

# 10th Annual Inkaba yeAfrica and !Khure Africa Conference (2014)



## Report of Contributions

Contribution ID: 0

Type: **not specified**

## Dual laser system for the HartRAO Lunar Laser Ranger: design, configuration and expected performance

*Tuesday, 30 September 2014 11:30 (15 minutes)*

HartRAO has been planning and developing a Lunar Laser Ranger (LLR) for the past 10 years. This system will also be used for Satellite Laser Ranging during available operational time. We already have a 1 m optical telescope as well as a functional control room. We are now at the stage of procuring the remaining hardware components and implementing these according to the overall system design.

The laser system for this LLR has been designed in collaboration with and procured via the NASA laser ranging network contractor, Cybioms Corporation. The system consists of 2 lasers: one providing high-power green pulses at 20 Hz for lunar capability and another delivering low power green pulses at 1 kHz for satellite capability. These lasers have recently arrived in South Africa.

An overview of the laser system configuration and design as well as anticipated performance will be presented.

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 1

Type: **not specified**

## The structure of the Karoo-age Ellisras Basin in Limpopo Province, South Africa, in the light of new airborne geophysical data

*Monday, 29 September 2014 15:00 (20 minutes)*

The Coaltech Research Association funded an airborne magnetic and radiometric survey over the Karoo-age Ellisras Basin in the Northern Province of South Africa in 2008. The Waterberg Coalfield, which is destined to become the major source of energy in South Africa in the future, is situated in this sedimentary basin. Interpretation of the processed geophysical datasets has added significantly to our understanding of the structure of the Ellisras Basin, in addition to providing additional constraints on lithological and structural mapping. The filtered magnetic and ternary radiometric images have yielded abundant information that will be important in future mapping. Two-dimensional modelling of the magnetic data has provided a novel half-graben model for the structure of the Ellisras Basin. The Melinda Fault Zone, which forms the northern boundary of the basin against Archaean Limpopo Belt rocks, is block-faulted and generally steeply dipping. The thickest development of the Karoo Supergroup rocks is against this fault, attaining up to 500 m. The sediment thickness decreases gradually to the south, indicating an asymmetric basin fill. The southern boundary of the basin is formed by the Eenzaamheid Fault Zone, south of which the ~2000 Ma Waterberg Group rocks are developed.

Despite its economic importance, the Ellisras Basin has not been well-studied, and there is a need to correct this in the near future as South Africa becomes more reliant on energy from the Waterberg Coalfield.

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**Session Classification:** Supervisor Talks

**Track Classification:** Oral Presentation

Contribution ID: 2

Type: **not specified**

## Shoreline length-series from virtual, artificial, natural deltas

The most used tool for a sedimentologist is a one-dimensional vertical log through sedimentary layers. The log provides a detailed record of the sedimentary system, but lack of time control frustrates correlation between logs on the one hand and between log and signal on the other, e.g. correlation between shoreline length-series and sealevel time-series. The objective of this study is to test whether shore line correlates to base level for alluvial shallow deltas. The fundamental question is whether one can infer sea level time-series from sea level length-series.

In order to infer paleo base level in the rock record one needs a base level proxy. A commonly used proxy is clinoforn brink point; the position of which indicates shore level. If all else steady and deposition continuous then shore line correlates to sea level. Here we test if shore line is indeed valid proxy for sea level by growing a miniature delta in a flume tank under steady tectonic subsidence, periodic water (sea) level fluctuation and two periodic discharge fluctuation scenarios: in- and out-of-phase with sea level. We took photographs every 10 minutes and digital elevation models every 3.5 hours. At the end of the experiment we made 4 radial cross-sections.

We then convert length-series to time-series. We measure the shore line in a cross-section for each lamina subsequently, i.e. distance of shore line to delta apex, lamina for lamina, from oldest to youngest. Thus we obtain shore line "length-series" for the cross-section. We then obtain depositional event times from the photographs. Thus we obtain shore line "time-series" for the same cross-section. We convert the time-series to length-series by omitting hiatus and match the two. We then convert the length-series to time-series and hence obtain shore line time-series.

Our results show that first order shore line cycles mimic sea level cycles, but higher order shore line cycles deviate from the trend. Regional supply fluctuations affect amplitude of shore line shifts; supply change in-phase with sea level attenuates fluctuations, out-of-phase amplifies them. Local supply fluctuations caused by lobe switches or other autogenic responses generate shore line cycles similar to higher order sea level cycles. In the out-of-phase scenario lobe switches are rare and generate second order cycles; in the in-phase scenarios switches are frequent and generate third order cycles.

In conclusion, the results show that deposition events are adequate samples to capture the lower order base level cycles accurately from shore line cycles, but two phenomena create significant misfit between the two: (1) Irregular local deposition causes a varying phase shift between sea level and shore line cycles similar to varying sea level cycle period; (2) Autogenic phenomena create additional shore line cycles similar to higher order sea level cycles. It is evident that one can not infer sea level time-series from shore line length-series.

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**Track Classification:** Oral Presentation

Contribution ID: 3

Type: **not specified**

## Gypsum Deposits Associated with the Whitehill Formation (Ecca Group) in the Steytlerville-Jansenville Area, Southern Karoo, South Africa

*Thursday, 2 October 2014 11:15 (15 minutes)*

The Steytlerville-Jansenville gypsum field is one of South Africa's smaller deposits. It is covered by an average of 500mm of soil and has fine powdery gypsum bodies which are, on average, 37cm thick and contain an average of 65% gypsum – medium grade. The calcium and sulphate ions required to form the gypsum mineral ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) are supplied by the Whitehill Formation shale which is carbonate and pyrite rich. The Early Ufimian (late Permian) Whitehill Formation (part of the Ecca Group, lower Karoo Supergroup) is, on average, 30m thick with a debateable carbon content up to 14% C. The lithology is split into 'deep-water' facies and 'shallow-water' facies. The former consisting of chert and carbonate concretions while the latter has silty horizons, carbonate beds, but no chert. This particular shale is undergoing close study with regards to its potential to supply gas energy, but must also be recognised for its other economic benefits.

In South Africa, gypsum forms mainly near the surface in clay, in veins or as powders in discontinuous horizontal layers. Prerequisites for gypsum formation include the supply of calcium and sulphate to a zone of weathering, restricted drainage such as a pan, a clay layer in the drainage area and an arid climate where evaporation exceeds precipitation. The area of Klipplaat, Eastern Cape, in the Great Karoo meets these requirements and Pretoria Portland Cement (PPC) have mined gypsum from a weathered zone of the Whitehill Formation shale. Gypsum grades vary greatly from below 40%  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  to well over 70%  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ , and seem to be affected greatly by the degree of weathering as well as their topographical position.

The folding and faulting of the shale provide the weaker, more penetrable region in which gypsum is able to precipitate. Folding of the shale occurs as a series of large-scale and small-scale anticlines and synclines striking from East to West. Pyrite should be concentrated in the fold axis (weakest point) and this is where the larger gypsum deposits are found. Small, iron-rich layers are overlain by small lenses of gypsum and this suggests a relationship whereby Iron (II) Sulphate, combined with Calcium Carbonate, produces Calcium Sulphate (gypsum) and is reduced to Iron (III) Oxide which remains as these iron-rich layers.

Carbonate concretions up to 5m in length and 3m in width are common in the study area and literature suggests that they are associated with the deposition of the shale whereby calcium-rich nuclei grow in a concentric fashion during a non-depositional period. This period is also associated with a higher pyrite phase and this could explain the connection between the concretions and a higher gypsum zone within the Whitehill Formation. It is also possible that organic carbon is concentrated in and around these concretions and this could provide 'pockets' of higher carbon content within the Whitehill Formation where shale gas might be trapped at depth.

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**Session Classification:** Minerals

**Track Classification:** Oral and Poster Presentation

Contribution ID: 4

Type: **not specified**

## Loud Calls as Species Markers in Fork-Marked Dwarf Lemurs (Phaner)

*Thursday, 2 October 2014 12:30 (15 minutes)*

Fork-marked dwarf lemurs (Phaner) are nocturnal strepsirhines endemic to Madagascar. Lemur systematic has witnessed the naming of many new species in the last decade. Four Phaner species have been recognized based on slight variations in pelage colouration, and their occupation of discontinuous ranges in Madagascar. Given that these lemurs are nocturnal, according to the Recognition Concept of Species, mate recognition cannot be by visual characteristics alone. The Recognition Concept of Species is the means by which organisms attract and recognize each other referred to as the Specific Mate Recognition Systems (SMRS). One of the SMRS that have been widely followed and proven fruitful in nocturnal primates is vocalization. Each species has particular loud call common to both sexes and used to advertise their presence to companions as well as rivals. Loud calls are species specific and constant across geographical ranges. Therefore, loud calls provide a diagnostic tool for the identification of new species. However, loud call species specificity has never been tested in the fork-marked dwarf lemurs. Our project was underpinned by the Recognition Concept. In contrast to many other lemurs, Phaner are known to rely less on visual signals and recognize each other principally by means of auditory and olfactory signals. They possess a rich repertoire of loud calls related to contact and alarm. We applied comparative bioacoustics, a tool successfully used to discriminate other nocturnal, cryptic species, to investigate whether species of fork-marked dwarf lemurs can be recognized noninvasively on the basis of their loud calls. Loud calls of five populations of forked-marked dwarf lemurs corresponding to the four recognized species were recorded along existing trails in the night with the aid of a professional sound recorder and directional microphone. Calls were analyzed using Sound Analysis Pro 2011 and the data subjected to multivariate analysis to produce a dendrogram and an ordination diagram based on Principal Component Analysis (PCA). Calls from all studied populations showed distinctive clusters based on the described species of Phaner. These results support pelage colouration and reflect species specificity. Differences in acoustic structure may be caused by genetic divergence, divergence in size and mass of laryngeal structure, the rate at which vocal cords open and close as well in muscles for breathing and vocal production. Equally, specific acoustic adaptation to the environment, genetic drift, founder effects and selection factors may have played a role in the evolution of species specificity in the loud calls of Phaner. Loud call fingerprinting may therefore be used as a non-invasive tool for species diagnosis and discrimination in Phaner. In addition, it offers an easy and inexpensive way to determine species in the field as well as in the laboratory.

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**Session Classification:** Food and Life

**Track Classification:** Oral and Poster Presentation

Contribution ID: 5

Type: **not specified**

## Reappraisal of single station locations reported by the South African National Seismograph Network during the period 2000 to 2005

*Friday, 3 October 2014 09:15 (15 minutes)*

We investigated 1 380 earthquake epicenters that were located through the single-station location method during routine data analysis of the South African National Seismograph Network for the period October 2010 to December 2012. Epicenter locations determined through single-station analysis prompted reports of an increase in seismicity originating from residents in the towns of Ceres and Tulbagh. This coincided with a partial interruption of seismological services at the Council for Geoscience due to an upgrade of the South African National Seismograph Network. These claims could not be substantiated from waveform recordings analyzed during this study. Moreover, the practice of evaluating earthquake epicenters through single-station locations was expanded during the period under review to other selective areas of the Republic of South Africa with limited success. A small percentage (25%) of the seismic events originally located with the single-station location method could be substantiated through phase readings identified on waveforms provided by the Incorporated Research Institutions for Seismology. In conclusion, the authors acknowledge that the single-station location methodology is founded on well established and sound scientific principles but cautions that its use in routine seismic data analysis at regional distances should be applied with care and oversight.

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**Session Classification:** Strain

**Track Classification:** Oral and Poster Presentation



Contribution ID: 6

Type: **not specified**

## Distribution Patterns of Contaminants in the Mogale Gold Tailing Dam; Case Study from South Africa

*Thursday, 2 October 2014 12:00 (15 minutes)*

This study evaluated the magnitude of possibly leachable metals and predicted the AMD discharge over time, from Mogale tailings dam into the environs in Randfontein area, Witwatersrand Basin, South Africa. Drill core samples were analysed for multi-elements and evaluated using multivariate statistical and geochemical mass balance techniques.

The tailings dam lithology was grouped into four distinct layers. The uppermost oxidized layer is siliceous and contains the highest SiO<sub>2</sub> (87.32%) contents, which is accompanied by the lowest contents in U, As, Zn, Ni, Co, and Cu. A downwards decrease in SiO<sub>2</sub> (76.39%) contents occurs, coupled by an increase in U, As, Zn, Ni, Co, and Cu, reaching maximum contents in layer 3. Layer 4 is the least weathered horizon.

The cluster analysis grouped the samples into four sub-clusters based on the variation in SiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> contents. Factor analysis, which explained 83.542% of the total data variance, related the seven controlling factors of element distribution to the occurrence in ore elements (sulphides), silicates, mining additives and refractory minerals. The geochemical mass balance showed variable gain and loss of oxides and trace elements within each layer. Based on the variation patterns of the total sulphur contents and other mobile elements, about 0.164kg/tonne/yr(±0.02) of the tailings materials are leached yearly. Layer 1 is the most altered.

Keywords: Acid Mine Drainage; Assessment; Prediction; Weathering; Geochemical data; Geochemical mass balance; Multivariate statistics; Contamination

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**Session Classification:** Minerals

**Track Classification:** Oral and Poster Presentation

Contribution ID: 7

Type: **not specified**

## Characteristics of Permian gas-shales in the lower Karoo Supergroup near Jansenville in the Eastern Cape, South Africa

*Wednesday, 1 October 2014 09:55 (15 minutes)*

This is a study on the geochemical and petro-physical properties of shales from the Prince Albert, Whitehill and Collingham Formations of the Lower Karoo Supergroup, near Jansenville in the Eastern Cape. Results are based on two boreholes sited on a southerly dipping limb of a shallowly plunging syncline. Lithological, sedimentological, structural, geochemical and petro-physical analyses provide detail of the characteristics of these rocks which have become the focus of interest for potential shale gas.

Petrographic, XRF, XRD and SEM analyses from black shales of the Whitehill Formation, show that these rocks are composed of quartz, illite, muscovite and chlorite, with lesser plagioclase and accessory pyrite. The Collingham Formation rocks have the largest proportion of quartz content which gives this formation a higher brittleness factor than that of the Prince Albert and Whitehill Formations. Mercury porosimetry analyses yield meso- and macro porosity in black shales of the Whitehill Formation of 0.83%. This confirms that these sediments are tightly packed. Thin layers of dolomite within the shales have porosities of 2.9%, and pores measuring 1.5µm wide.

Total organic carbon content (TOC) and Rock Eval pyrolysis data show that black shales of the Whitehill Formation are high in organic carbon and have an average TOC value of 4.5 wt%. The TOC of shales in the Collingham and Prince Albert Formations is <1 wt%. XRF and (13C and 15N) light stable isotope analyses suggest that the Prince Albert and Whitehill Formations were deposited under anoxic conditions, sourced by a mix of marine and terrestrial organic matter, whereas the Collingham Formation was deposited under more oxidizing conditions.

High maximum temperature values (Tmax average: 528), low hydrogen index values (HI average: 6.7) and high reflectance measurements on bitumen (BRo= 4%) characterise these sediments as overmature. As a consequence pyrolyses and thermovapourization data display few hydrocarbon yields.

The main characteristics of black shales in the study area indicate that their overmaturity with respect to hosting gas deposits is attributed to tectono-metamorphic overprinting during the Cape Orogeny. Rocks of the lower Karoo Supergroup outcropping within the area of the Cape Fold Belt therefore have limited potential for hosting gas deposits.

