Sentinel Vision
EVT-227
19 April 2018

2D Layerstack

South African Great Escarpment

Sentinel-1 CSAR IW acquired on **30 August 2017** from 17:17:27 to 17:18:42 UTC
Sentinel-2 MSI acquired on **03 September 2017** at 08:19:59 UTC
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Sentinel-1 CSAR IW acquired on **08 September 2017** from 16:53:05 to 16:53:30 UTC
Sentinel-3 SLSTR RBT acquired from **04 January 2018** to 07:59:47 UTC

Author(s): Sentinel Vision team, VisioTerra, France - svp@visioterra.fr

Keyword(s): Land, mountains, geology, faults, subduction, plateau, orogeny, South Africa

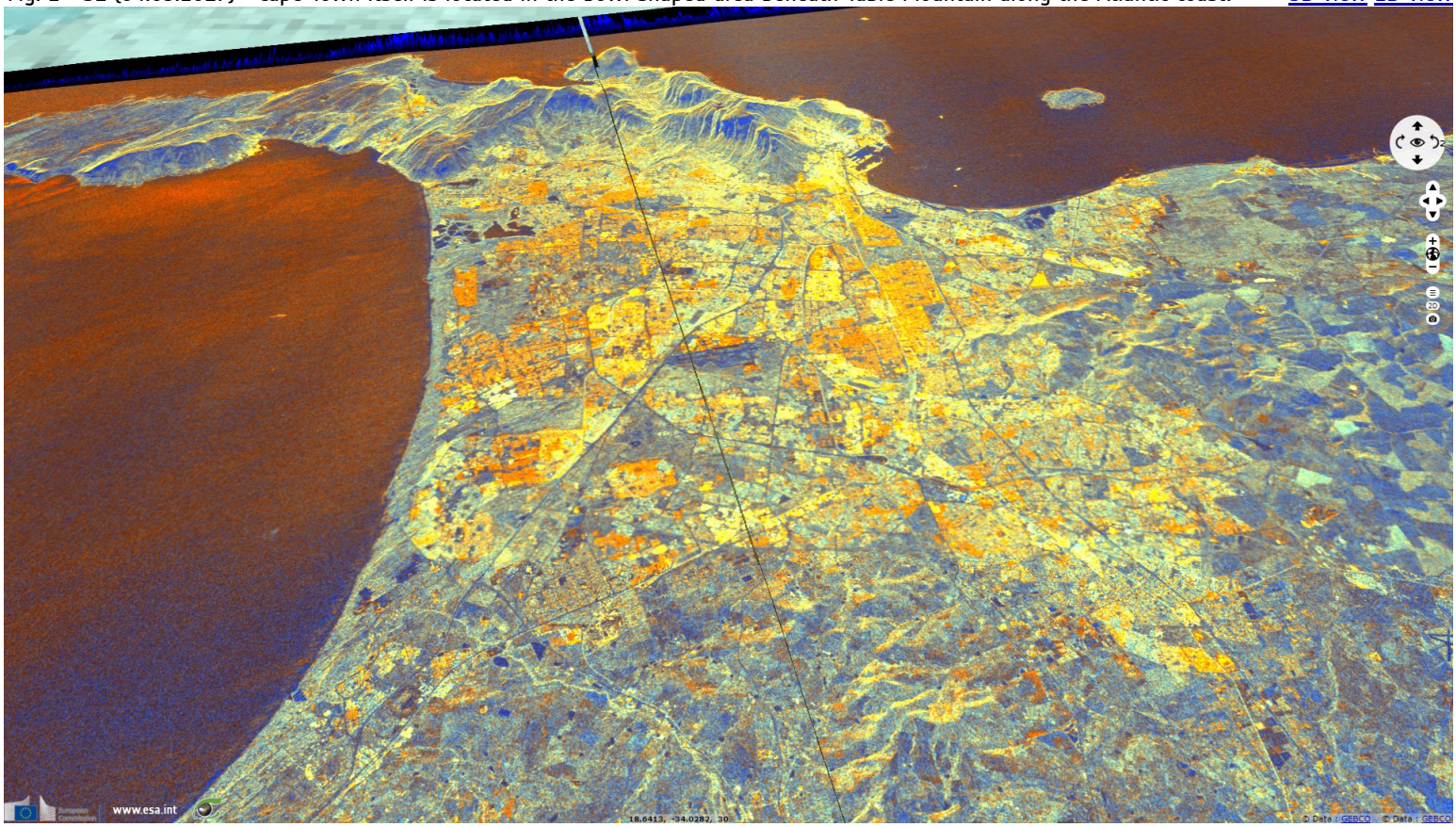
Fig. 1 - S2 (03.09.2017) - 11,8,2 colour composite - Zoom on Cape Town region evidencing Table Mountain. 3D view 2D view

Table Mountain, Sandstone layers form the ramparts overlying a basement of Precambrian slates and granite - source: Cape Town University

Department of Geological Sciences of Cape Town University describes the Geology of the Cape Peninsula: "*The late-Precambrian age Malmesbury Group is the oldest rock formation in the area, consisting of alternating layers of dark grey fine-grained greywacke sandstone and slate, seen along the rocky Sea Point and Bloubergstrand shorelines. These sediments were originally deposited on an ancient continental slope by submarine slumping and turbidity currents. The sequence was subsequently metamorphosed by heat and pressure and folded tightly in a NW direction so that the rock layers are now almost vertical.*

The Peninsula Granite is a huge batholith that was intruded into the Malmesbury Group about 630 million years ago as molten rock (magma) and crystallized deep in the earth, but has since then been exposed by prolonged erosion. The contact zone where the Malmesbury Group was intruded by molten granite can be seen at Sea Point and was made famous by Charles Darwin during his voyage of scientific discovery on H.M.S. Beagle in 1844. Here, slivers of dark coloured Malmesbury rocks, altered by intense heat are intermingled and folded with the pale coloured intrusive granite to form a complex mixed rock (migmatite). Large feldspar crystals occur in both the granite and dark hornfels layers."

