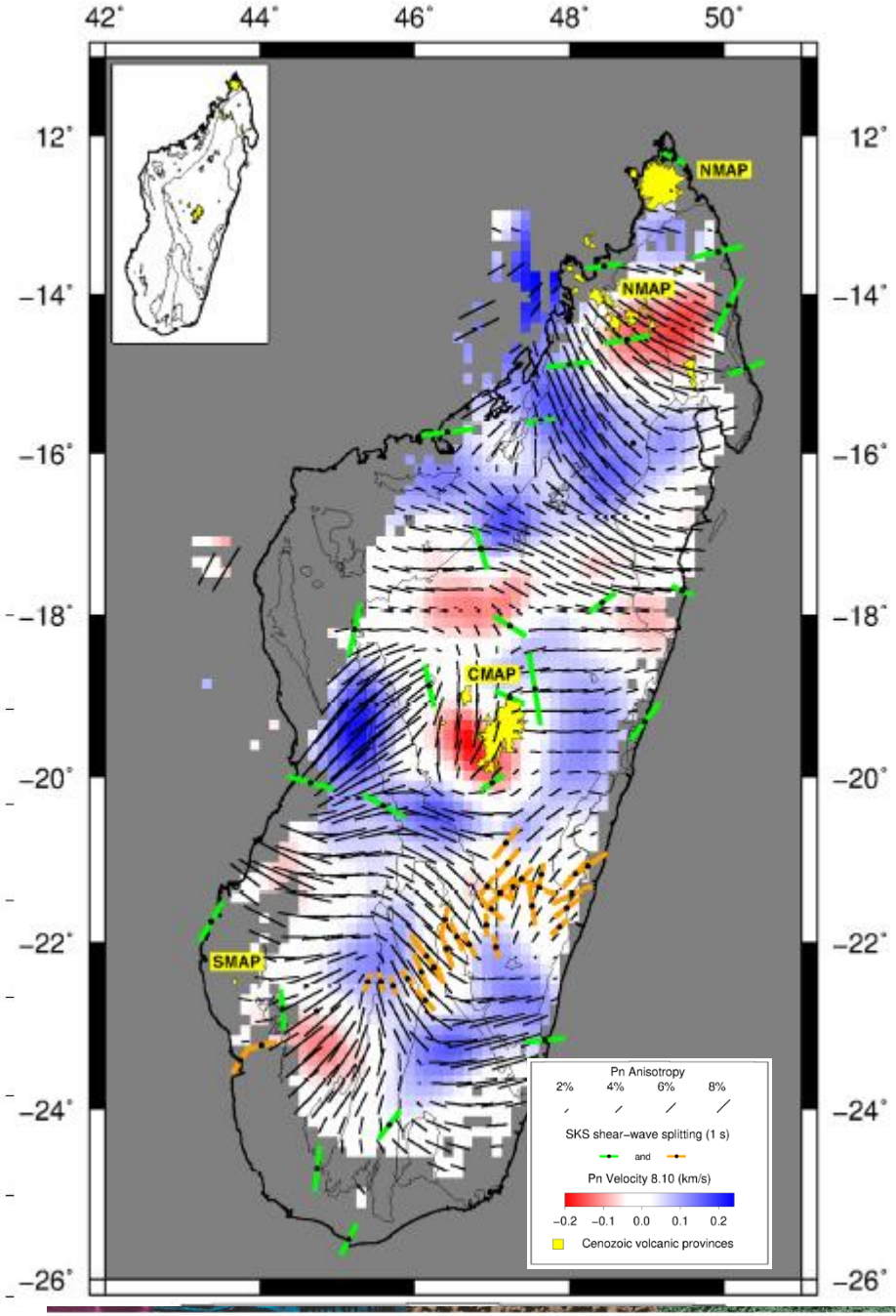
Geophys. J. Int. (2020) **224,** 290–305
doi: 10.1093/gji/ggaa458
Advance Access publication 2020 September 24
GJI Seismology

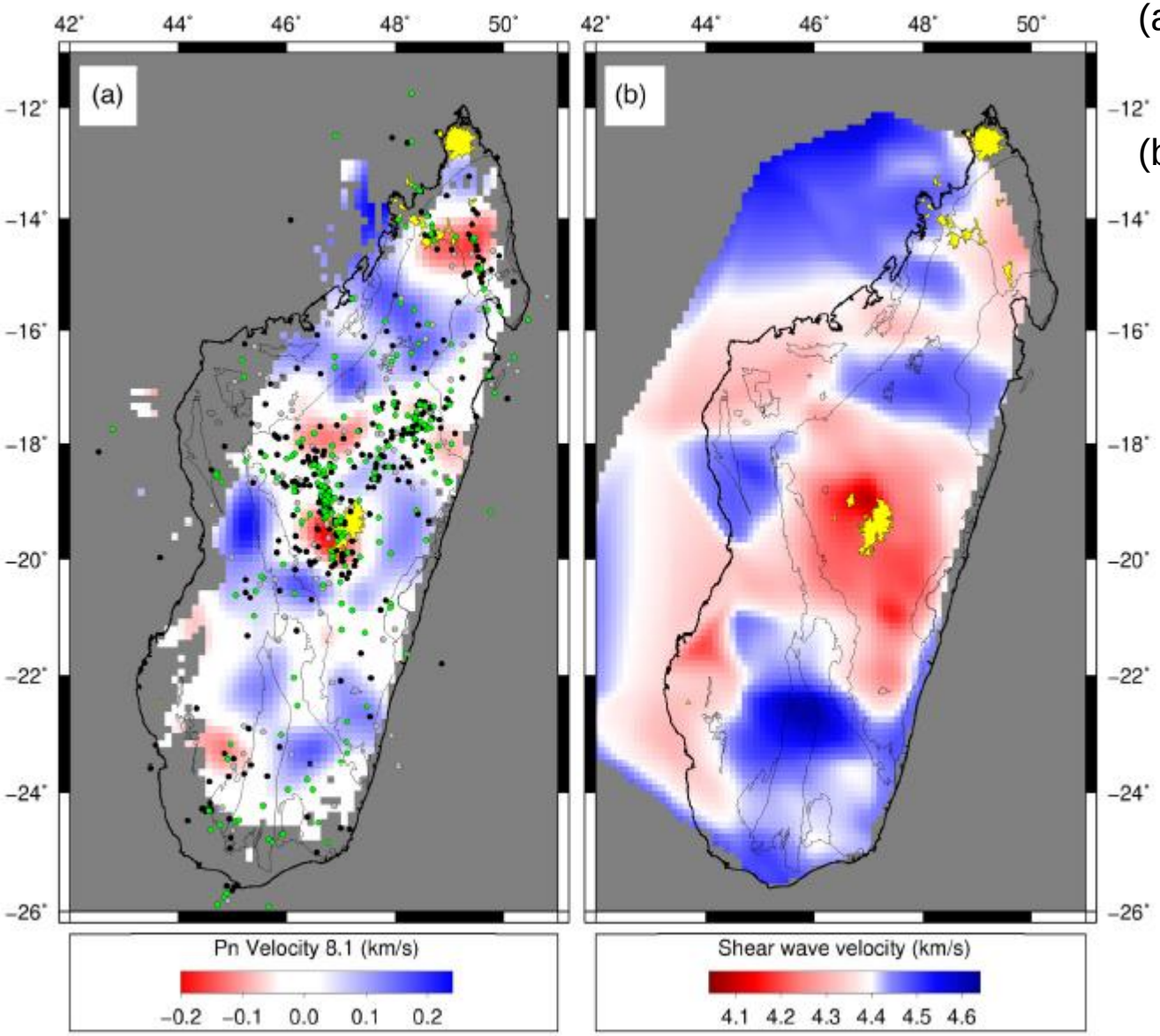
Seismic velocity and anisotropy of the uppermost mantle beneath Madagascar from *Pn* tomography

Fenitra Andriampenomanana[1,2] Andrew A. Nyblade,[1,3] Michael E. Wysession,[4]
Raymond J. Durrheim,[1] Frederik Tilmann[5,6] Guilhem Barruol[7],
Gérard Rambolamanana[8] and Tsiriandrimanana Rakotondraibe[1,2]









(a) Lateral variations of Pn velocity in the uppermost mantle (this study); earthquake epicentres from Rakotondraibe et al. (2020)

(b) Shear wave velocity at a depth of 50 km, from Pratt et al. (2017).

FINDINGS

- **Pn velocities** within vary by ±0.30 km s^{-1} about a mean of 8.10 km s^{-1}.
- **Low-Pn-velocity zones (<8.00 km s^{-1})** are observed beneath the **Cenozoic alkaline volcanic provinces** in the northern and central regions, corresponding to thermally perturbed zones, where temperatures are estimated to be elevated by ~100–300 K.
- Moderately low Pn velocities are found near the southern volcanic province
- **Pn anisotropy** is very complex, with small-scale variations in both the amplitude and the fast-axis direction, and generally reflects the complicated tectonic history of Madagascar.

