SOUTH AFRICAN REMOTE SENSING ATLAS

science & technology
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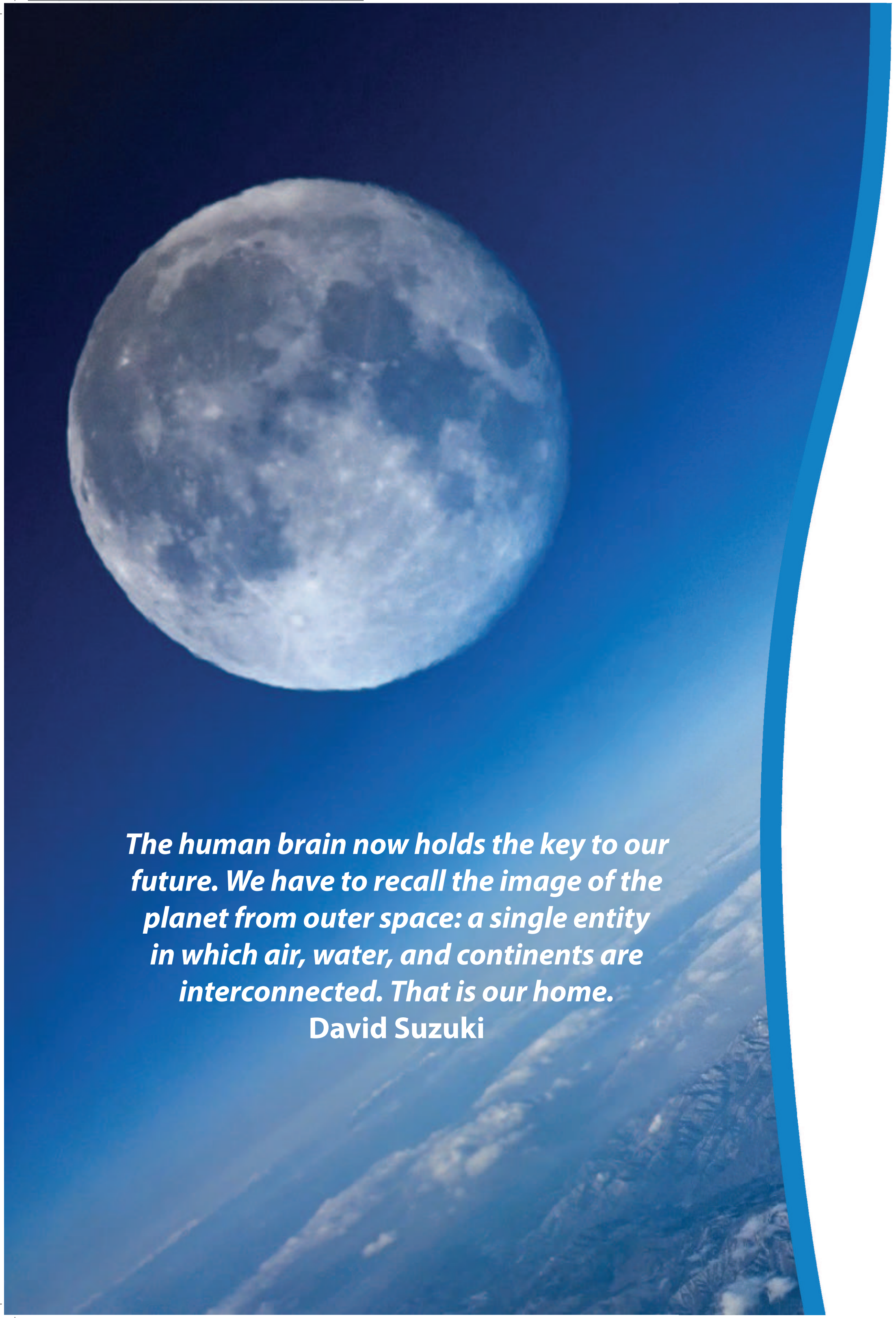
Science and Technology
REPUBLIC OF SOUTH AFRICA

