The volcanic sands are less known than more common quartz-rich sand sheets. 21% of Iceland is covered by volcanic sands that were analyzed in detail for two sites. Our results reveal diverse origins. The first site is the Dyngjusandur, located north of the Vatnajökull ice cap, and the second site is the Lambahraun area, located south of the Langjökull ice cap. At both sites, the sand origin is determined from a combination of approaches, including wind directions from ventifacts, chemical and mineralogical analyses of rocks and sands. At Dyngjusandur, the sand is dominated by glass grains, a situation typical of Icelandic sand plains. The hyaloclastite ridges buried beneath the Vatnajökull glacier are the dominant source of the sand, and only large size plagioclase crystals (0.5 cm) in sands seem to be derived from the lava flows. The hyaloclastite ridges crushed by glaciers were washed out by melt-water onto flood plains. The sand composition is spatially homogeneous, reflecting an efficient mixing of distinct sources below the glacier. In contrast, the sand at Lambahraun is dominated by crystals and is chemically consistent with a mixture of material derived from lava flows of Eldborgir and Skersli volcanoes. The analysis of the lava flow contacts with the glacier reveals that basaltic grains formed as the result of recent glacier advances abrading the rocks. The interaction of glacial and fluvio-glacial activity with basaltic plains is required to produce a large amount of sands in a short period of time (<4000 years).