Nomenclature Related to Sand, Beaches, and Dunes

A reference guide compiled and illustrated for use by the
International Sand Collectors Society (ISCS)

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Date of this edition: April 8, 2022

About the Author

Sand grains, their assemblies, and the dunes that they form are fascinating subjects. My personal interest in small particles began when I studied Apollo lunar soil samples for my master's degree research at Lehigh University in the 1970s. Trained as a materials engineer, I am not a practicing earth-scientist, nor do I claim expertise in mineralogy, geomorphology, or sedimentology. However, I am a fan of sand collecting and particle characterization, so I decided to compile this reference for the benefit of fellow arenophiles (avid sand fans).

As a longstanding sand and mineral collector, I have enjoyed sharing my interests with others. Over the years, I presented lectures on sand to scientists, engineers, and community groups. I also developed and taught a course on "The Amazing World of Sand" at the Osher Lifelong Learning Institute (OLLI) in Asheville, North Carolina. About ten years ago, I became aware of the International Sand Collectors Society (ISCS), and with encouragement from Thom Hopen, the leader of that group, took on editorship of its newsletter called *The Sand Paper*, a position I held until 2019.

The sheer volume of books, journal articles, reports, and Internet information about sand is enormous. Therefore, compiling a complete glossary of terms concerning sand, beaches, and dune fields is beyond the scope of this booklet. Rather, I offer the following listing of about 150 selected terms and definitions. Hopefully it will be useful for students, general science teachers, and of course, my fellow collectors.

I have tried to define the terms in this compilation concisely, sometimes combining definitions gleaned from several sources. The references on which I based most of the definitions are numbered at the end. In particular, I'd like to thank Prof. Stephen Leatherman (alias "Dr. Beach"), of Florida International University, and Prof. Nicholas Lancaster, Desert Research Institute (ret.), for their helpful comments on early drafts of the document. I'd also like to thank Thom Hopen and Bill Beiriger of ISCS for suggestions on later drafts.

No glossary is perfect, and some readers may disagree with some of its details and interpretations. Nevertheless, I hope this glossary will remain a helpful guide for those with an ingrained curiosity about sand, and will facilitate communication about this gritty subject.

Stay well and happy collecting!

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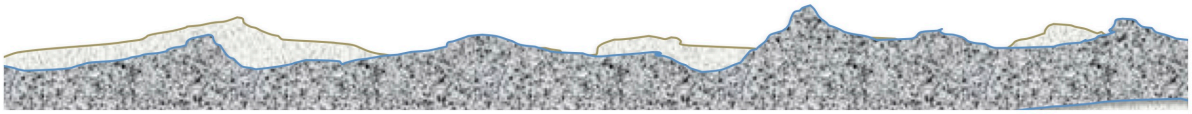
November 30, 2020 (2nd ed. April 8, 2022)

Cover image – sand grains from Malin Beg, Ireland; collected by M. Beckerman. Image captured by the author using a Dinolite™ model AM4815ZT digital microscope, original magnification 100X.



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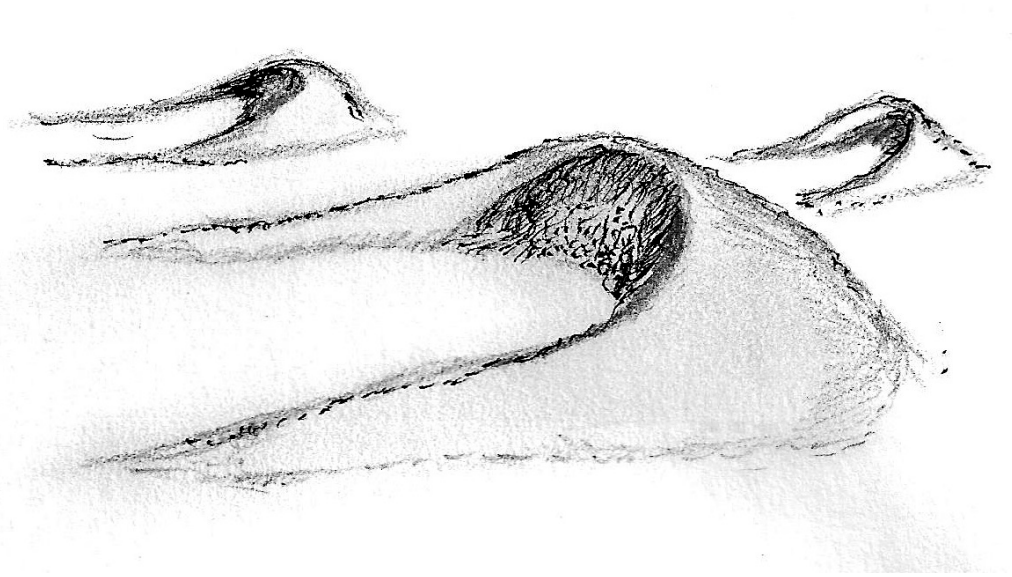


