

Context:

Geology, weathering.

Citation:

Doe, N.A., Colonial corallites and honeycomb holes in sandstone, *SILT* 15, July 2015. <[www.nickdoe.ca/pdfs/Webp555c.pdf](http://www.nickdoe.ca/pdfs/Webp555c.pdf)>. Accessed 2015 Jul 21.

NOTE: *Adjust the accessed date as needed.*

Copyright restrictions:

Copyright © 2015. No reproduction without permission.

Date posted:

July 22, 2015.

Author:

Nick Doe, 1787 El Verano Drive, Gabriola, BC, Canada V0R 1X6

Phone: 250-247-7858

E-mail: [nickdoe@island.net](mailto:nickdoe@island.net)

# Colonial corallites and honeycomb holes in sandstone

by Nick Doe



*Left:* Honeycomb erosion in the late-Cretaceous sandstone cliffs of De Courcy Island, BC, Canada. Such erosion patterns are sometimes said to be created by the wind; but if this is true, somebody should be thinking about revising the design of bus shelters.

*Below left:* Corallites of colonial corals often form polygons, some regular and some irregular. This is an extinct species *Emmonsia aplissima*. The similarity with honeycombing is not a co-incidence.



Illinois State Museum

A form of sandstone weathering that commonly attracts attention, especially of those with cameras, is honeycombing, also known as cavernous weathering or *tafoni*. Here on the west coast of Canada, the eroding agent that honeycombs the sandstone is salt.

Salt-weathering can take the form of arrays of irregular polygons—sometimes, on average, hexagonal and hence its name—arrays of circular small holes; isolated holes; caverns; galleries you can walk under; large boulders that appear to be rotting away from the inside; so-called “wave-cut” platforms; and unremarkable fresh-looking sandstone surfaces that have a gritty feel as you run your fingers over them.

### ***Origins***

Many people have differing ideas about how salt weathers sandstone, but the majority opinion seems to be that it is a result of *crystallization pressure*. When a solution of salt is being concentrated by loss of water due to evaporation, it reaches a point where the salt comes out of solution and forms crystals. If this happens within the confines of tiny pores in the sandstone, the crystals exert pressure as they resist having to form in irregular shapes that match the walls of the pores instead of being left to form the symmetrical, geometrical shapes they would if they were unconstrained.

Salt-weathering of sandstone operates on a microscopic scale; the crystallization pressure is exerted on small clusters of grains of sandstone, or even individual grains, and in Nanaimo-Group sandstones, it opens up pre-existing microfractures that were filled long ago with a grout of clay minerals and comminuted particles of sand.

Crystallization pressure is most damaging when the salt crystallizes just below the surface. Quite unlike freeze-thaw erosion, which is rare anyway here in the Canadian Pacific Gulf Islands, salt-weathering does not break off chips of sandstone, and it is most active on surfaces facing the sun, not in cool, sheltered north-facing rock faces.

### ***Patterning***

The ever-fascinating patterns of honeycombing in sandstone are generated by salty water that is evaporating very near to the surface of the sandstone after making its way there from deep inside the rock. Water can only move through rock if it is porous and permeable, like a sponge, and on a microscopic scale, sandstone is.

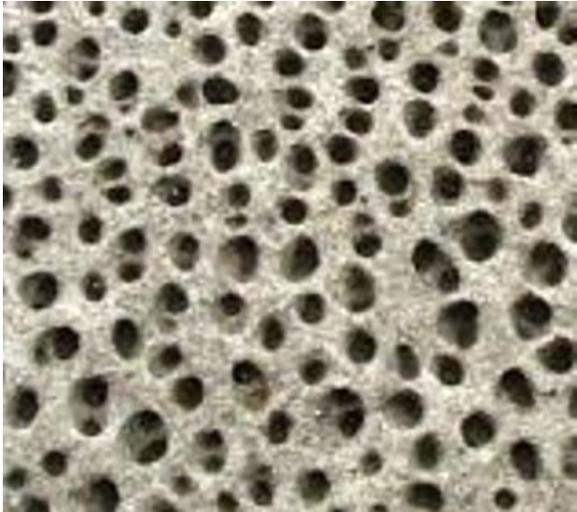


An explanation for sandstone honeycombing you sometimes see is that it is created by the “sea”, meaning presumably by waves. How crashing surf could create delicate lace-like patterns like these is left to the reader to figure out. In fact, the evidence is that waves destroy or prevent honeycombing, not create it, and the most impressive honeycombing is formed where waves seldom, if ever, venture.

The moisture is mostly being drawn out of the rock by the sun, but evaporation can continue into the night while the interior of the rock is warmer than the surface. To go where honeycombing is more common on north-facing rock surfaces than south-facing ones, you have to visit Australia.