sansa
SOUTH AFRICAN NATIONAL
SPACE AGENCY



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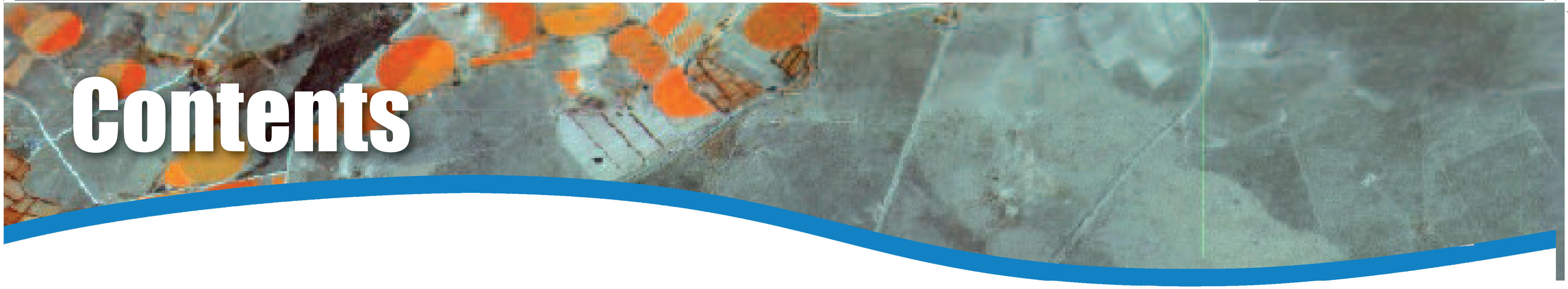

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Foreword

Dr Jane Olwoch
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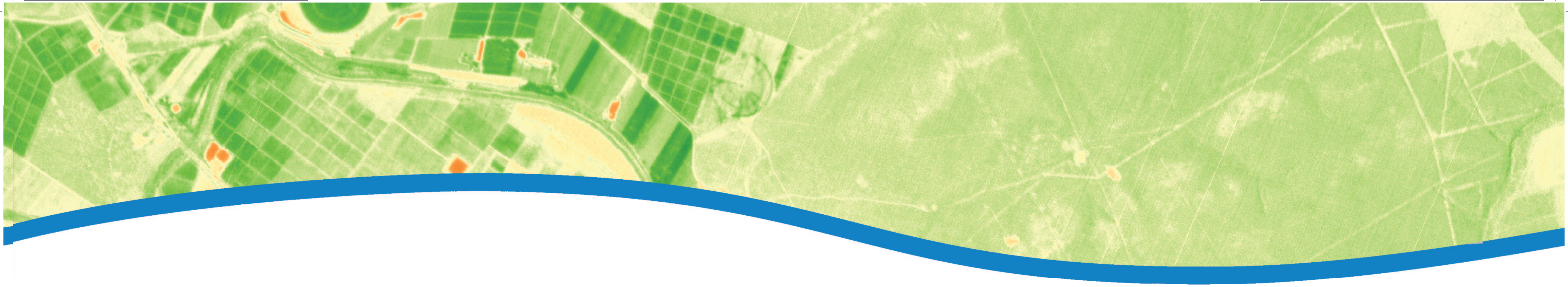
The important role played by Earth observation in achieving sustainability of environmental, social and economic systems is more pressing than ever before.

Population growth and its subsequent growing demand for resources, especially in some of the world's most populous countries, continues to deprive the environment of its natural ability to regulate itself. Very high consumption rates in the majority of rich nations contribute to the increase in greenhouse gases: the biggest contributor to climate change. Water pollution and high consumption rates expose human development to increasing vulnerability as usable water dwindles to almost a vanishing point.

As a result of high industrialisation, energy needs are growing in both developed and developing countries. Additional energy demand and use is a result of global inequality through which developing countries aspire to catch up with developments in the Western world.

Mineral resources are under strain as a result of unprecedented exploitation, with some of them nearing exhaustion or are already undergoing irreversible changes. This leads to a vicious cycle of poverty and global environmental change from overexploitation of fossil fuel, pollution, climate change and all its negative impacts on social and economic sectors, including livelihoods.