Keywords: shale gas; TOC; Whitehill Formation; overmaturity

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**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 8

Type: **not specified**

## The vegetation of the proposed Karoo fracking sites and ecophysiological responses of plants to fracking chemicals

*Wednesday, 1 October 2014 11:20 (10 minutes)*

Hydraulic fracturing or fracking is an extraction technique that is used to extract gas from rocks of low permeability. A number of companies have been either applied for, or been granted Exploration Rights for fracking in the Karoo. Shell's application area is in the magisterial districts of Aberdeen, Beaufort-West, Carnarvon, Graaff-Reinet, Middelburg, Murraysburg, Noupoort, Richmond and Victoria-West and covers an area of approximately 30 000 km<sup>2</sup>. Fracking has recently received much publicity due to concerns over the environmental, social, human health and aesthetic risks associated with this unconventional method of gas extraction. The objectives of this study are to survey the proposed fracking areas and evaluate the flora and vegetation of the area, highlighting Species of Conservation Concern. Furthermore, the study will investigate ecophysiological responses of Karoo plants to exposure to fracking fluid, with particular emphasis on phreatophytes. *Boscia albitrunca* (Burch.) Gilg & Gilg-Ben. will be used as a representative of phreatophytes, but examples of all the major life forms in the study area will be used. This study forms part of the AEON-ESSRI Baseline Research Program at NMMU that is undertaking a technical evaluation and socio-economic analyses of shale gas in the Eastern Cape. The area to be affected by fracking contains mostly Albany Thicket and Nama-Karoo and preliminary research indicates a number of Species of Conservation Concern at risk in these areas should fracking go ahead.

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**Session Classification:** Shale Gas

**Track Classification:** Poster Presentation

Contribution ID: 9

Type: **not specified**

## Development of a Solar Power Plant

*Tuesday, 30 September 2014 14:45 (15 minutes)*

South Africa has limited electricity resources and many parts of the country have limited access to electricity. Electricity capacity is at maximum and almost each Giga Watt is accounted for. Predictions suggest South Africa would have a serious electricity allocation problem in the very near future and current rolling blackout in many of our cities can attain to the looming problem. The energy crisis in South Africa has highlighted the need to increase electricity generation capacity and to search for alternative energy sources.

Solar chimney plants could form part of the solution in the near future in South Africa to create additional power. Solar radiation energy is abundant in South Africa, while wind sources are limited to some coastal regions. This study will aim in developing a wind generation system in areas where wind is very low. A solar chimney power plant is expected to provide remote areas in South Africa with electric power, or complementing the current electricity grid.

Research on alternative designs within the South Africa context and particularly on increasing the effectiveness of the solar chimney power plant technology is lacking, therefore this study proposes the development of an alternative solar chimney plant technology which endeavour to improve the effectiveness of the solar chimney power plant.

The outcomes of the simulations have shown that you can generate power if the relative ratio between the height and the inlet aperture of the power plant is optimized. The completed small pilot power plant was used to test the effectiveness of the power plant.

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**Session Classification:** Energy

**Track Classification:** Oral and Poster Presentation

Contribution ID: 10

Type: **not specified**

## Development of a Solar Desalination Plant

*Tuesday, 30 September 2014 15:00 (15 minutes)*

Development of a Solar Desalination Plant

By

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### ABSTRACT

South Africa is considered a water scarce country and water quality is an additional stress affecting available water supply. In the semi-arid to arid regions of the country significant salt loading in groundwater occurs where anthropogenic influences can be excluded. Treatment of these water sources requires desalination. The conventional desalination process requires large amounts of energy, either in the form of waste heat or grid electricity, which are not available in many rural areas in South Africa. However, many rural communities in South Africa that do not have reliable access to clean drinking water are situated in geographical areas where the annual solar radiation levels are high and where saline groundwater is available. The development and optimization of the solar distillation designs had to conform to the project goals of affordability, durability and performance in supplying sufficient volumes of drinking and cooking water, conforming to national health standards. There is a strong argument to use clean energy generation techniques to power desalination plants. The research adopted was largely exploratory and adapted using the limited number of previous studies available. In order to evaluate the effectiveness of the system a simulation of the entire system, including the solar water heating panels and proposed distillation system, was conducted. Although the proposed design was a solar-assisted distillation system, the distillation process could be viewed as a convective heat and mass transfer problem, as in any other distillation processes. The mechanism involves a temperature rise in the water due to absorbed solar energy and heat transfer; in turn the heated water evaporates at the air-water interface which increases the humidity of the air, the humid air is cooled to condense as clean water. This process depends on the water temperature, vapour pressures, initial air humidity and a variety of moist air properties including specific heat capacity, thermal diffusivity, thermal conductance, density and viscosity. The accuracy depends mainly on two temperatures, namely the evaporation and condensation temperatures of a system. The measured evaporation temperature in the reactor and the condensate temperature of the condensation tank throughout an average winter day.

The results revealed that for rural areas not connected to the electricity grid, it is feasible to invest in solar powered desalination systems instead of diesel powered generators. In conclusion the results have provided preliminary novel evidence of the effectiveness in provision of drinking water quality water through combining renewable energy technologies with low cost desalination technology.

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Contribution ID: 11

Type: **not specified**

## INVITED LECTURE: Evolving stress patterns across southern Africa since the end of Gondwana: puzzling clues to the intraplate seismicity of South Africa

*Monday, 29 September 2014 12:00 (30 minutes)*

Once again, after the M5.5 event of 05 08 2014 near Orkney (North West Province) many South Africans wondered whether it was of tectonic origin or mining induced, given the exceptional amount of seismic energy cumulatively released in that area over 50 years. The concept that mining stress includes a natural, tectonic component calls for mining and civil engineers to consider the intensity and orientation of the natural principal compressive stresses ( $\sigma_1 > \sigma_2 > \sigma_3$ ), or at least the maximum horizontal compressive stress ( $\sigma_H$ ) in their operational planning. Unfortunately, much of the African subcontinent is under-represented in the World Stress Map database.

Our consortium is addressing the problem of the scarcity of stress data by steadily unravelling previously unknown Post-Jurassic tectonic episodes in South Africa. We think that this holistic approach offers robust constraints when numerical models are used to duplicate the observed contemporary stress data.

*Palaeostress analysis. Published data for the Vaalputs site in Namaqualand demonstrate that strength and azimuth of  $\sigma_1 > \sigma_2 > \sigma_3$  waxed and waned during the Cretaceous-Palaeocene leading to at least 6 successive, different tectonic regimes. The most robust of these episodes, at ~84 Ma, was compressive, with  $\sigma_1$  oriented NNW-SSE, and probably affected the Waterberg plateau and Karas Mountains of Namibia. We are now studying Cenozoic tectonic events in the Cape Fold belt west of Cape Agulhas, and in the Kaapvaal craton at Bultfontein (NW Free State) and near Douglas (SE Northern Cape). In this area the Dwyka diamictite and the palaeo-Orange gravels are locally tightly co-folded and cut by thrusts with vertical throws of up to ~7m. Present day stress. To monitor and interpret the Grootvloer seismic cluster in the Northern Cape we replaced an obsolete TELS seismic instrument at the Vaalputs site with a compact, broad-band Trillium seismic sensor, and added two 1-sec sensors of the same make at Aggeneyns and Koffiemeul (Bushmanland). The data from these stations will be integrated with those from the national network to obtain the focal mechanisms of the events. These stress tensors are then combined with  $\sigma_H$  parameters obtained from calliper logs of off-shore wells, in situ  $\sigma_1 > \sigma_2 > \sigma_3$  measurements, and geodetic data.*

Our body of data consistently indicates a NNW-SSE oriented  $\sigma_H$  (nicknamed the Wegener Stress Anomaly or WSA) that prevails across most of central, southern and western South Africa and Namibia up to the Angola border. In the Congo basin, however, focal mechanisms of a few earthquakes suggest rotation of  $\sigma_H$  to an E-W direction, whereas  $\sigma_H$  oriented NE-SW prevails in E Mpumalanga, N Natal, and northern Limpopo. These NE-SW orientated  $\sigma_H$  vectors may define the southerly extension of the E African Rift System, whereas the strike-slip to transpressional character of the WSA and the thrust regimes of Mesozoic and Cenozoic age elude an explanation based on existing numerical models.

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Contribution ID: 12

Type: **not specified**

## Development of a D.C. Resistivity Modelling Laboratory for the Simulation of Wenner, Schlumberger and Dipole-dipole Configurations

*Thursday, 2 October 2014 16:45 (15 minutes)*

D.C. resistivity is an active geophysical method that employs the measurement of electrical potential associated with subsurface current flow, generated by a D.C. source. The purpose of any D.C. resistivity survey is to determine the vertical and lateral subsurface resistivity distribution through measurements on the ground surface.

D.C. resistivity is one of the principal electrical methods that have been used for many decades in geohydrological, geotechnical and mining exploration. Due to time constraints for students to go to the field and gain practical experience, a scale modelling tank was designed and developed to simulate the field geology and D.C. Resistivity field operations in a laboratory. This improves the student's study and understanding of the D.C. Resistivity techniques by the means of simulating the field D.C. Resistivity survey within a laboratory.

One modelling tank represents a normal fault and the second tank represents normal layering. The Wenner and Dipole-dipole configurations are simulated to detect the fault and the normal layering. The Schlumberger configuration is used to simulate D.C. Resistivity soundings. The results are processed and interpreted using sounding curves, inversion software and resistivity maps.

Keywords: D.C. resistivity, Wenner Configuration, Schlumberger Configuration, Dipole-dipole Configuration

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**Session Classification:** Rocks

**Track Classification:** Oral and Poster Presentation



Contribution ID: 13

Type: **not specified**

## A geological study of the lower Ecca Group north of Grahamstown, South-East Karoo Basin, South Africa

*Wednesday, 1 October 2014 09:25 (15 minutes)*

The area of study lies in the Eastern Cape, approximately 20km north of Grahamstown, in the direction of Fort Beaufort. The main rock outcrops are along the Ecca Pass and approximately 10km east of the pass, along the Committees Drift Road. The area was chosen as it incorporates an exceptionally well exposed outcrop portraying all the formations of the lower Ecca Group of the SE Karoo Basin in succession. The research aims at documenting the structural and sedimentological characteristics of the lower Ecca Group, with emphasis on the Prince Albert, Whitehill, and Collingham Formations. Geologic cross sections completed to date provide the basis for understanding the 3-D anatomy of the three formations. Facies characterisation and petrographic analysis are still to be undertaken, in order to infer the sedimentary environment of the lower Ecca Group.

The mudstones of the Prince Albert Formation along the Ecca Pass are mostly light coloured (e.g. light yellow brown), and the mudstones along the Committees drift road are mostly darker in colour (e.g. deep green). Open folding is present in the Whitehill Formation along the Ecca Pass and duplex faulting evident in the Prince Albert Formation along the Committees Drift Road. The Collingham Formation comprises of many layers of ash of various tints of yellow. The Ecca Group is thought by some to have been deposited in a large body of water surrounded by land and consists of approximately 2000m of sedimentary rock composed predominantly of rhythmites (comprising of tuff, mudstones, sandstones, and shales). The combined thickness of the Prince Albert, Whitehill, and Collingham Formation is approximately 130m. This makes up about 6.5% of the total thickness of the Ecca Group. These formations contain mostly organic rich shales and lesser tuffaceous and siltstone horizons.

The shales of the Whitehill Formation are of particular interest to exploration companies as a potential reservoir of natural gas, as they are rich in organic content. Fracking in the U.S. has grown over the past decade, as has the wealth of information around the industry. Because of the large scale success in the U.S., many countries including South Africa that have potential shale gas reserves have started exploring for shale gas. There is currently a great deal of speculation as to the amount of shale gas reserves, and exploration is necessary to determine the gas potential.

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**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 14

Type: **not specified**

## Drying effects on mineral surface catalyzed atrazine degradation

*Thursday, 2 October 2014 11:45 (15 minutes)*

Atrazine, a popular herbicide, endocrine disruptor and possible carcinogen, is frequently detected in water systems. Its biodegradation in soils is well documented, but its degradation on soil mineral surfaces is only partially understood. Furthermore, changing global climate and increased temperatures could possibly increase occurrences of extreme drying (evaporation) in soils, a process known to affect various soil mineral surface reactions. Therefore, the first part of this study investigated atrazine degradation on the drying surfaces of Mn-oxide, Fe-oxide, Al-oxide, Al-saturated smectite and quartz. Atrazine degradation appeared to be controlled by surface redox potential, with the extent of degradation being: Mn-oxide (66%) > Fe-oxide (18%) » other surfaces (~ 0%). The only degradation products formed were atrazine-2-hydroxy (A-OH) and atrazine-desethyl (A-DE). In part two, the effect of drying rate on degradation was investigated, by drying moist Mn-oxide-atrazine mixtures under gradual (ambient) drying conditions and rapid drying with an air stream. After 30 days of gradual drying, 90% of the atrazine was degraded, however the same extent of degradation was achieved after only 4 days of rapid drying. In part three, the reaction mechanism was investigated. The same rapid drying experiment was performed under a nitrogen ( $N_2$ ) stream to eliminate oxygen ( $O_2$ ) as possible oxidant. Dissolved  $Mn^{2+}$  was also measured in both rapid drying experiments to detect possible oxidation. No differences were found between air-drying and  $N_2$ -drying in terms of products formed and extent of degradation, with no  $Mn^{2+}$  being formed either. In all experiments, only A-OH and A-DE were formed, and degradation initiated only after drying to a critical gravimetric moisture content of 22%. It was concluded that atrazine was degraded by an overall net non-redox catalysis reaction on drying mineral surfaces, and that this degradation reaction is highly applicable in agricultural soils where extreme drying, due to windrowing/tilling, is possible.

KEYWORDS: atrazine, drying-enhanced degradation, mineral surfaces, catalysis, net non-redox

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**Session Classification:** Minerals

**Track Classification:** Oral and Poster Presentation

Contribution ID: 15

Type: **not specified**

## **A systematic approach to the interpretation of conductivity anomalies recorded with the Geonics EM34-3 electromagnetic instrument across intrusive dolerite dykes and sills in the Karoo Supergroup**

*Thursday, 2 October 2014 16:30 (15 minutes)*

Groundwater exploration has become increasingly dependent on the use of geophysical techniques to gain insight into the subsurface conditions to minimise the risk of drilling unsuccessful production boreholes. Dolerite dykes and sills are often targeted during groundwater exploration programmes in Karoo rocks. Due to the high pressures and temperatures that reigned during the emplacement of these structures, the sedimentary host rocks along the margins of the intrusive structures are typically strongly altered. These altered zones are often heavily fractured and, as a result, have increased hydraulic conductivities as compared to the unaltered host rock. The altered zones often act as preferential pathways for groundwater migration, making them preferred targets during groundwater exploration.

In conjunction with magnetic methods, electromagnetic (EM) methods are the techniques most often used for groundwater exploration in Karoo rocks. In South Africa, the ground EM system most commonly used is the Geonics EM34-3 frequency-domain system. This system has already been in use for a few decades, yet a great deal of uncertainty still remains regarding the interpretation of anomalies recorded over geological structures associated with lateral changes in electrical conductivity. This uncertainty results from the fact that the Geonics EM34-3 system employs measurements of the out-of-phase components of the secondary magnetic field relative to the primary magnetic field to calculate an apparent conductivity for the subsurface. The apparent conductivity profiles across lateral changes in conductivity often do not make intuitive sense.

This project focuses on the development of guidelines for the interpretation of anomalies recorded with the EM34-3 system across intrusive structures of geohydrological significance in Karoo rocks. Geophysical surveys were conducted across known dykes and sills in an attempt to systematically investigate the responses recorded across these structures. Data from magnetic and two-dimensional electrical resistivity tomography surveys, as well as from geological borehole logs in some cases, were used as controls to assist in the interpretation.