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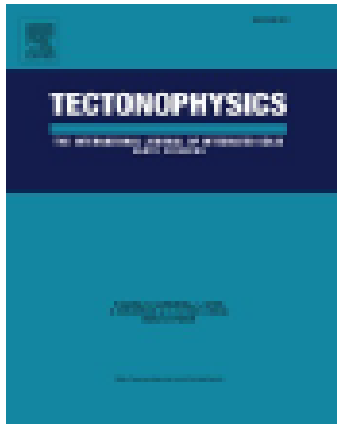
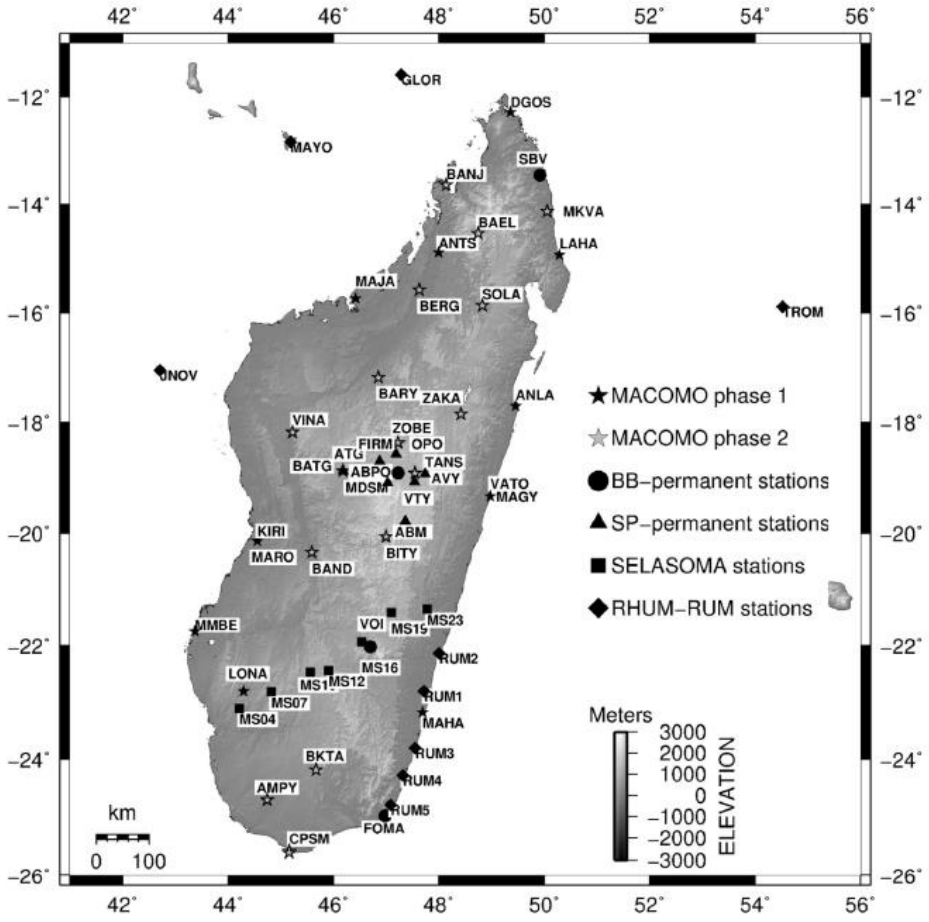
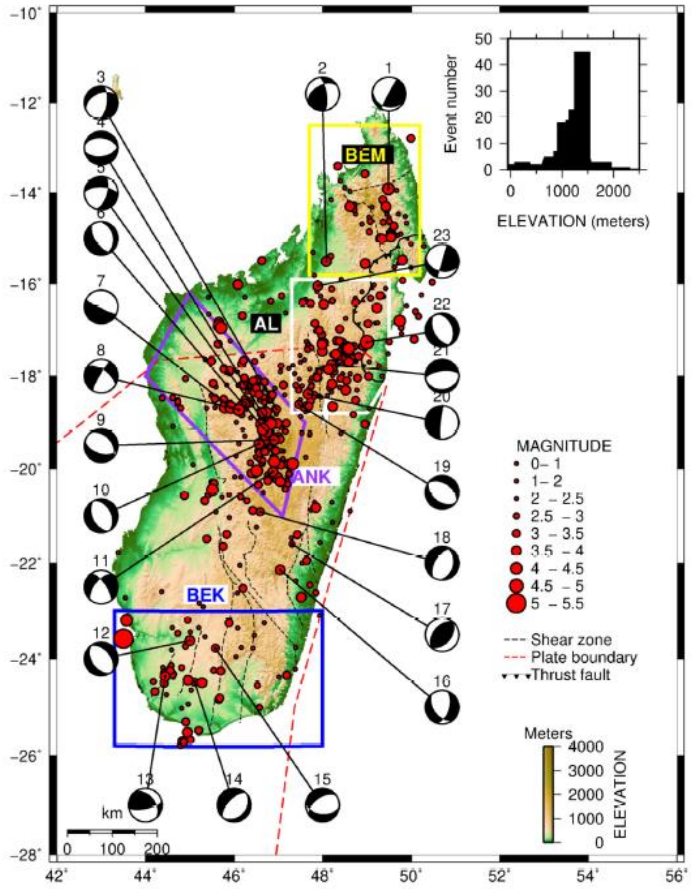


Seismicity and seismotectonics of Madagascar revealed by the 2011–2013 deployment of the island-wide MACOMO broadband seismic array

Tsiriandrimanana Rakotondraibe[a,d,*], Andrew A. Nyblade[a,b], Michael E. Wysession[c], Raymond J. Durrheim[a], Gérard Rambolamanana[d], Ghassan I. Aleqabi[c], Patrick J. Shore[c], Martin J. Pratt[c], Fenitra Andriampenomanana[a,d], Georg Rümpker[e], Elisa Rindraharisaona[f]





FINDINGS

- Most seismicity is clustered within central Madagascar, roughly aligned with extensional tectonic features.
- Focal mechanisms exhibit a wide orientation of nodal planes, show predominantly normal faulting throughout Madagascar.
- No support for a sharp EW-striking plate boundary in the middle of the island. A diffuse plate boundary cannot be excluded.
- Topographically-generated extensional stresses are thought

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

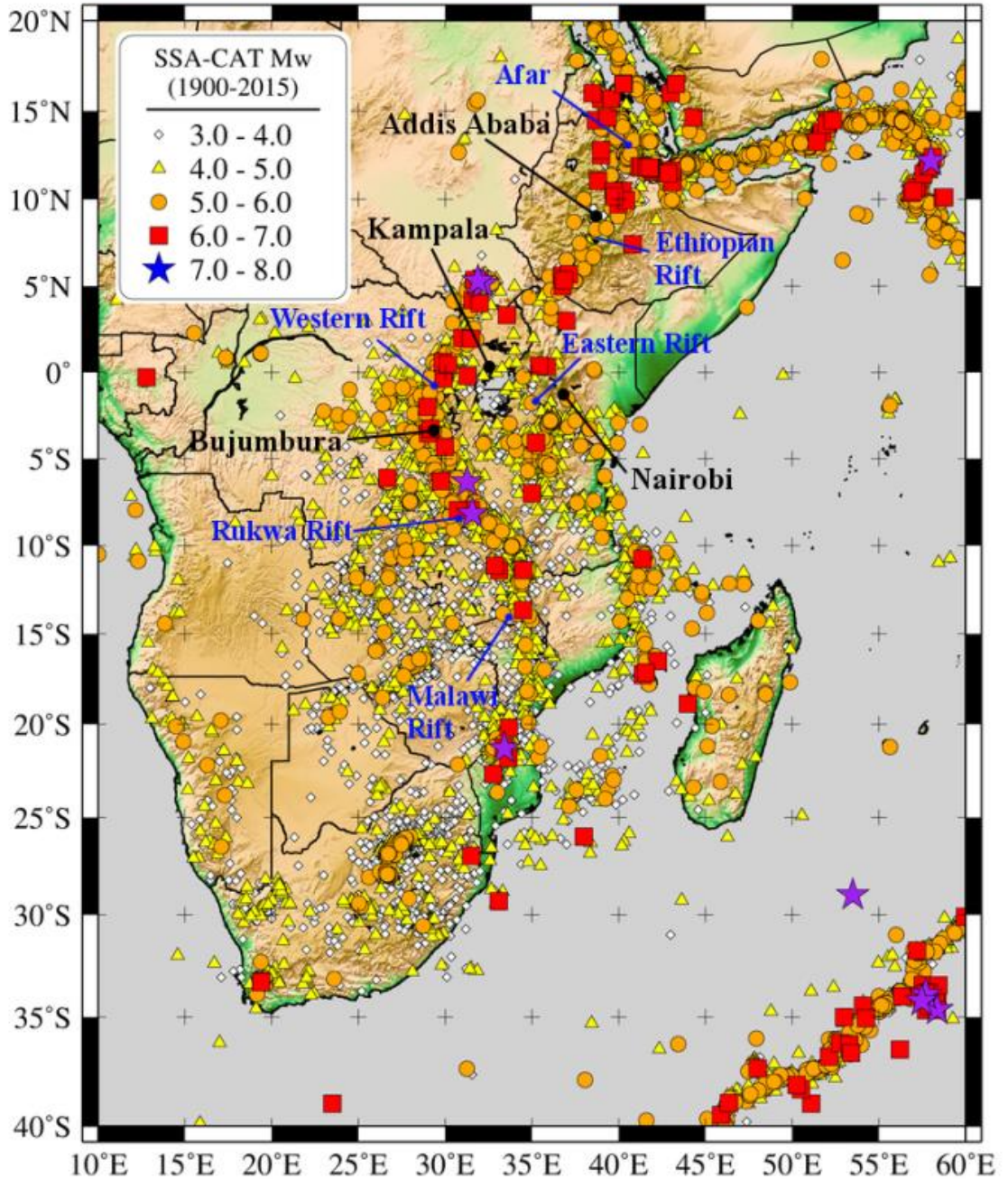
Bull Earthquake Eng (2017) 15:4499–4529
DOI 10.1007/s10518-017-0152-4

ORIGINAL RESEARCH PAPER

Assessing seismic hazard of the East African Rift: a pilot study from GEM and AfricaArray

Valerio Poggi[1] · Raymond Durrheim[2] · Georges Mavonga Tuluka[3] · Graeme Weatherill[1] · Robin Gee[1,6] · Marco Pagani[1] · Andrew Nyblade[2,4] · Damien Delvaux[5]

Distribution of earthquakes ($M_W \geq 3$) from the homogenised SSA-GEM earthquake catalogue.