Water **pollution** and high consumption **rates** expose **human** development to **increasing** vulnerability …



From its advantage of non-intrusive observation, uniformity, rapid measurements and data continuity, satellite Earth observation allows for the collection of data, without compromising national sovereignty, over sites that cannot be accessed by other means. The uniformity also allows for the same sensor to be used in different places in the world, thus helping to ensure that the data collected are comparable as it is generated by the same instrument. Moreover, rapid measurement capacity allows sensors to be targeted in relatively short order at any point on Earth, including remote and hostile areas, while continuity with single sensors or a series of sensors provides long-time series that can be collected over the lifetime of the spacecraft. Such continuity is particularly important for climate studies. It allows for satellite-derived Earth-observation data, products and tools to offer key information to aid effective decision-making across a range of fields, including agriculture, irrigation, water-resources management, forest and wildlife management, environment and climate change, health, coastal and maritime environment management, transport and logistics, disaster management and safety and security.

Mineral resources are under strain from unprecedented **exploitation**, with some of them **nearing exhaustion** or already undergoing **irreversible changes**

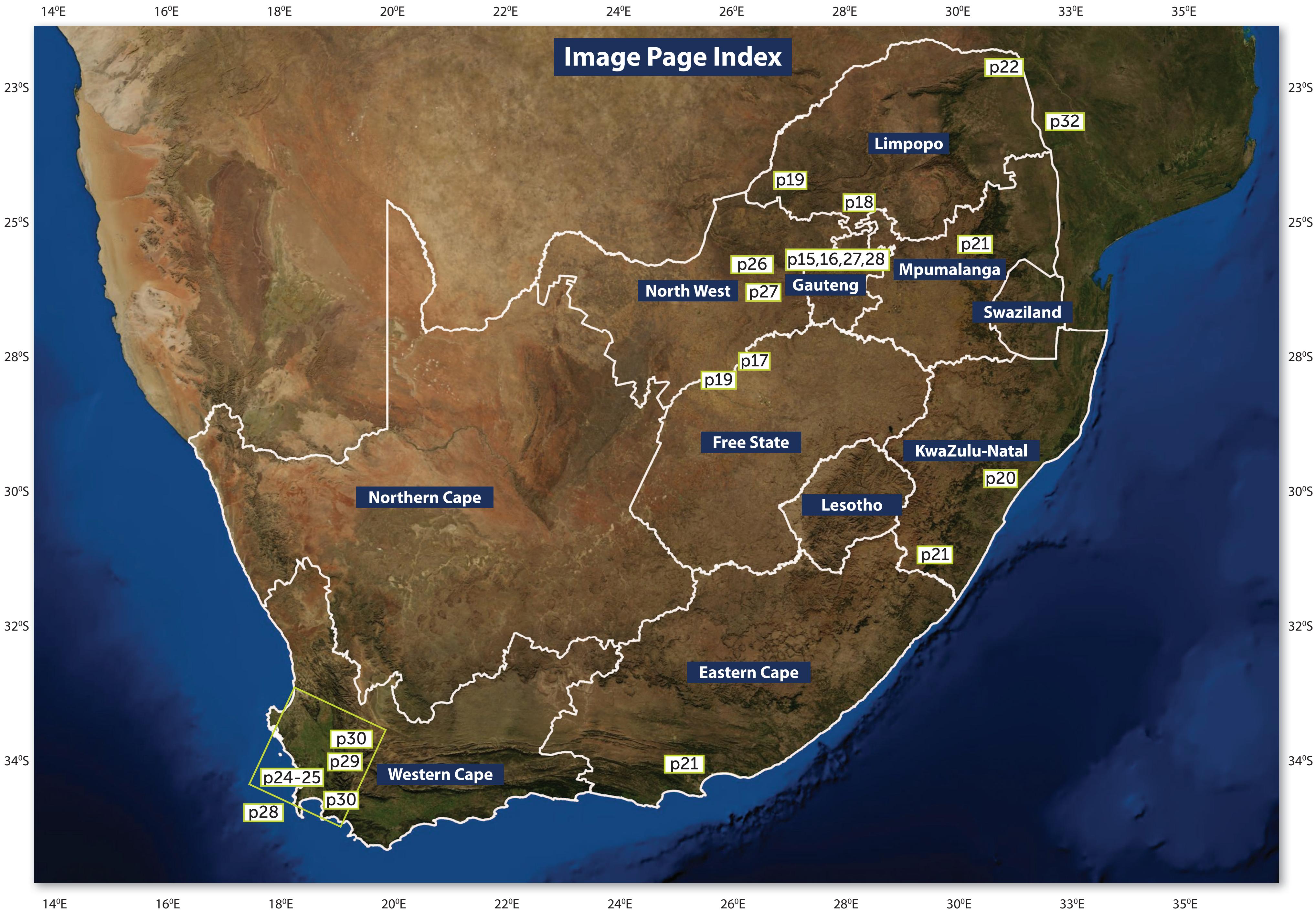
We do **not inherit** the **Earth** from our **Ancestors**, we **borrowed** it from our **children**

Indian Proverb

The biggest challenge to be tackled is to reduce the gap between scientists on the one hand and policy-makers, students and the public at large on the other. One way to do so is through targeted capacity-building activities and better communication of satellite Earth observation capabilities in a way that meets the needs of each stakeholder.

