Dr John Hancox, Managing Director, Caracle Creek International Consulting Coal

Dr John Hancox is a graduate of the University of the Witwatersrand with a B.Sc. (Hons.) Geology/Palaeontology and a Ph.D. focussed on the formation and fill of the Main Karoo Basin of South Africa. Whilst in academia he was involved in research in the fields of Economic Geology, Sedimentology, Palaeontology and Basin Analysis and has over sixty publications in recognized peer reviewed journals. During this time he lectured for undergraduate, graduate and postgraduate courses at the University of the Witwatersrand. He also currently presents the coal module for the M.Sc. course in economic geology at Rhodes University.

Subsequent to leaving academia he has been involved in dozens of exploration programmes, including coal, oil and gas, uranium, gold (conglomerate and vein hosted), stratiform copper-cobalt, MVT lead-zinc, iron ore, diamonds and platinum. Aspects covered included grass roots exploration to borehole planning, drill rig management, stratigraphic sequence determination, core logging and sampling, QA/QC, database management and modelling. Following from these programmes he has also been involved in the production of numerous in-house reports, as well as technical reports for the London, Toronto and Johannesburg stock exchanges. He has also played an integral role in determining strategic goals for a number of organisations.

Dr Hancox is a member in good standing of the South African Council for Natural Scientific Professions (SACNASP No. 400224/04), a Member and Fellow of the Geological Society of South Africa and the Society of Economic Geologists, a Member of the Geostatistical Association of South Africa, and a Core Member of the Prospectors and Developers Association of Canada. He is also an Executive Committee Member of the Fossil Fuel Foundation. Currently he holds the positions of General Manager at CCIC and Managing Director of CCIC Coal. CCIC (www.cciconline.com) is a professional geological consulting company with offices in South Africa, Zambia and Canada, that provides a wide range of geological services to the mineral exploration and mining industries. CCIC has significant experience in auditing and reviewing resources for a large range of projects and commodities including coal, copper, copper-gold, copper-uranium, diamond, gold, iron, lead-zinc, platinum group elements and uranium. The Coal Company in particular has considerable experience in the coalfields of Sub-Saharan Africa, having undertaken numerous exploration projects in the area for various clients, including most recently in Zambia and Mozambique.

THE KAROO BASINS OF SOUTH-CENTRAL AFRICA

This presentation focuses on the Karoo basins sensu stricto of south-central Africa and looks at the controls on basin formation and their sedimentary fills. Whilst these Karoo aged basins contain various economic commodities, and their sedimentary fills may act as sources for oil, particular emphasis is here placed on the impact of these variables on the formation and preservation of coal.

The Karoo basins of south-central Africa evolved during the first-order cycle of supercontinent assembly and breakup of Pangea, under the influence of distinct tectonic regimes sourced from the southern and northern margins of Gondwana (Cairncross, 2001; Catuneanu et al., 2005). The southern tectonic regime was related to processes of subduction and orogenesis along the Panthalassan (palaeo-Pacific) margin of Gondwana, which resulted in the formation of a retroarc foreland system referred to here as the Main Karoo Basin (‘MKB’). Within this tectonic setting, primary subsidence (and the creation of accommodation space for sedimentary fill) was controlled by flexural (supralithospheric) and dynamic (sublithospheric) loading.
The MKB is undoubtedly the best studied and most complete Karoo succession and preserves the reference section for the Late Carboniferous–Middle Jurassic Karoo time. The MKB has also previously been considered as the type basin for the coal-bearing deposits of southern Africa (Cadle et al., 1993). The stratigraphy of the Karoo Supergroup in the MKB is markedly different between the southern (proximal) and northern (distal) regions of the basin and these differences reflect contrasting tectonic histories across the flexural hinge line of the foreland system. Coal formation is restricted to three intervals of geologic time, these being the Early Permian Vryhied Formation, the Middle Permian Beaufort Group, and the Late Triassic Molteno Formation.

North of the main Karoo Basin, the tectonic regimes were dominated by extensional or transtensional intraplate stresses that were either linked to the orogenic loading, or propagated southwards into the supercontinent from the divergent Tethyan margin of Gondwana. Superimposed on the tectonic control on basin development, climatic fluctuations also left a mark on the stratigraphic record, providing a common thread that links the sedimentary fills of all the Karoo basins, even those formed under different tectonic regimes. As a general trend, the climate changed from cold and semi-arid during the Late Carboniferous to Early Permian interval, to warmer and eventually hot with fluctuating precipitation during the rest of Karoo time.