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**Session Classification:** Rocks

**Track Classification:** Oral and Poster Presentation

Contribution ID: 16

Type: **not specified**

## **Geotechnical Properties and Foundation Requirements of the Lunar Laser Ranger at Matjiesfontein Space Geodesy Observatory**

*Tuesday, 30 September 2014 14:30 (15 minutes)*

The intention of this project is to investigate and analyse the requirements for the emplacement of the Lunar Laser Ranger (LLR) at the Matjiesfontein Space Geodesy Observatory (MGO). To ensure accurate measurements and pointing to the exact location on the moon the LLR needs a very stable foundation. The foundation of the LLR should be such that it would cushion the smallest movement of the ground. To ensure that the ground on which the 7 ton LLR will be built is stable a complete slope stability analysis needs to be done. This includes investigations for circular slip failure, wedge failure and planar failure. Other slope stability analyses that have been done at the MGO include the area adjacent to the Gravimeter Vault site, a proposed site for the LLR and the proposed site for the main buildings. All of these studies have determined that these areas are safe to circular slip, toppling and wedge failure. The only instability that may occur on the site is possible planar failure if an access road with a cut of 2m is to be made on the northern side of the site. The cut will expose the toe of the inclined quartzitic sandstone that may lead to a failure. A retaining wall was designed for the site where the administrative buildings will be placed to ensure the safety of the building as a cut will be made into the toe of the slope. More detailed analysis will be done to determine the rock properties of the LLR site and to confirm the stability.

The main concern during construction is early thermal shrinkage. Early thermal shrinkage can influence the geometry and dimensions of a structure. The cracks can cause displacement of the LLR and lower the accuracy of the measurements. Various construction risks have to be taken into consideration to ensure smooth operations during construction. A complete risk register will be developed prior to the start of construction operations.

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 17

Type: **not specified**

## **Low-level river crossings and erosion repair of the access road for general ease of access and secure transportation of the Lunar Laser Ranger and Radio Telescope equipment to the Matjiesfontein Space Geodesy Observatory**

*Tuesday, 30 September 2014 14:15 (15 minutes)*

The Matjiesfontein Space Geodesy Observatory will be home to large and sensitive high-tech instruments which ought to be carefully transported to the observatory. The access road to and on the site itself intercepts five drainage channels and there are currently no existing structures to allow for safe and reliable passage. Three low-level river crossings were designed to withstand 1:20 year floods in order to grant access to heavy vehicle traffic for delivering the instruments securely and for hauling material during construction. Seasonal runoff is further responsible for a fair amount of erosion to the road itself, causing damage to an extent such that access to the site per normal light vehicle is practically impossible. Recommendations are made for the repair of the road that would also allow access to regular staff once the observatory is in operation. The problem is receiving further attention currently with the aim of implementing a final gravel road design with special consideration to sufficient side drainage. In addition to the Lunar Laser Ranger, two 34m diameter NASA Radio Telescope antennas will also require cautious transportation to the site. Appropriate foundations will need to be designed to ensure exceptional stability of the structures, as they need to point accurately at distant celestial objects, survive high wind speeds and resist any seismic activity. The antennas will be used for conducting geodetic Very Long Baseline Interferometry (VLBI) experiments, among others. This is the only long distance technique in earth observation to present the absolute orientation of the earth in an inertial coordinate system to high accuracy (Clark, 2003). The instruments would also have to be undisturbed in the case of disastrous events such as possible landslides, flooding etc. These events will be analyzed and the optimum locations on site will be determined and identified for installing each of the structures.

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 18

Type: **not specified**

## Quantifying groundwater-surface water exchange fluxes based on steady state riparian area aquifer water balance

*Thursday, 2 October 2014 14:45 (15 minutes)*

The aim of this study was to perform a riparian area aquifer groundwater budget with an objective to estimate water exchange fluxes at an ungagged Modder River groundwater-surface water interaction research site. The study was based on the conceptual and quantitative knowledge on hydrogeological-landscape units, recharge to the riparian-area-aquifer, groundwater evapotranspiration, influx from terrestrial-area-aquifer and change in groundwater storage of the riparian-area-aquifer. Using heat pulse velocity method, the riparian evapotranspiration was estimated as 15.15 Mm<sup>3</sup>/month. For the southeastern side terrestrial-area-aquifer, the slope of groundwater table was estimated to approximately be 0.042 with the transmissivity of about 91.73 m<sup>2</sup>/month. The aquifer width was estimated to be 3000m; subsequently, influx from the terrestrial-area-aquifer into the riparian-area-aquifer was computed to be 235.68 Mm<sup>3</sup>. On the northwestern terrestrial-area-aquifer, the slope of groundwater table was estimated to approximately be 0.041 with the transmissivity of about 1.44 m<sup>2</sup>/month. With similar average aquifer width, influx from the terrestrial-area-aquifer into the riparian-area-aquifer was approximated to be 6.71 Mm<sup>3</sup>. Change in storage was approximated to be -18087.15 m<sup>3</sup>/month for the southeastern riparian-area-aquifer and 5166.45 m<sup>3</sup>/month for the northwestern riparian-area-aquifer. Using the soil moisture balance model, the average annual recharge computed for the riparian-area-aquifer was approximately 8.67 mm. Subsequently baseflow was estimated for the southeastern reach to be 220.54 Mm<sup>3</sup>/month and -8.45 Mm<sup>3</sup>/month for the northwestern reach using a groundwater budget model.

Keywords: Modder River, Riparian-area-aquifer, Terrestrial-area-aquifer, Groundwater budget, Baseflow

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**Session Classification:** Water

**Track Classification:** Oral and Poster Presentation

Contribution ID: 19

Type: **not specified**

## Light bending General Relativity test during the forthcoming March 2015 total solar eclipse

*Monday, 29 September 2014 14:40 (20 minutes)*

According to Einstein's General Theory of Relativity (GRT), spacetime curvature in the vicinity of a large mass such as the Sun will cause light to bend. The measurement of light from stars close to the Sun during a total solar eclipse provides an opportunity to test this light bending, thus evaluating GRT. During 1919, Eddington performed such an experiment, obtaining results which supported the GRT concept, catapulting Einstein into fame. The last documented experiment of this nature was performed in 1973, by the University of Texas, also producing reasonably convincing results. All of these test were conducted using long focal length telescopes, equipped with photographic plates. Light bending due to spacetime curvature is an effect which must be compensated for in space geodetic measurements.

Here we propose another light bending experiment, but performed with a dual refractor telescope, equipped with a CMOS and CCD camera. A totally different observation strategy is proposed, where instead of capturing an image of the Sun and its immediate surrounds, selected star fields will be captured, and differential astrometry will be used to determine the apparent displacement of stars. Using this approach, we hope to capture a larger number of stars. Combining this with the higher sensitivity of the CCD and CMOS cameras, as well as by using modern astrometric software, we expect more accurate results to be obtained than before.

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**Session Classification:** Supervisor Talks

**Track Classification:** Oral Presentation

Contribution ID: 20

Type: **not specified**

## Catechol oxidase activity of Bis(pyridinonato)copper(II) complexes

*Thursday, 2 October 2014 11:30 (15 minutes)*

Pseudo first order oxidation of 3,5-di-tert-butylcatechol under aerobic conditions to 3,5-di-tert-butylquinone. The process was catalyzed by square planar Cu(II)(naltol)<sub>2</sub> complexes. The aim of this study was to imitate the activity and behaviour of the enzyme catechol oxidase by employing copper nano molecular materials, and to investigate electronic and steric effects on this catalytic oxidation process. A credible selection ensured that factors such as the effect of electron donating groups on ligands, steric bulk of the complexes, etc. could be investigated. Structural data revealed that all the 3-hydroxypyrid-4-one ligands which were synthesized were all in the keto-enol tautomeric form in the solid state. Furthermore in all the cases where a clear packing order was observed, weak hydrogen bonding is present. These interactions result in the formation of dimers, which stabilizes the structures. This data also indicated a C=O bond length increase with increasing electron donation in the synthesized O,O'-bidentate ligands systems. The synthesized copper complexes were planar with slight deviations from planarity and the copper atoms lie on inversion centers. These complexes exhibit strong intramolecular hydrogen interactions. The solution study results suggest that the complex with the least electron donating group on the ligand was the most effective catalyst; however, the same complex was coincidentally the most sterically demanding complex in the study. As the catechol oxidase is a macro-molecule which is very sterically crowded, the data suggests that steric effects play an important role in the catalytic process and this was successfully demonstrated at a small-molecular level of detail via solution modelling experiments.

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**Session Classification:** Minerals

**Track Classification:** Oral and Poster Presentation



Contribution ID: 21

Type: **not specified**

## Estimating the decant rate at a rehabilitated opencast mine where net groundwater inflow occurs

*Monday, 29 September 2014 14:20 (20 minutes)*

The expected decant rates at rehabilitated opencast pits are usually estimated by simply assuming a high recharge value (15% - 20% of the mean annual precipitation) through the spoils. This approach is based on the assumption that the inflow volumes of groundwater are balanced by the outflow volumes. However, using this standard approach for decant estimation at the mine under investigation yielded an estimate for the decant rate that was significantly smaller than the volumes of water dealt with on a daily basis at the mine. This observation suggested that either the recharge value used in the estimation of the decant rate was much too small, or the assumption of zero net groundwater inflow was wrong.

Non-zero net groundwater inflow to the pits would imply the presence of preferential pathways for groundwater flow connected to recharge areas at elevations higher than the water levels in the pits. Such preferential pathways are usually associated with geological structures such as faults or dykes. To investigate the possibility of non-zero net groundwater inflow to the pits, a magnetic survey was conducted at selected positions along the boundaries of the pits to detect the possible presence of magnetic dykes acting as, or associated with, preferential pathways. Groundwater levels in the vicinity of the pits and pit water levels were measured to evaluate the hydraulic head gradients driving groundwater flow. Information on the water levels at voids within the pits, as well as the pumping rates between the voids, was used in conjunction with measured rainfall data and estimated evaporation rates to obtain an independent estimate of the expected decant volumes. The presence of at least one prominent dolerite structure intersecting one of the pits was revealed by the magnetic survey. Groundwater levels in boreholes intersecting this structure were found to be more than 10 m higher than the ambient groundwater levels and pit water levels, confirming groundwater inflow into the pits along this structure. A water balance calculated from the measured water levels in the voids and pumping rates allowed estimation of the net groundwater inflow volume.

The results of the investigation show that incorrect estimates of the decant rates at rehabilitated opencast pits may result if the possibility of net groundwater inflows is not considered and investigated.

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**Session Classification:** Supervisor Talks

**Track Classification:** Oral Presentation

Contribution ID: 22

Type: **not specified**

## **Impact of long-term effects of wheat production management practices on soil acidity, P and some micronutrients in a semi-arid Plinthosol**

*Thursday, 2 October 2014 12:45 (15 minutes)*

Farmers continuously remove crop residues for use as building materials, fuel and animal feed or bedding as well as to avoid difficulties during tillage operations. Therefore, demonstrations of the benefits of recycling crop residues are necessary. The aim with this study was to evaluate the influence of different wheat production management practices on acidity and some essential nutrients from a long-term trial on a Plinthosol in semi-arid South Africa. The trial was set up in 1979, and since then two methods of straw management (unburned and burned), three methods of tillage (no-tillage, stubble mulch, and plough), two methods of weed control (chemical and mechanical), and three levels of nitrogen (N) fertilizer (20, 40 and 60 kg ha<sup>-1</sup>) have been applied. Soil samples were collected in June 2010 at depths of 0–50, 50–100, 100–150, 150–250, 250–350 and 350–450mm from plots that received 40 kg N ha<sup>-1</sup> and were analyzed for pH, phosphorus (P), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn). Results obtained showed that straw burning resulted in higher P and Mn but lower Cu than no-burning. No-tillage, and to some extent stubble mulch, suppressed soil acidification and increased P and Zn compared with ploughing, especially in the surface layers where crop residues accumulate. In contrast, mouldboard ploughing and stubble mulch increased Cu more than no-tillage, possibly due to the strong affinity of organic matter for Cu. Tillage effects on Mn were inconsistent and difficult to explain. Chemical weeding also improved P, probably because of the pesticide application, but resulted in lower pH and Cu values compared with mechanical weeding. Treatment combinations also had an influence on P and, to a lesser extent, on soil pH and Cu, which might be due to the higher organic matter present in no-tilled soils. Irrespective of straw management or weed-control methods, no-tillage resulted in higher P than did ploughing and stubble mulch. Nutrient concentrations and pH values were sufficient for wheat growth under all treatments. However, although the nutrients were highest under straw burning, no-tillage and, to some extent, stubble mulch, wheat yield was higher with unburned straw and mouldboard ploughing. Therefore, an integrated approach from various disciplines is recommended to identify and rectify yield-limiting factors under conservation tillage systems.

**KEYWORDS:** nutrients, soil pH, straw management, tillage, weed control

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**Session Classification:** Food and Life

**Track Classification:** Oral and Poster Presentation

Contribution ID: 23

Type: **not specified**

## An investigation of possible augmentation of water from groundwater resources to Mangaung (Part 2)

*Thursday, 2 October 2014 14:30 (15 minutes)*

The purpose of this study is to investigate the possible use of groundwater to augment the water supply to the Mangaung Municipality in the Free State Province of South Africa. The municipality is at present experiencing water shortages; as a result the State is currently spending large amounts of money to buy water from Lesotho.

Bloemfontein (the Dutch word meaning 'Fountain of Flowers') is the capital city of the Free State Province and the major urban area within the Mangaung Municipality. The city is named after a strong spring discovered in 1828 by Johannes Nicolas Brits. In 1950, a certain Mr. Norman investigated the geological setting of the spring and proposed the theory that the spring was associated with an intrusive ring dyke, which he referred to as a barrier reef.

Bloemfontein is underlain by rocks of the Beaufort Group of the Karoo Supergroup. The rocks of the Beaufort Group predominantly consist of sandstones, mudstones and siltstone. During the Jurassic period, these sedimentary rocks were extensively intruded by dolerite magmas in the form of sills and dykes. From a geohydrological perspective, the intrusions are often associated with the presence of groundwater due to the fact that host sedimentary rocks were significantly altered by the high temperatures and pressures that prevailed during the intrusion of the magmas. The altered sedimentary rocks along the contact zones with the intrusive structures are typically heavily fractured and prone to undergo weathering. These zones often act as preferential pathways for groundwater migration due to their increased hydraulic conductivities caused by the fracturing.

The current study focuses on investigating the potential of the ring dyke as a structure along whose boundaries high-yielding boreholes may be drilled. As part of the study a hydrocensus was conducted to identify existing high-yielding boreholes possibly located in the vicinity of the ring dyke. Geophysical surveys were conducted across the expected location of the ring dyke in various areas within the city limits where the surface infrastructure allowed such surveys. The purpose of the geophysical surveys was to gain insight into the structure of the dyke and its relation to potential groundwater resources. The magnetic and two-dimensional electrical resistivity tomography techniques were used during the survey.

As part of the current study, boreholes will be drilled at suitable locations as determined from the geophysical surveys. Aquifer tests will be conducted on the newly installed boreholes to determine the hydraulic parameters of the intersected aquifer(s) and to estimate the sustainable yields of the boreholes. Groundwater samples from the boreholes will be submitted for chemical analyses to determine the quality of water and its suitability for municipal supply.

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**Session Classification:** Water

**Track Classification:** Oral and Poster Presentation

Contribution ID: 24

Type: **not specified**

## **Biomarker records of environmental changes and their climatic inferences in Mfabeni Peatland (South Africa) since the late Pleistocene**

*Thursday, 2 October 2014 13:00 (15 minutes)*

Southern Africa is situated at a dynamic junction between tropical, subtropical and temperate climate systems, which are subject to seasonal excursion in the Inter Tropical Convergence Zone (ITCZ) and sea surface temperature (SST) gradients between the two regional oceans. As a consequence of topography and semi-arid climate, there is a lack of continuous terrestrial climate archives in the region and therefore, uncertainty prevails over how terrestrial ecosystem responded to past climate fluctuations and their dominant forcing mechanisms. The literature consists of limited terrestrial climate archives that rarely extend past the last glacial maximum (LGM) and those that do, tend to suffer from temporal discontinuities, dating uncertainties and are geographically clustered, resulting in ambiguity. In this study, we employed biomarker proxies extracted from the Mfabeni Peatland, KwaZulu Natal, South Africa, which returned a basal  $14\text{C}$  age of c. 47 kcal yr BP, positioning it as one of the oldest continuous coastal peatlands globally. This unique peat archive allowed us to reconstruct organic matter sources, palaeohydrology and diagenetic conditions on the eastern coastline of Southern Africa using molecular (alkane and fatty acid) distributions, and compare these palaeoenvironmental signals to other regional climate records. A significantly negative correlation was observed with Paq versus ACL and CPI alkane proxy trends, while peatland diagenesis and organic matter source indicators (TOC versus saturated / unsaturated fatty acids and Paq versus Pwax, respectively) showed similar trends to Indian Ocean marine core SST and continental rainfall runoff trends. Therefore, we postulate that the local plant assemblages responded more strongly to moisture availability than temperature fluctuations, and the regional climate was dominated by the Indian Ocean SST, as opposed to insolation fluctuations, during the late Pleistocene and Holocene.