Barchan dunes on parade

Introduction

The development and use of standardized terms and definitions helps us all to communicate effectively. As with other specialty fields, however, some sand-related terms are vaguely or ambiguously described in the literature. Disputes concerning the meanings and definitions of terms are not unique to the subject of sand and its formations. My experience as a member and past chair of ASTM International's subcommittee G02.91 on wear terminology has taught me that. Hopefully, the definitions that follow are acceptable by a consensus of those working in the field.

When comparing different sources on sand and sand physics, the reader may find general agreement on the major definitions, but some difference in the details. For example, "sand" is commonly defined as solid particles that fall within the size range of 0.063 to 2.00 millimeters (0.0025 to 0.079 inches), but not always – especially as regards the lower size limit, when values of 0.050 or lower are sometimes cited. The author sometimes found it a challenge to make the illustrative photographs of dunes given in some books consistent with the text that refers to them. In other words, the subtle, defining characteristics of some types of dunes might be obvious to geologists, but not necessarily to rookies like me who are hearing the terms for the first time. Furthermore, several kinds of dunes may occur in close proximity (e.g., complex dunes) and it may be difficult to decide where one ends and another begins.

The sources used for certain definitions are placed in brackets [ ] and referenced on page 10. Some of the definitions are based on combining information from several sources. In an attempt to be concise, more detailed descriptions of specific terms must be left to textbooks, journal articles, and field reports. The terms included here are intended for collectors or students, so the more information-rich terminology associated with coastal erosion, civil engineering, sedimentation, and the physics of blown sand, must be left to more rigorous references like [1], [3] or [24]). In one instance, I proposed my own new term and definition: "astrogenic sand."

As Lancaster points out (ref. [1], p. 8), some categorizations for dunes are based on shape (geomorphic categorization) but others are defined also by the knowledge of what processes formed them (geodynamic categorization). In the latter case, it is necessary to know *how* a dune was formed in order to specify its type. The processes of how a given dune was formed may not be obvious to non-experts, and in my experience they seem inconsistently described in some publications and on the Internet. Furthermore, the names for some sand formations may have originated in other cultures or in other languages that were only later translated into English.

In summary, the reader should consider this booklet an introductory guide for the diverse world of sand and its formations. It is not the end, but rather the beginning of a fascinating journey.

Sand-Related Terms and Definitions

abiogenic sand - a type of sand whose origins are mainly natural geological formations. Examples include material weathered or eroded from rock such as granite or sandstone. Fines may also come from volcanism or rocks pulverized under moving glaciers. Most, not all, abiogenic sand contains silicon-oxygen compounds such as quartz (SiO_2).

aeolian transport – movement of sand grains by moving air. (also spelled *eolian*) [13]

alluvial fan – a fan-shaped deposit of sand and sediments produced when particle-bearing water expands from the mouth of a narrow channel and allows deposition to occur. See also, [1] p. 13

alluvium – soil, sand, mud or similar material deposited by streams, or the deposits they form. [24]

angle of repose – the maximum slope, relative to the horizontal, of a pile of sand grains or granular materials that is stable, but is on the verge of sliding under the influence of gravity or greater tilt.

arkosic sand – sand formed from a sedimentary rock containing sandstone and at least 25% of the mineral feldspar. (See [12] under the title "Sandstone").

arm (of a dune) - prominent sloped feature on a dune that extends from a high point near the center to an extremity [1] p. 51

anthropogenic sand - a type of sand that primarily consists particles made by human activities. Examples include waste products of industrial processes, ash, conders, artificial grinding of rocks.