Fig. 2 - S1 (04.09.2017) - Cape Town itself is located in the bowl-shaped area beneath Table Mountain along the Atlantic coast. 3D view 2D view



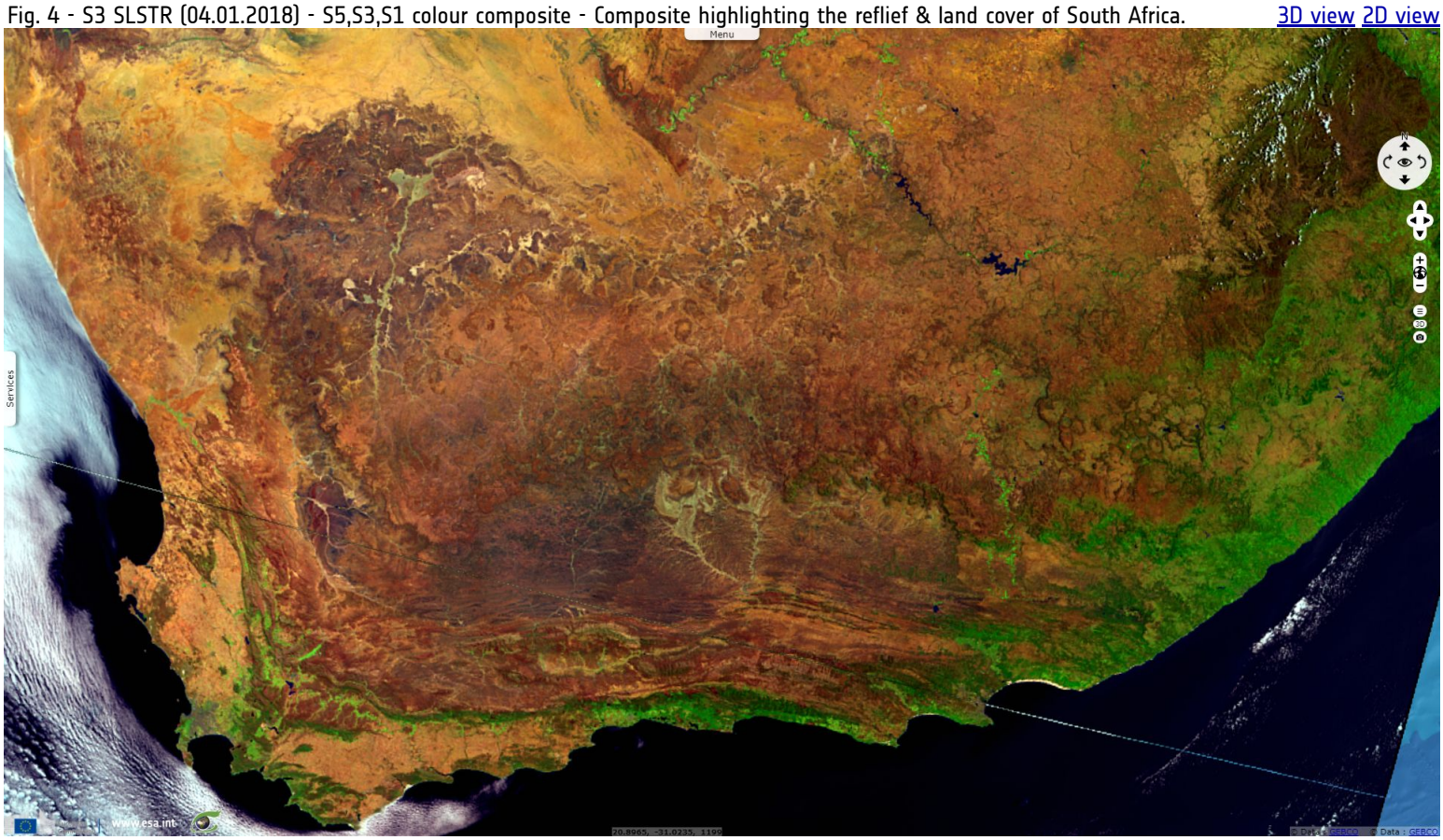
"*Though initially intruded at great depth, prolonged erosion eventually exposed the granite at surface and it now forms a basement upon which younger sedimentary rocks of the Table Mountain Group were deposited.*

