

## Development of a proposed geo-science train

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### ABSTRACT

The proposed Geo-Science Train (GST) facility will promote scientific research, science advancement, accumulation of scientific knowledge, service delivery of a geoscientific nature and training as its main objectives. It will attempt to reach South Africans from all walks of life strengthening the Public Understanding of Science Engineering and Technology (PUSET) program of the Department of Science and Technology (DST), but special attention will be given to rural areas and communities.

The facility will be a mobile geological survey and science centre, strengthen the science awareness program of DST through the network of science centres, by hosting science exhibitions on board that will move with the train from town to town. More children and adults will be reached who would otherwise not have had the means or opportunity to view these science exhibitions.

Training of students (to PhD level) through Research and Mapping of areas visited by the Geo-Science Train will contribute directly to education and economic development of the rural areas in South Africa. The Geo-Science Train will create an avenue for international research consortiums (e.g. Inkaba yeAfrica and SAMTEX) to make direct contributions towards the training of South Africans by promoting the understanding of the resources of South Africa.

Services by the Geo-Science Train will be geared as training and service delivery. Day to day problems of rural communities and municipalities, such as clean drinking water, sources of suitable local building materials and the placement of waste sites and cemeteries will also be addressed from this facility.

The train can provide access to a post box of the Department of Home Affairs, making it possible for persons in the rural areas to do applications for documents (I.D., birth certificates etc.). The contents of the post box will be delivered to the Department upon the return of the Geo-Science Train to Pretoria, approximately once every 3 months. Funding should be from government and industry.

**Key words:** Geo-Science Train, Education, Training, Rural Communities, Service Delivery.

### INTRODUCTION

The Geo-Science Train is currently a concept and in the advanced planning phase. We envisage this facility as a compact but complete geological survey on wheels, with the capacity to house all its personnel, equipment and vehicles. It will be fully sustainable in terms of water and electricity and it will be completely environmentally friendly (e.g. closed sewerage system and some energy supplied by solar panels). The train will house various science exhibitions and provide lectures of interest to the community (e.g. a telescope on board). It will also be a vehicle of excellence by producing high level training and research, by mapping the geology of South Africa. Operations in other Southern African Development Community (SADC) countries are possible (Botswana and Namibia operate the same railway gauge).

The Geo-Science Train will make a major contribution to all of the mentioned areas. It will complement all the strategies of the Department of Science and Technology (DST) by strengthening strategies such as the Public Understanding of Science and Engineering Technology (PUSET), Youth into Science Strategy and the Network of Science Centres. It will contribute directly to the PUSET programme by providing scientific services to all the communities of South Africa (e.g. foundations, building materials and groundwater etc.) and through lectures by specialists on board. Presentation giving of lectures on board the train and the display of science and museum exhibitions will be essential for the Youth into Science strategy programme. The train will also be a mobile science centre and will fit comfortably into the science centre development drive of DST. The training of students on research, exploration and mapping

projects will increase the number of students able to reach doctoral level.

The facility will contribute directly towards service delivery in South Africa. Ground water exploration can be done on behalf of the Department of Water Affairs and Forestry (DWAF) in certain areas of South Africa from the train to aid in the process of supplying clean and safe water to the communities. Service delivery of a geological nature may include identification of sources of local building materials and assisting municipalities with the correct and safe placement of cemeteries and waste sites. The train could also have a Department of Home Affairs postal box on board to assist the communities with the application of identity documents and birth certificates etc. A small library on board with maps and reports of the specific area that is visited will be available to the persons in the community that are interested in such information,

Research and mapping of areas visited by the Geo-Science Train will contribute directly to the economic development of South Africa. Vast deposits of Uranium ore in the Great Karoo are to a large extent unmapped and under evaluated. Detailed mapping and evaluation could successfully be done from the train as a base. Academic research consortiums (e.g. Inkaba yeAfrica and SAMTEX) that study the deep structure of the earth can make a direct contribution to the understanding of the resources of South Africa. This is one example of a very large project that can be executed from the train.

Although government will most probably be the largest funder of this project, returns on the investment will be immeasurable for South Africa.

**CURRENT EDUCATION SITUATION**

South Africa is currently not amongst the world leaders with regard to science education, science performance and scientific research. Various factors contribute towards this situation, but science exposure and science education are very important factors.