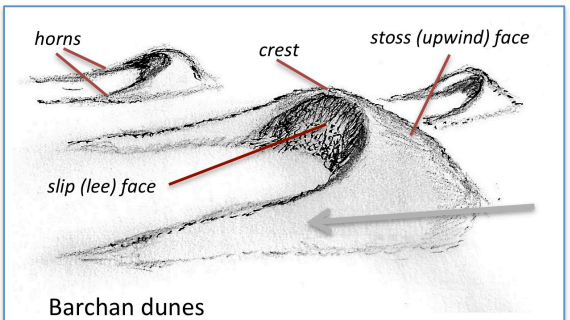
arenophile – an organism that thrives in sand, also a term used to describe a sand collector. (Syn. *psammophile*)

astrogenic sand – particles of extraterrestrial origin whose size falls within that for sand. Note: micro-meteorites could be considered *astrogenic sand*.

avalanche face – (See *slip face*).

backwash – a swash that moves straight down the beach face by gravity. Swash (consisting of uprush and backwash) is formed by a broken wave on a beach face. [26] See also *swash* and *longshore* drift in ref. [11].

barchan dunes – horseshoe shaped dunes that tend to form when the wind direction is relatively uniform and the sand supply is limited. The open end of the horseshoe faces downwind.



Barchan dunes
gray arrow shows primary wind direction

barchanoid dune – "a transitional dune form between transverse dunes with long crests and individual lobate or barchan dunes." [4].

barchanoid ridge – a sand formation of several connected barchans dunes that resemble a row crescents.

barking sand – a type of desert sand which, under the right wind conditions and the presence avalanching, can produce a noise akin to the barking of a dog. Note: there is a Barking Sands Beach at Kekaha, Kauai, Hawaii.

beach – an accumulation of wave-washed sediment at the water's edge. [26]

beach face – a sloping zone along a beach below the berm that is exposed to the swash of the waves. See *swash*.

beach drift – the gradual movement of sediments parallel to the margins of an existing beach and produced by the actions of waves and currents.

bed – a continuous layer of rock or sand, typically > 10 mm thick, that is separated from layers above and below by bedding planes and may be formed by sedimentary processes.

bedding plane – the boundary between successive, distinct layers of compressed, stratified rock or sand.

berm – wave-formed feature at the top of the beach face. It is not a dune feature as wind has little or no role in berm formation. [26]

berm crest – the seaward limit of a berm. [24]

biogenic sand - a type of sand that primarily consists of biological material plants or animals. It may be of silicate, carbonate, or other composition. Sources include foraminifera, diatoms, crushed shells, coral fragments, excreted matter from fish.

bioturbation - the disturbance or reworking of natural features like soils, sediments, or sand dunes by animals or plants [1] p. 100

blown sand – see *eolian sand*.

blowout – crater-like depressions in a sand dune field left when the wind removes an area of sediment.

booming dunes – a form of singing dune that produces a single groaning musical note (most often the key of "g", "e", or "f") with thicker sand layers of dry sand over more wet under-laying layers producing lower notes; generally produced by natural sand avalanches; research suggests the dune must be over 40 m tall, with a slope greater than 30 degrees, and the temperature must be relatively hot; boom may resonate longer than the avalanche that created it. [9] (See also *singing sand*)

bouquets du silk – a form of compound linear dune composed of parallel, slightly sinuous sharp-crested ridges. [1] p. 64]

brink – a break in the slope of a dune over the crest and leading to the slip face [4].

bypassing sand – in coastal erosion, the hydraulic or mechanical movement of sand from the accreting updrift side to the eroding downdrift side of an inlet or harbor entrance. Note: this can result from natural or human actions [24].

clastic – pertaining to fragments of rocks or minerals, transported by and deposited by wind, water, ice, or gravity [2].

climbing dunes – dunes that form on the windward side of obstacles in which the flow and deposition of sand is uphill [1] p. 48 (See also *echo dunes*.)