- *Table Mountain Group sandstones were deposited on this eroded surface of granite basement, in the stream channels and tidal flats of a coastal plain and delta environment that extended across the region about 450 million years ago. The sand, silt and mud deposits were lithified by pressure and then folded in the Cape Fold Belt, extending along the southern coast.*
- *The basal Graafwater Formation (300-450 m thick) consists of interlayered pale brown sandstone, laminated pink siltstone and dark maroon coloured shale. [...] Closer examination shows deposition cycles from current-bedded channel sandstones to increasing proportions of fine-grained maroon shales at the top, deposited in flood plains and lagoons.*
- *The Peninsula Formation (800-1500 m thick) consisting of hard, light grey coarse pebbly quartz sandstone, dominates the steep mountain cliffs. Current bedding and pebble layers suggest that it was originally deposited as migrating sand bars in broad river channels.*
- *The Pakhuis Formation tillite (a lithified glacial outwash gravel) occurs on the highest points of Table Mountain, such as Maclears Beacon. It contains clusters of angular boulders and pebbles and was deposited at a time when the Gondwana continent, of which Africa is a part, was situated close to the south pole. [...]*

The present landscape is due to prolonged erosion having carved out deep valleys, removing parts of the once continuous Table Mountain Group sandstone cover from the Cape Flats and leaving high residual mountain ridges."

Fig. 3 - S2 - 4,3,2 colour composite - Zooming out shows continuity between Table Mountains & Eastern ranges. 3D view 3D animation

Fig. 4 - S3 SLSTR (04.01.2018) - S5,S3,S1 colour composite - Composite highlighting the reflief & land cover of South Africa. 3D view 2D view



Cape Fold Mountains and the Great Escarpment don't share the same origin:

- As the closure of paleo-oceans caused the collision between South American and African cratons during the assembly of Gondwana (which also comprised Antarctica, Australia, India...) about 330 million years ago, orogeny rose the Cape Fold Mountains in modern South Africa.
- Just to the south, near the South Pole, the same process built an Himalayas-sized range on the portion of Gondwana called the "Falkland Plateau".
- The formation and orogeny of the Gondwana continent (which then merged with Laurussia, forming the Pangaea supercontinent) resulted in continent-wide glaciations similar to Antarctica.
- As wind, rain and ice slowly eroded the Falkland Plateau, sedimentation buried the Karoo region under kilometers thick layers of sediments.
- Rifts opened the Indian Ocean and the Atlantic Ocean, this process resulted in the orogeny of the Great Escarpment in South Africa by covering the region under a thick layer of lava.

- As the resistant lava layer is slowly abraded, underlying soft layers exposed are rapidly degraded, leading to a retreat of the Great Escarpment away from the coast.
- The erosion resistant dolerite that tops the Cape Fold Mountains is now exposed, it protects the soft layers below. Where the dolerite is absent, the landscape is eroded quickly.

This gives Cape Fold Mountains a tableland landscape similar to Monument Valley in the United States as embodied by its iconic Table Mountain that surrounds the city of Cape Town.

Fig. 5 - S3 SLSTR (04.01.2018) - S6,S5,S2 colour composite - Composite underscoring its vegetation & bare soil distribution. 3D view 2D view