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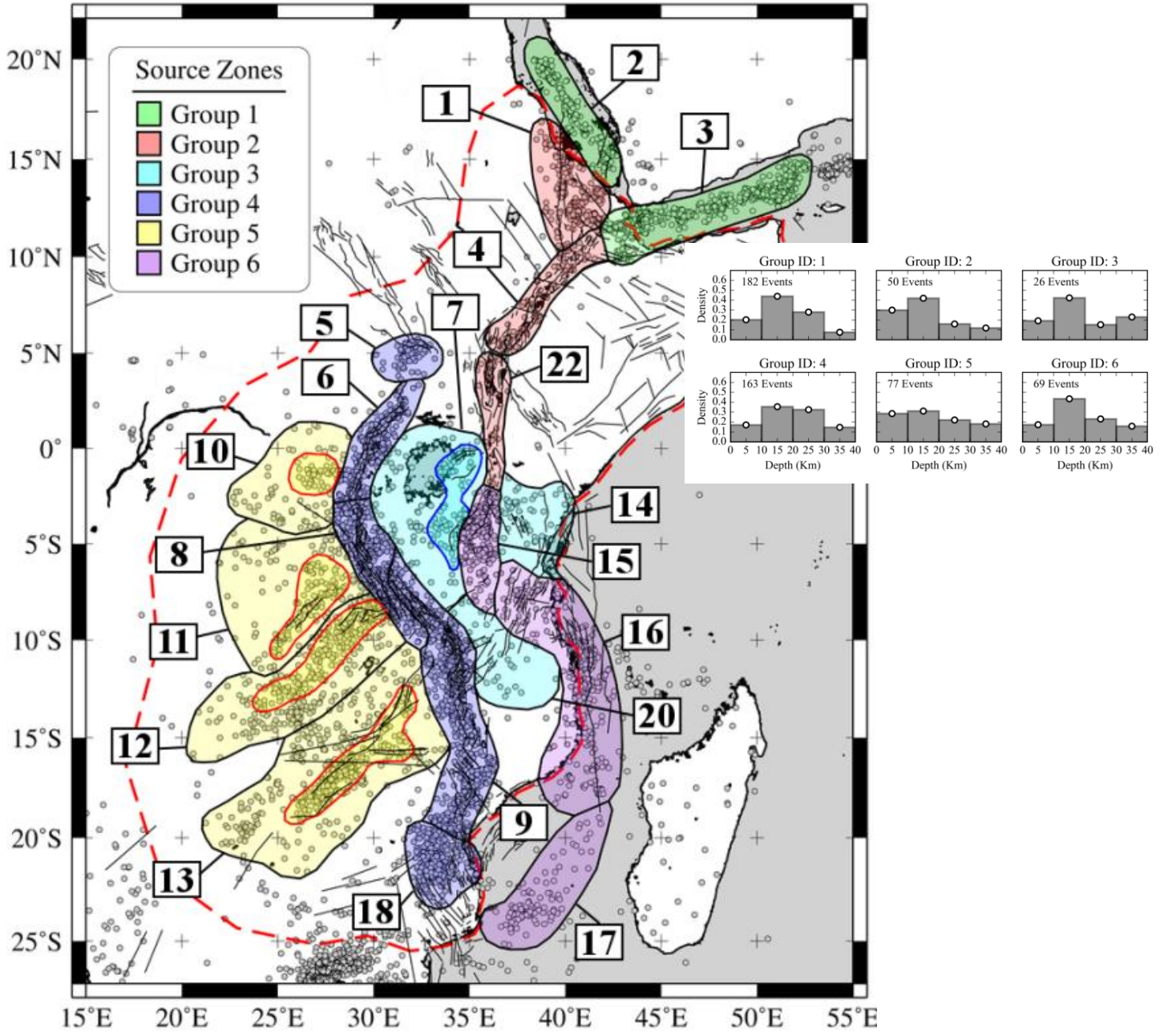
SOURCE ZONATION MODEL

Group	Source Zone	Name
1	2	South Red Sea
	3	Gulf of Aden
2	1	Afar Depression - Eritrea
	4	Main Ethiopian Rift
	22	North Kenya - Lake Turkana
3	7, 7.1	Lake Victoria
	14	South Kenya
	20	Rovuma Basin
4	5	South Sudan
	6	Western Rift - Lake Albert to Kivu
	8	Western Rift - Tanganyika
	9	Rukwa - Malawi (Nyasa) Rift
	18	South Mozambique
5	10, 10.1	Walikale - Masisi
	11, 11.1	Upemba Graben
	12, 12.1	Mweru - South Katanga
	13, 13.1	Kariba - Okavango
6	15	Eastern Rift
	16	Davie Ridge
	17	Mozambique channel



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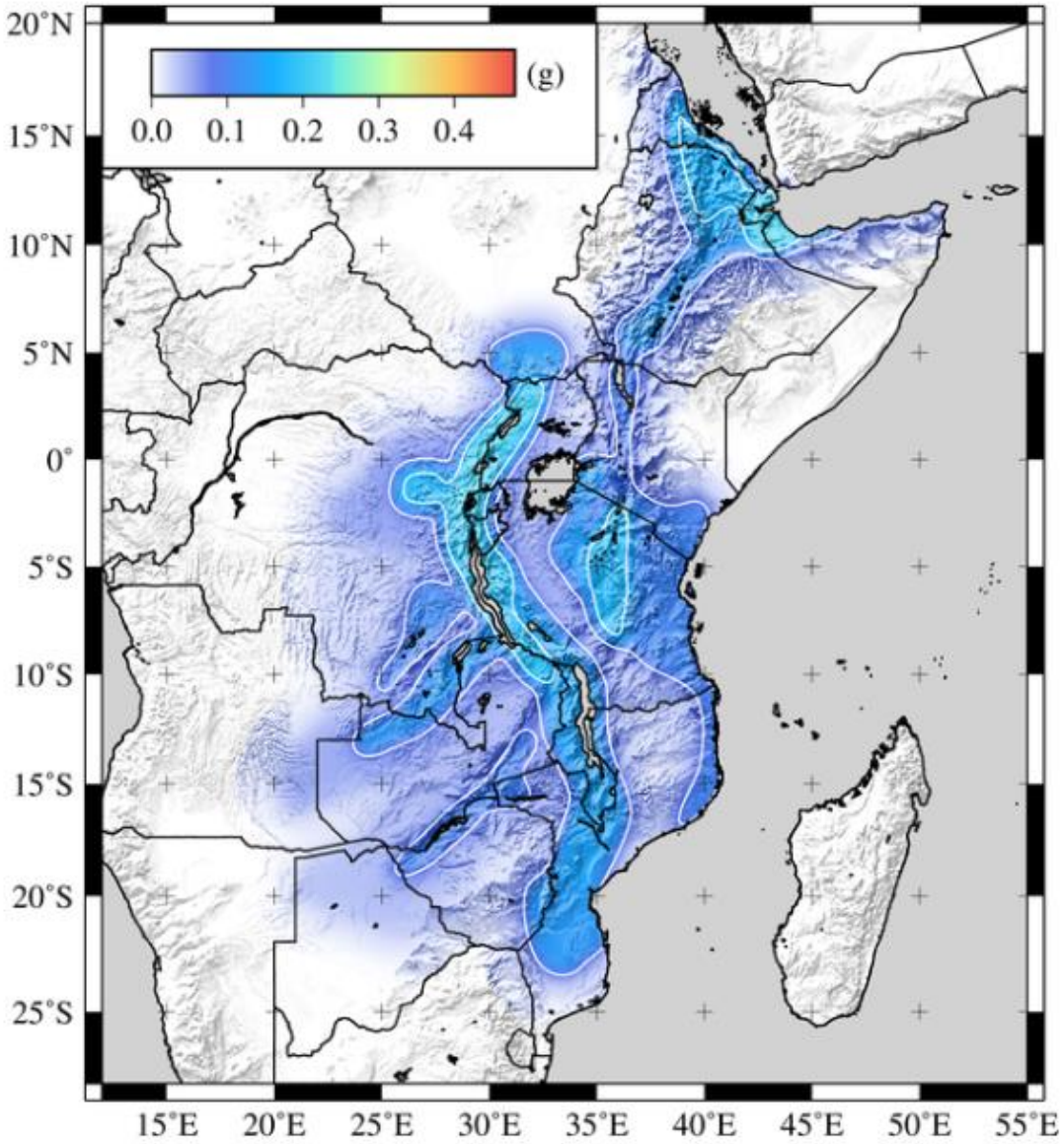
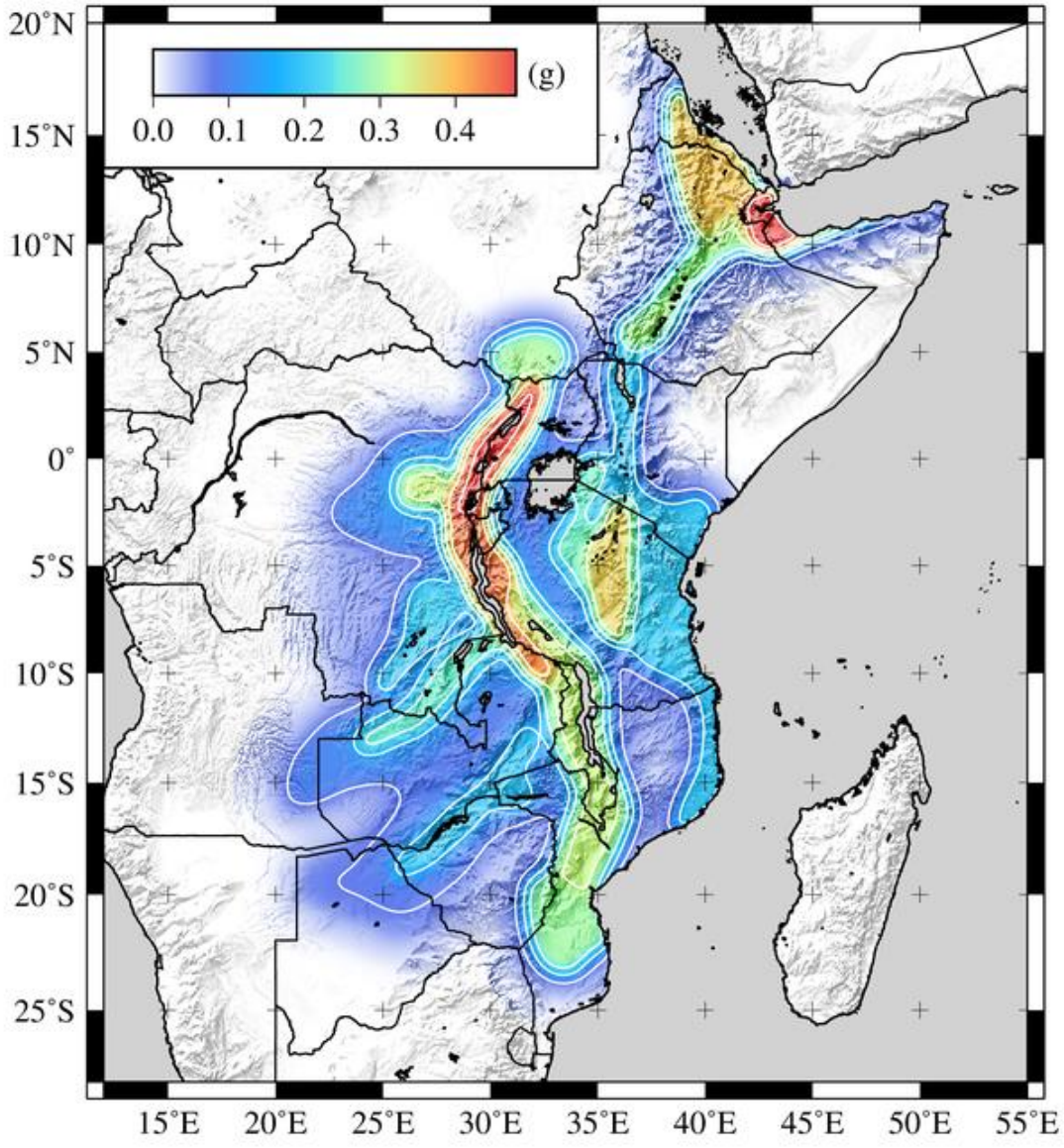


