

Namibia's IUGS Geological Heritage Sites

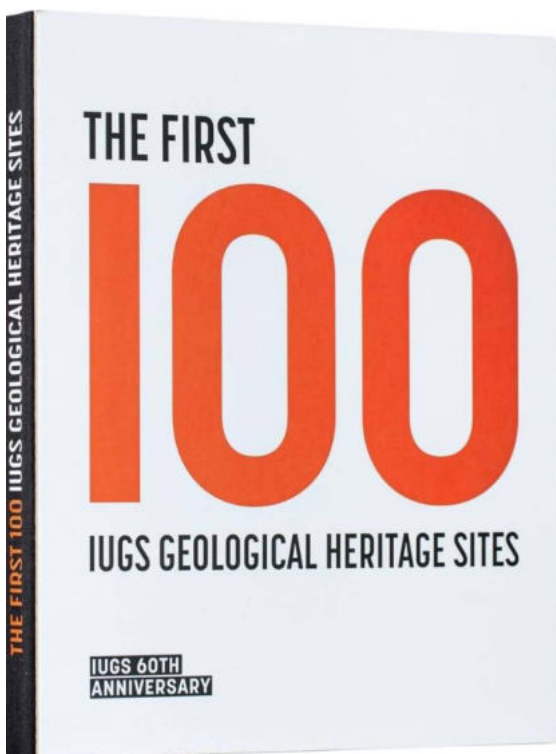
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In 2021 the International Commission on Geoheritage of the International Union of Geological Sciences (IUGS) introduced a global programme for the nomination of Geo-



logical Heritage Sites (IGCP-731). According to IUGS, a Geological Heritage Site is a “key locality exhibiting geological elements and/or

processes of international scientific relevance, used as a reference, and/or with a substantial contribution to the development of geological sciences through history” (<https://iugs-geoheritage.org/selection-process>). Under the slogan “The First 100” proposals were called for worldwide, requiring description, accurate location, geological significance and research history of the suggested sites, supported by suitable illustrations in the form of maps, sections, photographs or diagrams. Recognition as an IUGS Geological Heritage Site is expected to endorse its importance in demonstrating specific geological processes, ensure its preservation and protection in a changing - frequently endangered - environment, and promote geo-tourism through increasing its visibility in the public eye, with all attendant financial and environmental implications. The “First 100” were selected out of 181 entries from 56 countries by an international committee of geoscientists and announced on October 28, 2022, during the 60th Anniversary Meeting of the IUGS in Zumaia, Spain (Asrat *et al.*, 2023). They are featured in a “coffee table” book entitled - predictably - “The First 100” (available here: www.iugsgeoheritage.org), which was designed to bring the wonders of geology and the forces that created them closer to an audience beyond the narrow circle of the geoscientific fraternity.

Namibia's “Top Three”

Among the Namibian sites considered for the “First 100” were such varied items as the unique Nama fossil assemblage belonging to the oldest metazoans on Earth, the well-preserved Marinoan glacial deposits of north-western Namibia, testifying to a global ice age during the mid-Neoproterozoic, the Fish River Canyon, as the second largest canyon of the

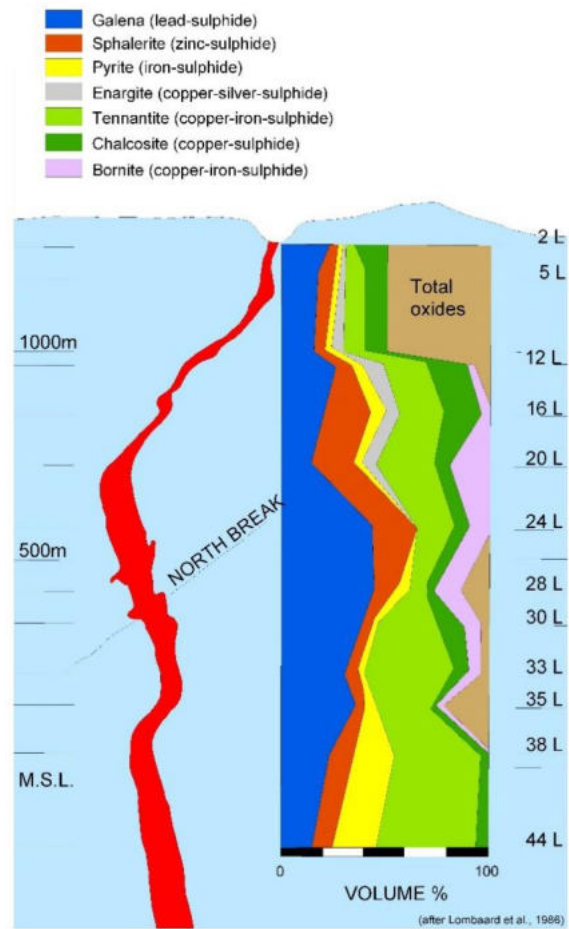
world after the Grand Canyon of the Colorado, the world-renowned polymetallic Tsumeb ore deposit, the Namib Sand Sea, already distinguished as a UNESCO World Heritage Site since 2013, and the Spitzkoppen, a couple of distinct granitic inselbergs on the Namib Plains representing igneous activity during Gondwana break-up and the opening of the South Atlantic