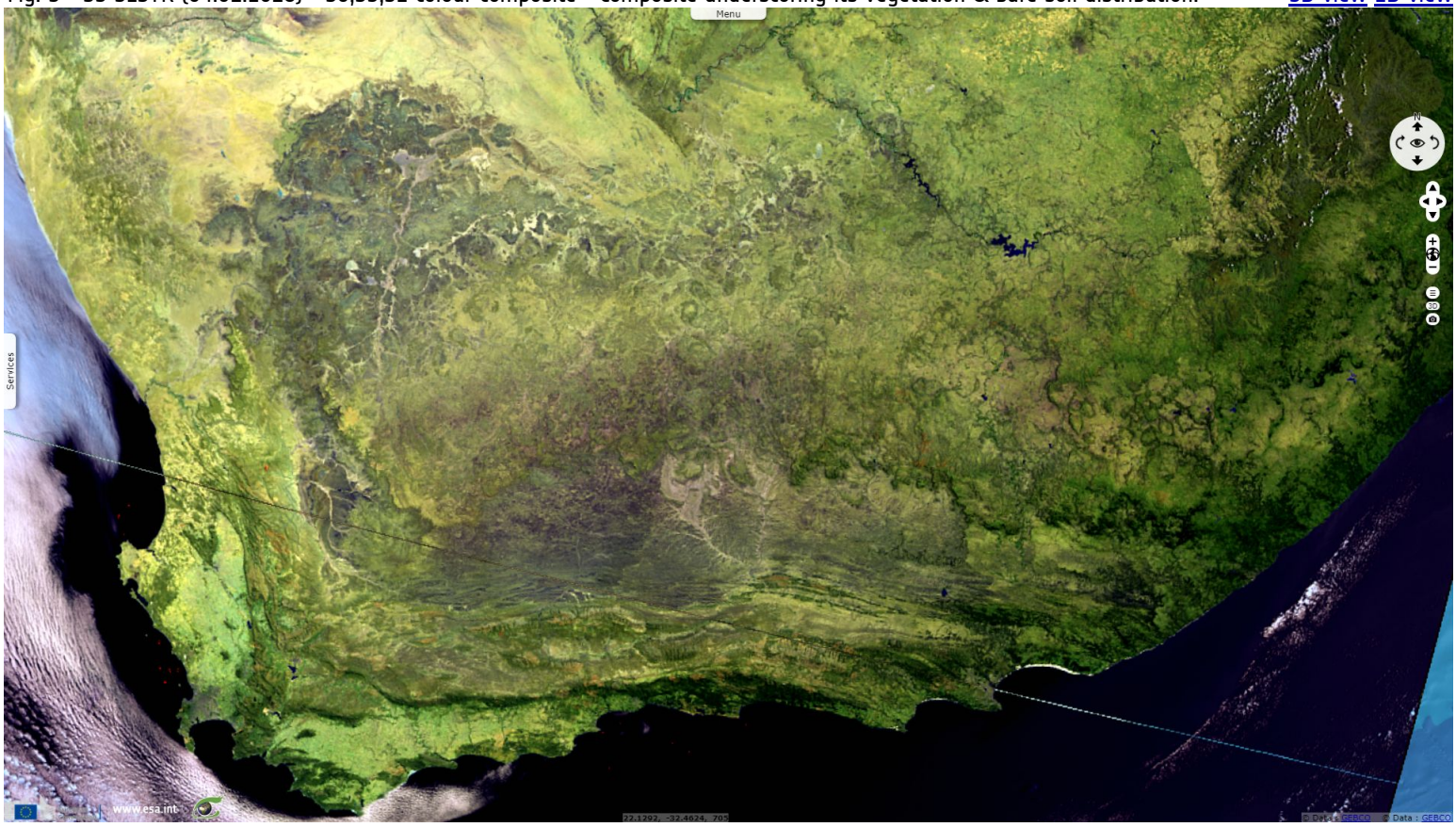


Fig. 6 - S1 (30.08.2017 to 08.09.2017) - vv,vh,ndi(vh,vv) colour composite - Structural details in Great Escarpment & Cape Fold Mountains. 3D view