References


Lopo Vasconcelos is professor at the Geology Department of Eduardo Mondlane University (UEM), where he graduated in 1975 and working there since then. He got his PhD in 1995 in Porto University Portugal, with a thesis on the Moatize coals.

Lopo Vasconcelos was head of Geology Department of UEM for several times, especially during the difficult times after independence (1976-1980) and later, after the peace agreement (1997-2000).

He has been involved in several planning discussion groups leading to the strategic plans of the University and of the Higher Education in Mozambique.

He is the founder of the Geological Mining Association of Mozambique (AGMM) and was its president from 2003 to 2010. He was Vice-President of the International Committee for Coal and Organic Petrology (2003-2010) and of the Geological Society of Africa for Southern Africa (2004-2013).

Currently he belongs to the council of the International Association for Geoethics (IAGETH) being its African representative.

**COAL DEPOSITS IN MOZAMBIQUE – AN OVERVIEW**

Permian coals of Mozambique occur in intra-cratonic rifts that belong to the Karoo Supergroup, spreading from Upper Carboniferous to Early Jurassic, starting with a sedimentary sequence and ending with an igneous episode in the Lower Jurassic. The main coal basins occur in Tete and Niassa Provinces, with some scattered small basins in other areas. Igneous activity was not recorded in the Karoo areas of Niassa Province. Coal seams occur mainly in the Moatize Formation (Tete area) and in Ecca Group (Niassa area). Matinde Formation, overlying Moatize Formation, can also contain coal seams.

Coal basins start with glacial/peri-glacial sediments (absent in the northern basins of Niassa), followed by a gradual change in the sedimentation into fluvial/lacustrine and, ultimately more arid and warm environments at the end of the Karoo. Very little data exists on Niassa coals, where only now some systematic prospecting is being carried out.

Coal rank varies from mostly Bituminous-B in Mucanha-Vúzi to Bituminous-B and Bituminous-A in Moatize-Minjova. Further SE it reaches anthracitic stage due to contact with many dolerites intruding the area. Typically the petrographic composition is dominated by vitrinite. Moatize has some coals with higher content of Inertinite and Mucanha-Vúzi with higher content of Liptinite. As for Gondwana coals in general, Mozambican coals are rich in mineral matter finely intergrown with organic matter. Total sulphur is moderately low-medium, reaching higher values in some horizons.

According to governmental information, present coal resources amount to 25,439 Million Tonnes (inferred: 11,348, indicated: 10,496 and measured: 3,585 million tonnes)).
Andy Lloyd has a degree in Geological Sciences from University of Leeds and an executive MBA from University of Cape Town. He has been with Rio Tinto for 19 years in Africa, working on Diamonds, Mineral Sands, Nickel, Iron Ore and Coal. He is currently Exploration and Resource Manager for Rio Tinto Coal Mozambique, which with 32 drill rigs and a budget of $90M was the largest exploration programme in Africa in 2012.

A SEDIMENTOLOGICAL MODEL FOR THE MOATIZE BASIN

Work completed by Rio Tinto Coal Mozambique over the past 5 years has produced more than 2000 drill holes covering a 100km strike length through the main Moatize – Minjova basins. This core library and drill hole database has allowed the development of a regional sedimentological model for the area.

This sedimentological model shows how the Permian coal measures of this area were deposited in half-graben extensional setting during frequent base level changes. Sediment influxes are characterised by transgressive and regressive cycles, depositing alluvial facies through to shallow marine facies. Field units are characterised by fining upwards sandstone units undispersed with channel splay related shale’s, mudstones and coals occasionally interrupted by hiatus’s of coarsening up sequences.

The integration of remote sensing, surface mapping, down hole geology and down hole geophysics has resulted in the construction of a type log for the main sedimentological sequences and a 3D image of the basinal formational environments.
Peet Meyer studied at the University of Pretoria and started his working career in 1990 with Anglo American Corporation as exploration geologist in the coal division.

He left Anglo American to start up an exploration drilling company. In 2000 he joined Total Coal as operations geologist and learnt all about coal mining, particularly the joys and tears of thin seam coal mining. During this time he completed a M.Sc in Earth Science Practice and Management, specializing in the economics of thin seam coal mining. In 2005 he joined BHP Billiton and was appointed Resource Manager at Optimum Colliery.

