

# How is the Namib Sand Sea explained within the biblical timeframe?

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The Namib Sand Sea in west-central Namibia has formed on a pediment between the ocean and the Great Escarpment, which rings southern Africa. Based on present sand delivery rates from the littoral zone, it should have taken over one million years to accumulate the sand. However, three other possible sources exist: the Tsondab Sandstone below the sand sea, the hinterland to the east, and the Sperrgebiet (an extensive rocky and sand-covered plain south of the Namib Desert). West-to-east changes in mineralogy and colour suggest sand from these sources. The Flood and a post-Flood rapid Ice Age can account for the volume of sand in the Namib Sand Sea.

Garzanti<sup>1</sup> and Dickinson<sup>2</sup> point out several myths in the earth sciences, including suspect terranes, mantle plumes, global sequence stratigraphy, Wilson cycles, and snowball Earth. Garzanti, a specialist in sands and sandstones, focuses on the myth that sands become more mineralogically and texturally mature through mechanical and chemical weathering. As proof, he points to the dry climate of southwest Africa in which chemical weathering can be eliminated, leaving just mechanical weathering. He notes no trend of textural and mineralogic maturity over 2,000 km of transport down the Orange River and 1,800 km of littoral transport northward from the Orange River to Angola. However, as sand is blown inland, wind rapidly rounds grains, resulting in textural maturity, especially for medium-large grain sizes.

## Namib Sand Sea

The ‘Namib Desert’ is a coastal desert in southwest Africa, stretching 1,800 km from the Olifants River of northwestern South Africa northward through Namibia into Angola (figure 1). In Namibia, the desert (erg; a desert composed mostly of sand dunes) or Namib Sand Sea stretches 600 km along the coast, covering 34,000 km<sup>2</sup> between Luderitz and the Kuiseb River. The Namib Sand Sea has been well studied.<sup>3–9</sup> It extends 100–150 km inland to the base of the Great Escarpment (figure 2).<sup>3</sup> The Kuiseb River flows annually past Gobabeb but then diminishes and vanishes in the desert. It is known to have reached the Atlantic Ocean only 15 times between 1837 and 1989. Southerly winds have pushed the desert sands and the river northward 30 km, which is why the river takes a north-west turn from near Gobabeb to the coast.

The Great Escarpment is the semi-continuous coastal escarpment outcropping over 3,500 km around southern Africa (figure 3).<sup>10,11</sup> Planation surfaces have also formed on

the plateau above the Great Escarpment from the Escarpment to the coast. In Namibia, the Great Escarpment rises from about 1,000 m at its base to 1,500–2,500 m above sea level (asl). The origin of the escarpment is a uniformitarian mystery. It is thought to have retreated inland from the coast at a rate of 5–7.5 km/Myr.<sup>12</sup>

Several rivers flow off the escarpment but do not extend very far out into the sand sea. The Tsondab and Tsaichab Rivers flow ephemerally today but have well defined valleys cut 80 to 200 m into the underlying Tsondab Sandstone, indicating greater flow during the past. These rivers penetrate west into the Sand Sea for 40–80 km, then disappear among the dunes in extensive playas.

South of the Namib Desert is the Sperrgebiet, an extensive rocky and sand-covered plain with some sand dunes. It runs from the coast to the Great Escarpment and from the Orange River northward to the dry Koichab River. ‘Sperrgebiet’ is a German word for ‘prohibited area’ after the discovery of alluvial diamonds at the mouth of the Orange River.

The surface below the Sand Sea is a large planation surface or pediment with inselbergs, such as the 600 m high Spitzkoppe (figure 4). The pediment was eroded into the Tsondab Sandstone, which, in turn, overlies Precambrian bedrock.<sup>13</sup> The Tsondab Sandstone is 45–220 m thick, and its dates have historically varied. Lancaster thought it Oligocene, but mammal fossils in nearby formations suggest it is Miocene or Pliocene.<sup>14</sup> Ward thought the sand was early- to mid-Cenozoic.<sup>15</sup> It is now dated Miocene, based on biostratigraphy.