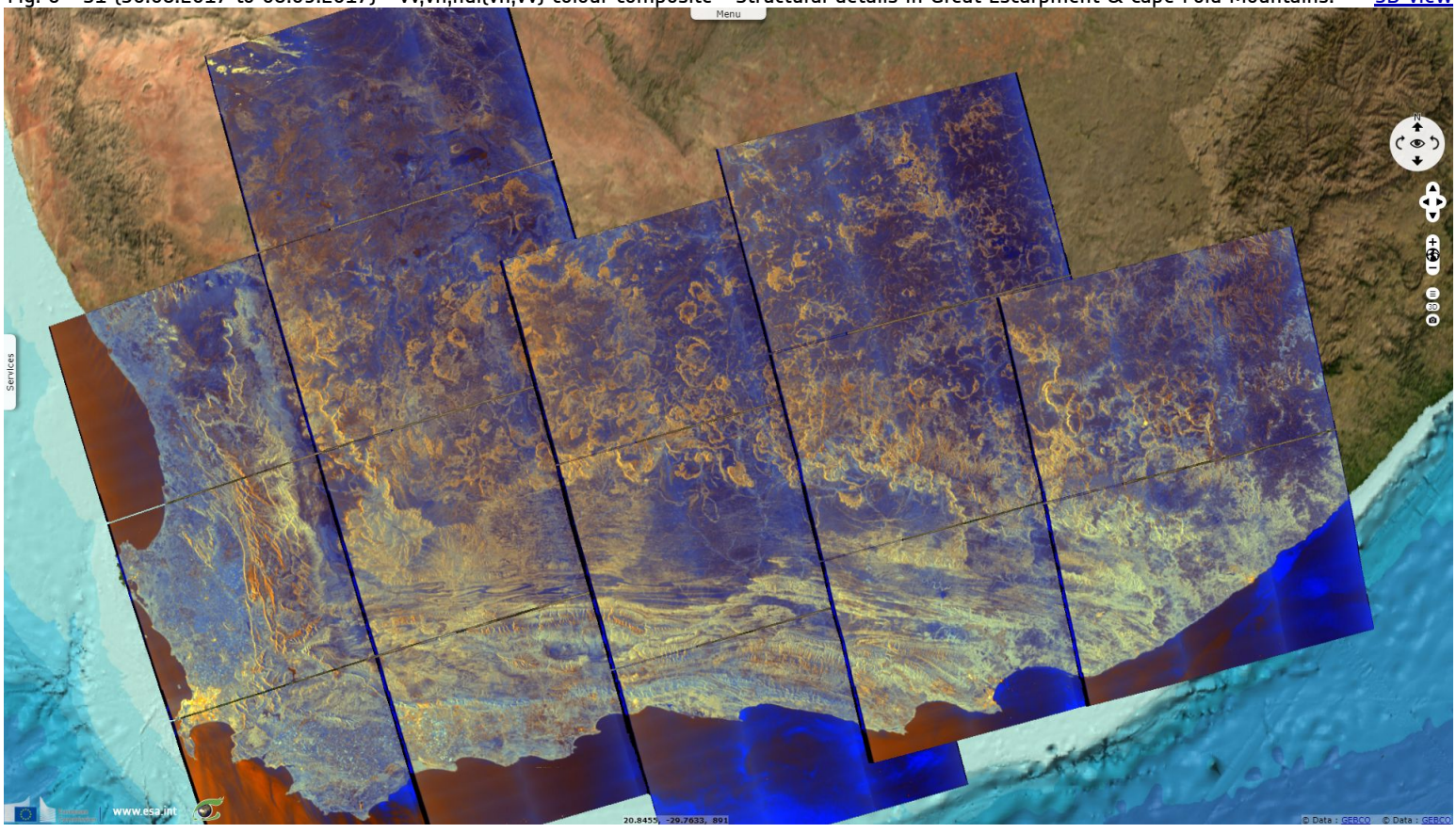
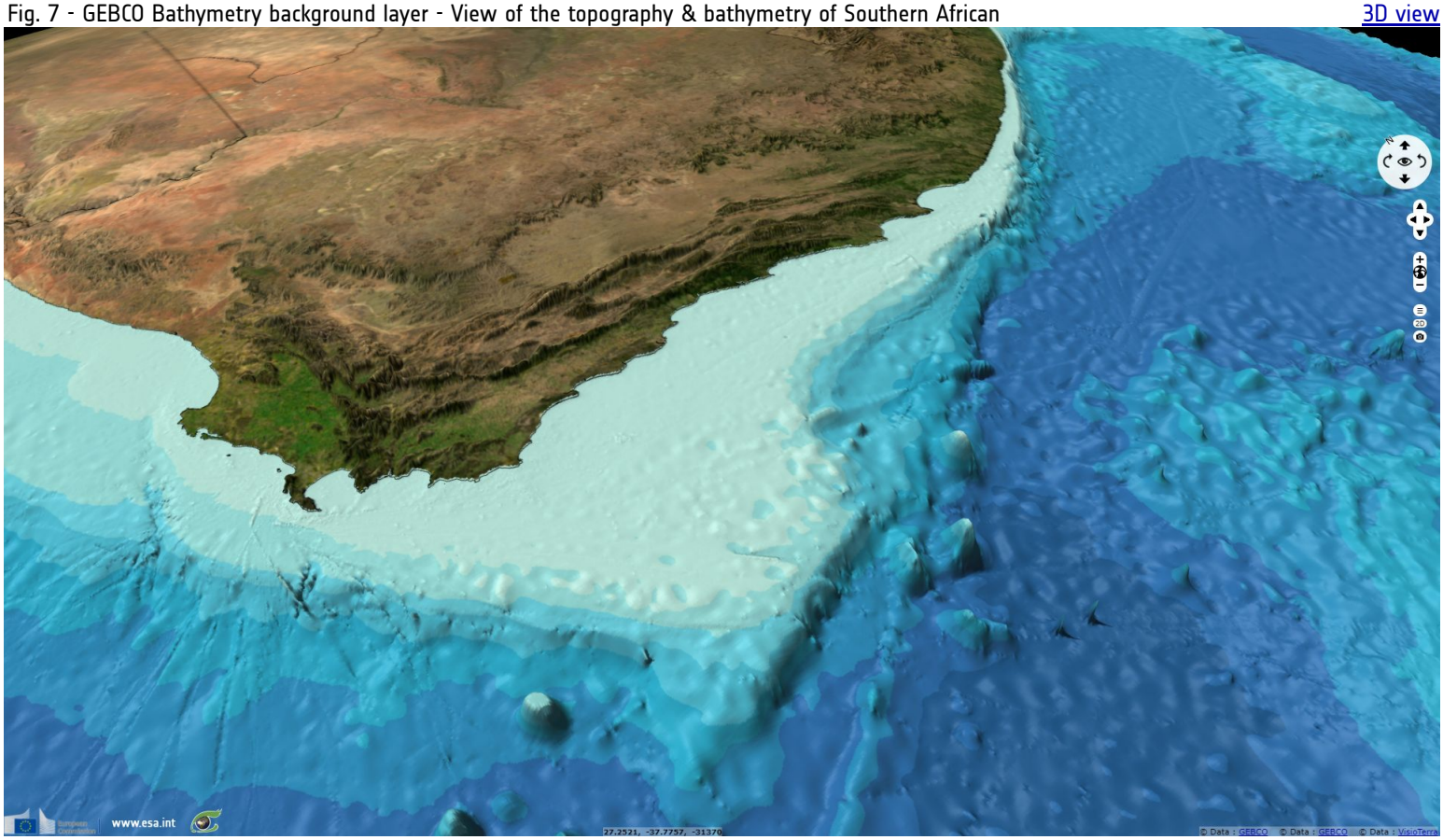