His exposure to junior exploration companies started in 2006 when he joined ASX-listed Aquila Resources as exploration manager for their coal properties in Mozambique and Botswana. During 2007 he started consulting on coal to various companies in Mozambique, Botswana and South Africa. He has written numerous Competent Persons Reports for coal exploration companies of which some are listed companies.

PC Meyer is a member of the South African Geological Society and registered Competent Person in both South Africa and Mozambique.

THE MOZAMBIQUE COALFIELDS AND CURRENT DEVELOPMENTS

Mining started at Moatize in 1926 and carries on until today. Since the year 2004 there has been renewed interest in the Moatize Coalfield of Mozambique. Companhia Vale de Rio Doce (CVRD), later to be renamed Vale CA, started this by acquiring a substantially size exploration licence near the town of Moatize. This was followed by a rush from different junior exploration companies to get a stake in the area. Millions of dollars were spent on exploration the past four years and some of these projects are entering into the construction phases of the mines.

The Mozambique Coalfields consist of 6 main basins of which the Moatize-Minjova Basin is the most prominent and contains the high grade coking coal. There is too a great interest in the Mucanha-Vuzi Basin, north of Cahora Bassa, but exploration is hampered by access problems north of the lake.

The Mozambique Coalfields are structurally very complex and a challenge for coal explorers. Coal qualities are very variable and the structural features determine mining methods and concomitant production rates. Of the current operators in the area, the highest production will come from Vale followed by Riversdale. ENRC (project halted) at Chitima and JSPL (Chirodze) are mining and JSPL transport coal by road as oppose to rail from Moatize.

Capital investments of billions of dollars have been spent by various companies exports are still slow from the Moatize-Minjova Coalfield. Exports will take place via rail to Beira and later to Nacala while some coal will travel by road to their respective markets.
Gavin Andrews, Senior Technical Advisor, The Mineral Corporation

Gavin studied for his undergraduate degree in geology at the University of Edinburgh before taking up employment on the African continent. He now has over 20 years’ experience in various exploration roles for commodities ranging from precious metals to coal and oil and has worked in a number of African countries. In 2002 Gavin completed a Master’s degree in Exploration Geology through part-time studies at Rhodes University and shortly afterwards spent several years in South America. From 2007, he was based in Mozambique where he ran the coal exploration activities of an AIM-listed company in the Tete Coalfields. For the last few years, Gavin has worked with advisory firm The Mineral Corporation, with a focus on coal and in particular the emerging Mozambican coal sector. Projects have ranged from desktop assessments to drilling programme management, resource modelling and due diligence studies.

SECURING THE VALUE OF YOUR EXPLORATION AND GEOLOGICAL WORK; THE FOUNDATION OF YOUR RESOURCE ESTIMATES AND FEASIBILITY STUDIES

An exploration investment is realised by shareholders in the resultant Resource Statement and Feasibility Studies. For listed companies, bound by reporting codes such as SAMREC or JORC, an independent third party will probably carry out or review the resource estimates and mining studies. At that stage, exploration data may be rejected because the geological and exploration work has not been conducted to sufficient standard. Value destruction lies not only in the wasted direct exploration costs and time, but also potentially in the share price if, for instance, an Indicated Resource has been anticipated but only an Inferred Resource delivered. This presentation addresses some aspects of the geology and exploration of the Tete Coalfields which, if not competently addressed, could lead to wasted exploration expenditure or a resource downgrade.

The Tete Coalfields extend for over 400km from Cahora Bassa Lake to the Malawi border. The coals are not homogeneous over that strike and this must be borne in mind when considering a target area for a specific coal product. Significant lateral changes occur in the coal seam stratigraphy and coal quality on a regional scale and in the frequency of post-Karoo Supergroup intrusions which may deleteriously affect the coal. Attempts to pull correlations back to the traditionally recognised stratigraphy of the central Moatize Sub-basin may, in all but the broadest geological sense, be misleading. Coal rank to a large extent determines the nature of potential coal products and rank varies laterally across the field and with depth. The rank/depth relationship illustrates the need for structural understanding as faulted blocks may have been buried to different depths, affecting the nature of potential coal products such as coking coal.

