Context:
Gabriola, geometry of cracks

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Other *SHALE* references:

http://www.nickdoe.ca/pdfs/Webp246c.pdf —alligatoring on the beach (surface cracks in weathering rinds on rocks)

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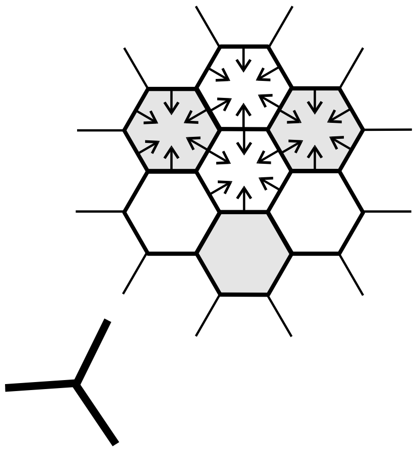
Polygonalling (a note for alligatoring fans)

by Nick Doe

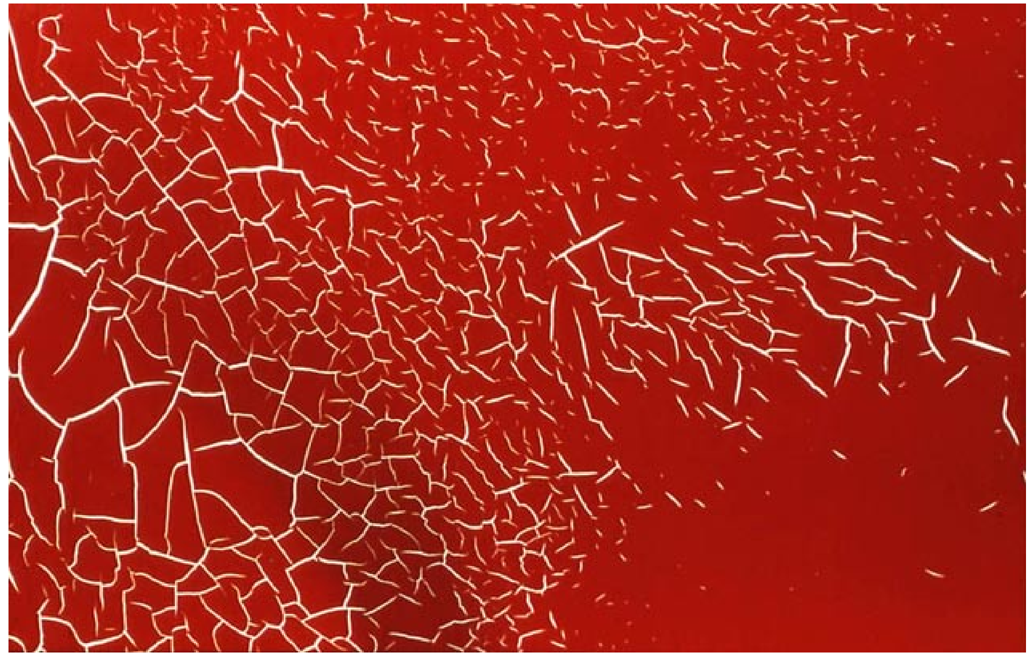


In *SHALE* 12, I made the case that the cracks seen on the surface of shale on Gabriola's beaches often take the form of *alligatoring* and that this was probably due to *compression* in the surface layer generated as it tries to expand as the minerals oxidize. But just as there are several reasons why a surface should want to expand relative to the underlying material, so there are several reasons why it might want to contract—desiccation is the obvious example. Shrinkage creates *tension* in the surface, which quickly leads to long cracks if the material is brittle. However, if the layer is somewhere between being plastic and brittle, a polygonal shrinkage pattern may develop. The "classic" form of this is *hexagonal patterning* where all intersections are Y-shaped as opposed to the T-shaped intersections in alligatoring patterns.

The most common example of hexagonal patterning is the pattern of the surface of dried mud (caking), but I haven't seen a really good example of this lately.

The picture *far left* is a textbook example of cracked mud that has been lithified to shale, while the picture *left* is more typical of what you see on Gabriola when walking winter-puddled trails in the spring, or the beach at low tide in summer.