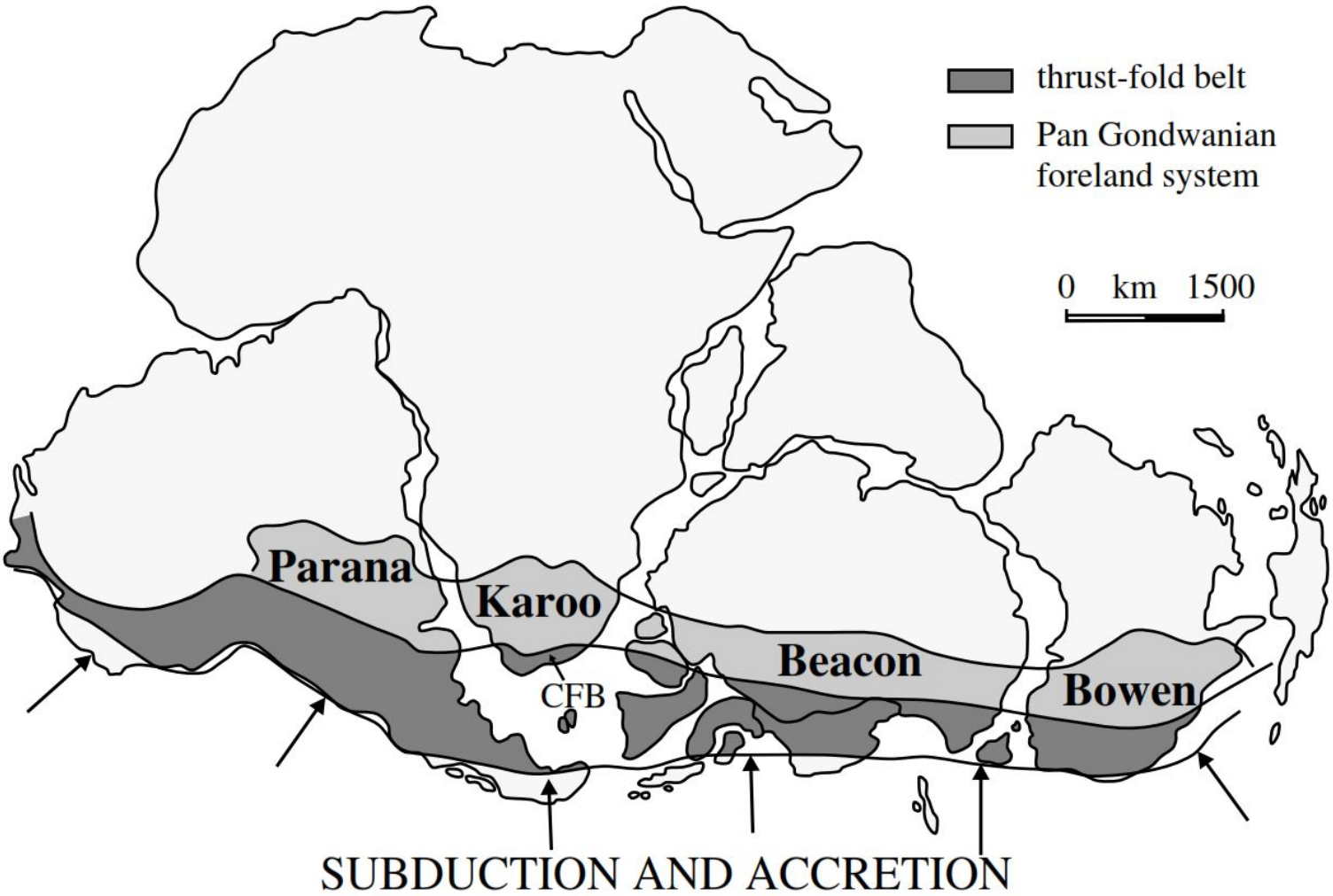