competent bed – a bed that maintains its nominal thickness despite being deformed, folded, or bent. Examples include limestones and sandstones. [16]

complex dunes – dunes consisting of combinations of more than one type of dune [8]

compound dunes – large dunes that contain superimposed features of a similar type of dune and similar slipface orientation. [8]

coppice dunes – (see *nebkhas,* synonym: *shrub-coppice dunes*). [1] p. 77

cover sand – a sand sheet of the late Pliestocene period of relatively uniform thickness that covers a large area with slope angles less that 6 degrees and whose topography does not vary by more than about 5 m. (Term is rarely used, but see ref. [13])

creep – the movement of relatively larger sand grains (> 0.5 mm) by either wind driving or as a result of impacts from saltation of the grains.

crescentic ridge – an undulating ridge of periodic, shallow, crescent-like features that lies atop a linear dune. [1] p. 46.

crest – the "highest part of a dune." [4]

critical shear velocity – the magnitude of the velocity of air or water needed to initiate movement for a certain type or size range of sand.

cross-bedding – a patterned structure of rock or sediments formed by changing currents of wind or water in which layers are formed progressively, burying previous layers and having different orientations than that of the bedform. [10] Note: It often indicates a dune deposit in the rock record. Geologists look for this type of bedding. [26]

deflation –the wind-assisted removal of smaller grains of sand from a poorly sorted deposit of sand and pebbles; may appear as craters or bowls; may lead to formation of a denser *desert pavement* from the large particles left behind; ceases when the rocky surface is formed [4]. Deflation results in lag deposits of coarser material and/or shells on the sand surface. [26]

depositional dunes – all dunes are depositional features, so this term is redundant. (i.e., this is a deprecated term).

desert pavement – a surface layer composed of interlocking, densely- packed pebbles and rock fragments in which lighter, finer material has been blown away. Note: Many workers now think that desert pavements may be accretional, in which dust accumulates and the surface layer of clasts rises over time [27].

dome dunes – relatively rare, circular or rounded dunes with no slipfaces; tend to evolve into crescentic dunes downwind; often found at upwind margins or lateral margins of dune fields [8]

draas – a form of large compound dune that contains superimposed bedforms. [1] pp. 48,181 (syn. *mega-dune*)

drift potential (DP) – in the construction of sand rose diagrams, the drift potential measures (in vector units) the relative sand moving capability of wind [5]

drift sand – sand sheet or dune deposit formed in the Holocene period by reworking of prior cover sand (Pleistocene). [13]

dune – an accumulation of sand or small particles that is produced by wind action.

dune decomposition chimney – remains of a decomposing, hollow tree trunk surrounded by the sand in a dune. These concealed structures, reaching 3 or more meters deep, can pose a hazard to animals and small children who can fall into them.

dune field – a expansive geographical area that contains one or more types of sand dunes and groupings of sand formations.

dune rock – strongly cross-bedded Aeolian sandstone formations, sometimes cemented by calcium carbonate deposits [19].

echo dunes – large dunes that form on the upwind side of a large scarp or massif due to the formation of a rolling eddy of air that keeps an intervening corridor free of sand. Echo dunes are among the largest and can read a height of 400 m [18]. Also [1] p. 48.

eolian sands – (see *aeolian transport*)

erg – in geology and also known as a *sand sea*, it is a large geographic region that is covered by sand [4]. (also spelled *ergh* [1] p.1). Derived from "*arq*" meaning dune field, but not to be confused with the old unit of energy, the *erg*.

erosional dunes – dunes that form by erosive removal of material so as to produce forms such as parabolic dunes or sand ridges. [1] p. 45

evaporites – layered sedimentary rocks such as gypsum or rock salt that form in marine basins which are subject to evaporation.

falling dunes – dunes that form on the lee side of topographic obstacles. There may be climbing dunes on the windward side of that obstacle as well. [1] p. 48 (also *lee dunes*)

fish hook dune – a hook-shaped dune in which the shaft consists of a sinuous ridge the ends in a well-defined crescent. [20] p. 403. (syn. *hooked dune*)

fluvial – in sand transport, a process in which sand structures or formations are produced by the action of water (rivers, creeks, ice sheets, or streams).