The climate of the Namib Desert is arid to hyper-arid. Temperatures are hot near the Great Escarpment but relatively cool with fog and related light drizzle near the coast, due to the cold Benguela Current offshore. Rainfall increases northwards into Angola. The southern part of the Sand Sea has little rainfall, although winter storms that affect the

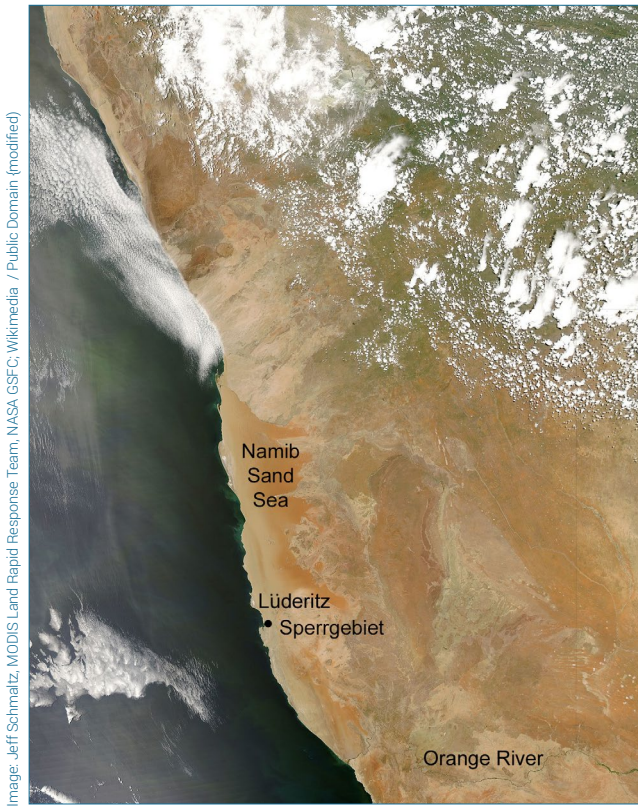


Image: Jeff Schmaltz, MODIS Land Rapid Response Team, NASA, GSFC, Wikimedia / Public Domain (modified)

**Figure 1.** The Namib Sand Sea with the Orange River to the south



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**Figure 2.** The Great Escarpment of Namibia in the background with inselbergs in the foreground

southwestern Cape might move as far north as into southern Namibia. Mean annual rainfall ranges from 15 mm or less at the coast to 27 mm at Gobabeb and 87 mm at Ganab near the Escarpment. The wind is generally from the south to southwest, but sometimes shifts and becomes strong from the east to northeast during winter, especially in the eastern Namib Desert.<sup>16</sup>

Some of the largest sand dunes in the world occur here. About 75% of the dunes are linear (figure 5), with the rest

being crescentic or star dunes.<sup>17</sup> The dunes start right at the coast (figure 6). The linear dunes rise up to 180 m above the interdune areas, while star dunes are up to 200–350 m high. It is interesting that linear dunes are the most widespread type of desert sand dune today but rare in the geological record.<sup>18</sup> Wind energy and sand transport decrease eastward.<sup>19</sup>

### The sand believed to have collected over a million years

The sand today is believed to be the Orange River sediment that is transported down its 2,000 km length, then spread northward by a 3-km-wide littoral transport system along the coast.<sup>19</sup> This sand is then moved inland by south to southwest winds. A small volume of sand is also contributed by the ephemeral rivers off the Escarpment.

Researchers have calculated how long it would take to accumulate the sand in the Namib Sand Sea by dividing the total volume by the annual input. The volume of sand has been variably estimated at 375–1,020 km<sup>3</sup>.<sup>19</sup> A later estimate was 773–1,020 km<sup>3</sup>.<sup>20</sup> Sand is added at about 400,000 m<sup>3</sup>/yr. If these assumptions are correct, the desert has been operating for over 1 million years, assuming zero sand at the beginning and uniform rates for the replenishment system.

The aridity of the area supposedly goes back to the Miocene, greater than 5 Ma, as verified by cosmogenic nuclide dating.<sup>21</sup> However, regarding the dunes themselves, optical stimulated luminescence gave dates of 5.7 to 43 ka.<sup>19</sup> Bristow *et al.* state, “The oldest sands within the dune are 5,700 yr old, indicating complete turnover of sand during the Holocene.”<sup>22</sup>

### Four possible sources for the Namib sand

Researchers have recognized three possible sources of sand for the Namib Desert: (1) northward littoral transport from the Orange River delta, (2) the Tsondab Sandstone below the erg, and (3) rivers and ephemeral streams from the Great Escarpment.<sup>21</sup> A fourth possibility, not considered by current researchers, is from the Sperrgebiet to the south.

#### The Orange River source

The source of Namib sand was poorly constrained in 2010: “The Namib Sand Sea is one of the world’s oldest and largest sand deserts, yet little is known about the source of the sand in this, or other large deserts.”<sup>23</sup> However, Garzanti *et al.* claim that 90% of the sand is from the Orange River, which starts in eastern South Africa, near Lesotho, and flows 2,000 km to the Atlantic Ocean (figure 7).<sup>20</sup> This would be a present-day estimate, but in the past, other sources could have added much sand, and because of uniformitarianism, they are not considered significant. It must be remembered that research usually only studies the tops of the sand dunes

that are probed,<sup>24</sup> which would be expected to have originated from the Orange River delta after the Flood. But the deeper sand may show evidence of having originated from other sources.