Ocean. Coordinated by the Geological Survey of Namibia, four of them were eventually submitted to the IUGS selection committee.

When the results were known, Namibia had won three places amongst the “First 100”, representing twenty percent of all selected sites from Africa - a notable achievement against tough competition from around the globe! The honours went to the Namib Sand Sea, the famous Tsumeb ore body and the glacial record of the Marinoan “snowball earth” (the order not reflecting on the relative importance or popularity of the selected sites).

With its many dune types, among them linear, transverse, star and barchan dunes, as well as rarer zibar and lace dunes (Miller, 2008), the Namib Sand Sea, extending between the Orange and Kuiseb River Deltas, well deserves the accolade of a “spectacular example for the geological and geomorphological development of a desert landscape”. No less fascinating, at least to mineralogists and mineral collectors, is the now mined-out, polymetallic (lead, copper, zinc, silver, arsenic, antimony, cadmium, cobalt, germanium, gallium, iron, mercury, molybdenum, nickel, tin, tungsten and vanadium) Tsumeb ore body, a ~1800 m deep pipe-like palaeokarst feature filled with feldspathic sandstone within folded carbonate

VERTICAL DISTRIBUTION OF MAJOR ORE MINERALS WITHIN THE TSUMEB PIPE



Geomorphology and active geological processes

NAMIB SAND SEA NAMIBIA



View from the International Space Station on the north-south linear dunes and star dunes along the southern linear dunes

THE WORLD'S OLDEST WITH THE HIGHEST DIVERSITY OF DUNE TYPES.

The Namib Sand Sea is an active geological-geomorphological phenomenon while it overrules an older dune system, representing a spectacular example of the geological and geomorphological evolution of a desert landscape. The Namib Sand Sea, a UNESCO World Heritage Site since 2019, is a well conserved part of the Namib Desert offering a spectacular landscape formed by an interplay of geological, geomorphological, and atmospheric processes. Dunes of the Namib Sand Sea show the highest diversity of types and form an unparalleled ocean geomorphological landscape. It presents a spectacular and fascinating desert scenery with red fluid majestic sand dunes.

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UNESCO Geological Heritage Sites

SITE 091

GEOLOGICAL PERIOD	Quaternary	
LOCATION	Namibia, West, UNESCO World Heritage Site 22° 55' 00" S 016° 00' 00" E	
MAIN GEOLOGICAL INTEREST	Geomorphology and active geological processes Stratigraphy and sedimentology	

Red star dunes and white plains at Sesuvium Bay

Geological Description

The Namib Sand Sea (the Sesuvium Sand Formation) constitutes a major physiographic feature of the Namib Desert, covering a 100-150 km-wide region of the coast between Lüderitz and Walvis Bay covering an area of 104,000 km² (Stane, 2013). It is bordered by the southern Atlantic Ocean to the west and by the Great Escarpment of southern Africa to east. New age control from cosmogenic dating indicates that the sand sea is more than a million years old (Wessels et al., 2010; Steen 2018). The sand sea overlies a Neogene age fossil desert (the Karoo Sandstone Formation). The sandy desert is demarcated by large linear dunes, with areas of star-shaped dunes at its southern margin and a belt of simple and compound transverse and barchanoid dunes along the coast (Langejans, 2003). Linear and star dunes attain impressive heights, in excess of 100 m and 300 m, respectively. The Orange River is the predominant ultimate source of sand for the Namib desert dunes. After long-distance fluvial transport, sand from the Orange River is washed by ocean waves and dragged northwards by vigorous longshore currents and under the incessant action of southerly winds, sand is blown inland and carried further north to accumulate in the Namib, e.g. a peculiar wind-dominated sediment sink displaced hundreds of kilometers away from the river mouth (Stancani et al., 2002).

Scientific research and tradition

The Namib Sand Sea has been studied over the past 50 years since the establishment of the research station at Gobabeb, which served as a base for geoscientific work by a considerable number of scientists. Numerous papers including in top journals have been published about the geology/geomorphology of the Namib Sand Sea.