Michelangelo, circa 1510



Above Alligator with wheels—paintwork of a Porsche parked in a backstreet in Osaka, Japan. A beautiful example of alligatoring. Short gashes on the right that haven't run, T rather than Y junctions, and a marked absence of hexagons. The car's bodywork must have shrunk slightly creating internal compression stress in the paint before it was dry. Now, external stress has opened up cracks, which are, the owner would be pleased to know, just like the ones in the shale on Gabriola.

Elias Wakan, circa 1985

Oh! And by the way, it isn't true that they have better cracked mud in Italy. As you can see in the picture *above* from the Sistine Chapel, they have exactly the same kind of pattern as we have on our tidal flats, but unlike ours, theirs are often obscured by artwork.

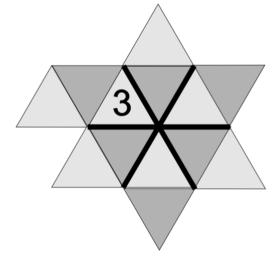
I have to admit though when it comes to alligatoring with its cracks that don't propagate very far and T junctions everywhere, the classic example *above right* is hard to beat. It's paintwork on a Porsche parked in a backstreet in Osaka, Japan, a picture taken by Gabriola's famous artist Elias Wakan.

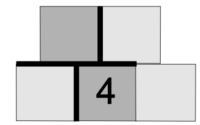
In mudcracks, triple intersections appear to develop independently and, more or less at random, and only later do they fill in the gaps to form polygons. Presumably, perfect hexagons only develop when intersections are densely- packed and able to influence the development of their immediate neighbours. Once I started looking for hexagons in dried mud, I found them to be much rarer than I had thought.

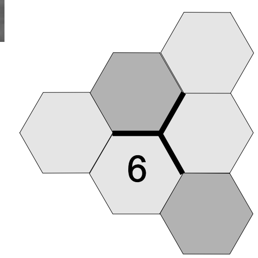
Really neat examples of polygons created by shrinkage are the columnar-jointed basalt lava flows just south of Whistler along Highway 99. These are the result of rapid cooling of the lava beneath a glacier.

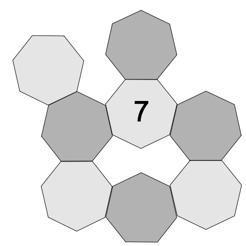
Mathematicians and floor-treatment experts know that you can cover a flat surface without gaps using *regular polygons* (all sides and angles equal) with three, four, or six sides—but you can't using polygons with five, or more than six sides.

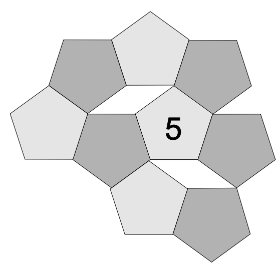
It requires 4 ⁄ (n-2) to be an integer, where n is the number of sides.











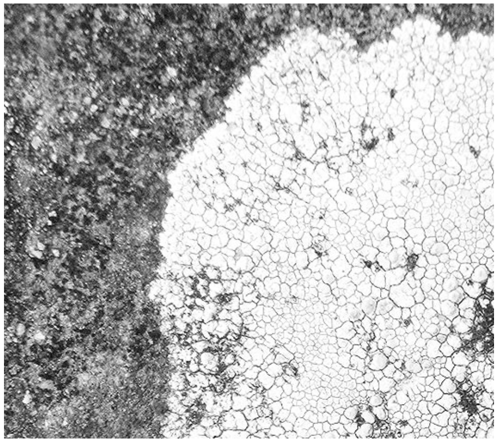
You can only get seamless tiling using 3-sided, 4-sided, or 6-sided polygons (*above*). 5-sided polygons (*left*) almost do it, but other polygons, like 7-sided polygons, don't.