Once a honeycomb hole has formed, it attracts more moisture moving out of the rock to the surface because the bottom of the hole is closer to the open air than is its surroundings. This results in more salt being deposited at the bottom of the hole, and so the hole grows deeper. This process is only arrested when the bottom of the hole ceases to become an effective evaporation surface, usually because the wall creates a shadow that shields the bottom from the sun, or the air circulation in the cavity becomes too weak and the humidity too high. Once a hole reaches this stage, it expands its diameter rather than getting deeper.

When holes grow enough to begin to interact with each other, they begin to “compete”, as it were, for salty water. The



*Left:* The typical early stage of honeycombing. Holes distributed over the surface, but not in a way that is likely created by random splashes of salty water. Each hole has a “zone of influence” into which other holes don’t intrude. The holes are actually exhaust holes, allowing moisture from inside the rock to escape when it’s heated by the sun. Exhaust holes have to be evenly spaced to be most effective. Salt deposited on the bottom of the holes makes them deeper.

*Right:* This view is not typical in that normally the salt-starved rims of the holes are level with the surface rendering them invisible—you see only holes. Here the holes are so close to the sea that the occasional large wave washes away the sandstone between the holes that has been weakened by salt-weathering, thereby rendering the rims visible.

moisture moving from deep inside the rock has a choice of moving to the bottom of one or other of the converging holes. No matter which hole it chooses, this is an easier route to the open air than struggling to reach the uneroded surface at a rate that may only be a few millimetres a day. This “competition”, if we can call it that, robs the walls between the holes of any more salt. So the walls cease to erode, stand proud of the eroding surfaces, and form the beginnings of a honeycomb pattern.

The popular idea that the walls of the polygons in honeycombed sandstone are protected in some way, is, I think, wrong. They are only protected in the sense that the salty moisture from inside the rock is preferentially moving to the bottom of the holes. The deeper the holes become, the more complete this salt-starvation of the walls becomes.

How does the salty water get into the sandstone? In any number of ways. By being immersed at high tide; by wicking up water from the sea, or in desert areas, from the ground by capillary action; by being soaked by spray; by being rained on during winter storms at places near the sea; sometimes by chemical weathering; and by leaching rock that in former geological times was below sea level.

Groundwater moving down vertically-inclined fractures a short distance behind cliff faces often gives rise to particularly spectacular honeycombs and, in the extreme, to cavernous galleries big enough to walk under. The fractures are easily filled with rain and any spray blown up during storms, but once in the fracture, moisture can only escape by slowly permeating horizontally through the rock to the surface. It does not



Another untypical example of honeycombing (Valdes Island, BC) but interesting in that you can actually see evaporated salt at the bottom of the holes. This is not wave splash, and no, I have not rotated the image, the face is vertical.

The upper-Nanaimo-Group sandstone is arkosic—in places, feldspathic wacke. In general, it contains no *calcite*, but it does contain often-spherical concretions like this that do. Calcareous concretions weather more slowly than the host rock.

matter how weak the salt solution initially is, evaporation will concentrate it.

The route through the rock that moisture takes is determined by its often-anisotropic permeability. Frequently there are strata within the sandstone that are more permeable and porous, than those above or below it, and if so, and if the pore size is

right, arrays of honeycomb holes form in these strata parallel with the bedding planes. Honeycomb holes can also often be observed clustered around hairline fractures in the rock because these are easing the outward passage of the moisture.

The development of honeycombing in the intertidal zone in the Canadian Pacific Gulf Islands is helped by the favourable pattern of tides in the Strait of Georgia (Salish Sea). These have a strong solar diurnal component. Low tide in summer is often when the sun is strongest during the day giving the rock ample opportunity to dry out before being wetted again during the high tide at night.

Being immersed in the sea hinders honeycombing by preventing crystallization. This creates platforms of uneroded, barnacled rock that reach up to the high-tide mark, only beyond which honeycombing begins.



Hairline cracks in the rock offer internal moisture an easy route to the surface, thereby encouraging honeycombing. In this example, thick-lip weathering (the brown stain resulting from oxidation of iron-containing minerals) is a clear indication that the fracture is a source of internal aerobic moisture.



*Top:* Honeycombing is often more developed in some sandstone strata and lamina than others. This happens when the some layers are slightly more permeable than others, and/or have a slightly more favourable average pore size, features that are not easy to see. Arrays of honeycombs in sandstone that was formerly a submarine fan, as here, often run parallel to the bedding plane.