PGA (g)
10% probability of exceedance in 50 years



Spectral acceleration (g) at 0.1 s / 10 Hz
10% probability of exceedance in 50 years

EPOS
EUROPEANPLATEOBSERVINGSYSTEM
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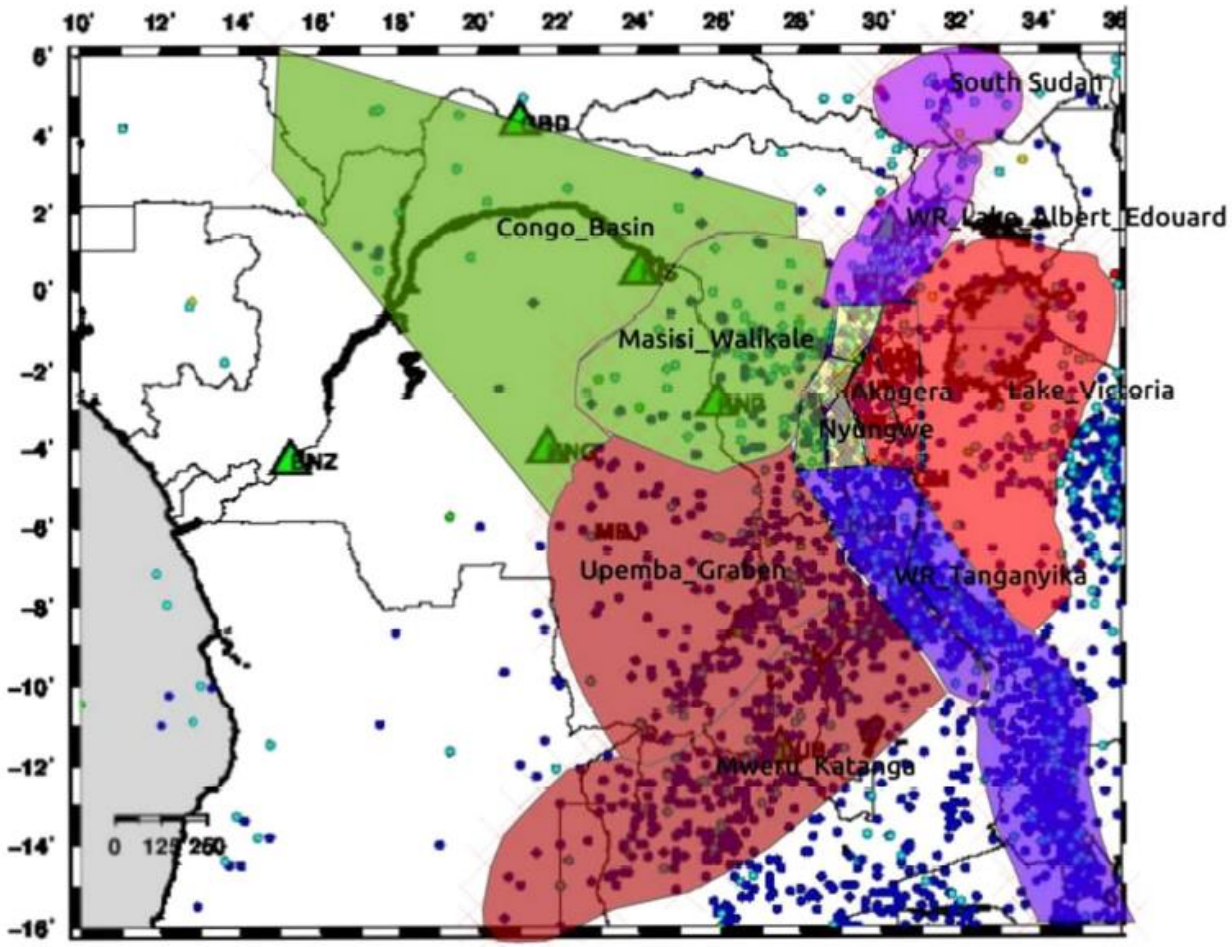
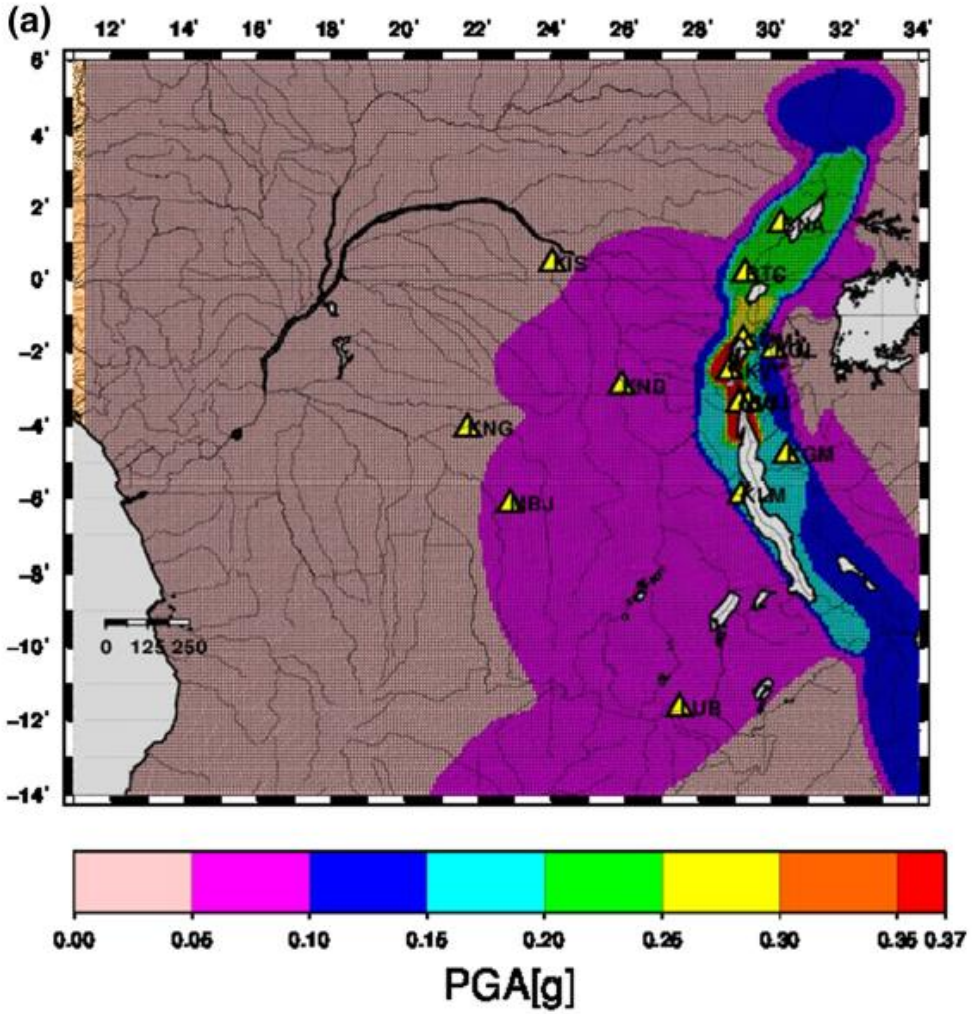
pure and applied geophysics

pageoph Birkhäuser

Seismic Hazard Assessment of the Democratic Republic of Congo and Environs Based on the GEM–SSA Catalogue and a New Seismic Source Model