fluvio-aeolian deposit – interbedded or reworked fluial and aeolian sediments formed by any of several mixing and sedimentation process. [13]

fore dune – in a dune field ending at a beach, the dune closest to the water; may have an avalanche face; may be eroded by waves or rebuilt by the wind or retained by anchorage from vegetation.

geomorphology – the branch of physiography and geology concerning the form of the earth, its surface configuration, and changes that take place in landform evolution. [24]

glaciofluvial deposit – an accumulation of sand produced by the action of glaciers.

goz – a term used typically in Egypt to describe a long sand ridge.

graded bedding – a form of bedding in which the size (fineness) of particles such as pebbles, sand, and silt increases from the bottom (older deposits) to the top of the bed. Multiple graded beds may be stacked in a formation. [16]

grus – sand formed from arkose (See [12] under the heading "sandstone" or granite.)

gypsum dune – a dune composed of sand-sized grains of gypsum; White Sands, New Mexico, is the largest gypsum dune field (syn. *calcareous* or *time dune*) [6, 27]

hemicyclic dune – wide, arc-shaped type of parabolic dune with a typical length to width ratio of 4:1. [7]

hooked dune – See *fishhook dune*.

horns – the two leading arms of a barchan dune, created on the lee (downwind) side and on opposite sides of the slip face (ref. [8] and ref. [1] p. 51)

horse shoe dunes (see *barchan* dunes)

hummocks - small dunes that may form on the lee side of shrubs; with eddies on the lee side, they may result in *barchan dunes*. (see also *nebkha dunes*).

hydraulically equivalent grains – sedimentary particles that settle at the same rate given the same conditions [24].

incompetent beds – structures of relatively weak docks like clay, mudstone, and shale that readily deforms under folding. [16] See also *competent beds*

keel – a ridge of sand between adjacent flutes. [4]

lamination – a thin, typically < 10 mm thick, sedimentary layer

lee slope – the slope on a dune or other object that it is opposite that of the windward slope and produces a sheltering effect from the wind. [4]

leeward – direction toward which the wind is blowing. Also refers to the direction toward in which waves are traveling. [24]

linear dunes - straight or slightly sinuous sand ridges that are typically much longer than they are wide; some may reach tens of km in length; may occur as parallel or isolated ridges; may merge into Y-shaped features (compound dunes); may form in bi-directional wind regimes. [7]

linguoid elements – connected crescents that form on higher dune ridges and may contain lower saddle areas between them. These were also known as barchanoid elements. [1] p. 55

lithification –compaction process by which sediments or sand layers become sandstone.

littoral – of, or pertaining to, the sea shore [24].

littoral transport – movement of sedimentary material in the littoral zone by waves and currents. May be either parallel to or perpendicular to the shore, depending on the use of term. [24]

littoral zone – the region from the cliffs overlooking a beach (or highest water splash point) to the distance offshore in which sunlight is able to penetrate to the top of the sediments to allow aquatic plants to grow. Typical depth corresponds to 1% of the surface sunlight.

lobate dune – narrow arched variety of simple parabolic dune with a slip face. Length to width typ. 1-3 [4, 7]

loess – windblown deposits, typically within the range of silt-sized grains, 2-63 µm, but mostly 20-60 µm in size [27].

longshore drift – movement of sand along a beach due to waves striking the beach at an angle to the shore. [26] (syn. *littoral drift*).

longitudinal dune – a narrow linear dune that extends parallel to the wind direction. [4]

lunettes – fixed, sub-parabolic or crescentic dunes, these U-shaped dunes form on the downwind margins of small playas. [L-77, 79] They are also called *source-bordering dunes*.