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**Session Classification:** Food and Life

**Track Classification:** Oral and Poster Presentation

Contribution ID: 25

Type: **not specified**

## Optical configuration and optical tests of the HartRAO Lunar Laser Ranger

*Tuesday, 30 September 2014 12:00 (15 minutes)*

The Hartebeesthoek Radio Astronomy Observatory, in collaboration with the Observatoire de la Côte d'Azur (OCA) and NASA are developing a dual Satellite/Lunar Laser Ranging system in South Africa. This project will strengthen the International Laser Ranging Service network and limit the biases caused by the under representation of satellite and lunar laser ranging in the Southern Hemisphere. The new system will be designed and developed as a permanent lunar laser ranging system with high precision laser and electronic equipment to achieve millimetre accuracy. The telescope used is a 1-m Classical Cassegrain donated by OCA. Limited technical details of the telescope exist so tests need to be conducted to determine the optical characteristics and performance of the telescope. Optical testing will determine parameters such as the reflectivity, focal lengths, radii of curvature, aberrations in the mirrors and the overall quality of the optical system. The primary mirror and its support structure will both be analysed by finite element analysis software to determine gravitational distortion. Taking into account the mirror weight, thickness and glass type, we can determine the deformation error of the mirrors and see how that affects the image quality of the telescope. Based on the RMS wavefront variation over the optical surface, estimation can be made on how good the mirror was figured. The accuracy of the technique will be verified once the optical quality of the system has been established through a star test. A mirror of high quality should yield a surface accuracy of approximately 25 nm rms. A coudé path will be created by directing a laser beam into and through the telescope via a connecting tube and a set of reflective mirrors. A high quality mirror will mean minimal loss of light in each reflection through the coudé optical path. We report on progress to date and describe the tests conducted and instruments built.

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 26

Type: **not specified**

## Variable link equation parameters and expected photon returns for the HartRAO Lunar Laser Ranger

*Tuesday, 30 September 2014 11:45 (15 minutes)*

The HartRAO Lunar Laser Ranger (LLR) system requires a state-of-the-art software tool that enables optimal efficiency and signal path parameter estimation. The existing link budget equation estimates the number of return photons for given conditions and LLR system parameters. This equation is one of the essential mathematical tools that can be considered when developing an integrated system and model for the LLR. The mathematical tool, still under development at HartRAO, can be used to estimate and visualise the relationship between the returned number of photons (observed and computed) and the varying link budget equation parameters. In this work, it is used to indicate “worse and best” parameter values which influence the return signal, presented as an estimate of expected number of returned photons for the HartRAO station. This is all done to achieve optimal efficiency in the LLR signal path in order to yield an improvement in the return-energy of the laser so that ranges to the corner cube retro-reflectors can be measured accurately. The geographic position of the HartRAO station, new state-of-the-art HartRAO LLR system under development and the expected number of returned photons will enable HartRAO to play a key role in improving the ranging accuracy to a sub-centimetre level. This will enhance the current effort to determine highly accurate Earth-Moon distances for various scientific purposes.

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 27

Type: **not specified**

## **The use of chemostratigraphy and geochemical vectoring as an exploration tool for platinum group metals in the Platreef, Bushveld Igneous Complex, South Africa: A case study on the Sandsloot and Overysel farms**

*Thursday, 2 October 2014 09:45 (15 minutes)*

The paucity of geochemical criteria for stratigraphic correlations and defining the styles of mineralisation pose serious problems in locating PGE-rich zones in the Platreef. This study is therefore aimed at identifying and appraising process-based mineralogical/ geochemical criteria which may be useful in stratigraphic correlations and characterizing the nature and styles of PGE mineralisation. In addition, the work investigated the possible use of geochemical vectoring as a tool to locate the PGE-rich zones. Boreholes OY 482 and SS 330, drilled at the Overysel and Sandsloot farms respectively, were logged, and a total of 119 quarter cores were sampled for petrographic studies. The elemental contents in the rocks were determined by XRF and ICP-OES analyses and were evaluated using various statistical and mass balance techniques.

In borehole OY 482, where the floor rock is Archaean granite, the Platreef consists of three feldspathic pyroxenite sills referred to as Lower, Middle and Upper Platreef units, from the bottom to the top, respectively. The results show that the Lower and Upper Platreef units have higher median values of Mg# (0.58 and 0.57) and Ni/Cu (0.68 and 0.75) when compared to the Middle Platreef (Mg#: 0.54 and Ni/Cu: 0.67) which may not be totally suggestive of two magmatic intrusive pulses. In borehole SS 330, where the floor rock is dolomite, the rocks consist of clinopyroxenites and olivine clinopyroxenites (variably serpentinised). These two units are intercalated with each other and are products resulting from the injection of Platreef magma sills within the dolomite floor rock.

The hierarchical clustering and mass balance calculations show that when compared to the Platreef feldspathic pyroxenites, which have higher SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> median contents, the clinopyroxenites possess higher CaO median content whereas the olivine clinopyroxenites have higher MgO and LOI median contents. The PGE-rich zones (i.e. Pt+Pd) in clinopyroxenites are marked by low Ca/Mg median values, whereas in both, the olivine clinopyroxenites and the Platreef units, these zones are marked by high Mg/Fe median values.

The suggested base metal index  $[(Cu/Zn) \times (Ni/Co)]$  used to vector towards PGE-rich zones, which reflects the presence of the base metal sulphides (BMS), correlates with the Pt+Pd in the BMS-rich zones. This is not always the case in zones of low BMS contents which may reflect changes in the mineralogy of the BMS.

In conclusion, the two boreholes studied show contrasting petrographic and geochemical attributes. This dissimilarity is mainly due to the fact that borehole OY 482 comprises Platreef magmatic rocks whereas borehole SS 330 intersected metamorphic/ metasomatic rocks.

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**Session Classification:** Minerals

**Track Classification:** Oral and Poster Presentation

Contribution ID: 28

Type: **not specified**

## Implementation and design of a web-based GNSS data management system at Hartebeesthoek Radio Astronomy Observatory (HartRAO)

*Tuesday, 30 September 2014 12:45 (15 minutes)*

The Space Geodesy Programme of the Hartebeesthoek Radio Astronomy Observatory (HartRAO) is actively engaged in improving the African Earth and ocean monitoring network by installing stations across the Sub-Saharan regions. This forms part of the drive to monitor different geophysical parameters via denser networks and with increasing accuracies, as to better our understanding of the Earth system. The instruments being deployed include Global Navigation Satellite Systems (GNSS) reference stations, tide-gauges, seismic stations and meteorological units.

The Space Geodesy Programme has four main space geodetic techniques collocated at HartRAO, making it a true fiducial site. These techniques are Global Navigation Satellite Systems (GNSS), Satellite Laser Ranging (SLR), geodetic Very Long Baseline Interferometry (VLBI) and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS). This fiducial site acts as a reference for the data received from the network of instruments located elsewhere.

It is important to avail all the collected raw scientific data as well as the derived data products, in a user friendly manner, to both the scientific community and general public for research and educational purposes.

As part of ensuring data integrity a new data management system needs to be implemented at HartRAO. This project focuses on implementing the GNSS sub-section of this data management system. Data are required to be quality checked for errors, reworked into a specific format, and made available in near real-time. We present a model for the GNSS data management system, where all the archiving, station monitoring, pre-processing and processing of the raw data are automated. Furthermore, an automated system to produce GNSS data products such as Precipitable Water Vapour (PWV), positional time-series plots and quality check outputs are presented. These data products are then visualized utilising an interactive web-based map.

Keywords: GNSS, VLBI, DORIS, SLR, PWV, data management

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 29

Type: **not specified**

## **INVITED LECTURE: The Role of the Geoscientist in the quest for energy resources in South Africa**

*Monday, 29 September 2014 11:30 (30 minutes)*

Energy in South Africa is a hot topic. Years of underinvestment by the State Utility ESKOM has lulled the country into a false sense of security during the years of cheap electricity only be rudely awakened by the annual price hikes leaving the economy reeling.

While mines, smelters and other industries have the upward pressure to grow, the limited supply of energy has prevented many from doing so. On the contrary, agreements with large electricity consumers have yielded a reduction in electricity consumption by these users implying a reduction in productivity.

The search for alternative energy resources is on. Solar panel farms are being built in the Northern Cape, wind farms are planned in various parts of the country and of course there is shale gas.

Shale gas has been exploited in various parts of the world with good results. The Netherlands have been on a gas bubble for decades and in the USA the amount of gas available today is such that export of shale gas is now a serious consideration.

What are the lessons we must learn from the shale gas revolution? What is the role of the geoscientist in this context? Is there a role beyond the exploration usually done by us? What is the information the legislature needs to make informed decisions and should we/you as geoscientists get involved with this aspect of the energy debate?

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**Presenter:** Prof. VAN BEVER DONKER, Jan (University of the Western Cape)

Contribution ID: 30

Type: **not specified**

## Seismic vault construction and challenges; HartRAO and Klerefontein

*Friday, 3 October 2014 10:00 (15 minutes)*

The National Academic Co-located Seismology Network is a collaborative project between Hartbeesthoek Radio Astronomy Observatory (HartRAO) and Tshwane University of Technology (TUT) whereby at least twelve seismic stations are to be built across South Africa, Marion and Gough islands. These stations are to continuously monitor real-time seismic events for scientific use and seismic risk determination.

Before construction of each station various parameters need to be carefully considered: a geological survey of the site and the civil engineering design that will suit this geology, to cater for different environmental conditions. It is best for a seismic station to be located on bedrock, so as to ensure good coupling between instrumentation and the local geology.

An underground vault was constructed at HartRAO utilizing precast chamber sections: these sections are engineered to withstand the pressure of overburden safely.

The construction at Klerefontein is to have a similar design as at HartRAO with the main difference being the excavation process. Due to the shallow bedrock, the vault can be constructed at a site where it can be partly buried. The structure is to be placed directly on the surface and boulders of rock will be added around the structure to create a small man-made hill, blending with the local environment and effectively burying the vault. Klerefontein is a challenging site as it is remote and there is no easy access to building material and earth-working machinery.

The construction process and challenges experienced with the HartRAO vault will be discussed, together with an overview of anticipated construction steps and challenges at Klerefontein.

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**Session Classification:** Strain

**Track Classification:** Oral and Poster Presentation

Contribution ID: 31

Type: **not specified**

## The Seismicity of the Eastern Cape Province

*Friday, 3 October 2014 09:45 (15 minutes)*

One of the fundamental requirements to the study and understanding of seismicity in any region is through the accurate location of earthquakes within the area of interest, determining spectral parameters and seismic moments. The principle aim of this study is re-evaluating the phase readings and location of the instrumentally recorded earthquakes in the Eastern Cape Province of South Africa during the period 1980 to 1989. The basis of this research was formed from the earthquake bulletins compiled from routine seismic analysis. These bulletins in principle consist of phase information (most often body-wave travel-time readings) observed at different seismological stations. These observations are then reduced to earthquake locations (epicenters).

The phase readings mentioned above are detected from the seismic stations built in an area depending on how quiet the local conditions are, the lower the background noise from human and natural resources such as traffic, the more likely the station will be able to detect earthquake signals. The phase information was typed in as digital record, to re-locating the event using the SEISAN earthquake analysis software.

In the Eastern Cape I entered phase readings from registered local and regional earthquakes manually and relocated the events from the existing phase reading data. Using this program you are able to search the data base for particular events without extracting the events. In addition, secondary seismic phases will be determined through a ray-tracing technique to better restrain earthquake depths in the region. A uniform magnitude scale will be adopted and the focal mechanism of the largest earthquakes determined where sufficient phase readings are available. The resulting database will be used to ascertain whether the recorded seismicity can be related to existing geological lineaments and tectonics in the Eastern Cap

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**Session Classification:** Strain

**Track Classification:** Oral and Poster Presentation

Contribution ID: 32

Type: **not specified**

## The Seismicity of the Eastern Cape Province

*Friday, 3 October 2014 09:30 (15 minutes)*

The most important requirements to the study and understanding of seismicity in any region is through the accurate location of earthquakes within the area of interest. Earthquake bulletins compiled from routine seismic analysis basically forms the basis of this research. These bulletins in principle consist of phase information (most often body-wave travel-time readings) observed at different seismological stations. These observations are then reduced to earthquake locations (epicenters). The principle aim of this study is re-evaluating the phase readings and location of the instrumentally recorded earthquakes in the Eastern Cape Province of South Africa during the period 1970 to 1979.

The phase readings mentioned above are detected from the seismic stations built in an area depending on how quiet the local conditions are, the lower the background noise from human and natural resources such as traffic, the more likely the station will be able to detect earthquake signals. The phase information was typed in as digital record, to re-locating the event using seisan earthquake analysis software.

In the Eastern Cape I used local and regional earthquakes to enter phase readings manually locating events, editing events, azimuth of arrival from a single component stations and plot epicenters. Using this program you are able to search the data base for particular events without extracting the events. In addition, secondary seismic phases will be determined through a ray-tracing technique to better restrain earthquake depths in the region. A uniform magnitude scale will be adopted and the focal mechanism of the largest earthquakes determined where sufficient phase readings are available. The resulting database will be used to ascertain whether the recorded seismicity can be related to existing geological lineaments and tectonics in the Eastern Cape.

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**Session Classification:** Strain

**Track Classification:** Oral and Poster Presentation

Contribution ID: 33

Type: **not specified**

## Development of an integrated timing and photon detection system for the HartRAO Lunar Laser Ranger

*Tuesday, 30 September 2014 12:30 (15 minutes)*

The Hartebeesthoek Radio Astronomy Observatory (HartRAO) in South Africa is currently developing a Lunar Laser Ranger (LLR) system in collaboration with the Observatoire de la Côte d'Azur (OCA) and NASA. The station will improve the current LLR network, especially in the Southern Hemisphere; this station will also contribute towards our current understanding of fundamental physics and the Earth-Moon system. To better understand the Earth-Moon system, the measurements made by the station are required to be at sub-centimetre accuracy levels.

Timing and photon detection systems are fundamental components which can affect the accuracy of the measurements. We present a design of the timing and photon detection system for the LLR station. The design is modular and will allow addition of Satellite Laser Ranger (SLR) capability at a later stage. The preliminary design indicates that the timing sub-system will achieve picosecond-level (ps) timing resolution with an Allan deviation of  $4 \times 10^{-11}$  at 1 second and a drift rate of  $1 \times 10^{-12}$  per 24 hours. The expected random error contributions by the photon detection systems for LLR and SLR are  $\sim 200$  ps RMS and  $\sim 52$  ps RMS per photon respectively, if maximum errors are considered. These errors translate to  $\sim 30$  mm and  $\sim 8$  mm single shot for LLR and SLR respectively. These errors are introduced by electronic instabilities, thermal variations and jitter during ranging. Statistical effects during the computation of a normal point (an averaged number of single shots) reduce these errors significantly.

Implementation of the proposed timing and photon detection systems will contribute towards high accuracy measurements at sub-centimetre level.