The images presented in this launch edition of the SANSA Space Atlas demonstrate the immense power that satellite Earth observation has in depicting the status of the environment and resources in time and space. Each pixel or a group of pixels represents a story that is a live story of the ever-changing status of the environmental ecosystems, functions and the natural resources within them. As human beings have the ability and need to use the environment and resources, they should also uphold a noble responsibility to protect the environment for us and future generations.

Atlas Footprint
-150⁰W
-120⁰W
-90⁰W
-60⁰W
-30⁰W
0⁰
30⁰E
60⁰E
90⁰E
120⁰E
150⁰E
Arctic Ocean
Arctic Ocean
North America
Europe
Asia
North Pacific Ocean
North Atlantic Ocean
Africa
South America
Indian Ocean
Australia
South Pacific Ocean
South Atlantic Ocean
Antarctica



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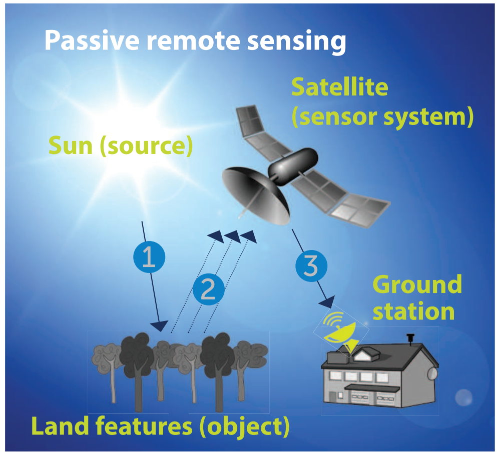
Introduction to Remote Sensing

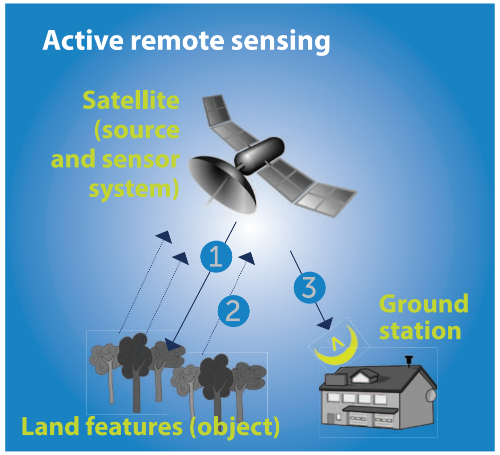
Remote sensing refers to the science of acquiring information about an object without being in physical contact with it. The term is commonly used to refer to the acquisition of information on objects on Earth from a raised platform, such as an aeroplane or a satellite in space. As humans, three of the senses we use to interact with our surroundings do not require physical contact, which are the senses of sight, smell and hearing. However, it is the sense of sight that is comparable to remote-sensing due to the mechanism of the optics used by both systems. As a result, humans actively participate in remote sensing in their every-day lives.

Passive systems rely on the sun to illuminate target objects. The sensor then records the reflected radiation emanating from the objects' surfaces, primarily in the visible and near-infrared regions of the electromagnetic spectrum. Due to their dependence on the sun, these sensors are predominantly effective during the day. However, some passive sensors measure thermal radiation, which can also be measured during night time.



Examples of passive sensors include Sumbandila and Landsat satellites.

Active sensors generate and transmit their own energy towards the target objects and then record the returning signals. As a result, they are not dependent on the sun for illumination. Such a mechanism allows active sensors to acquire information on the Earth's surface at any time of the day and in any weather conditions, as the transmitted signals can penetrate through haze, fog and clouds. Active sensors are also effective at night time.



Examples of active sensors include TerraSAR-X and RADARSAT 2.

