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The Richtersveld: an ancient desert mountainland

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The Richtersveld is a remote desert mountainland located in NW South Africa, at the transition from the coastal plain to the elevated interior plateau, and adjacent to the mouth of the Orange River. Despite this positioning, the primary landscape features of the Richtersveld reflect the much more humid conditions of the Cretaceous period 100 million years ago. Subsequent aridification of the southern African west coast during the Cenozoic resulted in lower landscape denudation rates that left the topography of the Richtersveld largely unaffected, except for periodic changes in climate when increased runoff incised the lower Orange River through the Great Escarpment and into the continental interior. Sea-level fluctuations during the Cenozoic also contributed to river incision, as well as the development of river terraces and marine benches that host economically-important diamond placers.

Three landscape terrains can be defined along a west–east profile, inland from the coast. The western Richtersveld forms the coastal plain that was cut to near sea level across all lithologies, irrespective of composition and hardness, and is covered by alluvial debris derived from the escarpment and aeolian sands from the coast. The central and eastern terrains form a linear corridor of high topographic relief and dissection that characterizes the Great Escarpment (Fig. 1). The great antiquity and long-term preservation of the Richtersveld landscape reflects its long geologic and climatic history, and is today protected as a wilderness region.

Figure 1. Isoclinally folded quartzites of the Rosyntjieberg Formation exposed in the Orange River canyon.

Tourist literature often describes remote, arid, largely uninhabited, terrestrial desert landscapes as 'lunar, 'moon-like, or 'Martian', which clearly alludes to their visual geomorphic properties. Indeed, many Moon and Mars exploratory missions have involved familiarisation with such desert environments, in order to prepare astronauts, test survey equipment and procedures, and assist in the interpretation of results transmitted back to Earth. Our accumulated knowledge of the Moon has revealed that its surface is arid, mantled by widespread and

often thick deposits of impact and volcanic ejecta (lunar 'soil'), with solid bedrock confined to the lunar *mare* (basalt lava) and highlands (anorthosite crust). Probably the only aspect that is common to both the lunar landscape and that of the Richtersveld is their largely relict nature, in the sense that the latter preserves a terrestrial façade generated in the Cretaceous (90–60 Ma ago) and has experienced limited surficial modification since that time. Apart from a few relatively small impacts and *mare* eruptions, the lunar landscape has likewise been preserved for ~3 Ga. Mars, however, is turning out to possess landscape elements that may show closer similarities with that of the Richtersveld. There is now evidence for ancient waterlain sediments and thus interactions between the Martian lithosphere, hydrosphere and atmosphere. Ancient relict landscapes originally carved by liquid water have been recognized and subsequently partially modified by impact cratering, aeolian processes and slope failure. Planetary geologists are increasingly interested in landscapes and their evolution (especially of Mars), and it would be advantageous if such scientists considered terrestrial landscapes such as the Richtersveld, as well as in broadening our understanding of hyper arid mountain geomorphic dynamics.