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 34

Type: **not specified**

## Diversity of invertebrates in temporary water bodies of the Eastern Cape Karoo region earmarked for shale gas exploration

*Wednesday, 1 October 2014 11:20 (10 minutes)*

Temporary freshwater bodies (endorheic pans) are facing a variety of disturbances including hydrological modifications, filling up with substrate and invasion by vegetation. These impacts have collectively resulted in loss of ecological value and habitat for invertebrate communities which utilise these transient ecosystems. Historically, the water bodies of the Karoo semiarid region have been poorly investigated. It is likely that they contain several invertebrate species that are still unknown to science and potential micro-endemics restricted to small isolated areas. Resource use by human communities (such as the proposed shale gas exploitation in the Karoo, water drawing for agriculture and domestic use) is without knowledge of the effects of these activities on community dynamics of invertebrate species in these temporary water bodies. Understanding of invertebrate species ecology, i.e. life history, population size and distribution as well as knowledge of the social component that interacts with this environment are fundamental requirements for the design and implementation of effective conservation strategies. We therefore need to understand the effect of the duration of hydroperiod, physicochemical parameters, dispersal patterns, system connectivity and anthropogenic influence so as to come up with measures to sustainably utilise and conserve these systems. The study will address the following objectives;

- 1.To establish the diversity of invertebrate communities in the temporary water bodies (pools & streams) in the Eastern Cape Karoo region
- 2.To determine the physical and chemical factors that structure invertebrate communities in the ephemeral water bodies.
- 3.To determine the dispersal vectors for invertebrates in the ephemeral communities.
- 4.To determine the effect of the hydroperiod on ephemeral invertebrate communities, with emphasis on production of resting stages.
- 5.To synthesise gathered information so as to establish baseline knowledge to be used as benchmark for monitoring and conservation once shale gas exploration begins.

The study findings will generate scientific data and provide baseline information that will guide future monitoring and management processes, should shale gas extraction eventually happen in the region.

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**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation



Contribution ID: 35

Type: **not specified**

## **Pore pressure prediction of some selected wells; Insight from the Southern Pletmos, Bredasdorp basin, Offshore South Africa**

*Thursday, 2 October 2014 15:00 (15 minutes)*

An accurate prediction of pore pressure is an essential in reducing the risk involved in a well or field life cycle. This has formed an integral part of routine work for exploration, development and exploitation team in the oil and gas industries. Several factors such as sediment compaction, overburden, lithology characteristic, hydrocarbon pressure and capillary entry pressure contribute significantly to the cause of overpressure. Hence, understanding the dynamics associated with the above factors will certainly reduce the risk involved in drilling and production. This study examined three deep water drilled wells GA-W1, GA-N1, and GA-AA1 of lower cretaceous Hauterivian to early Aptian age between 112 to 117.5 (MA) Southern Pletmos sub-basin, Bredasdorp basin offshore South Africa. The study aimed to determine the pore pressure prediction of the reservoir formation of the wells. Eaton's resistivity and Sonic method are adopted using depth dependent normal compaction trendline (NCT) has been carried out for this study. The variation of the overburden gradient (OBG), the Effective stress, Fracture gradient (FG), Fracture pressure (FP), Pore pressure gradient (PPG) and the predicted pore pressure (PPP) has been study for the selected wells. The overburden change slightly as follow: 2.09g/cm<sup>3</sup>, 2.23g/cm<sup>3</sup> and 2.24g/cm<sup>3</sup> across the selected intervals depth of wells. An accurate mud-weights of 1.98g/cm<sup>3</sup>, 2.12g/cm<sup>3</sup> and 2.6g/cm<sup>3</sup> are observes for the wells which are within the ranges of least mud-weights constant value (200psi/0.461 g/cm<sup>3</sup>) at hydrostatic level required in drilling hole to avoid loss of circulations or kicks. The predicted pore pressure calculated for the intervals selected depths of wells GA-W1, GA-N1 and GA-AA1 also varies slightly down the depths as follow: 3,405 psi, 4,110 psi, 5,062 psi respectively. The overpressure zone and normal pressure zone was encountered in well GA-W1, while normal pressure zone was experienced in both well GA-N1 and GA-AA1.

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**Session Classification:** Water

**Track Classification:** Oral Presentation

Contribution ID: 36

Type: **not specified**

## Geotechnical investigations at Matjiesfontein Space Geodesy Observatory for the emplacement of geodetic and geoscience instruments

*Tuesday, 30 September 2014 14:00 (15 minutes)*

The donation of a 1 m Cassegrain telescope by France to HartRAO facilitated the development of a combined Satellite and Lunar Laser Ranger (S/LLR). The S/LLR will be located at Matjiesfontein, South Africa and will be collocated with a gravimeter, seismograph and a Global Navigation Satellite Systems (GNSS) receiver. In addition to the mentioned instruments, the site could be considered for the installation of two 34 m dishes as part of the NASA Deep Space Tracking Network. These dishes may be suitable for International Celestial Reference Frame VLBI experiments. The possible future installation of a DORIS system will further enhance satellite tracking and orbit calculations.

Geotechnical properties of the terrain at Matjiesfontein are of crucial importance for the stability of these instruments as they should be anchored to firm bedrock. This will allow the measurement of the Earth's crust and allow precise orbit and range determination. The LLR is designed to achieve sub-cm accuracy ranges from Earth to the retro-reflectors placed on the lunar surface during the Apollo and Lunokhod era. Geotechnical work undertaken at the designated Matjiesfontein site includes measurements of the strength of materials, slope stability, road design and excavation depth. An accurate 3D model (within 10 cm) of the terrain is also being created through the collection of high density height measurements with the use of GPS instruments.

Investigations also include appropriate placement of administrative buildings, sewerage tank placement and installation and distribution of services such as access, water, electricity and potential future communication lines such as fibre-optic cable. The access road to the site is severely eroded and an appropriate design inclusive of low level river crossings will be done based on predicted future use. An environmental impact assessment is currently underway and should be completed by the year end. Here we report on the progress to date and provide an outline of future work to be done.

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 37

Type: **not specified**

## **Petrological investigation of Merensky Reef Unit lithologies at Two Rivers Platinum Mine and comparison to stratigraphically similar rocks north of the Steelpoort fault, eastern Bushveld Complex, South Africa**

*Thursday, 2 October 2014 10:15 (15 minutes)*

This research study focuses on the enigmatic occurrence of noritic lenses (termed “brown sugar norite” by mine geologists, here after referred to as BSN), within the feldspathic pyroxenite of the Merensky Reef (MR) at Two Rivers Platinum Mine which is situated on the southern sector of the eastern limb of the Bushveld Complex. The cumulate rocks associated with the MR unit are characterised by the use of geochemistry and mineralogy and compared to stratigraphically similar rock types north of the Steelpoort fault at Eerste Geluk.

The BSN are fine-grained and appear to only occur where the upper chromite stringer of the MR unit is present. Orthopyroxene is the dominant cumulate phase in both the BSN and feldspathic pyroxenite followed by interstitial plagioclase. Clinopyroxene occurs mostly as exsolved lamellae phase within orthopyroxene and intermittent rims around orthopyroxene which could be attributed to a decrease in temperature and compositional change of the melt. Textural features of the different rock types suggest recrystallization of minerals and disequilibrium of magma. At Eerste Geluk BSN is absent, minerals of the Merensky lithologies display more alteration or deformation and a higher concentration of hydrous minerals. Eerste Geluk’s close proximity to the Steelpoort fault makes it plausible for dynamic magmatic processes to have been active (Cawthorn et al., 2002) resulting in the alteration of minerals. Strontium isotope analyses of five representative samples of the Merensky interval at TRP yielded  $^{87}\text{Sr}/^{86}\text{Sr}$  typical of Critical Zone Magma. The BSN has a lower  $^{87}\text{Sr}/^{86}\text{Sr}$  ratio relative to pyroxenite. PGMs occur associated with base metal sulphides (BMS), silicates and chromite (Kinloch, 1982). Results show that pentlandite contains a higher concentration of PGEs relative to pyrrhotite and chalcopyrite. Pd is the most dominant PGE present in BMS analysed with concentrations ranging between 0.5 to 428 ppm.

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**Session Classification:** Minerals

**Track Classification:** Oral and Poster Presentation

Contribution ID: 38

Type: **not specified**

## Time- and Length-series analysis within artificial deltas

*Thursday, 2 October 2014 15:15 (15 minutes)*

The internal structure of natural deltaic systems can be analysed through interpretation of vertical logs and seismic sections. If we are to quantitatively investigate the correlation between the internal structures of a delta and the factors influencing them, we should start with simple-case examples. We expect that the complexity of natural deltas be at least as complex as that of artificial deltas.

The different deltaic structures exist within a physical space and thus have a length component to them. The factors that influence the formation of these structures, such as sea level change and tectonic subsidence, exist within the domain of time. Sedimentologists regularly compare these influencing factors with the structures they observe within sedimentary logs and seismic cross sections, and attribute physical changes to certain signal changes within the time domain. The implication of this being constant and homogenous sedimentation throughout the entirety of the delta.

We notice from artificial deltas that this is not the case. Sedimentation is discontinuous and localized to certain regions of the delta at different times. This creates periods of deposition that are not seen throughout the delta that result in a hiatus within the sedimentary history of the delta at a given location.

For correlation between different dimensions ,time and space, to be considered, we must construct a True-Time series from the evolution of the artificial deltas and compare it to the Time-series control factors and quantify the misfit to give an error range.

From this error range we can more accurately conclude comparisons between influencing factors and the internal structure of artificial deltas can be made.

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**Session Classification:** Water

**Track Classification:** Oral and Poster Presentation

Contribution ID: 39

Type: **not specified**

## Structural deformation features of the Bokkeveld Group (Cape Supergroup) in the Eastern Cape, South Africa

*Friday, 3 October 2014 09:00 (15 minutes)*

Previous studies of the Bokkeveld Group focussed mostly on the sedimentation and sedimentary features of this group with a view to interpreting the depositional environment. This study aims to contribute new information on the structural features of the Bokkeveld Group north-west of Uitenhage in the Eastern Cape, where there is evidence of folding and pervasive thrust faulting, similar to that occurring in the under- and overlying groups of the Cape Supergroup.

Field work to date shows that predominantly argillaceous units comprising siltstones, mudstones, with lesser arenites and thin conglomerate beds making up the Bokkeveld Group conformably overlie the Table Mountain Group of predominantly arenaceous beds. Both groups have been folded into asymmetric anticlines and synclines, with a prominent, south-dipping pervasive cleavage developed in the Bokkeveld Group. The fissile nature of argillaceous beds on outcrop have required that very careful observations of the all important bedding-cleavage relationship in the field are made so that correct interpretations of facing direction of strata can be applied. Thrust faults showing fore- and backthrusts are present in the Bokkeveld Group, similar to those occurring in the overlying Witteberg Group. These structures are interpreted to have formed during a main deformation phase of the Cape Orogeny, during the Permian.

In places structural orientation data indicate that bedding planes dip predominantly to the North-east and to the South-west. Cleavage dips consistently to the Southeast, although the dip of the cleavage varies from steeper to less steep in different formations. A section studied along the Hot-tentospoort road revealed that the more arenaceous beds often display folding as the main structural feature, whilst the argillaceous layers display more faulting and small scale folding. Faulting is present throughout the whole section, mostly in the form of south-south-west dipping reverse faults and shallow dipping thrust faults. Strike-slip faulting has also been recorded. Flexure-slip faults occur mainly in the more arenaceous units and are associated with large scale folding in the area.

This study so far indicates that structural characteristics of the Bokkeveld Group have been identified on macro and microscopic scale, and detailed analyses of these structures should reveal valuable information with regard to the deformational history of these rocks. In the field cleavages may easily be mistaken for bedding and this relationship needs to be carefully verified through microscopic studies. A significant emphasis is placed on this aspect to avoid incorrect interpretations in the field. The results of this study will inevitably point to the fact that strata have been disrupted by structures such as folds and thrust faults to the extent that the stratigraphic order of the Bokkeveld Group in this area will have to be re-assessed.

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**Session Classification:** Strain

**Track Classification:** Oral and Poster Presentation

Contribution ID: 40

Type: **not specified**

## **Assessments of the Effects of Clay Diagenesis on Some Petrophysical Properties of Lower Cretaceous Sandstones, Block 3A, Offshore Orange Basin, South Africa**

*Thursday, 2 October 2014 17:00 (15 minutes)*

Clay minerals diagenesis phenomenon and their effects on some petrophysical properties of lower cretaceous silliciclastic sandstones, offshore Orange basin have been established. Previous studies on Orange basin revealed that chlorite and quartz cements have significantly compromised the reservoir quality in this basin but it is expected that the reservoirs shows better improvement basinward where thge depositional environment is different, an analogy of this is displayed by tertiary sandstones deposit, offshore Angola.

Five lithofacies were identified based on detailed core description from wells KF-1, KH-1 and AU-1 in block 3A, offshore Orange basin. The facies were grouped based on colour and grain sizes, they are named: A1 (shale), A2 (sandstone), A3 (siltstone), A4 (dark coloured sandstone) and A5 (conglomerates). Depositional environment is predominantly marine, specifically, marine delta front detached bars and deepwater turbiditic sandstone deposit. Geophysical wire line logs of gamma ray, resistivity logs combo and porosity logs were interpreted, parameters and properties such as VCL, porosity, permeability and saturation were estimated from these logs and the values obtained were compared with values from conventional core analysis data, the values agreed well with each other

The reservoir within KF-1 well is approximately 5m thick and has an extreme low permeability value averaging 0.01 md, core porosity of 10 %, sonic log derived porosity of 14.6 % and average gas and water saturation of 18 % and 82% respectively (Simandoux model). AU-1 well reservoir is 6.5 metres thick with an estimated average value of 10 % for neutron and density porosity and core porosity, permeability of 0.015md, VCL (volume of clay) of 32 % and water saturation value of 65 %. KH-1 well has reservoir thickness of about 9 m while water saturation estimated from Simandoux saturation model is 50 %. Density porosity value is low with an average of 8.9 %, VCL of 30 % and extreme low permeability value of 0.09 md. There were consistent presence of kaolinite, montmorillonite and quartz cement within the reservoirs of the three wells from observations made from SEM, SEM also revealed the presence of chlorite at a deeper depth, chlorite might have been formed from kaolinite due to the presence of Mg and Fe as observed from EDS plus an alkaline pore fluids as interpreted from the porewater pH. SEM also revealed the presence of illite in KH-1 well which is not present in the other two wells (AU-1 and KF-1).

The pH of pore waters in all wells range from slightly acidic nature to predominant alkaline pore fluids, specifically from 6.78 - 9.5 while CEC ranges between 27 - 64.5 meq/100g for AU-1 well, 5 - 6.6 meq/100g for KF-1 well, and 7.3 - 80.5 meq/100g for KH-1 well. The values above suggest the dominance of mixed clay minerals of kaolinite-smectite and smectite-illite layers coupled with the occurrence of chlorite and illite which may have formed at a later stage of the paragenetic sequence.

Judging by this study, the peculiar Orange basin reservoir quality problems persist and ultra deep waters may be further explored for reservoirs with better quality.

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**Session Classification:** Rocks

**Track Classification:** Oral and Poster Presentation



Contribution ID: 41

Type: **not specified**

## Thermal distortion dynamics of the HartRAO Lunar Laser Ranger optical telescope; impacts on pointing, characterisation and modelling

*Tuesday, 30 September 2014 12:15 (15 minutes)*

Currently Hartebeesthoek Radio Astronomy Observatory (HartRAO) in South Africa is developing a Satellite/Lunar Laser Ranger (S/LLR) based on a 1 metre aperture telescope. This is done in collaboration with the National Aeronautics and Space Administration (NASA) and the Observatoire de la Côte d'Azur (OCA). The S/LLR is required to make ranging observations with sub-centimetre level accuracy. Various components of the S/LLR are currently being integrated, coupled with the development of operating models for the telescope. This includes, for example, the pointing and thermal dynamic models which depend on the temperature variations on the telescope. In particular, this study aims to develop a model based on thermal measurements of the structure, as thermal variations of the structure affect the pointing of the telescope. Excellent pointing will increase the chance being on-target with the retroreflectors located on the lunar surface.