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Distribution of different dune types in the Namib Sand Sea after Langejans et al. (2003)

Look into the book: The Namib Sand Sea - Site 091 of “The First 100”

rocks of the Otavi Group (Lombaard *et al.*, 1986). Well over 200 mineral types were recorded from Tsumeb over its hundred years or so of mine life, including several which have been found nowhere else. Indeed, minerals from Tsumeb grace many museum and private collections around the globe. Last but not least among Namibia's "Top Three" are the Marinoan glacial deposits of the Ghaub Formation (Otavi Group). The remarkable sedimentary features left by the ice bear witness to a worldwide ("snowball earth") glaciation around 635 million years ago, evidence of which can be found in the Neoproterozoic rock record throughout Namibia and around the world. Incidentally, this global ice age caused a dramatic sea-level fall of 400 m and an equal post-glacial

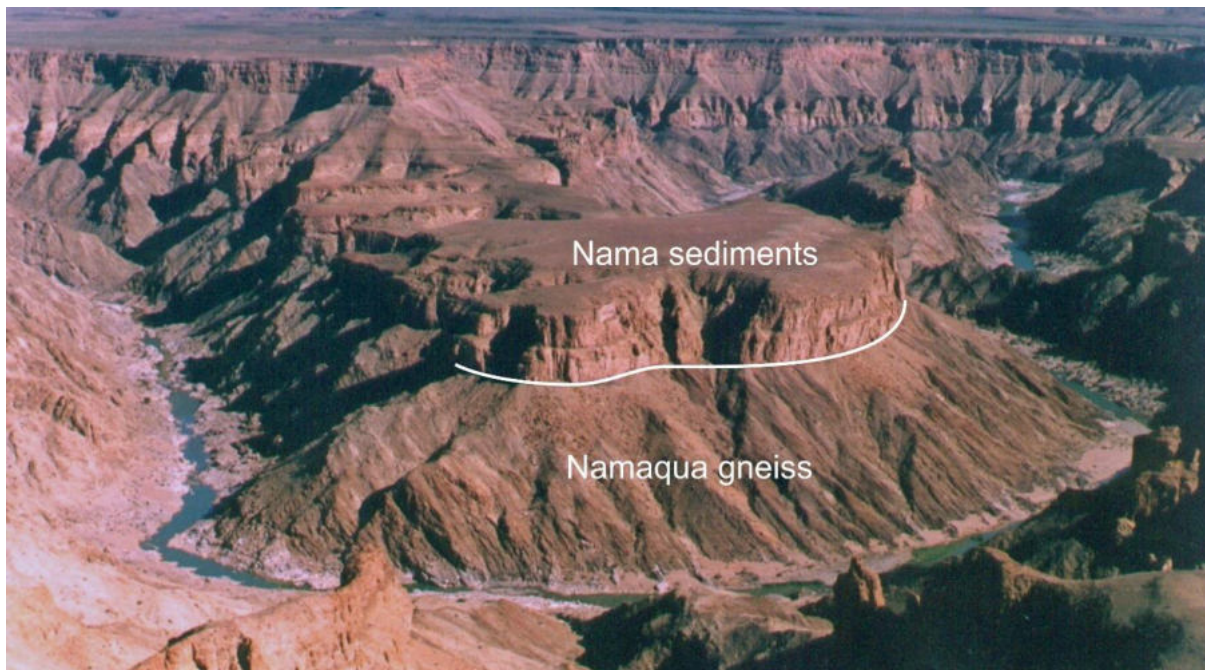
rise (Hoffman and Halverson, 2008), which, projected into today's world, would gradually have inundated much more than just coastal cities and plains.



The Next Stage

Recognising that "The First 100" scarcely do justice to the geodiversity of Planet Earth, IUGS quickly followed up with a call for proposals for "The Second 100". By September 2023 there were 174 candidate sites from 64 countries - among them 23 "newcomers" - to be reviewed. The decision of the selection committee, composed of 89 international experts covering all geoscientific fields, will be announced in August 2024 during the 37th Inter-

national Geological Congress in Busan, Republic of Korea. With luck, it may include Namibia's postponed candidate from the first round and / or a couple of new proposals (i. e. the singular Nama fossil assemblage, the impressive Fish River Canyon and the awe-inspiring Etosha Pan) – which, however, is not to say that they stand back behind the IUGS's choices for "The First 100" in either geological significance or natural grandeur!