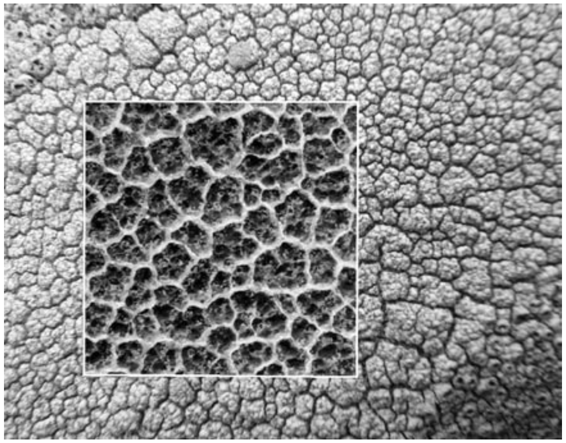
Despite there being hundreds of different shapes that a mineral crystal can have, all display either 3-, 4-, or 6-fold symmetry. Natural 5-fold symmetry is something that only occurs in plants and animals.

On the whole, nature prefers the number of polygons touching a vertex point to be small, such as three with hexagons, offset squares, and imperfect pentagons (which are common), rather than six with triangles and four with squares.

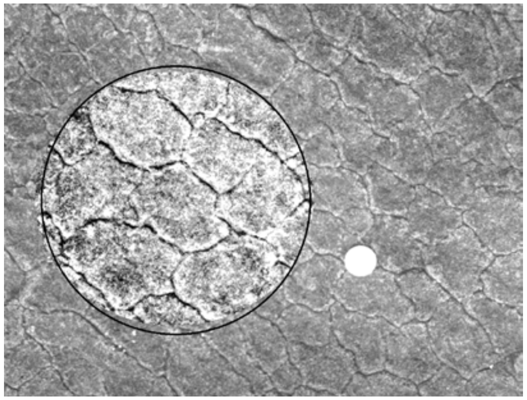
If all this sounds rather boring, I'm not surprised. Nature and artists working in the Islamic tradition create far more interesting arrangements of polygons.[1] The discarded skin of a snake after moulting found at the top of the beach, shown on the *right*, gives the general idea. This photograph was hard to get because there was a breeze that day, and the skin was so thin, it fluttered in even the slightest puff of air.

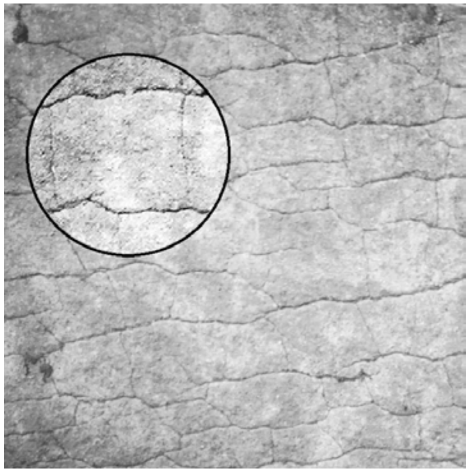
The pictures below it are of a soft-grey crustose lichen (*Acarospora* sp.), common on boulders on Gabriola's beaches, possibly (a guess) because of its affinity for iron. It dries out in summer and is revived by winter rain. The insert in the picture on the *far right* shows a magnified view with black and white reversed.





[1] If "loop quantum gravity", which, like string theory, integrates quantum mechanics and general relativity, is correct, then even spacetime is not arbitrarily divisible but can only take on forms dictated by assemblies of polyhedra.





Here's an interest contrast in weathering styles. That's a 25-cent coin in the picture *top left*. The cells in the pattern are a little smaller than those in the picture *bottom left*, but there's not much in it; however, while the ones on *top* (a silty-sandstone boulder on the beach near the Maples) form a hexagonal pattern, the ones *below* (in the grounds of the Gabriola Museum) form a reticulate alligatoring pattern. I could make a guess as to what causes what, but then I expect, so could you. Patterns like these are clues to how sandstone weathers, which is of interest when it comes to studying the reasons for the loss of our petroglyphs. Surfaces with internal compression remain strong and durable, just so long as there are no flaws. Once flaws develop however, spalling of the whole surface is inevitable. We should be grateful, I guess, that only tension afflicts the work of Michelangelo.

The picture *right* is part of a beautifully weathered and lichen-covered granite boulder, five-feet across, with a mossy cap. It's in the woods, and I always look for it whenever I'm passing by. ◊