There are multiple remote-sensing applications cutting across different disciplines, such as monitoring and understanding vegetation and weather conditions, ocean dynamics, and disaster risk and reduction. These applications use satellite images from different satellites that orbit the Earth at three different altitudes: Low Earth Orbit (2 000km), Medium Earth Orbit (20 000km) and the Geostationary Orbit (36 000km). The altitude at which a satellite will orbit the Earth is determined by different factors, such as the principal objective of the satellite – whether it will be used for navigation, telecommunication or earth observation. For most Earth-observation satellites the orbital altitude is determined by the size of the image, the size of each image pixel (spatial resolution), the time taken by the satellite to capture an image of the same point on Earth (temporal resolution) and the extent of the ground to be covered by each image (swath).


Low Earth Orbit
Geosynchronous Orbit
Medium Earth Orbit

History of Space Technology in South Africa

Space activities in South Africa started as Project Vanguard, America's contribution to the International Geophysical year (IGY) in 1958. Project Vanguard was managed by the American Naval Research Laboratory (NRL) and the objective was to launch the world's first "artificial" Earth satellite and to determine its orbit accurately, thereby yielding completely new information about the Earth's gravity field and shape.

The NRL designed and manufactured a precision radio interferometer tracking system called Minitrack. Minitrack could determine a radio source in space accurately to one thousandth of a degree. Seven of these Minitrack systems were deployed in North and South America to form an "electronic fence" through which a satellite transmitting in the 136MHz to 137MHz frequency band could not pass without detection.

The Satellite Applications Centre had its origins in 1958 when the national Telecommunications Research Laboratory (TRL) of the Council for Scientific and Industrial Research (CSIR) agreed to operate a Minitrack in South Africa, which is strategically situated relative to the launch facilities in Cape Canaveral, and could give early confirmation that a satellite launched from Cape Canaveral is in orbit.

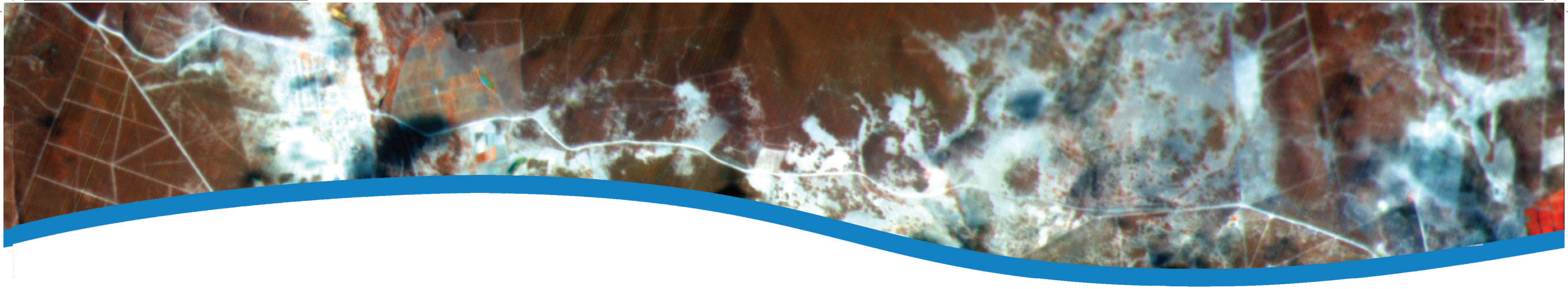
The Minitrack system was installed with the help of engineers from the NRL and became operational in January 1958. The Joburg Minitrack Station – as it was known – tracked its first Project Vanguard satellite, code-named 1958 Beta, in February 1958. Although the emphasis was on determining the position of the first satellites accurately, this soon became of secondary importance as more sophisticated instruments were placed in orbit to measure a host of physical and geophysical phenomena. To receive telemetry data from instrumented satellites soon became the primary function of the Minitrack Network.

It soon became apparent that the ground of the Railway College at Esselen Park was not an ideal electromagnetic environment in which to receive weak telemetry signals from space, because of its close proximity to high-voltage lines and electric mains. With the IGY something of the past, the American National Aeronautics and Space Administration

Minitrack was designed and manufactured in 1958

(NASA) was established and space research gained rapid momentum. The Joburg Minitrack Station became part of NASA's worldwide satellite tracking and telemetry network operated by NASA's Goddard Space Flight Centre (GSFC) in Greenbelt Maryland.