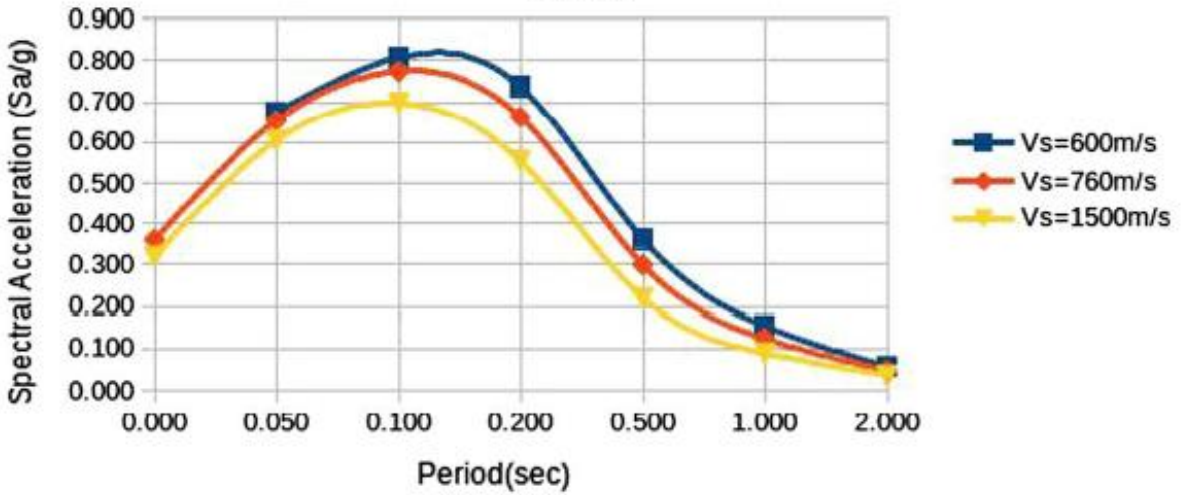
Georges Mavonga Tuluka,[1,3] Jeanpy Lukindula,[1] and Raymond J. Durrheim[2]



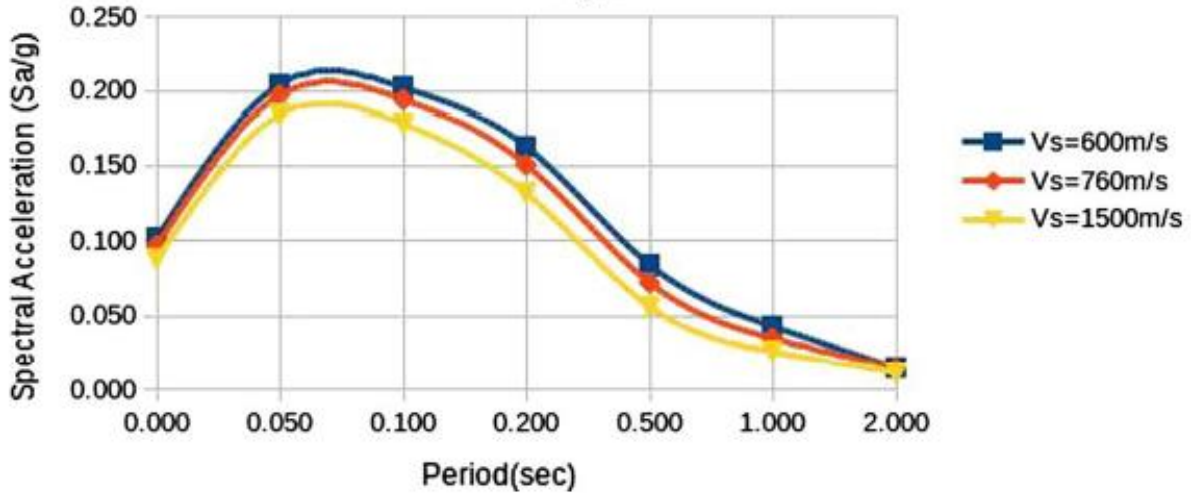


UNDER GRANT AGREEMENT N° 871121

A Spectral Acceleration (Sa/g) for specifiedVs defining the site soil at Bukavu



Kigali



FINDINGS

- Sub-Saharan Global Earthquake Model (SSA–GEM) catalogue augments global catalogues with information from local agencies and regional projects, particularly from the AfricaArray network.
- Declustered catalogue (1900-2015) has 782 events.
- Seismotectonic zonation into 15 seismic source areas based on:
  - regional geological structure,
  - neotectonic fault systems,
  - basin architecture,
  - distribution of thermal springs, and
  - earthquake epicentres.
- PSHA computations performed using the GEM OpenQuake engine (version 2.7.0-1).
- Calculated PGA and spectral acceleration at 0.05, 0.1, 0.2, 0.5, 1 and 2 s periods for several Vs30 models.

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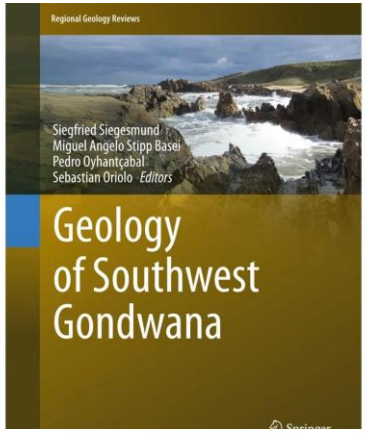
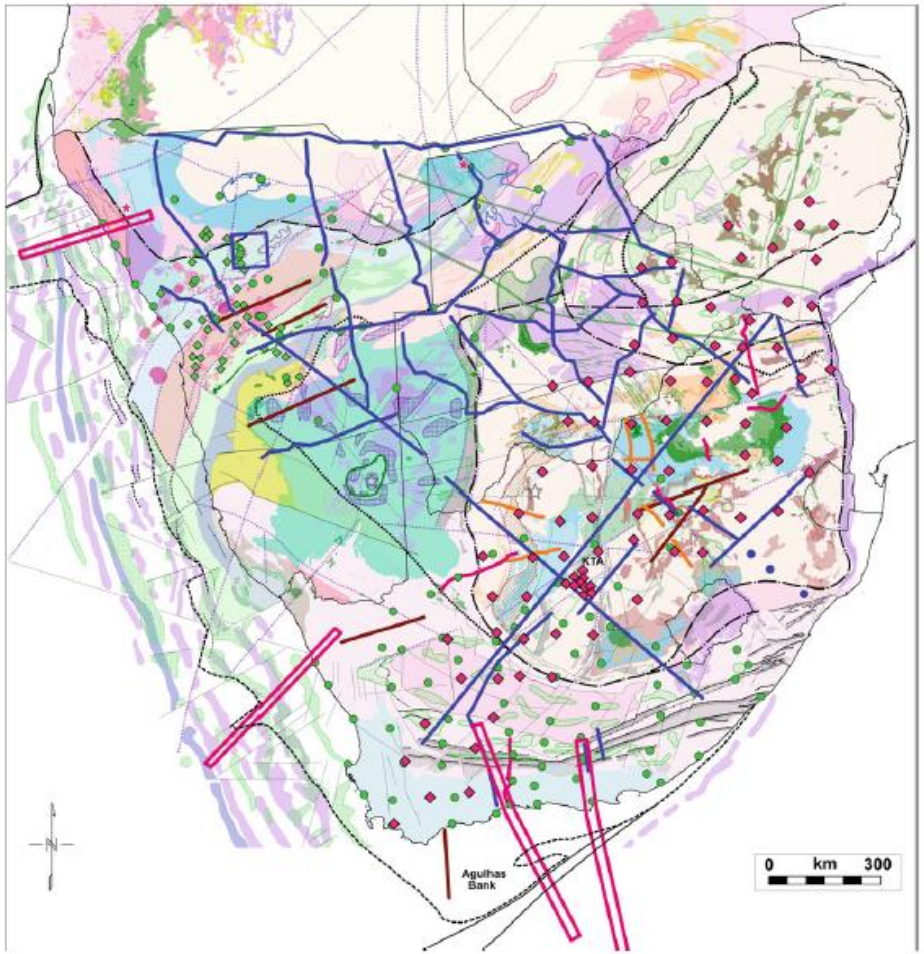
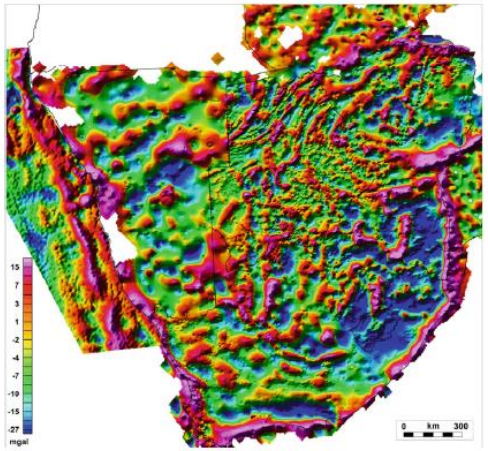


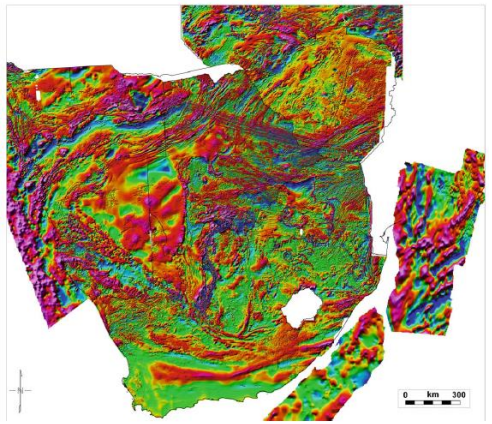
An Integrated Geophysical and Geological Interpretation of the Southern African Lithosphere