Fig. 7 - GEBCO Bathymetry background layer - View of the topography & bathymetry of Southern African 3D view





Paleogeographic reconstruction of Gondwana - source: Retroarc foreland systems - evolution through time

In this article, Octavian Catuneanu describes the phenonmenon that resulted in the formation of the Cape Fold Belt (CFB), the above image shows "*the subduction from south to north of the paleo-Pacific plate beneath the supercontinent. As a result of compression and terrain accretion, a ca. 6000 km long fold-thrust belt formed along the southern margin of Gondwana, with an associated retroarc foreland system to the north. Following the breakup of Gondwana, portions of this foreland system are now preserved in South America, South Africa, Antarctica and Australia.*"

Fig. 8 - S2 - 11,8,2 colour composite - View of the western part of the Karoos. 3D view 2D view

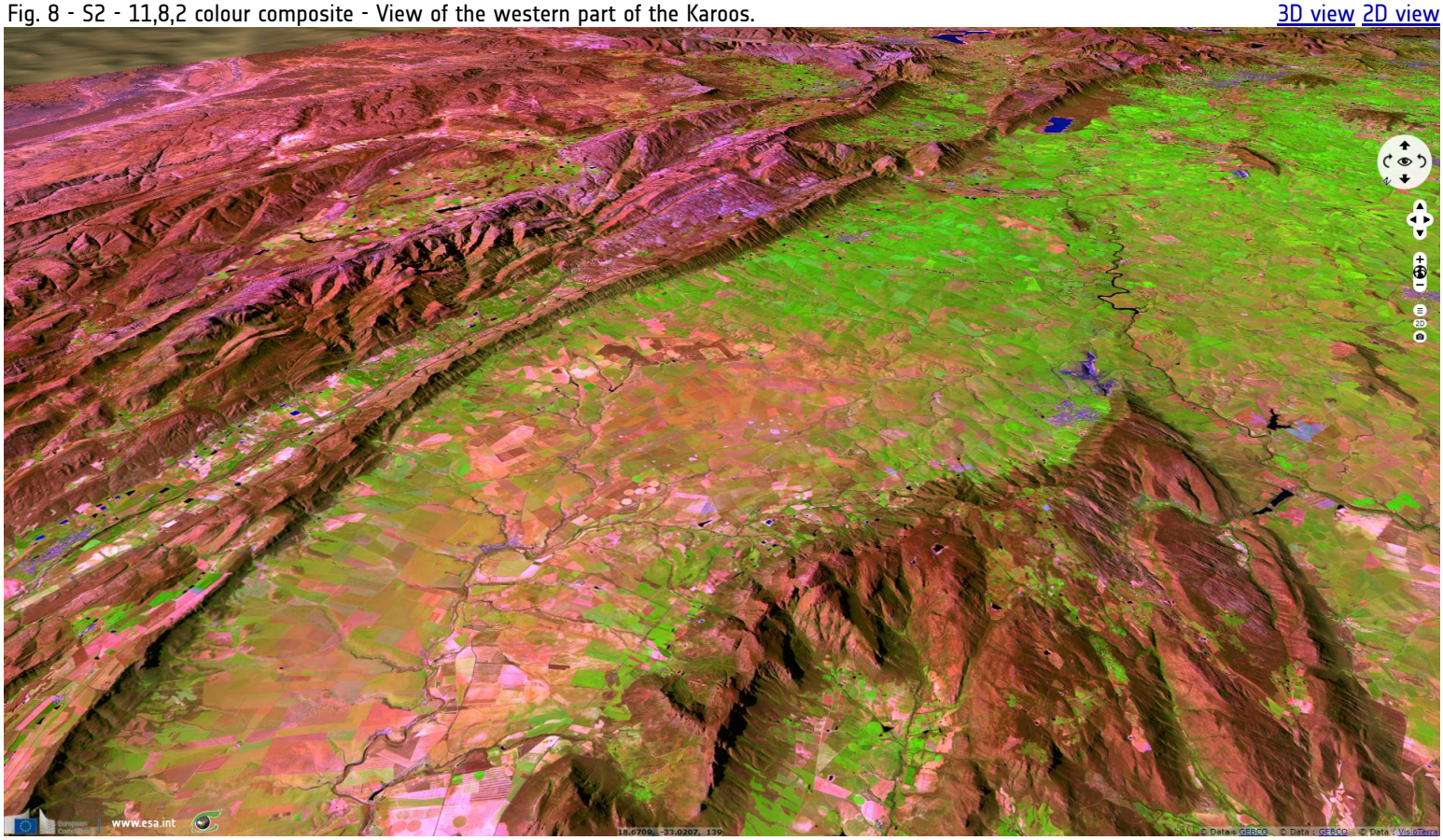
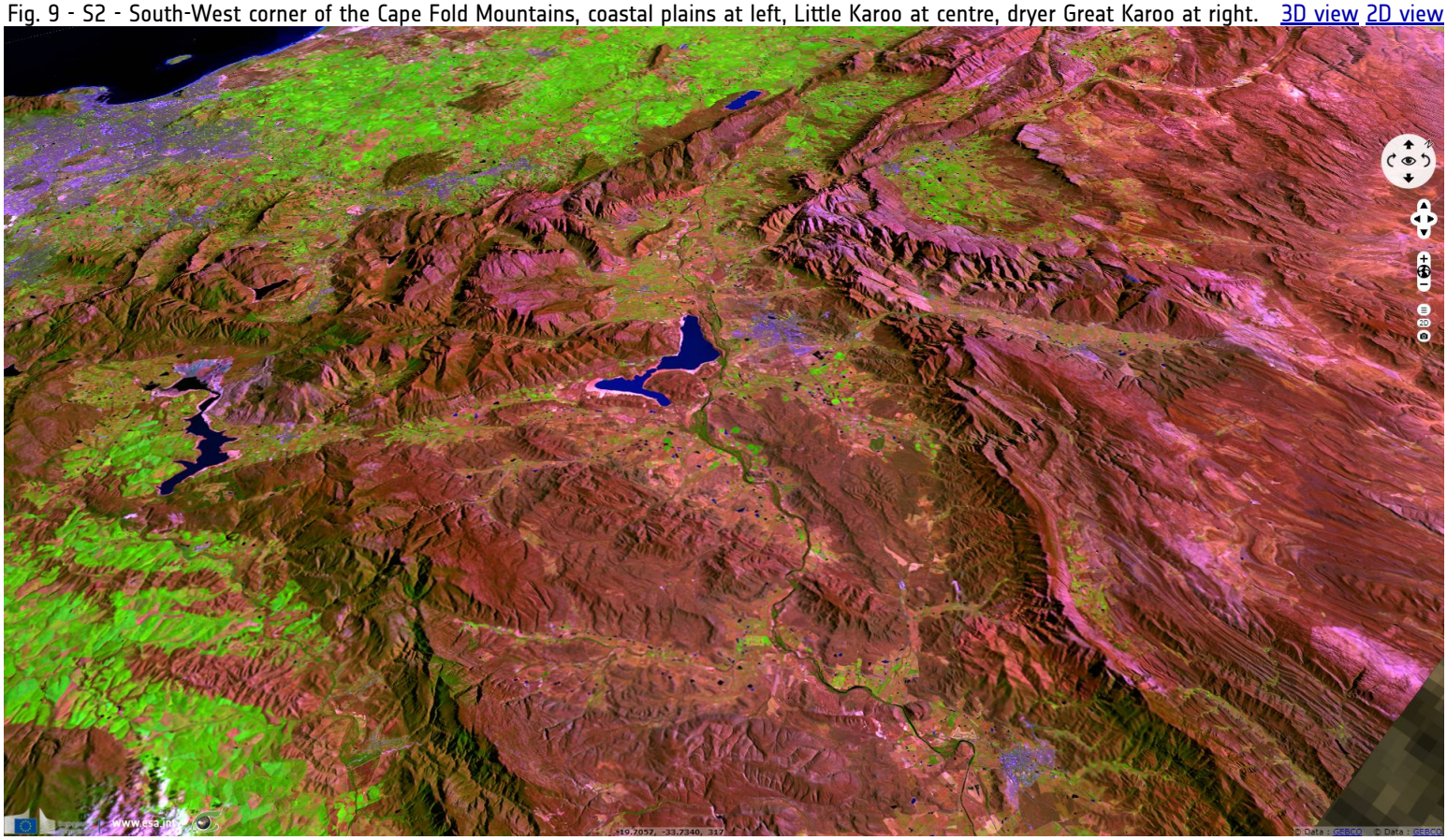