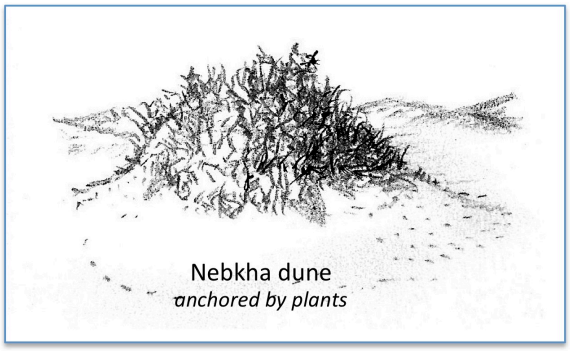
micro-meteorite – a particle of extraterrestrial origin that has survived entry through the earth's atmosphere and is within the size range for sand or smaller. (See *astrogenic sand*)

morphodynamic classification – a classification of sand dunes that is based upon their form, and feature orientation relative to the directions of the winds that created them. [1] (c.f., *morphological classification*).

morphological classification – a classification of sand dunes that is based upon their external form. [1] (c.f., *morphodynamic classification*).

Munsell color system – a means of designating colors based on hue, value, and chroma (saturation). Created by Albert. H. Munsell (1858-1919) it has been used in charts to describe sand and soil colors. For example, 5YR 5.5/6 is a reddish-yellow hue with a value midway between 5 and 6 and a chroma of 6. By comparison 10YR would be more yellow and less red.

nebkha (also, *nabkha*) – a type of aeolian sand dune, often with steep sides and a rounded or flat top, that forms around a clump of vegetation. Note: A variety of terms are used in conjunction with such formations. These include *coppice dunes, shrub-coppice dunes, hummocky dunes, phytogenic hillocks, bush dunes, bush mounds, nebbe, knob dune, rebdou, and takoult*. (Ref. [1] pp. 48, 77, also [12] under the heading "Nabkha.") Not to be confused with *sabkha* which is a type of coastal mudflat.



niveo-aeolian deposit – mixtures of wind-transported sediment and snow, usually found in polar regions. [13]

oblique dune – in morphodynamic dune classification, a dune whose crest is oriented between 15 and 75 degrees relative to the prevailing wind direction [1] pp. 45, 195

parabolic dunes – U-shaped dunes with convex noses; trailing arms can have steep sides and reach 10-25 m high; can form from a dome dune in which sand continues to blow from on direction to create a concave face and arms on both sides; well-vegetated trailing arms may be pinned, making them long and narrow; more common in coastal deserts and semi-arid regions (syn. *hairpin dunes*, *blow-outs*) [8]

percolation – ability of a fluid such as water to move through a granular volume. In beach forming, increased percolation may result from deposits of coarser sand and pebbles which reduce the power of the backwash and can lead to steeper beaches.

*phi (*Greek *ϕ) scale* – a scale of particle size attributed to W.C. Krumbein (1963) and that is defined by the equation:

$$\phi = -log_2\left(\frac{D}{D_0}\right)$$

where D = the given size and D_0 = a reference size of 1 mm. Thus, for the lower size of sand where D = 0.0625 mm ϕ = 4; and for the upper size where D = 2.0 mm, ϕ = -1. (See also *Udden-Wentworth scale*, and the Appendix).

phytogenic hillock – See *nebkha dunes*

playa - a flat area such as a *dry lake* or fan. Also called a *pan*, it may be periodically filled with water that evaporates.

plinth – portion of a dune below an avalanche face. [1] p. 51

psamment – in soil terminology, an area of unconsolidated sand deposits sometimes found in shifting sand dunes. May form during millions of years of weathering. Covering as much as 3.4% of the global land mass, they are also known as *arenosols*. [22]

psammophile – an organism that thrives in sand, also a term used to describe a sand collector. (Syn. *arenophile*.)

psammosere – in ecological systems terminology, a depression left in coastal sand sediments that can lead to the development of an ecosystem. [21]

quicksand –a basin of collected sand, silt or clay that exhibits the characteristics of a fluidized bed. A continuous flow of water enters from below and material loosened by the upward flow can reduce the buoyancy of objects. Rapid movement of an entrapped object can increase its tendency to sink, but slow movement may allow it to be freed.

rake-like dunes – compound parabolic dunes with multiple adjacent lobes resembling a form of rake. [7]

reduction factor – in plotting sand rose wind diagrams, the reduction factor is the number by which the vector-unit total of each sand-rose arm was divided so the longest arm would plot at <50 mm. [5]

relict dune system - stabilized landforms formed by past climatic regimes and depositional environments [1] pp. 228,231,233-6

reptation – a sand movement process in which grains are knocked loose by saltation of other grains and then creep downwind. Typical grain sizes can be 0.35 – 0.50 mm or larger [1] pp. 13, 23, 26.