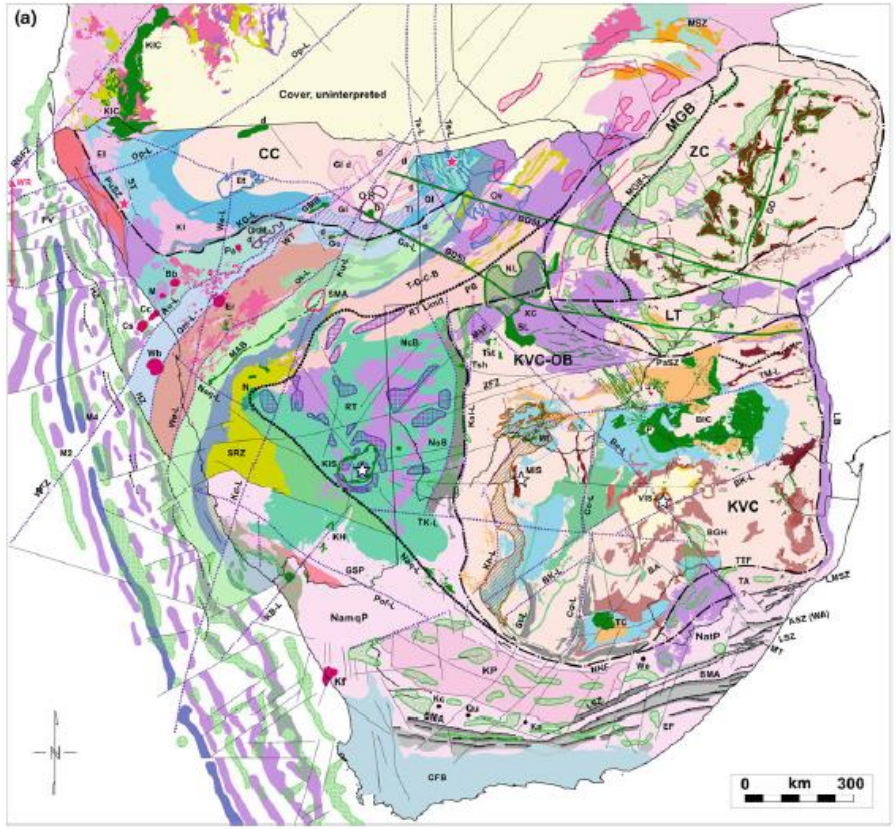
Branko Corner and Raymond J. Durrheim

- Geological mapping (surface, borehole)
- Gravity
- Magnetics
- Magnetotellurics (SAMTEX)
- Broadband teleseismics (SASE, AfricaArray)
- Refraction seismics
- Reflection seismics



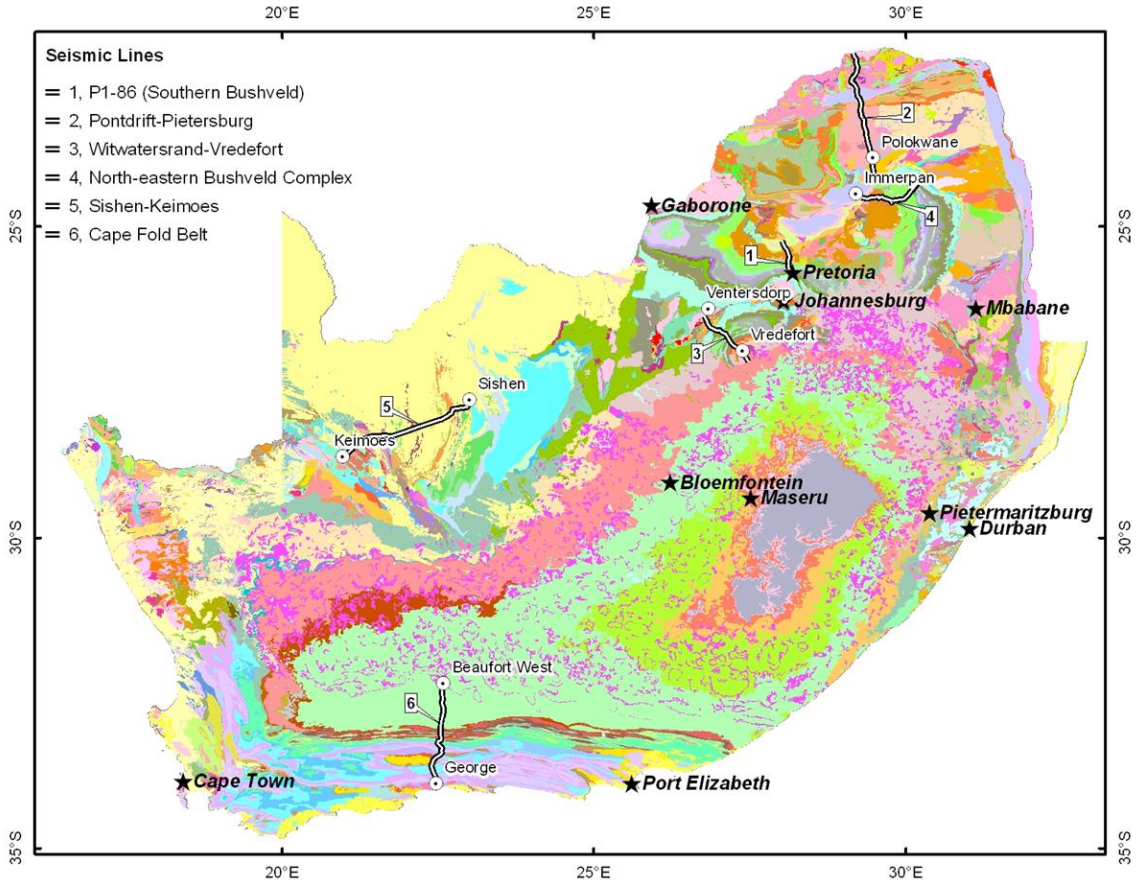


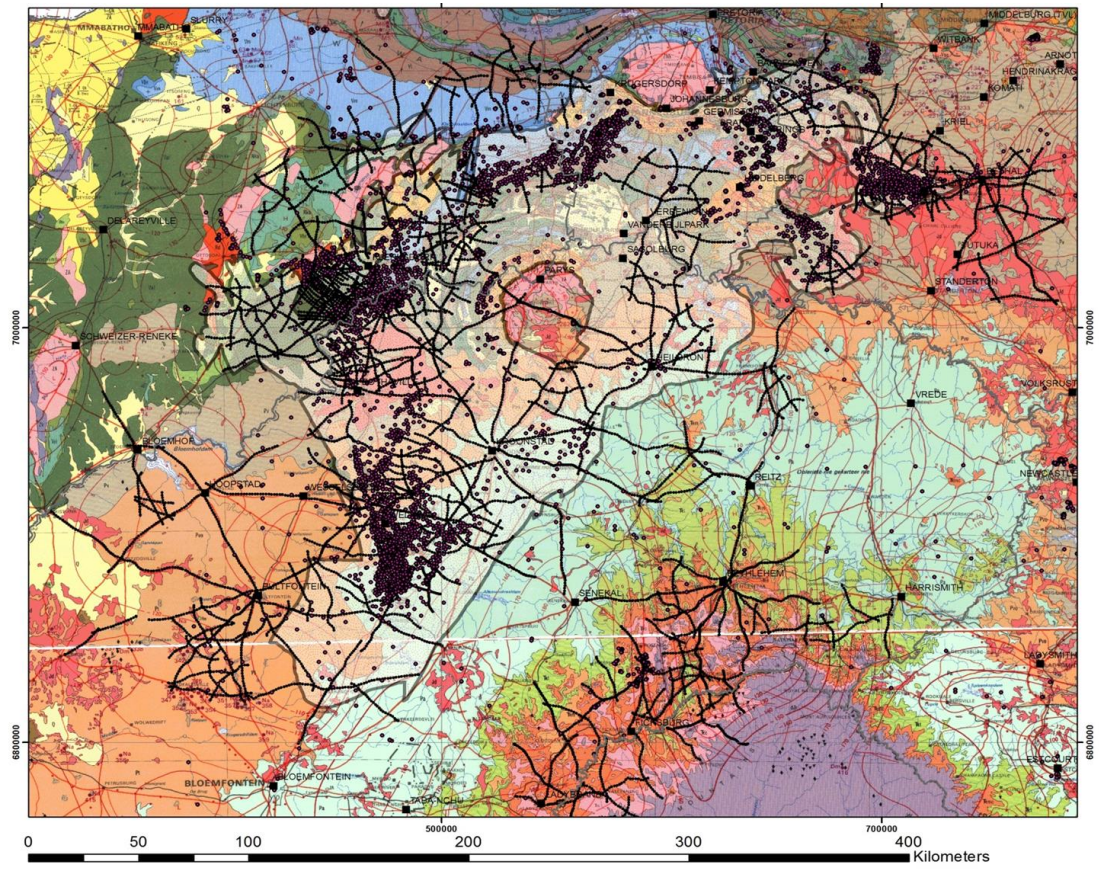




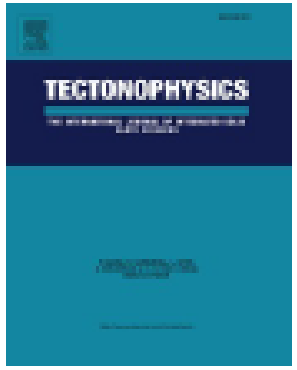
Giving the legacy seismic data the attention they deserve

Musa Manzi[1]*, Alireza Malehmir[2] and Raymond Durrheim[1] discuss the importance of retrieving, recovering, and reprocessing legacy seismic data for mineral exploration.



