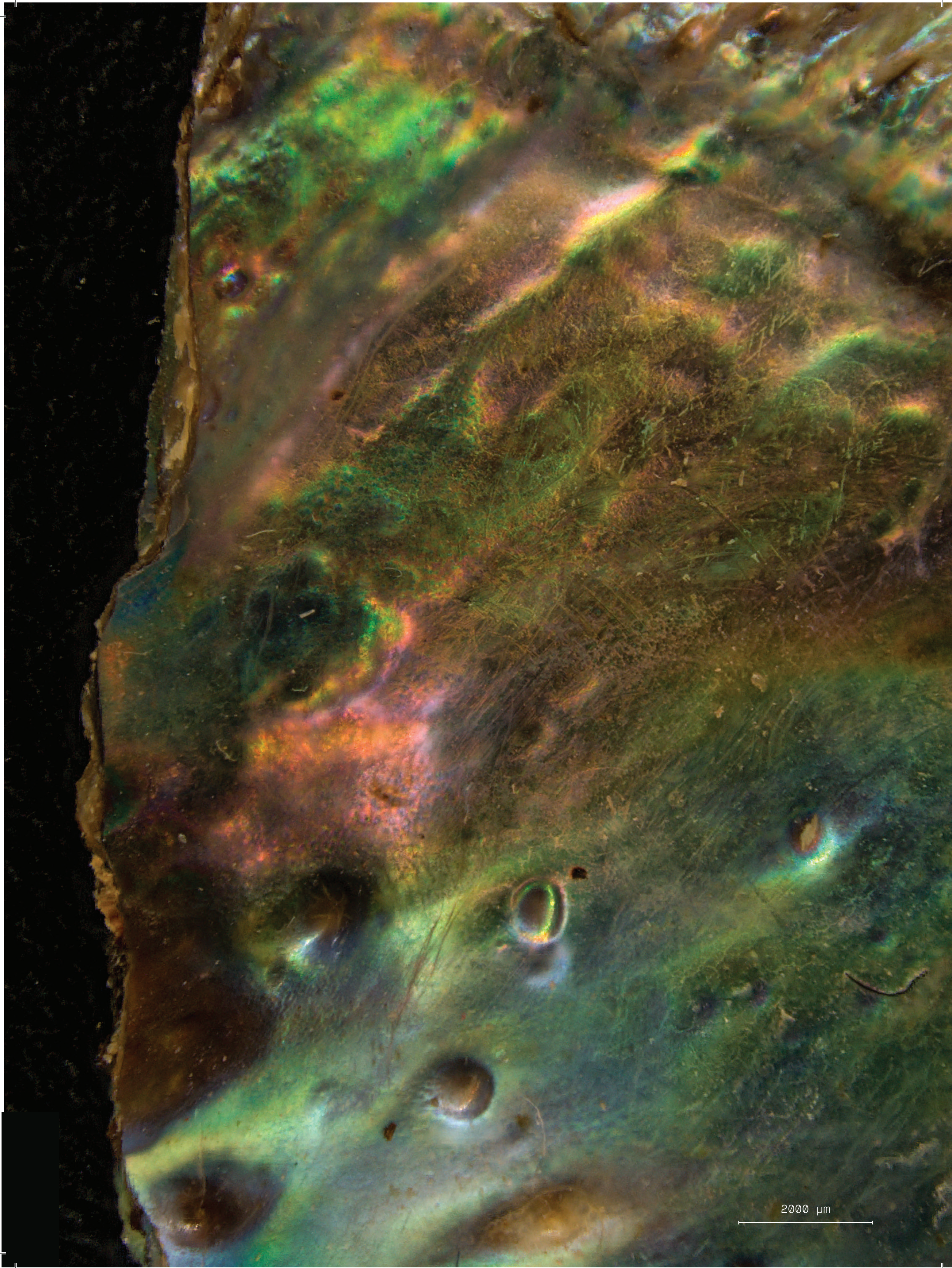
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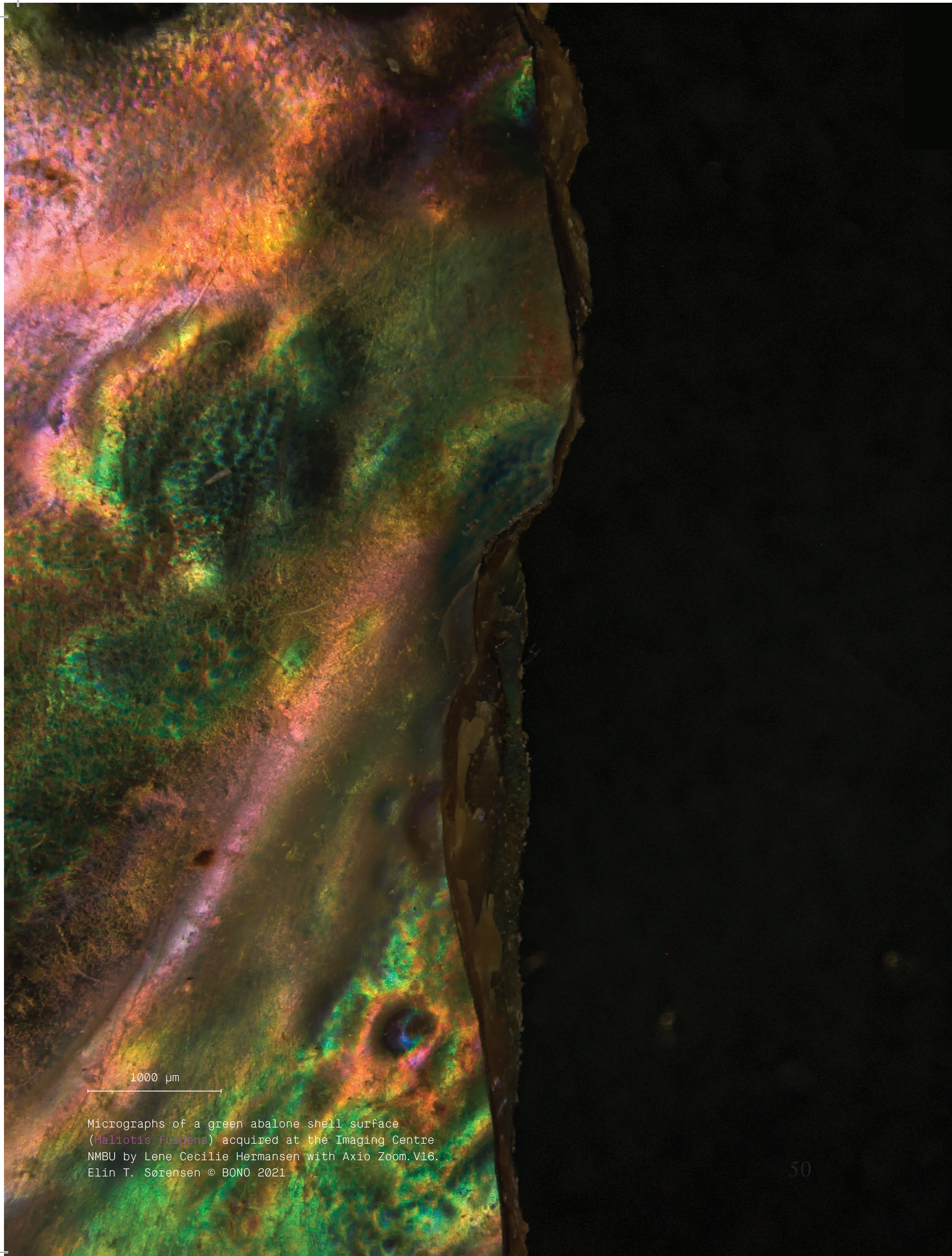