In 1960 operations were transferred from Esselen Park to Hartebeesthoek and the Joburg Satellite and Tracking and Data Acquisition Network station (JOBURG STADAN) was born. This became one of the busiest network stations in the GSFC satellite tracking telemetry and command (TT&C) network. It



In 1960 Minitrack was moved to Hartebeesthoek

STADAN at Hartebeesthoek (1961)

From 1961 to 1975 Minitrack supported NASA space missions

was eventually equipped with three receiving links at 136MHz and later five-band and two powerful VHF transmitting systems. During its 15 years as a GSFC satellite TT&C network station, the Johannesburg STADAN received more than eight million minutes of data recorded on half a million reels of tape, tracking 400 000 satellite passes, sent millions of commands and supported more than 250 NASA launches. NASA ceased operation in South Africa at the end of October 1975. The CSIR established the Satellite Remote Sensing Centre (SRSC) in 1976 for the reception of geo-information from satellites. The first images were received from a European meteorological satellite, METEOSAT in 1977, followed by LANDSAT in 1980, and ERS 1 and 2 in 1994.

In 1983 the SRSC became part of the worldwide tracking network of the French National Space Agency (CNES). The SRSC has supported more than 100 Ariane launches from Kounou in French Guinea. During the restructuring of the CSIR in 1988/1989, the SRSC became the Satellite Applications Centre (SAC), a programme of the CSIR. Since then SAC has grown to provide TT&C services to a multitude of international space agencies and aerospace companies as well as providing remote sensing data and value-added products to the geo-information sectors.

In 2008 the Department of Science and Technology (DST) set out to establish a national space agency. This was realised after the approval of the National Space Agency Bill, which paved the way for the establishment of the South African National Space Agency (SANSA), launched in December 2010. The existence of SANSA is to foster research in space science, advance scientific engineering through human capital and

History of Space Technology in South Africa

In 1963 NASA built a 12-metre antenna

In 1975 NASA handed over Minitrack to the CSIR

The first METEOSAT image taken in 1977

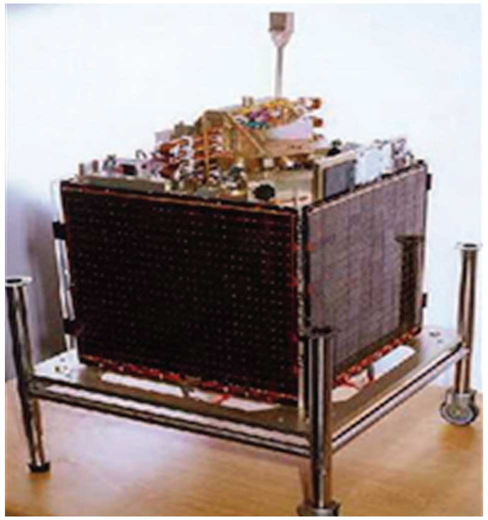
support the creation of an environment conducive to industrial development in space technologies within the framework of national government policy. The Corporate office at SANSA is responsible for the overall operations at the three SANSA directorates.

The former SAC at Hartebeesthoek became SANSA's Space Operation directorate; the Earth Observation directorate in Pretoria and, finally, the Magnetic Observatory at Hermanus became the Space Science directorate.

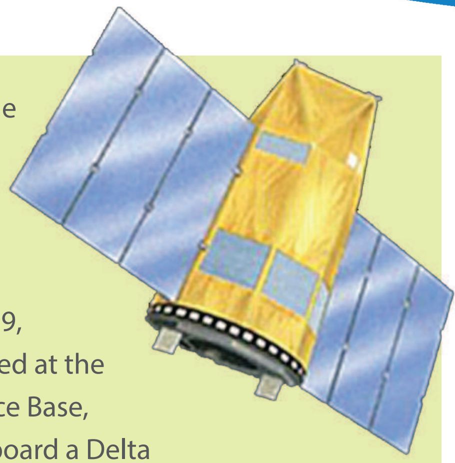
In 1983 became a Centre National d'Etudes Spatiales (CNES) ground station partner

In 2011 CSIR SAC migrates to SANSA.

