Figure 84. Raw diamonds mined from the West Coast come in a variety of colours and shapes. Many of the sharp edges of the diamond's octahedral (8-sided) crystal are resorbed (rounded), enhancing their survival during their long transport to and along the coast.

Diamonds, pumice stones and volcanoes

The West Coast is famous for its diamonds (Fig. 84). However, most people are not aware of the pumice stones that also end up on its beaches (Fig. 85). Both stones come from volcanoes. The historical records of earthquakes indicate that the West Coast is tectonically active, but volcanoes? The East African Rift Valley has earthquakes as well as active volcanoes, such as Mount Kilimanjaro, rising nearly 6 km above sea level. However, the southern extension of the rift valley's mantle plume, which includes the elevated Southern African Plateau, has not experienced volcanic activity for millions of years. The most recent volcanic rocks – dated to 46 million years old – are in the Klinghardt Mountains in southern Namibia.[47] Cloud streaming from the summit of Lion's Head can give the fanciful impression of a smouldering volcano, but the cloud plume is cold, not hot. It forms as moist sea air carried by a passing winter front is forced to flow up and over Lion's Head. The moisture unseen in the air at sea level condenses into cloud vapour as the air cools along its flow path over the peak, similar to the Table Mountain's larger tablecloth of cloud. Cloud on Lion's Head usually signals the arrival of a winter front and rain while Table Mountain's tablecloth usually signals fair weather.

There were claims at the time of the 1809 Milnerton earthquake 'that the earth had opened, that volcanic eruptions had taken place, that craters had been formed and that lava had issued!' Intrigued, the same Mr von Buchenroder who had written about the earthquake went to investigate these volcanic eruptions and reports:

> At Blauweberg's [Blouberg] Valley, I found the sandy surface studded with innumerable holes, resembling in shape, but in nothing else, craters in miniature. These holes were from six inches to a foot and a half, and some even three feet in diameter, and from four

> inches to a foot and a half deep; of a circular form and the sides sloping to the centre. They were lined with a crust of bluish clay, of about a quarter of an inch in thickness, which had been baked by the sun, and according to its nature had cracked and curled up in fragments, which however adhered still to the sloping sides of the holes. The appearance of the bluish baked clay, which had given rise to the story of lava (!) was easily accounted for, from the rain (a great quantity of which had fallen in the preceding season) having been prevented by the substrata from penetrating and sinking deep into the ground, so that under the sandy surface, a considerable quantity of water had collected, in which a portion of the substratum of clay had become dissolved [suspended], and which had been forced up through the loose sand, by the concussions [earthquakes] which took place. The people of Blauweberg's Valley, stated that 'they saw jets of coloured water spout from these holes, to the height of six feet, in the night of the 4th December, at the time that the shocks were felt.'[48]

Therefore, instead of volcanic activity, movement along the fault had forced water to escape through fissures, spouting liquefied sand and mud. The sand settled first into conical mounds, upon which the bluish mud settled out last.

Despite the long absence of volcanism, the West Coast is home to recently erupted volcanic rocks. Pumice stone is familiar to some, used as an abrasive to remove tough callused skin while having a bath. Pumice forms from bits of magma ejected from the volcano as gas held within the magma is released, forming a froth. Many pumice stones preserve a rounded, aerodynamic (bomb) shape acquired as they flew through the air or water and cooled quickly into a hard glass. Riddled with many holes from the quenched gas bubbles (vesicles), pumice is less dense than water and floats, and can be carried by ocean currents to end up on faraway beaches. On the West Coast, it is not unusual to find isolated pebbles of whitish to grey, sometimes black, pumice stone among seaweed, cuttlefish bones, bird feathers and plastics left behind on the last high tide.

Figure 85. Pebbles of pumice stone on Noordhoek Beach help to camouflage a bird egg (left). Close-up of a pumice stone reveals its many fine gas vesicles (right), allowing it to float.

The most likely source of the pumice found on the West Coast is from eruptions around Tristan da Cunha or Gough, volcanic islands 2600 km west of Cape Town that are associated with the Walvis hot spot (Fig. 55).[49] In 1725 Captain Charles Small of the *Lyell* observed pumice on the sea surface drifting in an area 480 km by 80 km just east of Tristan. The drift of pumice stone, carried by the predominant westerly wind, was 'so thick that we could scarce see the water between them' and some stones 'were as big as a man's head.'[50] Several pumice stones dredged from the seafloor east of Tristan are of similar composition to those found on the West Coast. Whether the dredged pumice stones are from the 1725 eruption is unknown – they may be from an earlier or a more recent, undocumented eruption. Eruptions commonly go unnoticed beyond the pumice floating at the surface because they occur under the ocean on the submerged flanks of volcanic islands.

More amazing than landed pumice stones on distant beaches is the recent discovery of volcanic ash in archaeological cave deposits on the South Coast that settled out of the air from the enormous Toba eruption that took place 74 thousand years ago.[51] No pumice has yet been found associated with the Toba eruption in South Africa. However, pumice from the 1883 Krakatoa eruption, located near the Toba volcano in Indonesia, has been found on the shores of the Indian Ocean, including the eastern beaches of South Africa. The fact that pumice can be so widely dispersed across vast ocean distances demonstrates the ability of floating seeds and rafted organisms to disperse and colonise new land or islands, a topic of great interest to Charles Darwin, who did experiments showing that seeds could remain viable after having been soaked for months in seawater. More recently, much of our discarded plastics have ended up forming disturbingly large floating patches in the ocean's central gyres.