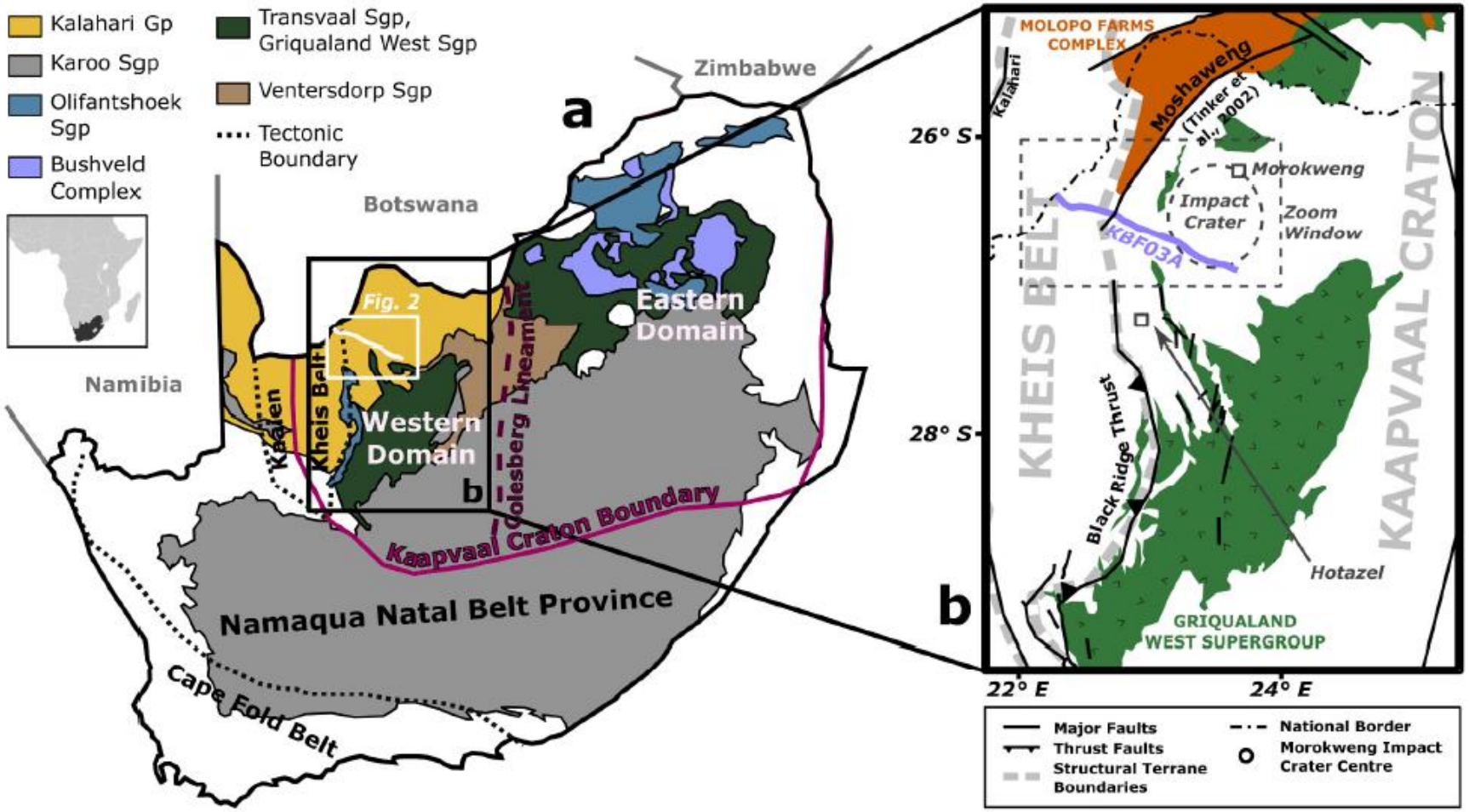


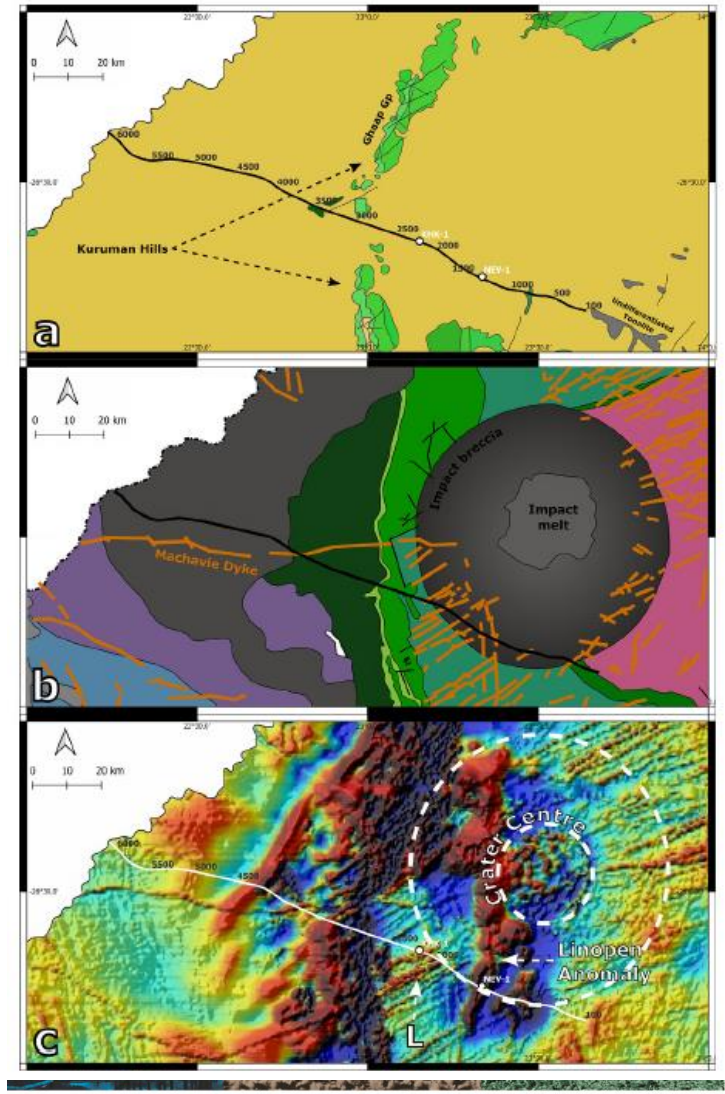
R GRANT AGREEMENT N° 871121

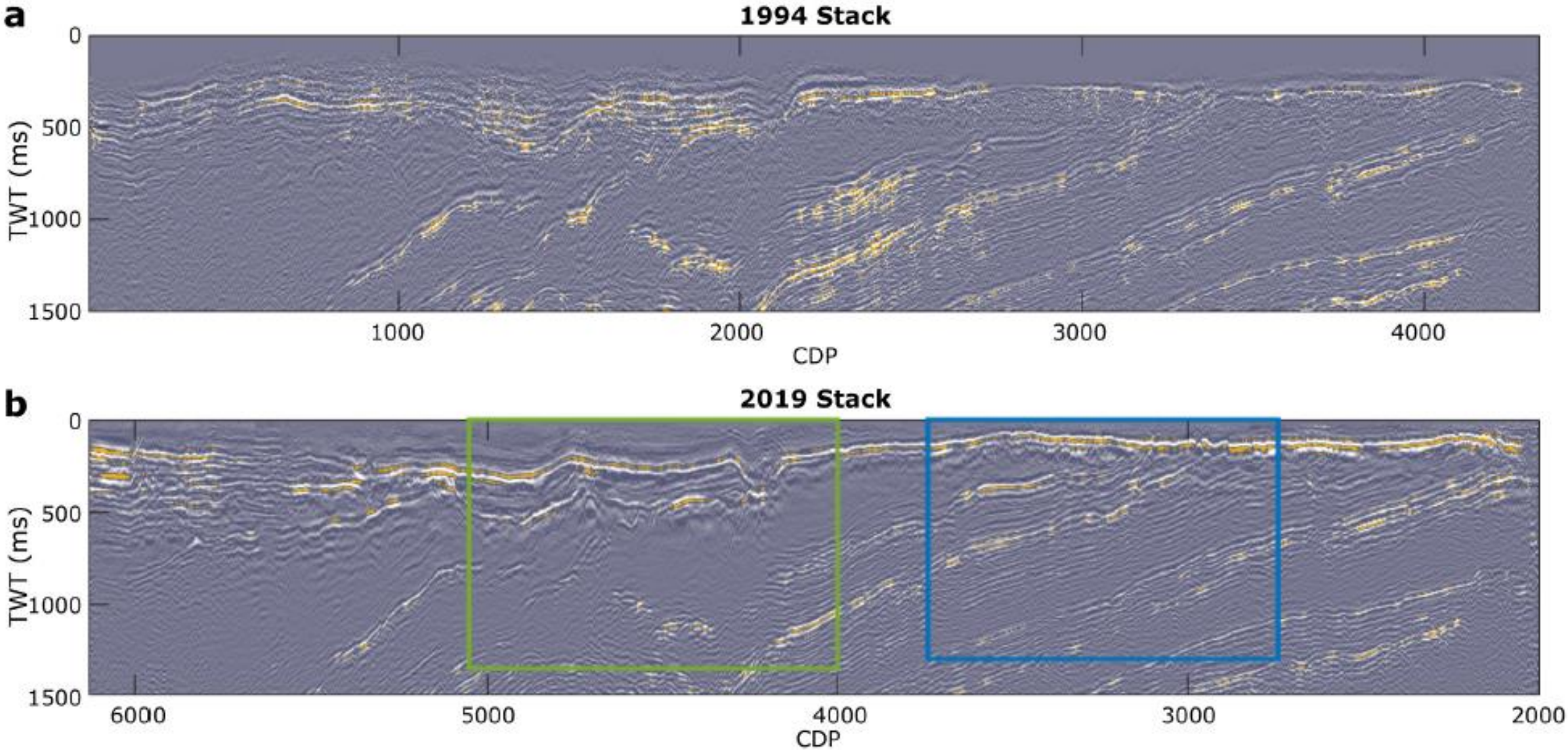


A reappraisal of legacy reflection seismic data from the western margin of the Kaapvaal craton, South Africa, with implications for Mesozoic-Cenozoic regional tectonics