#### The Tsondab Sandstone

The Tsondab Sandstone has often been considered a possible source, especially in the east.<sup>21</sup> It is only partially lithified,<sup>19</sup> so it would erode easily. The Tsondab Sandstone is reddish due to an iron oxide coating; the grains are mostly fine to medium quartz, subangular to rounded, well to poorly sorted, with one location showing the foreset dips oriented to the north to northeast.<sup>25</sup> However, other researchers state that the dominant dip direction is toward the south.<sup>13</sup>

The Tsondab Sandstone is quite similar to the desert sand,<sup>20</sup> so some of the sand of the Namib erg is likely reworked from erosion of this formation. Garzanti *et al.* state that the sand and the Tsondab Formation are quite similar:

“A major potential source of recycled sand is the up to 220 m-thick Tsondab Sandstone, underlying much of the modern sand sea (Ward, 1988). This unit displays quite similar morphology, geometry and mineralogy of modern linear dunes, and represents a Miocene analogue of the present erg.”<sup>26</sup>

Garzanti *et al.* later state:

“A major potential source of recycled sand for the Namib dunes is the partially lithified Tsondab Sandstone, which underlies much of the moderns and sea [refs]. ... Textural and mineralogical evidence thus fully supports the very close analogy between the ancient fossil desert and the modern active one [refs]. Virtually identical textural and mineralogical features unfortunately prevent the present authors from establishing how much mobile sand is recycled from the underlying aeolianites.”<sup>27</sup>

Garzanti *et al.* still later reinforced the point:

“As documented by the Tsondab Sandstone, which underlies most of the modern Namib Erg and represents its Miocene predecessor characterized by impressively

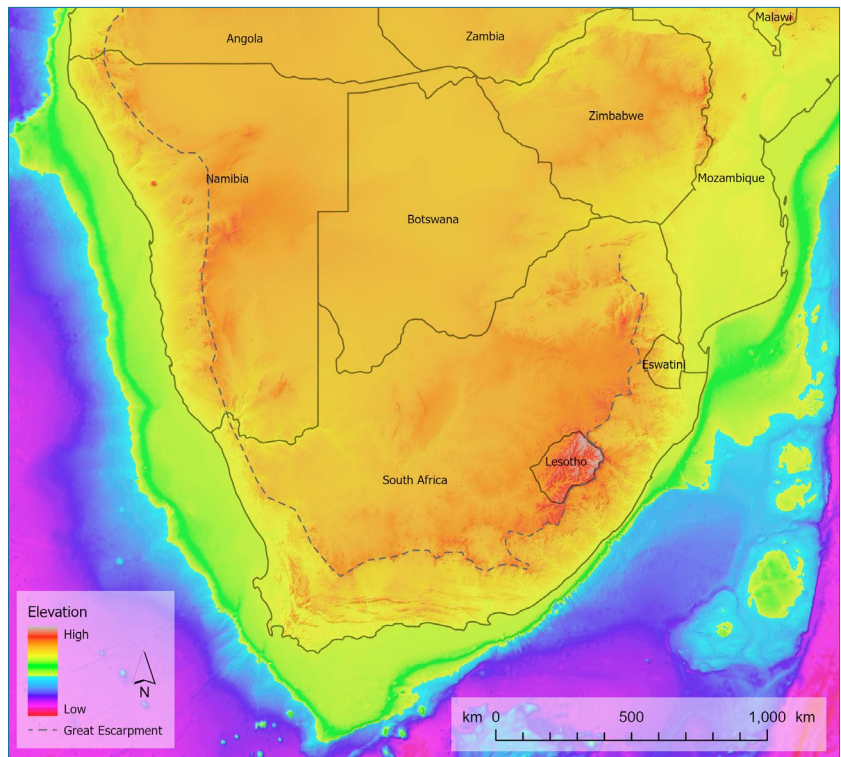


Figure 3. The Great Escarpment that parallels most of the coast of southern Africa



Figure 4. Spitzkoppe Peak, a 600-m tall inselberg on the coastal planation surface in the Namib Desert, Africa

similar sedimentological and mineralogical features.”<sup>28</sup>

The Tsondab Sandstone has been considered an earlier version of the Namib Sand Sea,<sup>13</sup> but it cannot be an older analogue for the Namib Desert sand since the leeward side of dunes dips predominantly in the opposite direction.<sup>13</sup> Because the Tsondab Sandstone is so similar, researchers do not know how much of the Tsondab Sandstone was added to the Namib Sand Sea. It could have been substantial in the past, accounting for a large part of the sand. At least the



Image: ESA, Wikimedia / CC BY SA 3.0 IGO

**Figure 5.** Linear dunes of the Namib Sand Sea



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**Figure 6.** Coastal dunes of the Namib Sand Sea

researchers acknowledge that some of the Namib sand comes from the Tsondab Formation.