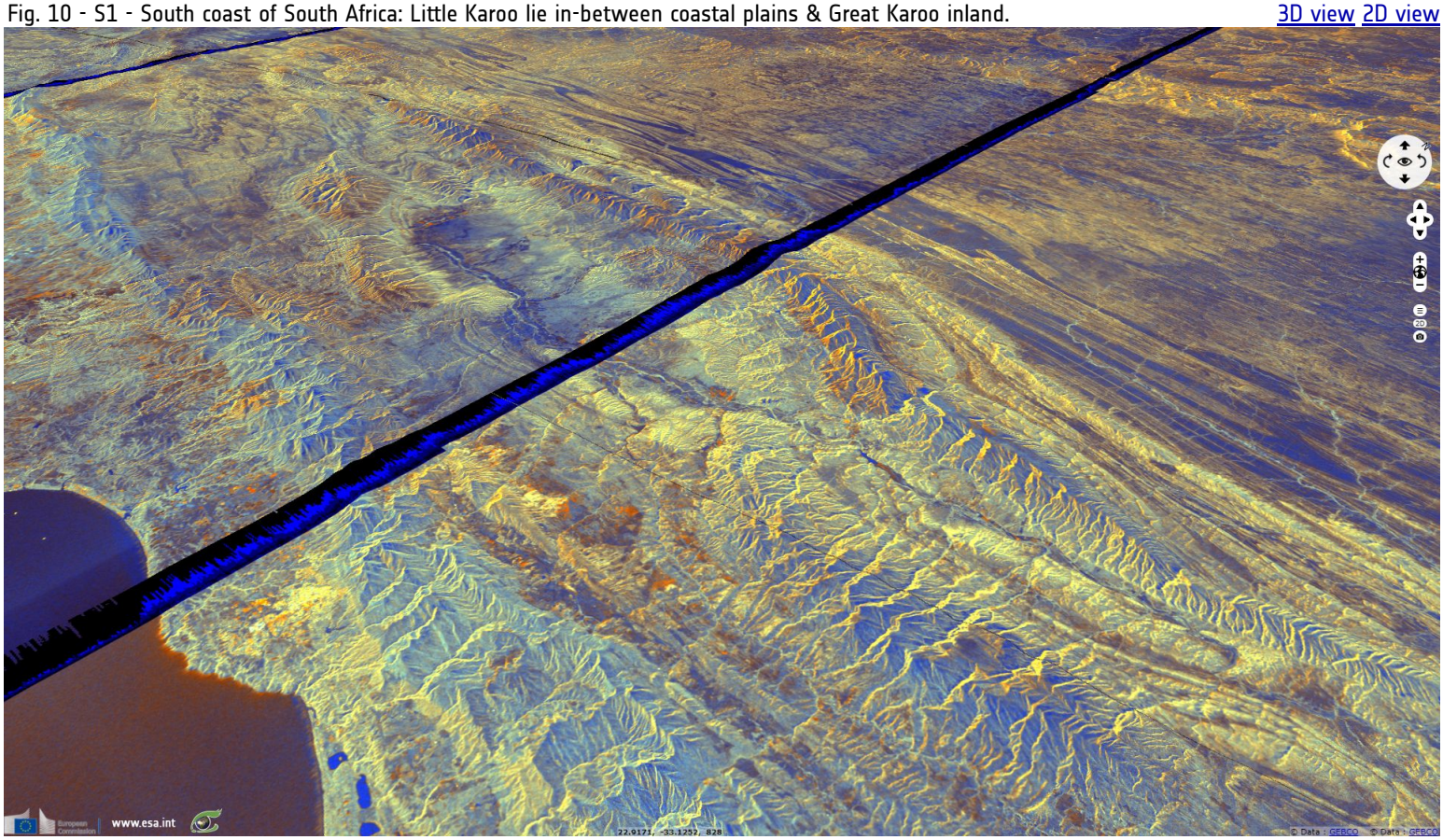
Fig. 9 - S2 - South-West corner of the Cape Fold Mountains, coastal plains at left, Little Karoo at centre, dryer Great Karoo at right. 3D view 2D view



In the article The Karoo basins of south-central Africa, Octavian Catuneanu explains the formation of the Karoo Basins: "*The Karoo basins of south-central Africa evolved during the first-order cycle of supercontinent assembly and breakup of Pangea, under the influence of two distinct tectonic regimes sourced from the southern and northern margins of Gondwana. 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 known as the "main Karoo" Basin, with the primary subsidence mechanisms represented by flexural and dynamic loading. This basin preserves the reference stratigraphy of the Late Carboniferous–Middle Jurassic Karoo time, which includes the Dwyka, Ecca, Beaufort and Stormberg lithostratigraphic units.*

North of the main Karoo Basin, the tectonic regimes were dominated by extensional or transtensional stresses that 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 fill of the Karoo basins formed under different tectonic regimes."

Fig. 10 - S1 - South coast of South Africa: Little Karoo lie in-between coastal plains & Great Karoo inland. 3D view 2D view



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Funded by the EU and ESA EVT-227-SentinelVision powered by VisioTerra