Both stratigraphic and faulted Karoo Supergroup/Basement contacts occur. The lower coal zones generally contain the higher-yielding coal horizons and, given that underground mining is not currently a preferred mining option, outcropping or near surface occurrences of the lower coal zones represent the prime exploration targets. In this context, it is important to differentiate between stratigraphic Karoo Supergroup/Basement contacts and faulted contacts. Aeromagnetics may assist with this exercise and field mapping is indispensable.

On a project scale, lateral sedimentological variation can be rapid and, for that reason, coal zone and ply correlation is one of the most challenging aspects of modelling coal resources in the Tete Coalfields. Continuity is key to the definition of a coal resource and must be demonstrated through correlation. If there is no convincing correlation there can be no reportable resource. Correlation is therefore an essential component of any exploration
campaign and must be conducted as the campaign advances. In order to facilitate correlation, drilling programmes may need to be conducted on a flexible and iterative basis, under the control of the geologist and taking on-going results into account, rather than on a simple, pre-planned grid.

Features which affect coal seam distribution and continuity include:

- Basement topography;
- Syn- and post-depositional faulting;
- Seam splitting and pinch outs;
- Channel scours; and
- Intrusions.

Basement topography often exerts a fundamental control on the nature and distribution of the coal, particularly in the case of the lower coal zones, and every effort should be made to intersect Basement when drilling. This will facilitate coal zone correlation. Field geologists must recognise the difference between Basement contacts and intrusive contacts, and true Dwyka Group (Vúzi Formation) units as opposed to diamictic units of other origins. If boreholes are stopped short, uncertainties will be introduced to the geological model which may result in parts of the resource classification being down-graded.

Both large and small scale faulting is common and frequently translates into drilling difficulties due to poor ground conditions. There is evidence that significant coal zone facies changes can occur across the larger displacement faults.

Many areas are heavily intruded by dolerite dykes and sills. In places, acid intrusives also occur. The devolatilisation and coal densification caused by these intrusions compound the correlation difficulties. Structural displacements induced by multiple transgressive sills can be difficult to model in thick, multi-ply coal sequences and additional boreholes may be required to resolve the structure of the intrusives. Heat-affected coal areas in the vicinity of intrusions may have economic value given modern boiler design and gasification technologies and could potentially be included in resource estimates, provided that they are clearly defined and adequately delineated and sampled during the exploration programme. A concept of potential coal products is therefore required prior to the design of the exploration programme.

In most areas accurate correlation of either coal zones or internal plies is impossible without good down hole geophysics. Resistivity logs aid the identification and correlation of heat-affected coals. Directional surveys are recommended, particularly on open holes. Dipmeter information will aid correlation and structural interpretation. Good geophysical records also allow validation of geological logging records and borehole depths when due diligence exercises are conducted.

The lateral variability of the coal zones, the frequency of faulting and the local abundance of intrusions may impact on the appropriateness of resource classifications based on the minimum permissible borehole densities as recommended in the SAMREC sister document SANS 10003:2004. Careful consideration must be given to the nature of the geological regime and, in particular, to the level of confidence in the coal seam/ply correlations prior to resource classification and such matters need to be considered when drilling programmes are designed.

Core recovery is an issue in the Tete Coalfields. It is best to drill as large diameter core as can be afforded (at least HQ), to employ experienced drillers and to use triple tube techniques. Intervals of low recovery may not be admissible and could result in a downgrade of the anticipated resource classification.

The resource modeller may also discard any boreholes for which collar survey data appears erroneous or cannot be validated, for instance against the DTM. Any boreholes in which the
down hole geophysics does not match the logged geology or seam intervals, or in which analytical data conflicts with sample descriptions or geophysically logged densities could also be rejected. All exploration data should be validated by the Project Geologist in order to minimise such rejections. A useful method of validating the data is through integrated graphic presentation of geology, geophysics, samples and analytical data on strip logs.

A coal resource tonnage must be reported with appropriate coal quality parameters. The sampling and analytical programme must therefore be well planned, comprehensive, consistent and suited to the nature of the targeted coal products. Lack of suitable analytical data or the existence of abnormal trends in, for example, ash/CV/RD correlations may lead to a resource downgrade.