South Africa has very large rural areas where facilities and especially science facilities at schools are very limited. Science awareness centres, science exhibitions and museums (with discovery centres) are mostly situated in larger metropolitan areas. The children and young people of rural areas never have an opportunity to see these exhibitions unless they visit these cities by chance.

South African students are mostly not exposed to the latest technologies and equipment due to a lack of funding. South African universities are usually not in a position to co-ordinate, initiate or participate in very large international research projects due to the lack of capable supervisors and sufficient funding.

The task to reach all these thousands of school children is enormous. Currently there are about 12, 5 million children in South Africa attending school [2]. There are 740 000 students at Universities (all disciplines) and of those only 500 students obtain masters or doctoral degrees in science and engineering.

The amount of school children varies in the different provinces in South Africa. The provinces with smaller numbers of school children usually have lower population densities and usually also cover vast areas (e.g. the Karoo and Northern Cape Province). The next table shows the total number of South African school children in each province in 2005.

Province	Number of children (million)
Limpopo	1.47
Mpumalanga	0.72
North West	0.68
Northern Cape	0.17
Kwazulu-Natal	2.2
Eastern Cape	1.8
Free State	0.6
Western Cape	0.8
Gauteng	1.4

Table1: After Report of the Department of Education – number of school children in South African provinces.

**CURRENT SCIENCE AND RESEARCH SITUATION**

A very large amount of geo-scientific research remains to be done in South Africa. South Africa is adequately mapped at 1:250 000 scale, but not at 1:50 000 scale. Currently only the most important areas are completed in detail, and amounts to about 25 maps, which is only 3%. This illustrates the enormous amount of work that still needs to be done to map South Africa at this level of detail. This detail mapping will have an economic impact on South Africa, as it will reveal possible economic targets and the location of building materials.

South Africa is currently involved with two international Geoscience research initiatives. The "Inkaba yeAfrica" scientific agreement is between South Africa and Germany. It is already in operation for 5 years and a very large number of projects and students have already benefited from this project. A large reflection seismic survey was completed across the Cape Fold Belt into the Karoo as part off this cooperation. Logistically this project would have been much easier if the Geo-Science Train was in operation already, by providing boarding, lodging and infrastructure backup such as storage space and an electronic workshop).

The South African Magneto Telluric Experiment (SAMTEX), which is an shared initiative with Ireland (Dublin Institute for Advanced Studies - DIAS), United States (Woods Hole Oceanographic Institute in

Massachusetts - WHOI), Canada (Canadian Geological Survey - CGS), University of Witwatersrand, (WITS), CSIR, Council for Geoscience of South Africa (CGS), Botswana (Department of Geological Survey - DGS), Namibia (Namibian Geological Survey - NGS) and industry. The main purpose of this research initiative is to preliminarily probe the deep lithospheric structure (up to a depth of 350/400 km) of the Kaapvaal Craton. The Kaapvaal Craton is the oldest surviving continent on earth and constitutes about 75% of South Africa. It extends into Botswana and Namibia. The Kaapvaal Craton is very stable and important for diamond and Kimberlite research.

## **FUTURE SCIENCE AND RESEARCH FROM THE GEOSCIENCE TRAIN**

The Geo-Science Train will be a moving platform to enhance science and technology literacy, but also act as a high level scientific research and education tool. The research that is envisaged includes mapping, geophysics, airborne geophysics, geochemistry, geology and palaeontology. This will provide the opportunity for high level education to university students under competent supervision.

Students will be exposed to research in the international research arena. The facility will create opportunities to be part of relevant and state of the art research. International research cooperation initiatives and agreements such as "Inkaba yeAfrica" and SAMTEX can be supported by a project like this, because it will solve logistical problems and create a vehicle for continued cooperation.

## **FUTURE TRAINING FROM THE GEOSCIENCE TRAIN**

The Geo-Science Train will be a vehicle to educate South Africans of all walks of life, but especially to take educational exhibitions and lectures to children in the rural areas. The extra education of school children will be facilitated through lectures on the train, but also through the exhibitions of museums and science centres. This facility will take the museum and science awareness exhibitions to the children, in the rural areas and other larger town and cities, that would never have the chance to see it otherwise (museums are based only at certain main cities).