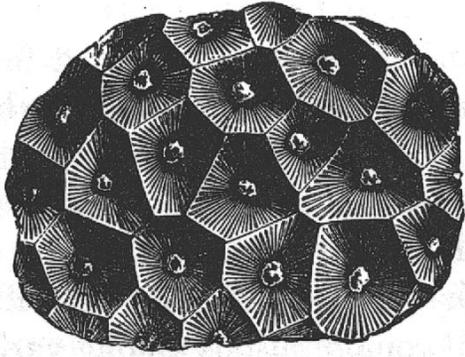
*Below:* The walls of Dunstanburgh Castle, Northumberland, UK shows what can happen if the bedding planes of individual stones are not parallel. The visible facing of the wall is argillic sandstone quarried from near Howick within sight of the sea, but the core of the wall is basalt rubble. It's thus easy to see how moisture could be trapped in the core behind the facing, leading to salt-weathering and honeycombing as salty moisture permeates through to the surface.



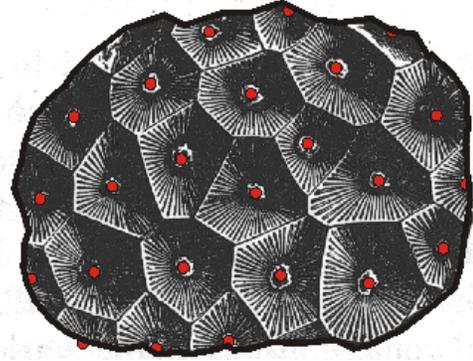
### **Corals**

So what has any of this to do with corals?

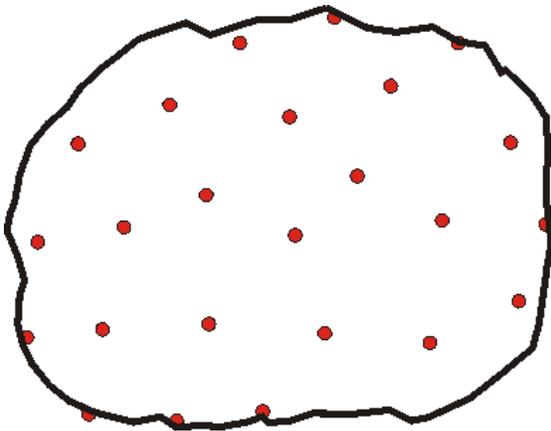
Well, try reading the next two pages.



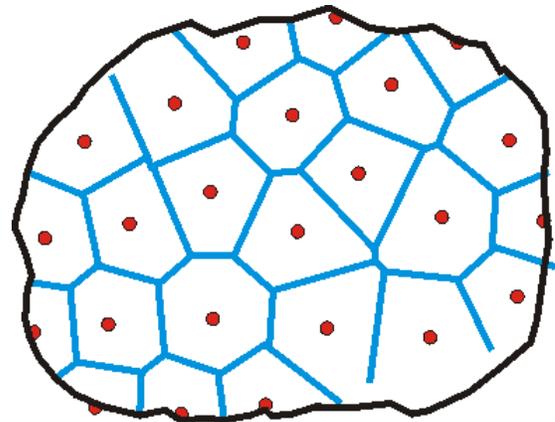
Step 1: Take a picture of the coral  
*Arachnophyllum pentagonum*



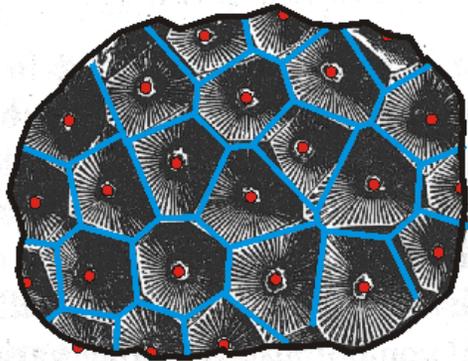
Step 2: mark the centres of the corallites (red dots)



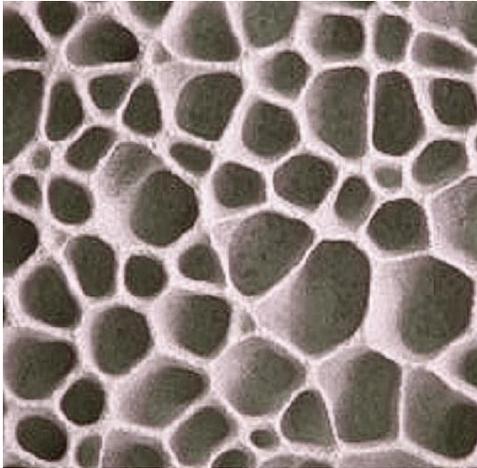
Step 3: remove the original picture to prevent cheating