As the first step, we present simulation results through the use of transient heat conduction on the thermal behaviour of the telescope, in particular the tube and primary mirror. The results reveal a temperature gradient of about 1 deg;C which means that, both the tube and especially the mirror may respond very slowly to ambient temperatures ( $T_{\infty}$ ). Furthermore, the simulation produced a similar temperature gradient on both components for rapidly changing ambient temperatures with a range of 13 deg;C. These findings provide an indication of: i) understanding the thermal behaviour of the telescope's critical components with respect to the changing thermal environment, ii) guiding the strategic location of the thermal sensors on the telescope, and iii) options for developing a thermal dynamic model which would correct for thermal variations that affect the pointing of the telescope.

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**Session Classification:** Space

**Track Classification:** Oral and Poster Presentation

Contribution ID: 42

Type: **not specified**

## **Influence of sedimentological and hydrological processes on the distribution of salt marsh in the Keurbooms Estuary, Western Cape**

Salt marshes are the most productive ecosystems, second after tropical rain forests in biodiversity and biological productivity, yet their survival is threatened by global sea-level rise and anthropogenic activities. They play a significant role not only on the ecosystem but in coastal defence, enhancing coastal sedimentation. However, their development and distribution has been closely linked to several environmental drivers such as tidal exchange, freshwater inflow, water column salinity and temperature, groundwater, elevation, sedimentation, sediment moisture, sediment organic and soil salinity. The present study is to be undertaken in the permanently open Keurbooms Estuary, located on the warm-temperate south coast of South Africa. The Keurbooms Estuary lacks well developed intertidal areas and as a result salt marshes are not extensive and *Spartina maritima* is limited. The sediment dynamics of the estuary and their influence on the ecosystem of the estuary, particularly salt marshes, are poorly understood. Therefore, the study will examine the sediment distribution of the estuary and quantify the current sediment load from the three sources. We hypothesise that the limited *Spartina maritima* area in the estuary is attributed to the sediment dynamics of the estuary. Therefore, sediment characteristics of *Spartina maritima* will be examined and compared to those of other estuaries (Knysna, Kromme and Swartkops) to get better understanding of their environmental drivers. Spatial distribution of salt marshes in the estuary will be examined using a series of GIS maps digitised from historical and recent aerial images to determine how the salt marshes have changed over time. In addition the sediment characteristics such particle size, moisture, organic content and soil salinity will be examined within the salt marshes to determine the main environmental drivers responsible for salt marsh distribution in the Keurbooms Estuary. This study will address conservation of biodiversity of salt marshes and identification of potential threats posed by past, present and potential future management practices and climate change.

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**Track Classification:** Oral and Poster Presentation

Contribution ID: 43

Type: **not specified**

## **An investigation of possible augmentation of water from groundwater resources of Mangaung (Part 1)**

*Thursday, 2 October 2014 14:15 (15 minutes)*

Grace and Christinah we will be presenting the abovementioned topic together at the conference.  
Our ID number is 23

**Primary authors:** Ms MAKOAE, Christinah Manthofeela (Institute for Groundwater Studies (IGS-UFS)); Ms MOLABA, Grace Lebohang (Institute for Groundwater Studies (IGS-UFS))

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**Session Classification:** Water

**Track Classification:** Oral and Poster Presentation

Contribution ID: 44

Type: **not specified**

## Numerical Analysis of finite strain in the Warm Zand Structure

*Friday, 3 October 2014 11:15 (15 minutes)*

The distribution of strain and its variation within geologic terranes have always been a matter of great interest to structural geologists. The absence of good markers, especially in metamorphic zones has made strain analysis a very laborious task. A work flow for finite strain analysis is presented in this study. In the development of the work flow two important points were considered; firstly, the work flow should be applicable both for sedimentary and metamorphic rocks and secondly, the methods that would make up the work flow would integrate data that are easy to obtain from geological features. Using The Warm Zand structure as a case-study, we have investigated the finite strain using several advanced numerical methods. The Warm Zand Structure consists of strongly deformed calc-silicates of the Puntsit formation and feldspathic quartzites of the Goede Hoop formation which gradually change into pure quartzites in some locations. The second phase of folding F2 in the calc-silicates gave rise to isoclinal folds. Based on the type of strain markers we encountered, we designed a procedure to estimate the strain of the area of interest; for instance, in the Puntsit formation, folds are common and were used as strain markers. A mathematical analysis of the shape of these folds was first performed using Fold Profiler developed in the MATLAB® environment. As a result we found that the set of folds analysed was best fitted by conic sections and bézier curves. The latter showed that the Warm Zand Structure's folds are close ( $30 < ILA < 70$ ) to open ( $70 < ILA < 120$ ) folds. The shape parameters (aspect ratio, eccentricity, and normalised area) obtained with the conic section method were used to simulate theoretical folds that best fit the natural folds under consideration, with the aim of investigating the strain pattern. The proposed strain sequence model begins Initial Layer Shortening (ILSH), Tangential Longitudinal Strain (TLS), Flexural Flow (FF) and Flattening (FL). In each fold the intensity of each strain pattern has a small variation compared to each other. FF is less important than TLS and usually occurs after the latter. Viscosity, shortening and strain partitioning were estimated from fold shape parameters using Fold Geometry Toolbox (FGT) developed in the MATLAB® environment. Euhedral quartz crystals grown as a pegmatite of quartz mobilisation sampled from the feldspathic quartzites were used to measure the robustness and reliability of the DTNNM and MRL. The method that would identify the error (due to the quartz crystals oriented in different directions) would be recommended as the most reliable method for strain analysis of elliptical objects. The confidence ellipses for bootstrapped data showed that the DTNNM results are associated with errors.

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**Session Classification:** Strain

**Track Classification:** Oral and Poster Presentation

Contribution ID: 45

Type: **not specified**

## **Geochemical characterization of P1, P2, P3 and P4 units at the Akanani prospect area, Bushveld Complex, South Africa: Combination of R-Cluster, R-Factor and Discriminant analysis approach**

*Thursday, 2 October 2014 10:00 (15 minutes)*

The Platreef is located in the northern limb of the Bushveld Igneous Complex (BIC) and is comprised of a 10- to 400-m thick package of pyroxenitic lithologies, which host platinum-group element (PGE) and base metal sulphide (BMS) mineralization at various heights above the floor rocks. The pyroxenites are overlain by norites and gabbronorites, generally assigned to the Main Zone of the BIC.

The greatest challenge facing mining personnel is differentiating between mineralized pyroxenites and those barren off mineralization and also finding a definitive criteria for characterizing the four lithological units. Exploration geologists at the Akanani prospect area have classified the pyroxenitic units into P1, P2, P3 and P4 units in their order of succession with depth based on their textures, color and mineralogy. The geochemical attributes which distinguish them still remains unresolved.

Fifty-three pyroxenite samples were therefore taken from 6 boreholes at the Akanani Prospect area for geochemical and petrographic studies. The samples were analyzed for over 40 elements by X-ray Fluorescence (XRF) and Inductively Coupled Mass spectrometry (ICP-MS). The geochemical data were evaluated using combination of three multivariate statistical techniques, these being: cluster, factor and discriminant analysis using SPSS 20. The present study was initiated to determine the distinctive geochemical characteristics that can be used to identify each layer and in so doing determine geochemical elements characterizing each of these pyroxenite layers.

The discriminant accuracies for the four groups resulted in a 100% recognition rate, indicating that the percentage of accurate analysis is high for discriminating between the four Platreef units. Results identifies P1 unit as high in Cr, Fe<sub>2</sub>O<sub>3</sub>, and TiO<sub>2</sub>, higher MgO and LOI characterize the highly serpentized P2 unit which corroborates with the high olivine and orthopyroxene contents associated with this unit. The P3 unit shows SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, K<sub>2</sub>O and Na<sub>2</sub>O in line with a pronounced feldspathic composition for this unit, while a higher CaO and P<sub>2</sub>O<sub>5</sub> is associated with the P4 unit. The stratigraphic subdivision presented here conflicts widely with the A-B-C reef terminology as well as the most recent PU1, PU2 and PU3 subdivision of the Platreef at Akanani.

The results presented here underline the effectiveness of the combination of R-mode cluster, R-mode factor and discriminant analysis in distinguishing between various rock types as well as exploring various relationships amongst data sets. The correlation between the geochemical and petrographic results shows the effectiveness of this technique especially in areas where the identification of the unit is unclear, uncertain or unknown or in areas where the stratigraphy is unclear due to processes like structural deformity, assimilation and metasomatism. The results presented here provide a new guide to the exploration of PGE-BMS mineralization in the Platreef at Akanani. **KEYWORDS:** Bushveld Complex, Platreef, Multivariate statistics, cluster analysis, factor analysis, discriminant analysis

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**Presenter:** Mr MANDENDE, Hakundwi (University of the Western Cape)

**Session Classification:** Minerals

**Track Classification:** Oral and Poster Presentation

Contribution ID: 46

Type: **not specified**

## **Lithogeochemical characterization of the Hondekloof Ni deposit, Kliprand area, Garies terrane, Namaqualand, South Africa**

*Thursday, 2 October 2014 11:00 (15 minutes)*

The Hondekloof deposit represents a family of small, orthomagmatic massive sulphide Ni-Cu-(Co-Zn) deposits occurring in the central part of the Garies terrane, Bushmanland, Namaqualand, South Africa. The study area is located in the Westcoast region of South Africa, in the settlement called Kliprand where various granulite facies rocks of the Namaqua-Natal Metamorphic province ranging from pre-to-syn-tectonic metasedimentary and meta-igneous rocks as well as post-tectonic granitic to charnockitic intrusions are regionally distributed.

Since the discovery of this deposit, however, it remains largely unclassified given the limited attention given to the studies of its genesis. Understanding the origin of the deposit is however relevant in many respects as it allows to target other areas where arbitrary deposits of its kind may be found.

Therefore this project seeks to examine the petrography, petrology and geochemistry (particularly whole rock geochemistry) of the host rocks to the deposit to constrain their origin, protolith and tectonic settings. Doing that will further enable us to understand the nature of those rocks, their characteristics and the involvement of deformation and metamorphism or metasomatism on the deposit. The above information, then based on the standard criteria globally used to classified the magmatic Ni mineralization will be employed to characterize this deposit on the basis of: 1. the nature of its sulphide mineralization, 2. the composition of its parental magma (e.g. magma involved in the formation of the deposit), and 3. the tectonic setting where that magma has been deposited.

A selection of six exploration boreholes were logged and examined at the deposit site and seven lithologies encompassing both the metamorphosed sedimentary rocks as well as the meta-magmatic rocks of bi-modal composition were identified. Petrographic study has subsequently been done and still in progress and is followed by the whole rock geochemical analysis. A selection of 42 core (rock) samples were prepared for both XRF (X-ray fluorescence) and ICP (inductively coupled plasma) analysis and both trace and major elements data are heavily involved in process studies.

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**Session Classification:** Minerals

**Track Classification:** Oral and Poster Presentation

Contribution ID: 47

Type: **not specified**

## The Cape Fold Belt – some stratigraphic and structural insights

*Friday, 3 October 2014 11:00 (15 minutes)*

The Cape Fold Belt (CFB) which lies along the southern margin of the African continent incorporates deformation of the Cape Supergroup, its basement rocks, as well as the lower Karoo Supergroup in the southern part of the larger Karoo Basin. The fold belt forms part of a larger tectonic picture that correlates with other remnants of Gondwana, thus confirming a late Palaeozoic-early Mesozoic timescale of deformation, when Gondwana was still one continent. Current models invoked to explain the compressional and metamorphic characteristics of the fold belt include mainly those involving collision and transpression tectonics. Extension which occurred as a result of the breakup of Gondwana, during the Mesozoic, is the last phase of tectonism associated with the fold belt.

Some stratigraphic and structural anomalies of the fold belt remain as yet unexplained, signalling a need for detailed fieldwork and analysis to resolve such anomalies. The recognition that some units of the Cape Supergroup are abnormally thickened in certain regional zones of the fold belt, coupled with the fact that shale beds are often entirely missing, is explained by the thrust stacking model, where thrust faulted zones are present in the region encompassing Port Elizabeth, Kareedouw and Uniondale areas.

A north-south section through the fold belt reveals that deformation is greatest along the southern coastal zone where highest degree of metamorphism occurs in basement rocks and greatest amount of crustal shortening has occurred. Near the coast where isoclinal folds are evident in cover rocks (Cape Supergroup) and further northwards mainly open folding is present in Cape and Karoo rocks, coupled with zones of low angle (thrust) faulting. Low angle thrust faults and gentle folds are characteristic of the frontal deformation zone of the fold belt. Some characteristics of this type of deformation in the Fort Beaufort area of the Eastern Cape show a complex interplay of fore and backthrusting where strata of the Beaufort Group have been locked up through duplexing above footwall ramps.

Recent seismic surveys through the Karoo Basin show that thrust faults disrupt strata of the Cape and Karoo Supergroups and are prevalent for some 300 km from the coast to the frontal zones of the fold belt near Beaufort West. These surveys also reveal that strata of the Karoo “foredeep” are of lesser thickness than predicted, thus requiring a different tectonic model to explain this new data than previously proposed.

In the Uniondale area a strike-slip model is invoked to explain a configuration of juxtaposed folded Cape Supergroup strata, separated by steeply dipping faults. This event probably occurred late in the deformation history of the CFB.

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**Presenter:** Prof. BOOTH, Peter (Research Associate - NMMU)

**Session Classification:** Strain

**Track Classification:** Oral Presentation



Contribution ID: 48

Type: **not specified**

## The effect of faulting and dolerite intrusions on gas-bearing potential of lower Karoo strata

*Monday, 29 September 2014 14:00 (20 minutes)*

There are two phenomena that would have had a detrimental effect on natural gas contained in strata of the Ecca Group, in that at least some of the contained gas would have escaped, or at least been redistributed. These phenomena are (i) deformation features associated with the Cape Fold Belt (CFB) and, (ii) large scale intrusion of dolerites during the Mesozoic.

Deformation features of importance include faults, joints and, to a lesser extent, cleavages associated with folding during the Cape Orogeny. Normal faults are not that common in Karoo strata, but thrust faults are prevalent. The latter are ubiquitous in Cape Supergroup strata near the coast. However, recent studies have shown that this type of faulting extends northwards from the coast for some 300 km, and does affect Karoo strata. A deformation front therefore is defined between Matjiesfontein to Beaufort West, extending on to Fort Beaufort, and then onwards towards East London.

Seismic surveys conducted by Stankiewicz and Lindeque in the southern part of the Karoo Basin confirm the presence of thrust faults that transect and displace Cape and Karoo strata, right up to the frontal zones of deformation near Beaufort West. These surveys show that gas-bearing strata of the Whitehill Formation are disrupted, thus providing escape channelways for redistribution of gas in these and overlying horizons. It remains yet to be quantified to what extent these faults have caused redistribution and escape of gas originally contained in lower Karoo horizons. There is therefore a need for petrophysical studies of fault zones to be conducted, particularly in this frontal region of the CFB, to arrive at some quantification of results.

The effect of dolerite dykes that have intruded gas bearing strata and effectively driven off gas in lower Karoo rocks would probably not be as great as those of sills and sheets of dolerite (e.g. Thabankulu), where heat from the larger igneous bodies would be more widespread. The latter intrusions would more effectively have driven off the gas from the host rocks (Whitehill Formation). In a best case scenario, exploration for gasfields north of the escarpment may be favourably pursued, albeit in smaller segments of the Karoo .