resultant drift direction (RDD) – in plotting sand rose wind diagrams, the resultant vector of a sand dune at the location for which the diagram is constructed. [5]

resultant drift potential (RDP) – in plotting sand rose wind diagrams, the resultant drift of a sand dune [5]

reversing dunes – a version of any of the basic dune types in which major and minor slip faces are oriented in opposite directions as a result of changing winds that blow from opposite directions. [8]

ripple index – ratio of the wavelength of a repeating feature to its height [4].

rock flour – a finely powdered abiogenic substance formed by the grinding action of glaciers on rocks or by erosive processes.

sabkha – coastal mudflat or sandflat, between the land and the tidal zone, in which water-soluble minerals may deposit after evaporation.

saltation – a process of grain dislodging and hopping that transports grains along a surface; typical grain sizes can be 0.06 to 0.50 mm or larger; claimed to be responsible for over 80% of all sand transport [4]

sand ripples – (see *wind ripples*)

sand rose diagram – vector (graphical) representation of the wind history at a given region or location. It can represent direction, force, speed, and relative duration of the local winds. North is generally at the top, one arrow indicates the prevailing wind direction and its length is a reference unit long. Other line segments depict wind speeds in other directions. The length of a spoke is the relative amount of time that wind blows from that direction per unit time. The more 'spokes' on the diagram, the greater the wind variability. For example, star dunes form after a lot of changes in wind direction. (See also *drift potential, resultant drift potential, resultant drift direction*). [5]

sand sea – a large area of dunes, greater than 100 km^2. (see also, *erg dune field).*

sand sheets – undulating areas of sand that are generally less subject to saltation or dune formation because grains are too large or the wind conditions are unfavorable for dune formation. Other factors include vegetation and/or a high water table [27, 28].

sand strips - parallel linear features developed from transverse instabilities of a sand-transporting wind [1] p. 126

sand wave – a large, wave-like sedimentary feature of sand in relatively shallow water. These can be as much as 100 m in wavelength with amplitudes of about 0.5 m. [24]

sandstone – a reddish, yellowish, or brownish sedimentary rock formed from sand grains, usually quartz and related minerals. (based on Wikipedia)

sebkha – see *sabkha.*

seif dune – a longitudinal dune with two slip faces that may meet at a sharp straight or slightly sinuous ridge (seif is the Arabic word for sword)

shadow dunes – triangular sand forms whose upwind apices are composed of some obstructive object that extends above the level of the windblown sand and which creates a widening 'shadow' downwind.

shrubb-coppice dunes (see *nebkhas*)

silica – a chemical compound consisting of one atom of silicon for every two atoms of oxygen (SiO_2). Notes: this compound is estimated to comprise about 70% of all sand on Earth. The mineral form of the pure compound is called *quartz*, but there are many varieties of Si-O based minerals that include other elements.

silk dune – low, closely-spaced dunes with curved crests. [14]

silt – 2-63 µm-sized material that may contain mud, soil, or similar. Silt particles are smaller than fine sand.

sinuous crested dune – a form of simple linear dune exhibiting a wavy crest. [1] p. 60

simple dune – a single dune of a given type [1]. (c.f. *compound dunes*, *complex dunes*)

singing sand – one of several types of phenomena that occur or sand surfaces and/or dunes; these range from small squeaks when walking on a moist beach, to low drones associated with booming sands in the desert. [9] (see *booming sand*)

slip face – typically the concave side of a barchan, crescentic, or tranverse dune [8].

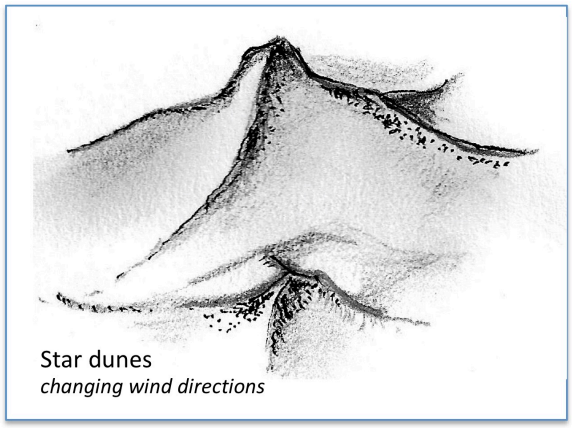
source-bordering dunes – see *lunettes*.

star dune – dunes with several arms radiating in different directions and meeting at a central crest; form when wind direction is variable and sand supply is relatively plentiful; contains a relatively large volume of sand; some stars may reach heights of 500 m [8].