Given the importance of accurate correlation and relevant sampling, a recommended resource definition strategy is to drill open boreholes, run an appropriate suite of geophysical tools down hole, correlate the coal zones and plies and any dolerite intrusions and only then follow up with targeted core drilling and sampling.

The exploration programme and subsequent geological model are the foundation on which resource estimates and subsequent mine plans are built. It is important to ensure that the information is correctly gathered, interpreted, stored and utilised. If not, significant project value may be destroyed.
Dr Annette Götze, Rhodes University

Prof Annette E. Götz works on sedimentary basins in Europe and Southern Africa, applying palynofacies analysis to high-resolution cyclo- and sequence stratigraphy. She obtained her Master and PhD degrees in Geology from TU Darmstadt, Germany and worked at TU Darmstadt and Halle University as Associated Professor in Sedimentology and Palaeontology. From 2012 she joined Rhodes University as the Geology Department’s sedimentologist and her recent research focusses on coal deposits as palaeoclimate archives.

MOZAMBIQUE’S COAL DEPOSITS: UNIQUE PALAEOCLIMATE ARCHIVES OF THE PERMIAN PERIOD

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The Permian coal-bearing formations of the African Karoo basins play a crucial role in the study and for the understanding of Gondwana’s climate history and biodiversity in this time of major global changes in terrestrial and marine ecosystems. Here, we report on new palynological data from the Tete Province in Mozambique, covering a 200 m thick stratigraphic interval which represents an equivalent to the Upper Ecca Group of the Main Karoo Basin. The studied core material of postglacial fluvo-deltaic deposits yields diverse palynomorph assemblages with characteristic stratal changes, documenting palaeoenvironmental and palaeoclimatic signals.

Generally the palynofacies is characterized by a high amount of opaque phytoclasts pointing to swamps and flood plains abundantly covered with vegetation. The spore/pollen ratios, used as a proxy for humidity changes, indicate short-term changes in palaeoenvironment. A long-term palaeoclimate signature is recorded by vegetational elements characteristic of warm temperate climate conditions: bisaccate taeniate pollen grains are dominant within the pollen group and increase upsection, spores on the other hand show an opposite trend.

Ongoing studies focus on deciphering Gondwana’s climate history by major vegetational changes, applying palynofacies analysis as high-resolution correlation tool. Mozambique's coals provide an excellent palaeoclimate archive and are an important source for sedimentological and palynological data, serving to identify the major signatures of a phase of prominent climate amelioration on basin-wide, intercontinental and intra-Gondwanic scales.

Keywords: Palynology, Palaeoclimate, Permian, Karoo Basins, Gondwana, Mozambique
Lyonell Fliss, Principal, Lyonell Fliss & Associates (LFA)

Born in Iassy – Romania and studied Civil Engineering at the Technical University of Bucharest and Mathematics at University of Bucharest

BSc in Civil Engineering, MSc in Industrial Civil Engineering, Professional Engineer (Pr Eng- South Africa) specialist in Industrial Civil Engineering
Established in South Africa since 1975

Served as Chief Civil Engineer of EMS and Murray & Roberts Engineering Solutions from 1975 to 2001 when retired.
Presently with his own firm Lyonell Fliss & Associates (LFA) consulting since 2002 for major industrial projects in SA and abroad.
Designer of major industrial complexes in SA and abroad for most of the sectors of heavy industry, mining and industrial harbors, including container terminals, export stockyards at Saldanha, Richards Bay, and silos at Matola-Mozambique.

Designer of major coal mining civil engineering infrastructure, including large bunkers and overland conveyors at Isibonelo AAC, Optimum BHP Billiton, Impumelelo, Shondoni (at present under construction) Sasol.

Lecturer at WITS University on Integrated Engineering
Some of his projects received Fulton awards and commendations

MODERN INFRASTRUCTURE IN COAL INDUSTRY WITH REFERENCE TO MOZAMBIQUE COAL

Coal Mining Developments include in general large Material Handling and Storage facilities and the Civil Engineering Infrastructure for Coal Mining has its specific aspects compared with other sectors of the mining industry.

As coal is an important commodity for local usage but mainly for export, the new developing Mozambique coal industry which combines mining, land transportation and coastal export terminals, considering its potential large scale operation, will require amongst other engineering features a modern infrastructure to sustain this industrial enterprise.

Specific of Mozambique conditions for its coal mining industry are the location of the coal mining deposits (Moatize area) relatively isolated from industrial developments and large distances to the potential coastal exporting ports (Beira, Nacala, Matola).