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**Session Classification:** Supervisor Talks

**Track Classification:** Oral Presentation

Contribution ID: 50

Type: **not specified**

## Induced seismicity in South Africa. Failure mechanisms, source parameters and magnitude estimates

*Friday, 3 October 2014 10:15 (15 minutes)*

Natural seismicity within South Africa is limited to low-moderate magnitude intraplate activity broadly grouped into clusters such as Ceres, Koffiefontein, Lesotho and Namaqua clusters or swams. Intraplate seismicity is ~ 10 % of global natural seismicity with a smaller  $M_{max}$  in South Africa of about  $M_L = 6.3$ . The vast majority of “recorded” seismicity in South Africa occurs in the centre of the very stable Kaapvaal Craton within the Witwatersrand gold basin. These events are almost wholly induced by mining despite some suggestions of triggering of paleoenergy. The maximum magnitude induced event recorded to date was about a  $M_L = 5.2$  event. Methods and techniques for studying induced events have been transferred directly from earthquake seismology since no systematic differences have been found, though many have been observed. This includes failure models, magnitude and source parameter estimates and statistical hazard quantifications. Major differences between natural and induced events are details of heterogeneity and the proximity of infrastructure and people to the source. Natural events are up to 10’s km while induced events are within 100’s of meters. The Richter or local magnitude scale ( $M_L$ ) has been used, with some modifications, to measure the size of earthquakes since 1935. It has long been recognised that this single-number representation of a multi-dimensional phenomenon is inadequate and cannot fully describe the energy released by an earthquake or the displacement caused by it. This study aims to identify and quantify the effect of various factors on estimates of the size of events and how this affects hazard quantifications. I propose three parameters to estimate the size of a seismic event namely, (i) Area of the source ( $m^2$ ), (ii) Energy per unit area of the source ( $KJ/m^2$ ) and (iii) Azimuth of strongest shaking (degrees).

KEYWORDS: Seismic magnitude, spectra and source parameters

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**Session Classification:** Strain

**Track Classification:** Oral and Poster Presentation

Contribution ID: 51

Type: **not specified**

## Understanding source rock contribution to hydrocarbon accumulation and natural gas leakages in the Bredasdorp Basin- a 3D basin modelling study

*Tuesday, 30 September 2014 15:15 (15 minutes)*

To assess the total petroleum system and prospectivity of the Western Bredasdorp Basin (WBB), this study investigates the contribution of Upper Jurassic-Cretaceous source rocks to the reservoir hydrocarbons and natural gas leakages using a 3D basin modelling technique. The established 3D model is based on an integration of subsurface datasets (2D seismics, well data and cores) and links the present-day configuration and related tectonic/geodynamic evolution of the basin at a crustal scale (Sonibare et al., 2014) with the local- to regional-scale thermal histories of the Southern African continental margin. By analysing the temporal and spatial distribution of critical moment for hydrocarbon generation, migration and accumulation, we find that three periods, coinciding with the main phases of hydrocarbon generation and expulsion, characterise the reservoir filling history of the basin. The first period corresponds to the Early Cretaceous syn-rift rapid subsidence and sedimentation rates. While the second period indicates the significance of post-rift thermal subsidence and the heating effect of the Late Cretaceous-Early Tertiary hotspot-related heat flow pulse, the third period corresponds to the Miocene margin uplift and thermal perturbation. According to our results, the largest amounts of hydrocarbon accumulations and possible seafloor gas leakages are respectively contributed by the syn-rift Late Hauterivian and Mid Hauterivian source rocks. By performing a series of sensitivity tests, we further gain better insights into the timing of migration pathways and dynamics. We consider the scenario that couples faulting activity, seal bridging mechanism and facies heterogeneity as our best approximation of the probable controlling factors of migration, accumulation and leakage, as it gives the best location of discovered accumulations and observed leakages in the WBB.

Keywords: Southern South Atlantic, Basin modelling, Sensitivity analysis, Basin dynamics, Source rocks, Reservoir history, Seafloor leakage

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**Session Classification:** Energy

**Track Classification:** Oral Presentation

Contribution ID: 52

Type: **not specified**

## **A structural and geochemical analysis of the Karoo sedimentary rocks along dolerite dyke and sill contacts with implications on shale gas potential**

*Wednesday, 1 October 2014 10:10 (10 minutes)*

The main Karoo basin sedimentary sequence covers an approximate area of 700 000km<sup>2</sup>, and attains a thickness of more than 5Km. The emplacement of the Karoo Large Igneous Province (LIP) through dolerite dykes and sills, and lava flows (ca 183Ma) led to extensive devolatilization, metamorphism, and out-gassing of approximately 2000Gt of carbon dioxide and methane into the atmosphere. The effects of these intrusive rocks challenges shale gas reserves in Karoo Basin.

The purpose of this study is to address the effect of dolerite intrusions on the Karoo sedimentary strata along contact aureoles, so as to understand the Pressure-Temperature (P/T) conditions that prevailed at the time of contact metamorphism and ultimately the effect on shale gas content. Field mapping and sampling of contacts will be conducted along a transect from the Eastern Cape coastline to the basaltic outcrops. The changes in mineralogy of the host rocks, thermal maturity, and fluid inclusion chemistry will be investigated using analytical techniques such as SEM, TEM, and fluid inclusion microthermometry on samples collected along contact aureoles.

The results of this study will assist in quantifying the effects of dolerite intrusions on the Karoo sediments in the Eastern Cape Province; it will also shed light to P/T conditions prevailing at the time of magmatic activity and the subsequent effects on shale gas potential.

**KEY WORDS:** Karoo Basin, dolerite dikes and sills, contact metamorphism, gas content.

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**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 53

Type: **not specified**

## Preliminary results from a field reconnaissance for shale gas in the Karoo of Tanzania

*Wednesday, 1 October 2014 12:00 (10 minutes)*

The Karoo is a Gondwanan basin type sequence that extends across South America, south-central Africa, Madagascar, India and Antarctica. It is currently being investigated in South Africa, with special interest for black shale and its potential toward energy and socio-economic development. Curiously, there was no mention of shale gas at the 25th Colloquium of Africa Geology, in Dar Es Salam, Tanzania, despite the continent's energy and economic challenges and apparent vast shale gas potential. We therefore decided to undertake some field reconnaissance work to investigate the Karoo of Tanzania and target the Permian black shale (main potential source rock in South Africa). Challenges facing us were mainly logistical (transport), and bureaucracy (permits and authorizations). These problems resulted in the majority of our time spent waiting, often in very testing conditions.

We first investigated the contact between the Karoo and basement Pan-African TTG and marble sequences. These form the Uluguru Mountains around Morogoro (300 km west of Dar Es Salam). This contact delineates a topographic change; and despite being mapped as a tectonic contact, field observations were inconclusive. Toward the south, Selous is the largest Karoo outcropping region within Tanzania. This represents more than 50 % of the total Karoo in Tanzania. North of the Rufiji River, we were able to identify probable Karoo sequences. We will however require additional support for work extending south into Selous. Finally, by bicycle, we were successful in locating and sampling black shale in the coastal region of Tanga (along the Sigi River, northern Tanzania). This section bears remarkable similarities to the Whitehill-Prince Albert Formations contact region in South Africa. Displaying similar features like probable glacially-derived soft-sediment deformation structures and characteristic white-weathered laminated shale (also suggesting possible high TOC values).

From these preliminary results, we will build a program for further field investigations, now supported by a one year research permit. This will include geological mapping, delineating the stratigraphy, geochemistry and understanding the structure of these Karoo basins. We intend to perform these investigations in Selous, Tanga and those extending to Kenya.

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**Presenters:** Mr LINOL, Bastien (AEON - NMMU); Mr DHANSAY, Taufeeq (AEON - NMMU)

**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 54

Type: **not specified**

## **Characterise and quantify contamination from anthropogenic activities within the Crocodile (West) and Marico Water Management areas, South Africa**

*Thursday, 2 October 2014 12:15 (15 minutes)*

Chemical signatures from river waters and sediments were collected in the Crocodile (West) and Marico Water Management Areas, South Africa. Surface water samples were analysed for anion complexes using Ion Chromatography (IC) and major and trace element chemistry using quadrupole Inductively Coupled Plasma-Mass Spectrometry (q-ICP-MS). Major and trace element chemistry was measured by XRF and mineralogy by XRD on all sediment samples. The results are used to define the various chemical signatures resulting from activities within the study area and to differentiate the 'background' that arises from natural geological heterogeneity. The aim of this characterisation is to fingerprint the chemical signatures of various anthropogenic activities irrespective of background in order to gain an insight into the level of chemical contamination by the receiving environment. Based on the results, the contamination sources within the area can be identified and ranked in terms of the contribution to the total effective chemical contamination received at Hartebeespoort Dam.

Keywords: Heavy metal, chemical fingerprint, geochemistry, South Africa

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**Presenter:** Mrs LONG, Chazanne (AEON - NMMU)

**Session Classification:** Food and Life

**Track Classification:** Oral and Poster Presentation

Contribution ID: 55

Type: **not specified**

## **Borehole stratigraphy, organic geochemistry and petrography of Permo-Carboniferous Lower Ecca black shales: Implications for their shale gas potential**

*Wednesday, 1 October 2014 09:40 (15 minutes)*

In the Main Karoo Basin, Permo-Carboniferous black shales of the Lower Ecca Group, especially the Prince Albert and Whitehill Formations, are considered to be a potential source of shale gas. Core samples of shale were collected from eight boreholes predominantly drilled in the 1960's, and stored at the Council for Geosciences' core library in Pretoria. The carbonaceous black shale of the Whitehill Formation attains a maximum thickness of 60m in the western portion basin, whereas an average thickness of approximately 33m is recorded in the south western region of the basin. Due to the occurrence of such thick successions of black shales, the Karoo Basin is one of the targeted regions for shale gas exploration.

The samples were analysed for their gas potential, using standard shale gas exploration parameters, which entails detailed source rock characterization. This has been accomplished mainly through organic petrology and organic geochemistry. Organic petrography included techniques such as optical microscopy and electron microscopy (i.e. SEM, FIB-SEM). These are important in identifying compositional and textural variability within the rock. Complementary geochemical analysis such as Rock Eval and GC MS were crucial in determining factors like fraction of gas present as adsorbed gas, organic matter type and TOC content.

The mineralogical composition, as observed through thin section microscopy, is dominated by quartz, feldspars, clays and carbonates. Moreover, the shale samples were shown to predominantly consist of alternating layers of silt-enriched and mud-enriched horizons through thin section studies. Investigations with the XRF technique showed SiO<sub>2</sub> to be the dominant major element component. In addition, XRD analyses reveal quartz to be the dominant mineral phase in most of the samples. SEM further confirms the dominance of quartz and clay minerals (illite). The enrichment in quartz indicates high brittleness of the shale which is crucial for controlled hydraulic fracking and successful extraction of potentially tight gas. SEM was used to further identify minerals that appear opaque under the optical microscope (e.g. pyrite) as well as to identify organic matter. FIB-SEM was utilized to study rock specimen at a nanometer scale, enabling the identification of organic matter, porosity within the organic matter as well as intragranular porosity.

Total organic carbon (TOC) content must be greater than 0.5 wt % for the rock to be a potential source rock. The Karoo shale samples reach a maximum of 7.3 wt% TOC in the south western region of the basin. The samples from borehole KI1/65 record the highest TOC values and adsorbed methane content, as detected by thermovap-GC, with up to 10.2 µg/g CH<sub>4</sub>. Open pyrolysis analysis show the organic matter from samples of well LA 1/68 to be of Type III type kerogen, the QU 1/65 to be Type I/II and the samples of KI 1/65 to consists organic matter of both Type I/II and Type III. The combination of the results from these geochemical techniques and the understanding of the evolution of the Karoo basin (i.e. thickness variation, thermal history, variation in depositional environments) have been used to characterize the shales from the Main Karoo Basin for their gas potential.

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**Presenter:** Ms CHERE, Naledi (AEON - NMMU)

**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation



Contribution ID: 56

Type: **Poster (All students)**

## Shale Gas in South Africa: Contextualizing the Socio-Economic and Political Implications

*Wednesday, 1 October 2014 12:10 (25 minutes)*

The confluence of three key technological and social-economic drivers have given rise to the advent of the new 'Golden Age of Gas', as articulated in the new global discourse of unconventional oil and gas, and in particular what has been described as the 'Shale Gas Revolution'. These drivers include the technological advances in multi-directional and horizontal drilling and hydraulic fracturing; The need to identify alternative energy sources in mitigation of its anticipated economic and political impacts; as well as the availability of new energy alternatives. The latter, in particular being considered critical to sustained economic growth.

In understanding the impact of these three drivers on the broader social, economic and political landscape for local, national, and international geo-politics it is important that the discourse takes into consideration a holistic outlook on both the risks and the implications of this new 'Shale Gas Revolution' or 'Game Changer' for local communities, nations and civilization as a whole.

It is anticipated that this development will bring with it profound geopolitical implications across the globe, presenting both opportunities and threats on a global scale, with far-reaching implications for socio-political stability and ecological sustainability.

In South Africa in particular, critical consideration must be given to an assessment of social, economic and political drivers and risks associated with the prospect of advancing the development of Shale Gas, whilst considering the potential ecological and natural resource implications. In this regard, the study seeks to identify critical socio-economic and political risk factors which should be considered, managed and mitigated, as part of the ongoing discourse on shale gas development in South Africa, and within the Karoo Basin in particular.

This study will therefore attempt to undertake three (3) initial tasks within the broader context of defining the socio-economic and political landscape for Shale Gas development in the Karoo Basin of South Africa. These are:

1. Contextualize the socio-economic and broader political drivers within the National, Regional and Local setting of the Eastern Karoo, in relation to proposed shale gas development.
2. Identify and categorize associated risks, within the aforementioned context as pertaining to the proposed development of shale gas in the region.
3. Highlight key mitigation factors which would need to be taken into consideration by policy makers and regulators, across the various spheres of government (Local, Provincial, and; National); and
4. In synthesizing the above, advance a set of preliminary guidelines for policy makers at National, Provincial and Local level.
5. Citizen science, crowdsourcing etc

This study forms part of ongoing research being conducted by the author, as part of the AEON-ESSRI at NMMU and is informed by existing data on the localities identified in the Eastern Karoo, as well as data collected from interviews and workshops conducted with local communities in the affected localities as part of the Karoo Shale Gas Baseline Study.

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**Presenter:** Mr MORKEL, Barry (AEON - Karoo Shale Gas Research Programme)

**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 57

Type: **not specified**

## Baseline Groundwater Hydrochemistry and Aquifer Connectivity of the Eastern Cape Karoo Prior to the Proposed Hydraulic Fracturing of Shale Gas

*Wednesday, 1 October 2014 11:10 (10 minutes)*

The anticipated exploration and exploitation of Karoo Shale Gas has raised considerable debate about the benefits and risks associated with this process for both the Karoo, and the country as a whole. Focus has been placed on the potential impact of hydraulic fracturing on ecological, environmental and especially its scarce water resources. The Karoo region is highly dependent on groundwater as an important water resource and it will become increasingly so. Thus, groundwater management and the sustainability thereof are of prime importance.

This research will aim to hydrochemically characterise both the shallow groundwater (<300m) and deeper saline groundwater in the vicinity of the Shale Gas bearing formations, based on major and trace elements, as well as gas isotope analyses. Sampling will include water sampling and gas measurements from shallow boreholes (<300m), SOEKOR drillholes (oil exploration holes drilled in the 60's and 70's up to 4km deep) and thermal springs (source of water >500m).

To-date, a desktop study includes the collation of information determining the areas with the highest potential for Shale Gas Exploration throughout the Eastern Cape Karoo. All recorded boreholes obtained from online databases of the Department of Water Affairs (DWA) have been spatially visualised in these areas. A Hydrocensus will follow, during which downhole electrical conductivity profiling of the water column will be recorded. Borehole selection will be finalised from the acquired information. These boreholes will be sampled a minimum of three times which will occur after summer (April/May) and winter (October/November). The sampling will be preceded by purging of all inactive boreholes.

The hydrochemical results will be presented as chemical ratios by use of graphs, Piper Diagrams, Durov Diagrams and Expanded Durov Diagrams. Relevant parameters will be compiled and translated into spatial GIS maps.

