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Geology and geoheritage in the Sahara and Sahel

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The Sahara is the largest desert in the world. It is made up of sand seas (ergs), gravel plains (regs) and mountains, including volcanoes. The Saharan region comprises a Precambrian crystalline basement, overlain by Phanerozoic platforms. The Precambrian basement consists of the Archaean to Palaeoproterozoic West African Craton and East Saharan Metacraton, and numerous Pan African (late Neoproterozoic to early Palaeozoic) mobile belts (the Rokelides, Mauritanides, Anti-Atlas, Ougarta, Adrar des Iforas, Hoggar, Aïr, Gourma, Dahomeyides, Oubanguides, and Nubian Shield). Following the Pan-African-Brasiliano tectono-thermal events, which took place during the formation of the Gondwana supercontinent, there was uplift and erosion, and a major Cambro-Ordovician sand sheet was deposited as a post-orogenic molasse, in a wide variety of continental environments, in an area extending from Morocco to Arabia. This was followed by an epicontinental margin in the north of Gondwana, along which marine transgressions over much of the Phanerozoic led to the deposition of major platform cover sequences ranging in age from Silurian to Neogene [1]. Since the Oligocene (~30 Ma), the African Plate has been stationary with respect to the underlying mantle, resulting in continent-wide basin and swell topography, which reflects an underlying shallow-mantle system of convection cells [2]. Broad uplifts have formed over regions of rising convection cells, and in these regions the Phanerozoic cover has been stripped by erosion, exposing the Precambrian basement. These uplifted swells are commonly capped by young Cenozoic intrusions and lava flows. The largest of these volcanic regions is the Tibesti swell in NW Chad, while other similar regions include the Anti-Atlas in Morocco, Hoggar in Algeria, Al Haruj el Aswad and other volcanic areas in Libya, and Jebel Marra in Sudan. The areas overlying regions of downwelling convection cells in the upper mantle are characterised by the formation of large intracontinental basins, such as the Tindouf, Taoudeni, Iullemedin and Chad basins. Other areas of subsidence overlie the Central African Rift System extending from Benue through Niger to the Sirte Basin of Libya and the Western Desert of Egypt.

The landscapes of the Sahara are influenced by two major factors: (1) uplift and erosion of the cover sequences and the volcanic-capped swells, and (2) onset of a hyper-arid regime and formation of the Sahara Desert, starting with the shrinking of the Tethys Sea in the Late Miocene, followed by orbital forcing of climatic changes during the Quaternary ice ages [3]. In the regions undergoing uplift and erosion, major features of interest include the **Richat Structure** in Mauritania (a 40-km diameter dome uplift in Palaeozoic sandstones overlying an alkaline intrusion); the **Hand of Fatima** and related landforms in the Gourma Basin of the semi-arid Sahel region in Mali; the **Hoggar** region of southern Algeria, which is characterised by the uplift and exposure of deformed Precambrian basement intruded by Cenozoic volcanic pipes and lava flows, mantled by spectacular and grotesquely-sculptured Palaeozoic sandstone formations of the Tassilis of Algeria and the Tadrart Acacus of SW Libya; the **Tibesti** volcanic region of Chad (one of the most extensive Large Igneous Provinces on Earth); and the **Ennedi** Massif of NE Chad, with its astonishingly large and varied natural arches. The **White Desert** of Egypt is a unique and surreal sight, produced out of sandstone-capped white chalk cliffs eroded through sand-blasting by winds in the Libyan Desert. The geology, landscape development, and Neolithic rock art

of various geoheritage sites in the Sahara and Sahel are discussed by the author in individual chapters in the new book on the Geoheritage of Africa [4].

References:

[1] Guiraud et al. (2005) *Journal of African Earth Sciences* 43:83-143

[2] Thiessen et al. (1979) *Geology* 7:263-266

[3] Zhang et al. (2014) *Nature* 513:401-404

[4] Anhaeusser et al. (Eds.) (2016) *Geoheritage of Africa*. Struik Publishers, Cape Town