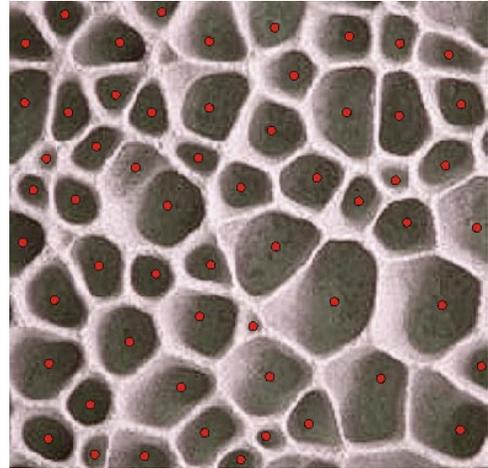
Step 4: draw Thiessen polygons



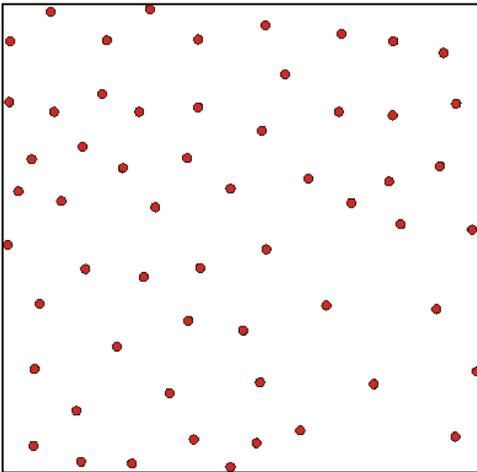
Step 5: restore the original picture and check that, yes indeed, this extinct form of colonial coral knew all about Thiessen polygons.



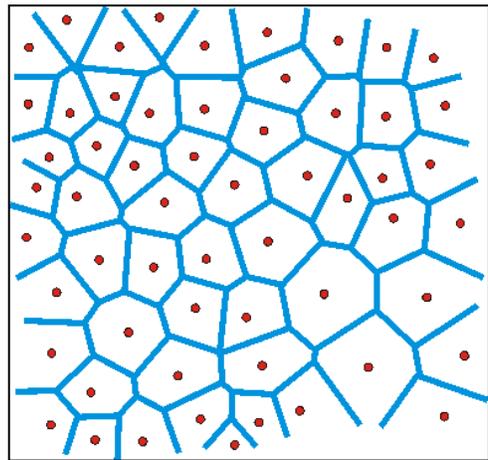
Step 6: select a honeycomb example



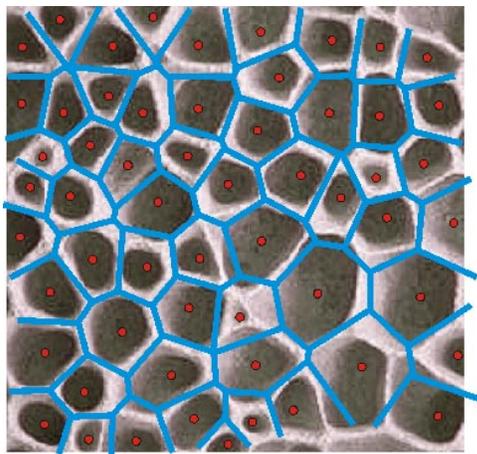
Step 7: mark the centres of the holes (red dots)



Step 8: remove the original picture to prevent cheating



Step 9: draw Thiessen polygons



Step 10: restore the original picture and check that, yes indeed, honeycombs probably also know about Thiessen polygons.

Thiessen (Voronoi) polygons mathematically define “zones of influence” around a set of points. The boundaries of the polygons define the area that is closest to each point relative to all other points. They are defined by the perpendicular bisectors of the lines between all points.

In fossil tabulate corals, these lines are the calices between the individual corallites. They mark the boundary between the coral polyps that on the surface of the colonial coral are “competing” with each other for access to the open water and the nutrients it contains.

In honeycombs, these lines are walls that mark the boundary between holes that are similarly “competing” with each other for access to the open air into which they vent the moisture absorbed by the rock, thereby acquiring the salt that makes them grow. ◇

## Acknowledgements and references

1. Most of the material in this essay was presented more formally in the two papers:

Doe, N.A., [\*What makes holes in sandstone\*](#), *SHALE* 9, 2nd ed., pp.12–40, August 2004.

Doe, N.A., [\*The geometry of honeycomb weathering of sandstone\*](#), *SHALE* 26, pp.31–60, November 2011.

2. Most of the photographs are my own, but the photograph of the cavity was taken by Peter Middelkoop while I steered the boat.

3. The photograph of the *Emmonsia aplissima* is from the gallery of the Illinois State Museum.

4. The photograph of the wall of Dunstanburgh Castle is by Maurice Rogers who has professional experience of investigating weathering damage to historical stone buildings.

5. The drawing of the *Arachnophyllum pentagonum* is after Nicholson cited in:

D’Arcy Wentworth Thompson, *On Growth and Form*, Complete Revised Edition, ...of *hexagonal symmetry*, p.513, Dover Publications, 1992.