Pumice is not the only stone sourced from volcanoes to be found on the West Coast. Stones of diamond are delivered by rivers to the West Coast, eroded out of kimberlite pipes (Fig. 86). No kimberlite volcano has been active historically, with the youngest kimberlite pipes in southern Africa dated to 170 to 70 million years old. Although never witnessed, we know from the preserved remains of kimberlite volcanoes that they were spectacularly violent, explosive eruptions. Unlike pumice, the diamonds do not form during the eruption of the kimberlite volcano. Instead, diamonds form at great depths of 150 km, where temperatures and pressures are high enough to transform pure carbon in the form of graphite (pencil 'lead') into translucent octahedral crystals of diamond. The kimberlite's deeply sourced magmas rip pieces of diamond-bearing mantle rocks from the sidewalls of the pipe as they explosively rise to the surface.

Extract from Compton, J.S., 2021. *West Coast, A Natural History*, Earthspun Books (johnscompton.com).

Figure 86. The Big Hole in Kimberley (right) is famous for its 13.6 million carats (2.75 tons or 6000 pounds) of diamonds, most carried to the surface within mantle xenoliths (above).

Not all kimberlite pipes contain diamonds, but the erosion of those that do releases the diamonds, many of which are carried by rivers to the sea. Currently the Orange River is the main source of diamonds on the West Coast because it drains interior areas that have diamond-bearing kimberlites. The Olifants River was also a source of diamonds long ago when its drainage area included kimberlite pipes that were later 'captured' by the Orange River following upheaval of the land surface. An ancient Olifants River source of diamonds is supported by the fact that diamonds are mined north, but not south, of the Olifants River. This southern limit of coastal diamonds reflects the process of longshore drift, which moves beach sand north, not south (Fig. 73).

The intense winds in southern Namibia, in which it is sometimes difficult to remain standing upright, blow sand, as coarse as grit 1 to 3 mm in diameter inland. It is a strange landscape where, rather than carved by the flow of rivers, valleys are sandblasted out over time, carved largely by wind-propelled grains of sand. The sand carves out valleys from the less hard carbonate bedrock, leaving more resistant ridges called yardangs. Included in the grit are diamonds that together with the sand travel along the coast from the Orange River and are blown by wind up the valleys. Diamonds are only one in a million compared to quartz sand grains, but being significantly denser, the diamonds tend to lag behind and collect on the wind-deflated surface of the yardang valleys (Fig. 87).

Figure 87. Men crawling on their bellies in southern Namibia pick diamonds up with tweezers, even under moonlight, or so the story is told.

Some diamonds are mined from ancient gravel deposits left high and dry on river terraces as the river progressively cuts deeper into the bedrock. However, most diamonds outside of kimberlite pipes are found along the coast in beach gravels and bedrock gullies that trap the diamonds. Some gravels are on raised beaches that formed when the sea was higher than today, while others are located in offshore gravels formed when the sea was lower than today. Marine mining extends out to 130 m water depth, which coincides with the maximum lowering of sea level during past glacial periods. Coastal diamonds are not nearly as plentiful as in kimberlite pipes, but most coastal diamonds are of high quality. Diamond is the hardest natural substance known on Earth and nothing can scratch it, but the impact of other, even less hard stones can fracture the diamond into smaller pieces. As the diamonds tumble along the riverbed in their long journey to the coast, those with impurities or imperfections are more likely to break apart. Only the best-quality diamonds tend to survive the journey, and for this reason the West Coast has a high percentage of gem-quality stones compared to those mined from kimberlite pipes.

The fact that diamond mining has been successful only north of the Olifants River hasn't stopped some from exploring for diamonds to the south of the Olifants River. Mr Werner, who was one of five surviving German World War II U-boat captains at the time, formed a company to explore for diamonds in the Cape Canyon in the 1990s. The Cape Canyon is impressively long and deep, forming a major feature offshore that cuts obliquely through the continental margin (Fig. 54). The head of the Cape Canyon is located south of the Olifants River mouth offshore at water depths of several hundred metres. The canyon then extends as a deep incision from the outer shelf down to the Cape Basin abyssal plain at water depths of 4 km. Mr Werner thought that this major submarine canyon may have acted like a funnel, focusing sand and diamonds from the Olifants River to the deep sea. He proposed purchasing a second-hand Russian nuclear submarine modified into a mining vessel capable of extracting sediment out of the Cape Canyon. He managed to convince enough investors to fund the endeavour, and initial offshore exploration included the collection of a large number of sediment cores from the seabed. However, the modified nuclear submarine never materialised nor did any mining take place, but the many cores retrieved were donated to the University of Cape Town and formed the basis of several research projects. If diamonds exist in the Cape Canyon, they are probably too few in number to justify the expense of mining at such great water depths.

Extract from Compton, J.S., 2021. *West Coast, A Natural History*, Earthspun Books (johnscompton.com).