View of the Fish River Canyon from Hobas lookout point, southern Namibia

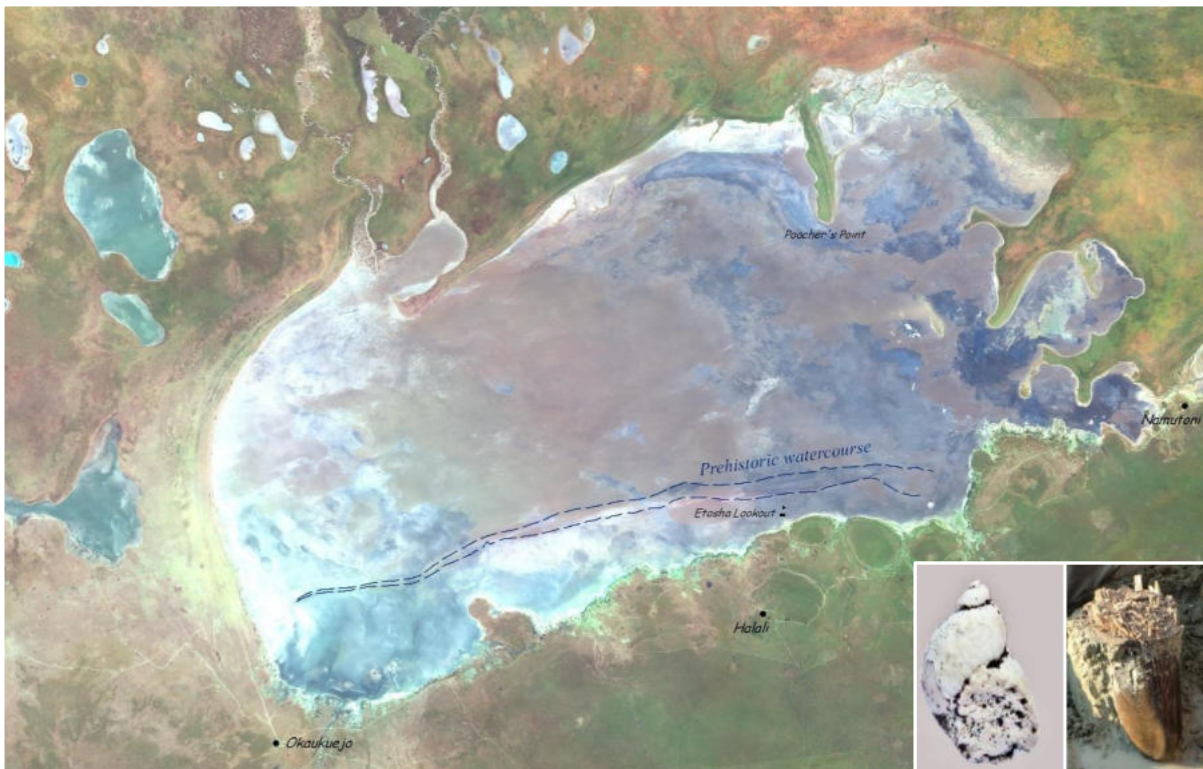
The 50 km long and 160 to 550 m deep Fish River Canyon, whose walls expose flat-lying late Precambrian Nama sediments unconformably overlying strongly deformed gneisses of the Mesoproterozoic Namaqua Metamorphic Complex, already is one of Namibia's top destinations not only for the geotourist, while the Nama fossils hold a unique place in the evolution of life. Considered older even than the South Australian Ediacara Fauna for which the terminal period of the Precambrian era was named, they encompass an exceptional suite of late Neoproterozoic fossil organisms including soft-bodied metazoans in sheet sandstones, calcified fossils in thrombolitic and stromatolitic reef complexes, distinctive Ediacaran trace fossils and a typical assemblage of terminal Proterozoic microfossils (Grotzinger and Miller, 2008). Last but not least among the new submissions is the ~4760 km² large Etosha Pan which - although it covers only a fraction of Pliocene "Lake Etosha" - is still one of the largest palaeolakes in the world, with a well-preserved and diverse fossil fauna from snails to mammoth tusks (Pickford *et al.*, 2014).

There remains to be seen how this IUGS programme and its publications, which hope to bring the geological legacy bequeathed to man-



Nama fossils (photos: M. Meyer)

kind by its home planet to the notice – and appreciation - of a wider public, and save it from destruction through population growth and industrialisation, among other threats, is received. If expectations are fulfilled, we may soon be looking at “The Third 100” – with more candidates from Namibia such as the intricate Naukluft Mountains and Nappe Complex, the Permo-Triassic succession of Mount Etjo and Waterberg with its fine record of fossil tetrapods (Mocke *et al.*, 2023) or the massive Hoba Meteorite that, while not of this Earth, has become part of earth history.



Landsat 5 image of the Etosha Pan (NASA-USGS); insets: Pleistocene landsnail (left) and mammoth tusk (right)

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