In addition to the location conditions, the coal mining in Mozambique is affected by the tropical climate particularly aggressive at the coast due to marine environmental factors.

To overcome these specific adverse conditions, it is necessary regarding at least the infrastructure, that the engineering concepts should address problems of durability, constructability and maintenance, within the cost and time available for the whole development.

The paper presents innovative concepts for the characteristic coal mining industry infrastructural main elements, with working solutions in the form of already built structures in operation and under construction or R&D prototypes, as examples.

In our opinion the proposed concepts are applicable in the case of Mozambique coal mining industry and their advantages are discussed.

A brief description of newly developed infrastructural elements including, precast coal bunkers, overland minipile sleepers and frames using high performance concrete, illustrates the topic.
James Derbyshire, Process Engineer, DRA Mineral Projects

Process engineer employed by DRA Mineral Projects. He has 5 years mineral processing experience on design and project implementation. James has worked on projects in South Africa, Mozambique and the DRC. He has dense medium separation experience in Coal, both thermal and coking, Copper, and iron ore. Some of the projects he has been on include final design and commissioning of the 2000tph DMO wash plant, Final design and commissioning of Kipoi copper pre-concentration plant, design and commissioning of the Jindal coking coal plant as well as providing commissioning support for several other projects.

ASPECTS OF COAL PREPARATION IN MOZAMBIQUE

The principle objective of the presentation is to show how the Mozambique coal characteristics need to be taken into account with regards to Dense Medium Separation circuit design and consideration on washing the entire size range compared to a split wash. The benefits of fine coal separation on coking coal yield will be touched upon with regards to spiral plants and floatation.

The DRA in-house simulation software was used with EPM inputs taken from running plants and generic washability tests from the region.

We will take into consideration a process solution balancing operational complexity and coking coal yield through multiple Dense Medium Circuits with floatation and fine coal separation added to further increase coking coal yield.
Danie Krige, Global Iron Ore and Coal Consultant, Tenova Mining & Minerals

Danie has extensive senior management experience in Iron Ore and Coal business development with over 30 years experience in bulk materials processing and project development. His main area of expertise is in Iron ore and Coal. Located in Johannesburg, Danie has been involved in all aspects of mineral processing from Plant Metallurgist, Plant Metallurgical Manager up to Head of Metallurgy for a large Mining Corporate Company.

Danie currently operates as a Global Consultant for Tenova Bateman Technologies on Iron Ore and Coal projects with the aim of providing clients with a high level of technical expertise for Processing, QA and End User aspects of developing a Project.

MODULAR PLANTS FOR AFRICA

The Tenova name is introduced in the Modular Process Plants industry and then linked to the previous well-known brand of Bateman.

The advantages of modular plants are discussed with specific reference to being manufactured and supported from South Africa for Africa.

Three general flow sheets of hydro-mineral processing and bulk mineral processing are discussed to point out what modular units are already available. A reference list is also presented.

The topic of “When to choose modular units” wraps up the presentation.
Lopo Vasconcelos is professor at the Geology Department of Eduardo Mondlane University (UEM), where he graduated in 1975 and working there since then. He got his PhD in 1995 in Porto University Portugal, with a thesis on the Moatize coals.

Lopo Vasconcelos was head of Geology Department of UEM for several times, especially during the difficult times after independence (1976-1980) and later, after the peace agreement (1997-2000).

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Currently he belongs to the council of the International Association for Geoethics (IAGETH) being its African representative.

**GEOETHICS – URGENTLY NEEDED**

A definition of Geoethics according to IAGETH (International Association for Geoethics) is presented and discussed. The concept of Ethics (and Professional Ethics) and its meaning according to individuals, societies, etc. is also discussed as well as the deontological duties of geo-professionals. Reference is made to the difference between deontology and ethics. The Spanish Code of Deontology is presented as an example, describing the guide-lines and responsibilities for geoscientists. Reference is made to the International Declaration of Geoethics which lists some indicators for the development of Geoethics and its relation with sustainable development. Reference is also made to the role mineral resources can have in a country – benefit or curse. Finally, a description of what is being done in Mozambique through its Geological Mining Association (AGMM), in Africa (in collaboration with the Geological Society of Africa) e in the World (through IAGETH).