The eastern hinterland

Several researchers have suggested that there is a hinterland source from the Great Escarpment and the terrain to the east. Sand could come from the ephemeral rivers, as observed today. But the conditions likely were much different in the past, as indicated by the depth of erosion in the river valleys. So, this source could have potentially added much of the total volume of sand.

Sperrgebiet, to the south

Researchers do not think much sand came from the south, since there is very little sand there today. But it is possible that in the past, especially when considering Flood runoff, more sand existed in that region. The prevailing winds from the south to southwest would then have carried it to the Namib Sand Sea.

### The west to east changes in mineralogy and colour in the Sand Sea

The sand in the Namib Sand Sea is not homogeneous, as would be expected if the source was nothing but the Orange River. One would expect that the coastal dunes would have the same lithology as the Orange River sands, and this is true.<sup>19</sup> Feldspar, volcanics, and heavy minerals are the same for the Orange River and coastal Namib sand. However, there is a west-to-east change in lithology, from the coast to the Great Escarpment, including an increase in quartz and a decrease in volcanic lithic fragments and pyroxene.<sup>19</sup> The eastern dunes reflect more the Tsondab Sandstone and the hinterland to the east. In addition, grain size decreases and sorting increases from west to east.

There is also a gradient in colour. Lancaster writes that the colour increases from pale in the coastal zone to red in the east, because of a thicker iron-oxide coating on the grains.<sup>3</sup> The colour may represent different sand sources, with the red sand originating from the red Tsondab Sandstone.

### Possible Flood/post-Flood solution to Namib Desert sand

How can over one million years of sand in the Namib Desert be explained during biblical earth history? Like many challenges from the secular world, this challenge initially seems powerful. But the Flood and the post-Flood rapid Ice Age can explain the volume of sand within the short biblical earth history.

Tremendous erosion in southwest Africa

From a biblical point of view, we need to include the Flood in any discussion of the origin of the sand and the geomorphology of Namibia. Based on the amount of offshore sediment from Walvis Ridge to the Falkland/Agulhas fracture zone (figure 8), about 2,400 m of erosion is estimated to have occurred across southwest Africa!<sup>12</sup> During this time, the Great Escarpment formed, probably by retreating inland during Flood erosion. So, the Namib Desert and its surrounding areas were greatly eroded during the Flood.

Planation surfaces formed above and below the Great Escarpment, likely by fast-flowing Flood runoff.<sup>29,30</sup> The planation surface above the Great Escarpment is either part of one African surface that covers much of the continent or a series of planation surfaces separated by erosional scarps and dissected by valleys that are now occupied by rivers and ephemeral streams.<sup>11</sup> New research indicates that the African surface may not be one large continent-scale planation surface that was later faulted or folded to different elevations, as some uniformitarian scientists believe.<sup>31,32</sup>

Sand left over after Flood erosion

I suggest that a large volume of sand in this desert was left as a lag during Flood runoff. Evidence for fast Flood runoff is the existence of coarse gravel at the base of the Tsondab Sandstone.<sup>13</sup> This gravel is predominantly resistant quartz and chert.<sup>33</sup> Some of the sand above the coastal pediment became partially lithified to form the Tsondab Sandstone, while unlithified sand remained on the surface to ‘jump start’ the Namib Sand Sea. The predominantly south-dipping foresets in the Tsondab Sandstone, different from the foresets of the Namib Sand, do not support an origin of the Tsondab Sandstone from the Orange River Delta. Instead, it was a lag deposit of waning Flood currents flowing off southwest Africa as the continent was uplifted late in the Flood.<sup>29,30</sup>

The east-to-west change in the sand is further evidence that much of the sand was deposited as a lag during Flood runoff, especially the sand to the east. Besler writes that some researchers do not believe the source of the sand for the Tsondab Sandstones is from the Orange River, and that it could have come from the Gamsberg quartzite to the east.<sup>34</sup> The sand in the west may have accumulated after the Flood from the present transport system during and after the Ice Age.