Michael Westgate [a,*], Musa S.D. Manzi [a], Alireza Malehmir [b], Roger L. Gibson [a], Marco A. G. Andreoli [a], Adam Bumby [c]







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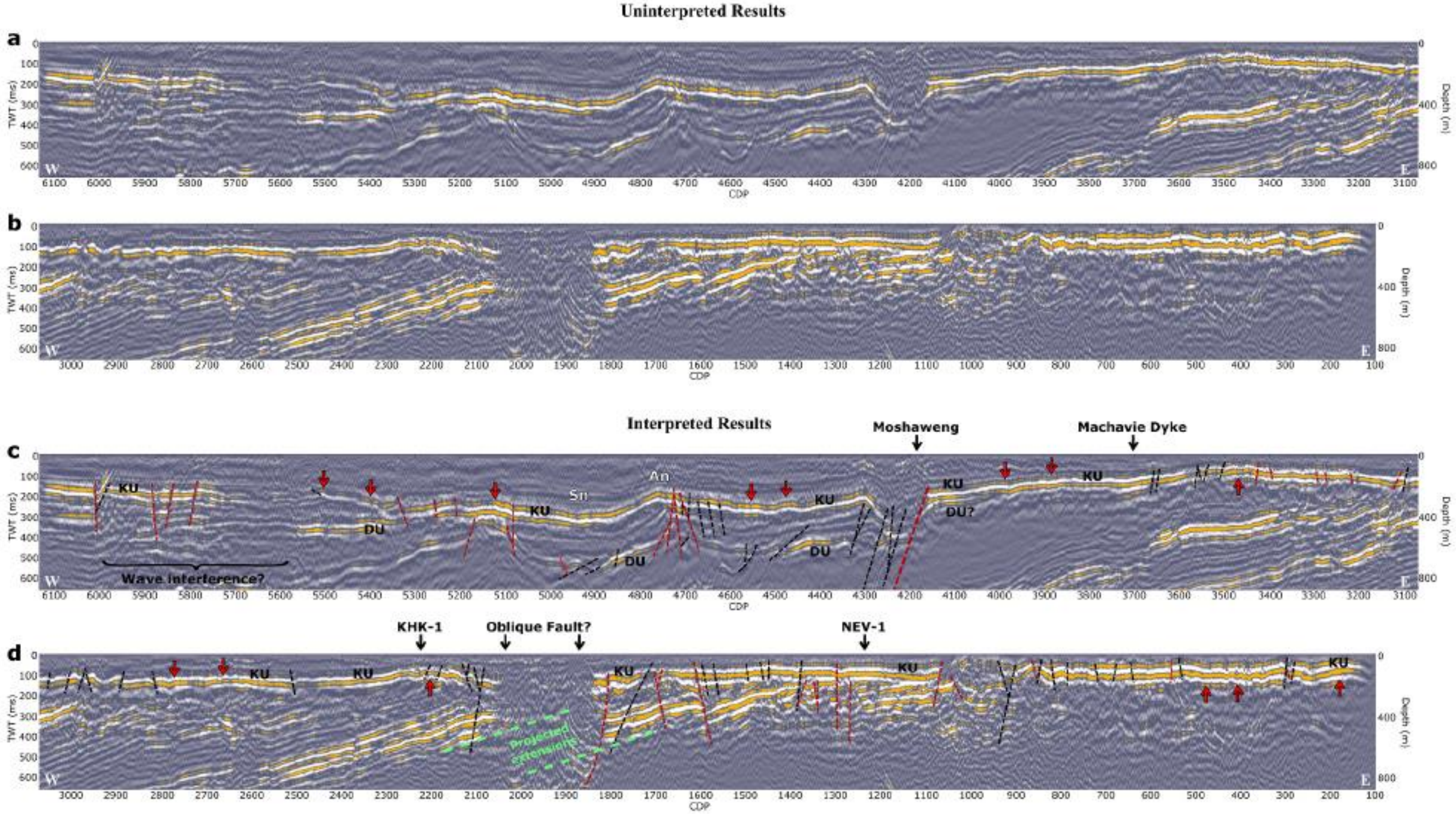
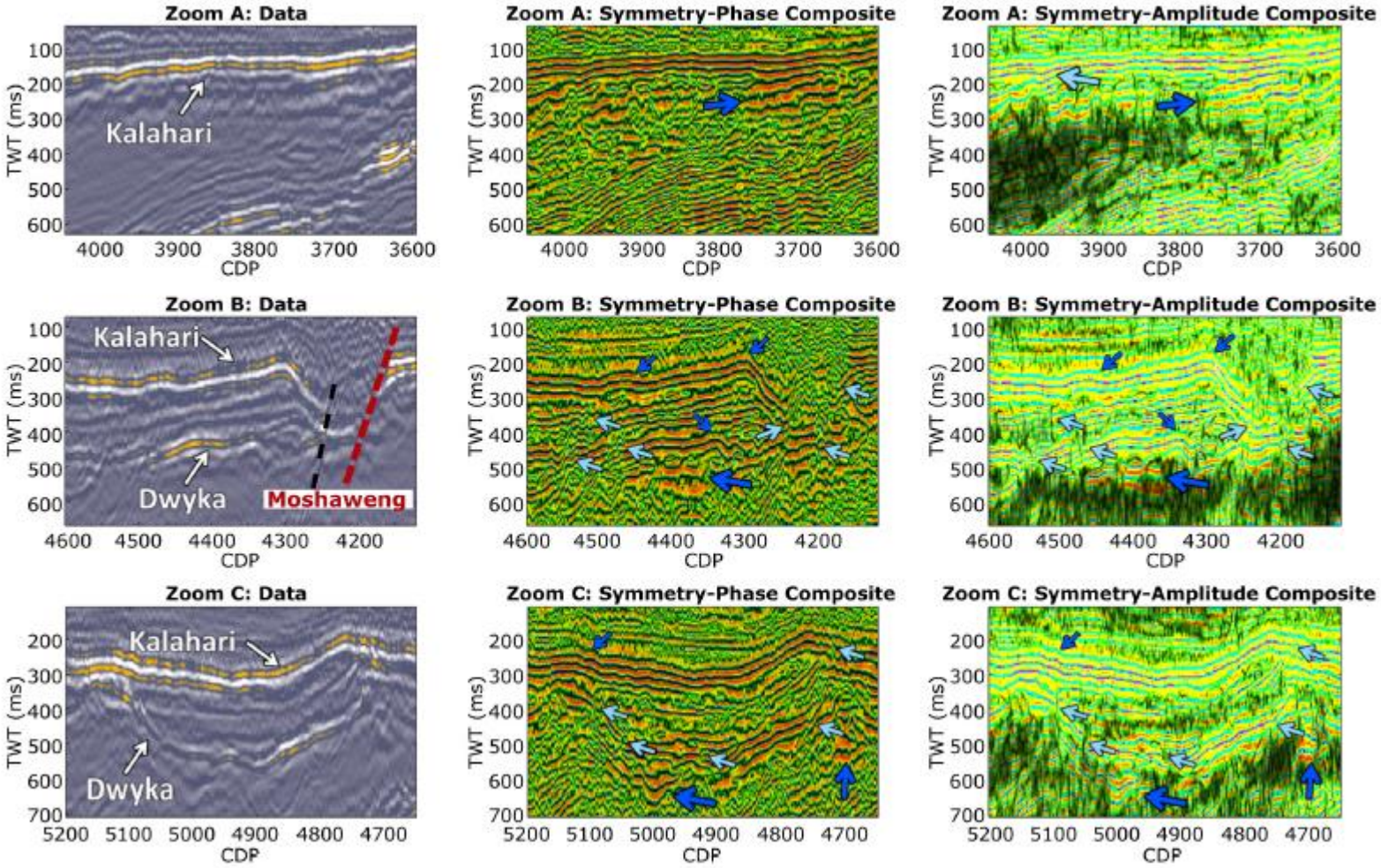

Uninterpreted Results
a
b
TWT (ms)
Depth (m)
W
E
CDP
Interpreted Results
c
d
KU
DU
DU?
An
Sn
Wave interference?
Moshaweng
Machavie Dyke
KHK-1
Oblique Fault?
NEV-1
Projected extensions



FINDINGS

- 150 km long, 6 s TWT 2D seismic profile acquired in 1994 reprocessed using modern reflection seismic processing methods.
- Significant improvement in the imaging quality of the subsurface.
- Newly imaged features provide evidence for multiple Late Mesozoic to Cenozoic tectonic events, including polyphasic reactivation of basement structures, under both extensional and compressional stress regimes.

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Summary

In past 5 years considerable advances in knowledge of the deep structure and geodynamics of Africa south of the equator **by African scientists and institutions**.

- Definition of craton boundaries,
- Origin of southern African plateau,
- Application to earthquake risk mitigation,
- Application to mineral exploration,
- Future focus on Bushveld Complex and environs

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