Micrographs of a green abalone shell surface (*Haliotis Fulgens*) acquired at the Imaging Centre NMBU by Lene Cecilie Hermansen with Axio Zoom.V16. Elin T. Sørensen © BONO 2021

The Parent of All Abalone is the first creature to live in the sea. If it dies it will let out a cry that everyone can hear. So, if the first abalone ever dies—that would mean all the abalones had died—and all creatures. It would be like the end of the world.[1]

IRIDESCENT LAMENT

Elin Tanding Sørensen

I *Cry*

In an unfathomable darkness—within the timeless eternity—a crowd of dead sits about.

Sometimes, in between infinite time scales, the dead talk to each other sharing their life stories. Suddenly, a loud, horrible roar cuts through. From far down in the darkness they hear a strangely drawn out, bellowing cry—infinitely plaintive, like a beast weeping: “They all knew it, but they didn’t know what it was. It was something that didn’t belong with them. It was a man who had lived too long ago. He sat on his haunches, he had hair over his body, his nose was flattened, his mouth huge and half-opened. No one knew who he was, not even himself, he didn’t remember having lived. He only remembered a smell, a smell of a great forest, of resin and wet moss. And a smell of another being, of something which was warm like him, something which was like him. He didn’t remember it was a human being. He only remembered the smell. Then he sniffed around him in the darkness with nostrils distended and bellowed like a beast weeping. It sounded horrible. It was such an agonizing wail of boundless sorrow and yearning that they shuddered. But he wasn’t one of them. They lived their life, seeking and seeking, they suffered and struggled, believed and doubted; they didn’t bellow.”[2]

Across a vastness of time beings are interconnected by an ear-splitting sound: a cry possibly being the closest we can ever get to our earliest ancestors and perhaps even the origin of life—whether that is a microfossil or the first abalone.

I think I hear a scream so loud—as if the world is falling apart.