Ice Age sand input

The Ice Age would have delivered a little sand to the Sand Sea to add to the lag left by receding floodwater. It is difficult to know the set of ocean currents during the Ice Age, but it is reasonable to infer that the northward Benguela Current and the southerly trade winds developed soon afterward, beginning to transport Orange River Delta sediments north. Sand from the delta would take a fair amount of time to be transported 300–900 km to reach the Namib Desert. Garzanti *et al.* estimate that with a velocity of 1 mm/sec, currents could transport a single sand grain 1,800 km to Angola in only 57 years.<sup>20</sup> Another estimate gives a minimum of 450 to 3,600 years. Regardless, it does not seem that the Ice Age, which lasted about 700 years,<sup>35</sup> would have been a significant source of sand.

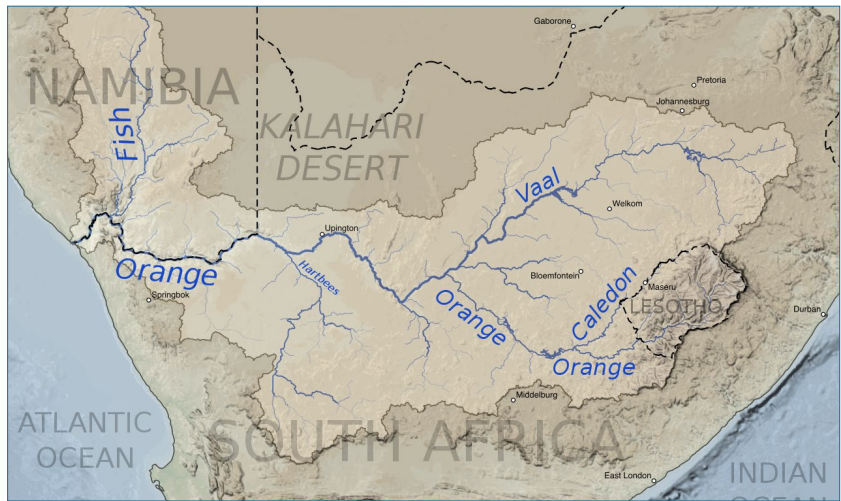


Figure 7. Map of the Orange River and its major tributaries

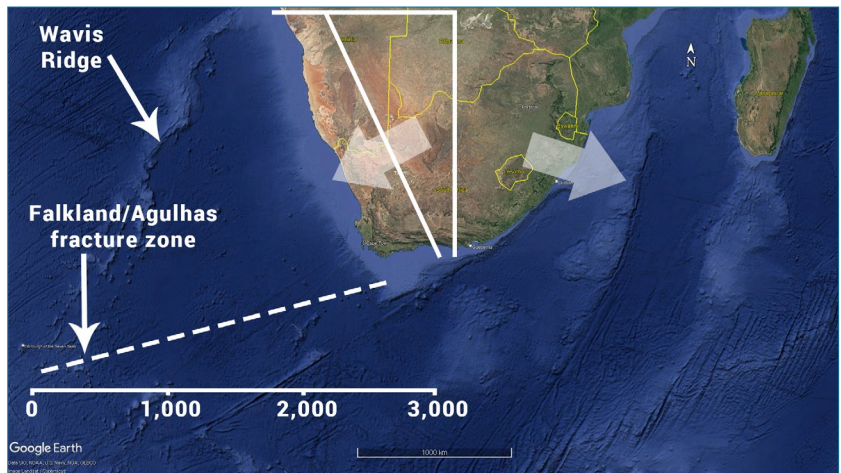


Figure 8. Map of southern Africa and the adjacent oceanic margin (annotations by Melanie Richard). Large arrows show direction of runoff during the uplift of southern Africa. Lines in southwest Africa show the two areas of estimated continental erosion of that area.

Conclusions

The Namib Sand Sea in west-central Namibia is claimed to have over one million years’ worth of sand, believed to have originated from the Orange River Delta. However, much of that sand could have come from the underlying Tsondab Sandstone or from the eastern highlands. A third source, not considered, could be the Sperrgebiet to the south.

During the Flood, 2,400 m of erosion occurred over southwest Africa. Such erosion likely left a lag of sand on the pediment that extends from the Great Escarpment to the ocean. The lag would consist of a fining up sequence of conglomerate and breccia forming the base of the Tsondab Sandstone. This sandstone is weakly lithified, transitioning to the unconsolidated sand of the Sand Sea. Ice Age input from the Orange River sands along the coast would have added

a little more sand, especially near the coast and atop that deposited during the Flood. The combination of sand sources can account for the west-to-east change in sand properties. We do not need a million years for the sand to accumulate in the Namib Sand Sea. The Flood and post-Flood Ice Age can explain the volume of sand just as readily.

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