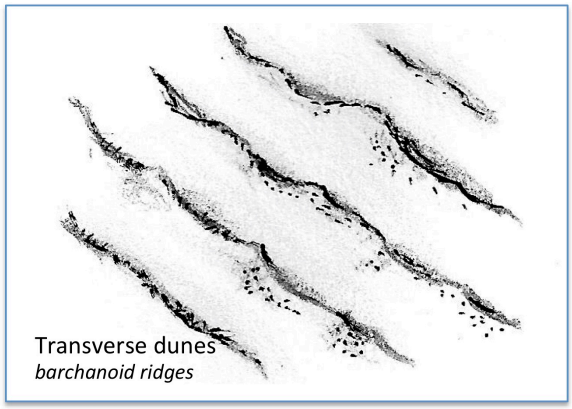
stoss slope – the windward side of a dune [1,4].

swash – uprush and backwash of a broken wave on the beach. [26] see also, *backwash*.

topsets – a thin layer of sand that lies on the stoss side of a dune and covered previous beds (*foresets*).


Star dunes
changing wind directions

transverse dunes – parallel dunes that lie perpendicular to the wind direction. As shown in the figure below, they may possess scalloped or barchanoid ridges that eventually become barchans.


Transverse dunes
barchanoid ridges

tuning fork junctions – Y-shaped locations where the ridges of linear dunes meet. There may be multiple such junctions in a field of near-parallel, linear dunes. [1] pp. 62-64

Udden-Wentworth scale – a scale of particle size proposed by C. K. Wentworth [29] to assign certain size ranges of aggregates to certain terms. By decreasing size, these included "bowlder" gravel, cobble gravel, pebble gravel, granule gravel, very course sand, coarse sand, medium sand, fine sand, very fine sand, silt, and clay. (See also the more current *Phi scale*, and the Appendix).

ventifact – an object that has been formed or modified by wind [4].

whaleback – a type of dune, named by Bagnold [3] and formed into relatively large linear sand platforms that may have seif dunes lying along the top. [1] p. 64.

wind ripples – linear features usually formed by saltation, lying perpendicular to the primary wind direction; typical wavelengths 50 – 200 mm; can form in minutes; amplitude 5-10 mm for fine sand, but greater than 100 mm for coarser sand; typical asymmetric profile with 8-10^{o} stoss slope and 20-30^{o} lee slope; small ripples may move across the faces of a larger dune [1, 4, 8] Note: Similar ripples in sand may also form underwater.

windward slope – in desert dunes, the slope that faces into the direction of the prevailing wind; also known as the *stoss* slope.

wrack line – a section of beach that is the highest reach of the daily tide and at which organic or non-organic debris is deposited by the waves.

yardang – a small wind-sculptured form whose shape is produced in part by differential rates of erosion. Also, a depression formed when a linear ridge breaks through, new dunes form on the windward slopes on both sides of the breakthrough, and a depression on the windward side results when the winds erode the core of the original dune. [4]

zeugen – block-like ridges, typ. 3-30 m tall, formed by erosion in a landscape of ridges and deep furrows [17].

zibars – low angle, rounded bedforms of coarse-grained sand that may form between larger dunes. Undulating zibars do not have well developed slip faces.

Colorful sand grains from Oneuli, Maui, HI. Collected by Sara Sherman. Image captured by the author using a Dinolite™ model AM4815ZT digital microscope, original magnification 100X.

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Appendix

Particle Sizes and Sieve Numbers

(Data plotted from references [23, 24, 29], Phi (ϕ) is defined on page 6)
Note that 1 in. = 25.4 mm, and conversely, 1 mm = 0.0394 in.)