This train will reach the remotest areas alongside South Africa's current excellent railroad network, and create opportunities to view the discovery exhibitions of Science Awareness Centres and Museums on the train. It will ensure that learners (and adult learners, including science teachers) from these small, remote rural communities will also have the opportunity to see and experience Geo-Science-on-Track.

Lectures by versed scientists and experts will be delivered on the train. High and medium level training and research to university students under full time mentorship and supervision will contribute directly to High-level and Low-to-middle-level skills development.

The more informal science education of adults will also be catered for through lecturing on station platforms and on the train.

The railway network in South Africa is very extensive (Figure 1). The Geo-Science Train will be a vehicle to educate South Africans of all walks of life, but will especially be a vehicle to take educational exhibitions to children in the rural areas.

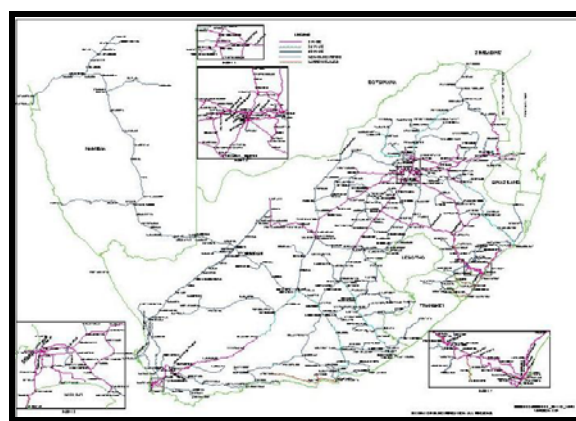


Figure 1: Railway network through South Africa and some SADC Countries.

## **FUTURE SERVICE DELIVERY FROM THE GEOSCIENCE TRAIN**

Although the government is continually involved in projects to provide basic services to the community, there is currently still a large backlog in the delivery of services.

Day to day issues facing rural communities and municipalities, such as the provision of clean drinking water, suitable building material and the placement of cemeteries and waste sites will also be addressed from this facility. The Geo - Science Train will also provide advice regarding alternative forms of renewable energy sources and access to a post box of the Department of Home Affairs, making it possible for persons in the rural areas to do and post applications for official documents (I.D., birth certificates etc.). The contents of the post box will be delivered to the Department every time the Geo-Science Train returns to Pretoria, approximately every 3 months.

A small library on board with maps and reports will be available with information of the specific area that is visited. This will provide information about the area to the community that is usually not so easy to access.

Certain demographic areas of ground water exploration can be done for DWAF from the train to speed up the provision of clean and safe drinking water to the rural communities. Mapping of areas visited by the train will contribute directly to the economic development of South Africa. As an example vast deposits of Uranium ore in the Great Karoo are to a large extent unmapped and unevaluated. This detailed mapping and evaluation could successfully be done from the train as a base.

## ROLLING STOCK FOR THE GEO-SCIENCE TRAIN

In order to provide a fully functional facility to render the envisaged services, the following rolling stock should be acquired. Transnet Freight Rail agreed to sell old rolling stock to the project and consists of:

- 1 Kitchen Car.
- 1 Dining Car.
- 5 First Class Sleeper Coaches.
- 3 Third Class Coaches for Museum Exhibitions.
- 3 Third Class Coaches for Working Space Area.
- 3 Third Class Coaches for Laboratories.
- 2 Baggage Cars for storage.
- 1 Baggage Car to transport cars and motorbikes.
- 1 Baggage car for micro light aeroplane.
- 1 Stainless Steel Water Tanker.
- 1 Baggage car modified as a Power Car (Figure 2).
- 1 Diesel Tanker.
- 1 Bogie to transport Backactors and Auger drills.
- 1 Low bed for telescope.

The rolling stock acquired from Transnet Freight Rail will be second hand coaches. They will be in a less than perfect condition (Figure 2). Coaches would need to be refurbished to meet the design criteria for geological research and services, such as laboratories and storage space. A kitchen car and dining car should be constructed. Meals will be prepared for 30 to 50 persons on board. Sufficient storage space for groceries and cutlery will be required. Clean water should also be standard.

The first class sleeper coaches must be modified to provide each person with his own compartment or single quarters (30 to 50 compartments envisaged), each with its own small bathroom.