The possible hydraulic connectivity between the shallow and deep aquifers will be tested, particularly in those areas where dolerite intrusions as well as fault systems may enhance preferential flow of water, using the chemical forensics complemented with passive seismic profiling/imaging and deep penetrating Magneto-Telluric imaging.

The research is critical for the successful governance of groundwater in light of the proposed Shale Gas development. In its absence, effective regulation of the sector will not be possible.

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**Session Classification:** Shale Gas

**Track Classification:** Poster Presentation

Contribution ID: 58

Type: **not specified**

## Geophysical processing, integration, and visualisation of multi-parameter survey data over parts of the Eastern Cape

*Wednesday, 1 October 2014 11:30 (10 minutes)*

The Eastern Cape, South Africa, suffers from a general lack of high-resolution geophysical data. This is largely due to a historical lack of interest in subsurface exploration in the area from an economic

viewpoint which led to a lack of funding being available to carry out such surveys. Until relatively recently, studies have been largely limited to small areas for particular research projects. However, valuable information of subsurface conditions can be provided by geophysical methods. This includes information about geological structures (including folding and faulting), intrusive bodies, and potential mineral deposits.

Airborne data, particularly of radiometric and magnetic properties has been used worldwide for a number of years with good results. In addition, airborne collection of gravimetric data is becoming more

reliable. Resolution of these three geophysical data collection methods from the air is approaching the resolution of ground-based surveys, but airborne platforms provide much faster and cheaper acquisition over wider areas. The large amount of data that is collected has led to the development of a number of computer-based systems for processing and visualising this data in informative ways. However, many of these existing systems are aimed primarily at relatively large industry clients. This makes most of them extremely expensive and difficult to modify for new applications. The use of these computer-systems is therefore often prohibitively expensive in academic and small or start-up business contexts.

This project seeks to address both these problems with the collection of high-resolution airborne magnetic, radiometric and gravimetric data over parts of the Karoo Basin in the Eastern Cape, using a gyrocopter platform. The area between Jansenville, Graaf Reniet and Aberdeen will be the primary focus for the data collection effort. The data will be collected as part of the Airborne Geophysical Observatory (AGEO), which is a project of the African Earth Observatory Network, based at Nelson Mandela Metropolitan University, Port Elizabeth. This will utilise a gyrocopter as a data collection platform, which is cheaper than traditional fixed-wing or helicopter platforms. Software designed for the processing, integration and three-dimensional visualisation of this newly-gathered data will be developed in tandem with the data collection.

At the conclusion of this project, a new, high resolution data set will be available for an improved understanding of the general basin architecture, including geological structures and intrusive bodies, and a possibly better understanding of the controls within the basin of groundwater flow. It may also help in guiding future land-use. The software developed as part of the project will also lower barriers to entry for conducting similar initiatives in the future.

**Primary author:** Mr BENTLEY, Martin (AEON - NMMU)

**Co-authors:** Dr COWLEY, Lester (NMMU); Prof. DOUCOURE, Moctar (AEON - NMMU)

**Presenter:** Mr BENTLEY, Martin (AEON - NMMU)

**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 59

Type: **not specified**

## **A Discussion of choice of colourmaps in visualisation: Perceptual colourmaps and colourmaps for the colour-blind**

Poor choice of colourmaps within visualisation can lead to the creation of visual artifacts, which creates false interpretation of the visualisation, either by seeing edges that do not exist or by obscuring edges that do. The use of perceptual colourmaps, where each change in colour is perceived as smooth can greatly enhance the ease of interpretation of a visualisation by removing ambiguity. In addition, many default colourmaps do not allow for good visualisation by people suffering from colour-blindness. Colour-blindness in its most common form, red-green causes these two colours to appear undifferentiated to colour-blind people. Development of suitable colourmaps, that is, those that do not obscure matters for colourblind individuals, has been improved.

This discussion will focus on the selection of appropriate colourmaps for avoiding the introduction of perceptual errors in visualisations and to maximise the utility of the colourmap for people who are colour-blind. This will aid in creating better visualisations of data of any kind for maximum utility by as many people as possible.

**Primary author:** Mr BENTLEY, Martin (AEON - NMMU)

**Presenter:** Mr BENTLEY, Martin (AEON - NMMU)

**Track Classification:** Oral and Poster Presentation

Contribution ID: **60**

Type: **not specified**

## **Registration, Posters Set-up**

*Monday, 29 September 2014 09:00 (1h 30m)*

**Primary author:** Ms SCHAAP (SMIT), Elronah (Inkaba yeAfrica - Operations Manager)

Contribution ID: **61**

Type: **not specified**

## Welcome and Opening

*Monday, 29 September 2014 11:00 (30 minutes)*

**Primary author:** Prof. DE WIT, Maarten (AEON - NMMU)

**Presenter:** Prof. DE WIT, Maarten (AEON - NMMU)



Contribution ID: **62**

Type: **not specified**

## **Group Photo**

*Monday, 29 September 2014 12:30 (30 minutes)*

Contribution ID: 63

Type: **not specified**

## Discussions and Closure

*Friday, 3 October 2014 11:40 (30 minutes)*

**Presenters:** Prof. DE WIT, Maarten (AEON - NMMU); Mr KRIGER, Robert (NRF)

Contribution ID: 64

Type: **not specified**

## Wrap-up: Space and Energy

*Tuesday, 30 September 2014 16:00 (30 minutes)*

**Presenters:** Prof. COMBRINCK, Ludwig (HartRAO); Prof. DE WIT, Maarten (AEON - NMMU)

Contribution ID: 65

Type: **not specified**

## **Wrap-up: Minerals, Food, Life, Water and Rocks**

*Thursday, 2 October 2014 17:15 (15 minutes)*

**Presenter:** Dr FOURIE, Francois (University of the Free State, Institute for Groundwater Studies)

Contribution ID: **66**

Type: **not specified**

## **Wrap-up: Strain**

*Friday, 3 October 2014 11:30 (10 minutes)*

**Presenter:** Dr FOURIE, Stoffel (TUT)

Contribution ID: 67

Type: **not specified**

## Matjiesfontein GeoTrail Walk

*Tuesday, 30 September 2014 09:00 (2h 30m)*

Opening of the Matjiesfontein GeoTrail developed by final Inkaba Sub-Project 1.1 DTech students, Ms Danel van Tonder (TUT/UNW) and Mr Leon Croukamp (SU). Accompanied Walk with Prof. Erik Holm (Entomologist) on the Matjiesfontein GeoTrail to search and identify some of the Karoo's unique insects and spiders. As a renowned South African Entomologist, Prof. Holm will be able to share interesting and unfamiliar facts and figures about these insects and spiders on the Matjiesfontein terrane.

**Presenter:** Prof. HOLM, Erik (Private)

Contribution ID: **68**

Type: **not specified**

## **Insects and Spiders of the Karoo**

*Monday, 29 September 2014 15:50 (40 minutes)*

**Presenter:** Prof. HOLM, Erik (Specialist Entomologist)

Contribution ID: 69

Type: **not specified**

## **Wrap-up: Shale Gas Round Table Student Discussion**

*Thursday, 2 October 2014 09:00 (30 minutes)*

**Presenter:** Mr KRIGER, Robert (NRF)



Contribution ID: 70

Type: **Poster (All students)**

## 3-D Karoo basin reconstruction from ambient passive seismic noise

*Wednesday, 1 October 2014 11:40 (20 minutes)*

The increased interest in the potential shale gas extraction within the Karoo basin is raising concerns regarding the potential impact it may have on this fragile environment. In order to be in the possible position to moderate any negative effects associated with possible hydraulic fracturing, a scientifically thorough base-line of this region will need to be obtained. Since our current geophysical knowledge of this complex region is incomplete, we have set out to survey the sub-surface geology, as well as determine the intrinsic seismic activity using ambient passive seismic measurements.

In this study, passive seismic network of 20 three-component (N-S, E-W, vertical) geophones will be deployed for predetermined periods in various areas of interest in the Karoo. Ambient seismic signals up to frequencies of 160 Hz can be monitored. The data acquired from the three component seismic sensors results in a time signal that needs to be converted to a velocity signal. The highly non-linear inverse problem created from the retrieval of the velocity variation of the travel times is numerically solved using Green's cross correlation function to construct the 3-D map. Thus, passive seismic velocity inversion tomography is a technique that uses group velocities, derived from continuous ambient noise propagating through the Earth's crust to construct 3-D imagery of its sub-surface.

This technique allows for easy deployment of seismic stations, requires no induced source, can reach highly sensitive areas, is environmentally friendly and is more cost effective compared to active seismic techniques. It is envisaged that the use of the ambient noise passive seismic survey in the Karoo basin can aid in gaining better understanding of the sub-surface geology and to complement other techniques in determining the locations of potential gas bearing formations.

Keywords: Seismic, 3-D construction, velocity

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**Presenter:** Mr BEZUIDENHOUT, Lucian (Nelson Mandela Metropolitan University)

**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 71

Type: **Poster (All students)**

## Baseline Geochemical study of the natural gas and Karoo formation waters prior to Fracking

*Wednesday, 1 October 2014 11:10 (10 minutes)*

The potential for shale gas extraction in the South African Karoo has been one of the most controversial issues because of the unknown extent of socio-economic and environmental impacts. Although we can learn about the pros and cons of shale gas development from the US and other countries, South Africa's unique geology and semi-arid climate makes the extraction of gas more complex. South African geohydrological challenges include limited water resources, gaps in geohydrological research, potential release of the thermogenic gas into the shallow aquifers and dolerite intrusions associated with high yielding wells that create preferential pathways for water between solid dolerite and adjacent Karoo sediments.

The aim of this research is to establish a geochemical baseline data of groundwater resources in the South African Eastern Cape Karoo by primarily focusing on methane gas emissions (with emphasis on previously deep Soekor boreholes), the origin of methane gas and the analysis of current water quality. Stray-gas discharge via connected fractures into shallow formation waters or to the surface can result in contamination of domestic groundwater and air.

Isotope characterization of  $^{13}\text{C}/^{12}\text{C}$ ,  $^{18}\text{O}/^{16}\text{O}$  and  $2\text{H}/^1\text{H}$  ratios analysed by the Picarro cavity ring-down spectrometer and Gas Chromatograph-ICP-MS will be used as environmental tracers to fingerprint the origin of methane and also evaluate whether gases originating at deeper horizons will have impact on shallow aquifers. Compilation of historic and current water quality results will be used to compare and construct a database of groundwater quality, characterise the groundwater type and status. Along with laboratory experiments, computational (chemical-mass-transport models) studies will be conducted to further reach the objectives of the research.

The geochemical database from this research will serve as benchmark against which future groundwater qualities can be evaluated to identify contaminant impacts that might originate from deep wells. The understanding gained during the research is likely to be valuable to farmers, communities and government institutions affected by deep drilling, hydraulic fracturing (fracking) and other processes related to the shale gas development.

Keyword: Isotopes, Methane, Natural gas, Karoo water quality, Fracking, Hydraulic Fracturing

**Primary author:** Ms MOKOENA, Moipone Precious (AEON - NMMU)

**Co-author:** Prof. DE WIT, Maarten (NMMU AEON)

**Presenter:** Ms MOKOENA, Moipone Precious (AEON - NMMU)

**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 72

Type: **Poster (All students)**

## **FRACTURE SYSTEMS in the Karoo basin: Differentiating brittle structures related to DYKE AND SILL EMPLACEMENT from those related to Tectonics**

*Wednesday, 1 October 2014 10:20 (10 minutes)*

The Karoo Basin is an area intruded by dolerite sills and dykes. It is also speculated that those dolerite rocks may have intruded through pre-existing fractures. Fractures are well known as joints by geologists. Fractures are commonly formed when the stress exceed the rock strength and they acts as pathways to the hydrocarbon migration, water and other fluids during Karoo dolerite emplacement.

The presence of opening of natural fractures networks in the Karoo Basin defines an economic shale gas potential. This project is going to explore the tectonic fracture systems and fractures related to the emplacements of dolerite sill and dykes. The emplacement of the dolerite dykes and sills are going to be modeled from the coastal plain of the Eastern Cape Province coastal region toward the Lesotho Escapement in order to test their chemistry and geochronological relationships. The density of joints will be statistically analyzed and joints density will establish the relations of joints with faults, lithology types and intensive brittle deformations.

The fracture or joint systems will be analyzed using the stereo-plot open source software. Fractures can display self-similarity pattern, their geometry is also going to be tested using ImageJ software. The GIS and remote sensing will be used to compile satellite images and map productions of the Shixini area geology. A radiometric dating technique is going to be used to date dolerite sill and dykes from the coast towards inland emplaced dolerites in order to establish and to test emplacement relationship. The outcome of this project could be an open window to the decision makers and could stimulate more interest on more studies to be conducted to understand the Karoo well before fracking could take place.

**KEY WORDS:** Fracture systems, dolerite dykes and sill, Fracking, Fractals and geochronology

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**Co-author:** Prof. DE WIT, Maarten (AEON - NMMU)

**Presenter:** Mr MUEDEI, Thomas (AEON - NMMU)

**Session Classification:** Shale Gas

**Track Classification:** Oral and Poster Presentation

Contribution ID: 73

Type: **not specified**

## **Introduction to Shale Gas**

*Wednesday, 1 October 2014 09:00 (15 minutes)*

**Presenters:** COLE, Doug (CGS); Prof. DE WIT, Maarten (AEON - NMMU)

**Session Classification:** Shale Gas

Contribution ID: 74

Type: **not specified**

## **INVITED LECTURE (Shale Gas): Karoo GeoHydrology**

*Thursday, 2 October 2014 16:00 (30 minutes)*

**Presenter:** Mr DE LANGE, Fanie (IGS UFS)

Contribution ID: 75

Type: **not specified**

## **Introduction to Topics**

*Wednesday, 1 October 2014 09:15 (10 minutes)*

**Presenter:** Ms GEEL, Claire (NMMU Masters Student)

**Session Classification:** Shale Gas

Contribution ID: 76

Type: **not specified**

## **Shale Gas Discussion**

*Wednesday, 1 October 2014 12:35 (25 minutes)*

**Session Classification:** Shale Gas

Contribution ID: 77

Type: **not specified**

## **Hotel Check-In Hotel Reception**

*Sunday, 28 September 2014 12:00 (5 hours)*



Contribution ID: 78

Type: **not specified**

## **Light Lunch - Hotel Dining Room**

Contribution ID: 79

Type: **Poster (All students)**

## **Evaluating shale-gas potential by analysing (organic) shale facies, micro-mineralogy and desorption capacity, Whitehill Formation, Karoo, South Africa**

The Whitehill Formation has been identified as a significant potential area with organic rich shale in the Karoo Basin of South Africa for the exploration of shale gas. The study aims to investigate the gas resource potential (gas in-place) of the Whitehill Formation, lithofacies distribution of the shale and properties as well as the processes that lead to accumulations of gas. This will commence with as a field oriented characterisation of shale lithofacies and their continuity. If natural fractures are non-existent, then, but not exclusively, adsorption and desorption capacity of gas will be measured. Research activities will involve integrating lithostratigraphic analysis, organic geochemical and, mineralogical properties of gas shale as well as comprehensive analysis of its hydrocarbon system. Also, the geological parameters of the rock mechanism from investigation of the desorption capacity of the shale gas will be used to determine its producibility. In order to achieve these objectives, an integrated approach will be adopted which include; petrographic (scanning electron microscopy and x-ray diffraction) for shale diagenesis, geochemical (total organic carbon and kerogen type), maturation (vitrinite reflectance), and sorption isotherms analyses. The integrated parameters will be used in a model of the predictive indices for unconventional hydrocarbon exploration in frontier basins.

Keyword: shale gas, lithofacies, organic geochemistry, adsorption, desorption and Whitehill Formation

**Primary author:** Ms OGHENEKOME, Monica (University of the Western Cape)

**Presenter:** Ms OGHENEKOME, Monica (University of the Western Cape)

**Track Classification:** Poster Presentation