South African Satellites

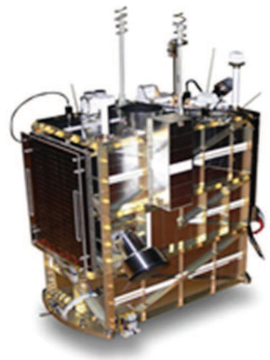


GreenSat was the first project to develop a South African Earth Observation satellite. The project started in 1985 as a military reconnaissance satellite to be launched on the indigenous RSA-3 rocket, but in 1991 it was changed into the civilian **GreenSat**. **GreenSat** would have been about 2,3m high, with a mass of 330kg and would have carried panchromatic and multi-spectral cameras. The resolution would have been 2,5m for the high resolution camera. The RSA-3 rocket was cancelled, as a result, the Russian Start-1 rocket was identified as a replacement. Although engineering models had been built, the project was cancelled in 1994 due to lack of funds.



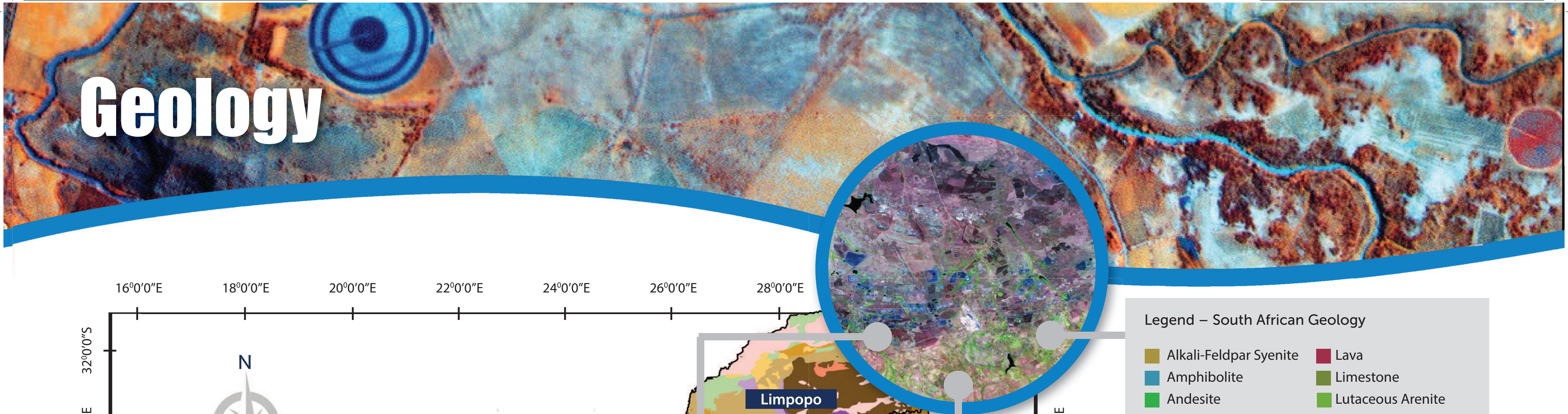
SunSat was the first satellite built in South Africa to make it into orbit. On 23 February 1999, **SunSat** was launched at the Vandenberg Air force Base, California, USA on board a Delta II rocket. The satellite successfully operated in space, fulfilling all mission objectives. Designed and built almost in its entirety by postgraduate students of the University of Stellenbosch, **SunSat-1** heralded South Africa's entry into the Space Age. **SunSat** was a low Earth orbit (LEO) microsatellite, weighing 64kg, with dimensions of 45cm x 45cm x 60cm. The satellite's payloads included NASA experiments, amateur radio communications, a high-resolution imager, precision altitude control and school experiments. It followed an elliptical polar orbit of between 620km to 850km above the Earth's surface and circled the globe approximately once every 100 minutes at a travelling speed of nearly 7,5km/s, or 27 000km/h.