In a normal train coach, electricity is generated when the train is moving. Solar geysers will supply the coaches of the Geo-Science Train facility with hot water. Sewer tanks should be fitted for hygienic reasons. A laundry should also be installed.



**Figure 2: An example of an old baggage car that can be refurbished to fulfil in the needs of the proposed Geo-Science Train facility.**

Some third class coaches will be transformed into large exhibition spaces for the museums and science exhibitions. The exhibitions will be designed to be firm and sturdy so that they remain motionless whilst the train is in transit.

Some of the third class coaches will be transformed into large working areas. This will be the areas where map making, computer and data processing and communication will take place. It will be fitted with ample electricity supply points and large table working space.

Some third class coaches will also be transformed into laboratories and equipment storage spaces. The laboratories will be scaled down versions of the laboratories used at the home base.

A baggage car will be converted to transport field vehicles, motor bikes and quad bikes. Two baggage cars will be used for storage and backup support of the drilling rig and back actor. One baggage car will be transformed into a vehicle to transport a micro light aeroplane that will do the airborne geophysical surveying. One baggage car will be transformed into an electricity generator car.

A stainless steel water tanker will be used with an inline water purifier to ensure a constant supply of clean water. A diesel tanker is needed to supply diesel to the power car and vehicles. Solar equipment will also be installed to minimise the use of diesel generated electricity. A low bed will be used to transport the back actor and the drilling rig.

## HOW THE TRAIN SHOULD EQUIPPED

The train should be equipped to render a comprehensive geoscience service on a smaller scale. All equipment should be exclusively procured for the Geo-Science Train. The laboratories and working areas on the Geo-Science Train should include small electronic, geochemical and water laboratories, including data processing areas. The larger working and data

processing areas will have a computer network and also internet facilities.

Laboratories and storage space envisaged are:

- A physical property laboratory.
- A fully functional and equipped electronic and seismology laboratory to repair and modify instruments.
- A fully functional soil characteristics laboratory.
- A basic water quality laboratory.
- A fully equipped petrology laboratory with microscopes and sample preparation.
- Fully equipped Geophysics laboratory.
- Fully equipped micro light for airborne geophysics.
- Storage space for geochemistry samples.
- Storage space for geophysical instruments.
- Storage space for seismometers.
- Storage space for geology samples.
- Storage space for vehicles and drilling machines.

## **CONCLUSIONS**

The Geo-Science Train project will be of immeasurable value to the South African community. It will ensure that:

- A facility is created with the latest technology.
- High level research and mapping is done for South Africa.
- Our students will train with the most recent equipment.
- Study and application of the most recent technology and ideas on relevant research topics.
- Full time mentorship training and research supervision by university students.

Reaching the remotest areas alongside South Africa's excellent railroad network will expose the rural communities to museums and science discovery exhibitions.

Once the Geo-Science Train matures, it will become a mobile entity which forms part of DST's Network of Science Centres. It will also create partnerships between government, universities, science councils and business and stimulate the production of new resources through new mainstream research.

There are numerous benefits to the South African community. The Geo-Science Train will enhance service, training and knowledge and also initiate, execute community upliftment through certain government initiatives. The train will benefit and educate communities to minimise their impact on the environment. The benefits from this train will be immediate and the return on the investment from government would also be immediate. (DST's Human and Social Dynamics; One of four ground challenges for 2008-2018). The number of South African citizens that will be influenced by this project each year will ensure that the price per capita costs are very reasonable.

Services rendered by the Geo-Science Train will be geared for research, training and service delivery to the various communities, and should run for the next 20years.

A very large return on investment is expected:

- Research output, such as publications, MSc's and PhD's.
- Training of the MSc and PhD students.
- Economic potential development, in mostly rural areas.
- Social aspects, especially in previously disadvantaged areas.
- Training and education at all levels.
- Deliverables such as maps and geological information which will benefit the whole country for future economic development.
- Service delivery that is associated with the project, mostly in the rural areas. This includes placement of cemeteries, water divining and finding of building material.

By demonstrating and displaying the value of science to the communities (e.g. by offering building foundation advice, finding building materials and groundwater divining) it will contribute directly to the PUSSET programme.

Finally, the Geo-Science Train will be geared for research, training and service delivery to the community. It will be the only purposes of the facility. Costs will be covered, but the intension is not to make a profit.

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