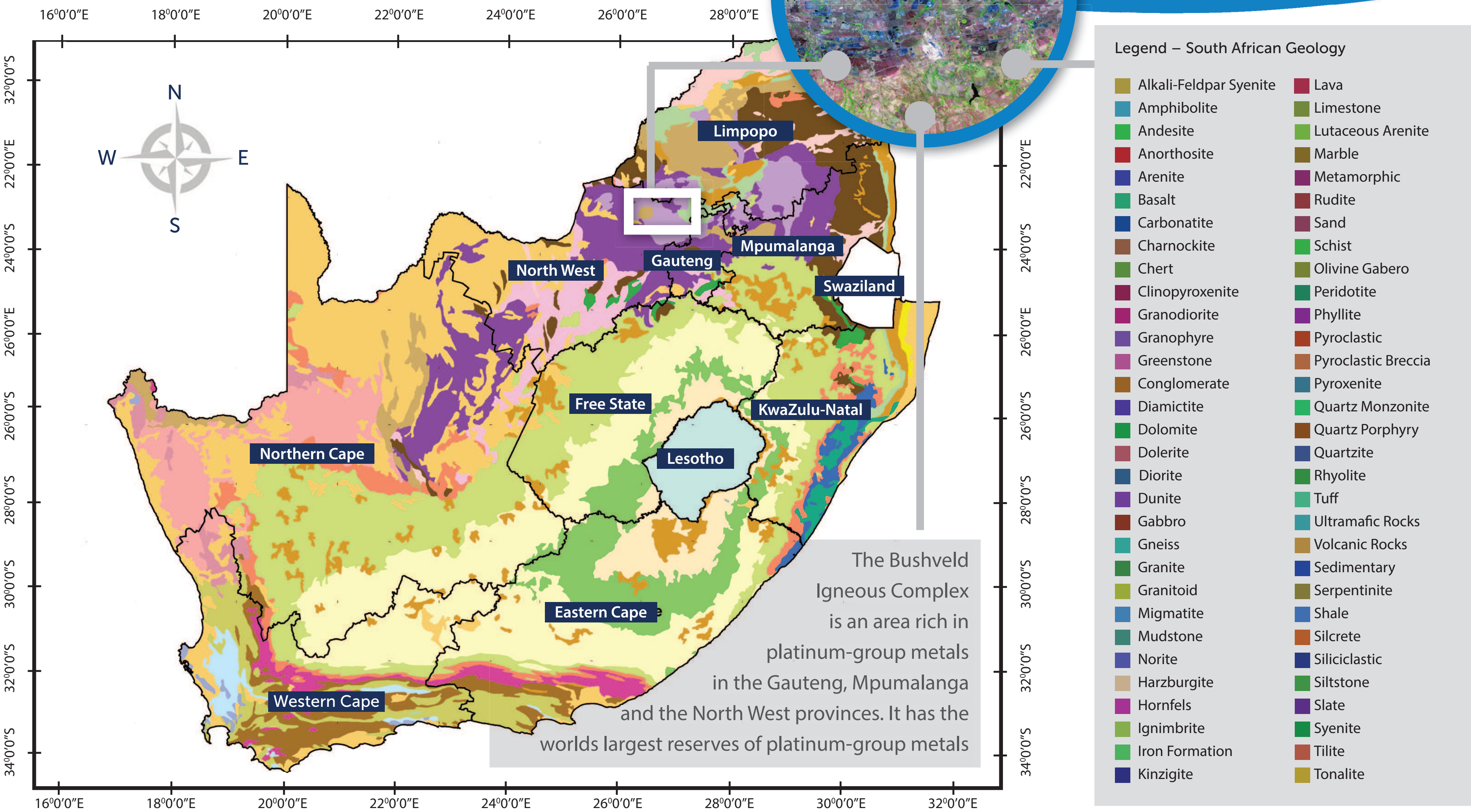
SumbandilaSat, initially known as ZA SAT-002, was developed by SunSpace in conjunction with the University of Stellenbosch. "Sumbandila" is a Venda word that means "lead the way". The Sumbandila project was a government-funded project aimed at advancing the South African space programme and building capacity in space technology in the country. Sumbandila was launched on 17 September 2009 at the Baikonur Cosmodrome launch facility in Kazakhstan. **SumbandilaSat** contained a high resolution (6,25m) optical sensor that recorded reflected radiation in six spectral bands: the visible, red-edge and near-infrared region. In June 2011, **SumbandilaSat** was damaged by solar storm that damaged power supply to the on-board computer, preventing the satellite from transmitting images to the ground receiving station. Over its life span, **SumbandilaSat** delivered up to 1 150 global images covering areas such as Sossusvlei pan in Namibia, the Palms islands in Dubai, Cape Town and East London.



Applications of Satellite Images

Geology





The Bushveld Igneous Complex is an area rich in platinum-group metals in the Gauteng, Mpumalanga and the North West provinces. It has the worlds largest reserves of platinum-group metals