1 (Field et al., 2008, pp. 3, 65-67, 82)
2 (Lagerkvist, 1934, p. 43)

The First Creature
The earliest physical evidence of life found so far are microfossils from the Nuvvuagittuq Greenstone Belt of Northern Quebec. The fossils are in the form of Banded-iron formation (BIF): that is a metamorphic rock consisting of 15 percent or more iron of sedimentary origin and layers of chert, chalcedony, jasper, or quartz. They are at least 3.77 and possibly 4.28 billion years old, and thus the microfossils from Nuvvuagittuq indicates that life developed very soon after oceans formed.[3] In Native Californian creation myths, stories about abalone as the First Creature of the sea are still told by Pomo-speaking people at the Kashaya and the Point Arena reservation. The story of the Parent of All Abalone is unique: transcending gender and linking the fate of the ocean with a humble bottom dwelling mollusk. To the Native Californians the abalone is a sentient being with agency and destinies linked to the humans with whom they cohabitate: *Abalone Woman* is one such spirit being.[4]

Lament
The Greek term elegeia (from ἔἔἔἔἔἔ, elegos, “lament”) originally referred to any verse written in the poetic form elegiac couplets including sad and mournful songs. This is a form of poetry natural to the reflective mind. It may treat of any subject, but it must treat of no subject for itself, but always and exclusively with reference to the poet. As s/he will feel regret for the past or desire for the future, so sorrow and love become the principal themes of the elegy: presenting everything as lost and gone or absent and future.[5]

Living abalones in display tank at Ty Warner Sea Center on Stearns Wharf, Santa Barbara, California February 27, 2011. Photo by Sharktopus CC-BY-SA-3.0

3 (Dodd et al., 2017)
4 (Field et al., 2008, pp. 3, 41, 82)
5 (Coleridge, 1835)

The Balancing Act

The origin of the abalone shells—these iridescent vessels of imagination—carry the essence of the ocean: as if the animal that made the shell “distilled silvery splinters from its watery home and then crystallized them. Like a painter catching on the canvas fleeting diamonds of light that glitter on the sea.”[6] For a chemical characterization of an abalone shell the Energy Dispersive X-ray Spectroscopy detector (or EDS analysis) can show us that the shell consists of carbon, oxygen, calcium, and small pieces of silicon.[7]

Seawater
The six most abundant ions of seawater are chloride (Cl^-), sodium (Na^+), sulphate ($SO^2{}_4{}^-$), magnesium (Mg^{2+}), calcium (Ca^{2+}), and potassium (K^+). By weight these ions make up about 99 percent of all sea salts. Inorganic carbon, bromide, boron, strontium, and fluoride constitute the other major dissolved substances. Of the many minor dissolved chemical constituents, inorganic phosphorus and inorganic nitrogen are among the most notable, since they are important for the growth of organisms that inhabit the oceans and seas. Seawater also contains various dissolved atmospheric gases, chiefly nitrogen, oxygen, argon, and carbon dioxide.[8]

Calcium carbonate (formed by three main elements: carbon, oxygen, and calcium) is the key building block for most of the marine life. Sea-dwelling creatures—from microscopic coccolithophores to coral-building algae, and giant snails—owns the ability engineer their own house-building materials directly from their watery surroundings. As with magic, the dissolved chemicals calcium and carbonate is extracted to form solid composite shells of this chemical compound. No less magical, the shells do not dissolve back into calcium and carbonate as soon as they are built. This is because seawater already holds as much calcium and carbonate as it can, and thus the mineral forms more easily than it dissolves.

In the ocean’s eternal material cycle, the shell-builders has adapted to thrive close to the surface: a place abundant with calcium carbonate so that they easily can make their protective homes. At greater depths, the housing material would easily dissolve because the water is not similarly saturated with this chemical compound. This fluid border—being dependent on the seawaters fluctuating concentration of calcium and carbonate—is called the *dissolving depth*, or Carbonate Compensation Depth (CCD). At a high concentration, the shells must sink deep before their calcium carbonate dissolves. Oppositely, when the concentration is low, the dissolving depth moves upward. This is a typical feedback-loop, as dissolved shells add more calcium carbonate to the water, making it harder for other shells to dissolve and lowering the dissolving depth. This is how the chemistry in the deep ocean stabilizes the overall concentrations of calcium and carbonate in the sea.

As a small proportion of gases like oxygen and carbon dioxide dissolve into the water, the ocean interacts with the atmosphere at the surface: and the mix of oxygen helps sea creatures to breathe. The rising and falling concentration of the gases in the atmosphere and the amount of gas dissolve in the ocean is another feedback-loop. This is the ocean’s *balancing act*.

6 (Vileisis, 2020, p. 40)
7 (Yu, 2021)
8 (Duxbury et al., 2021)

When carbon dioxide in the atmosphere increases, carbonate in the ocean decreases. The effect is that shell-building becomes harder to do. Yet, in its own time cycle, the physics and chemistry of the ocean will cause the dissolving depth to rise, and more shells on the sea floor will return their calcium and carbonate back to the water. In this process the normal levels are restored. However, if something happens disrupting this balancing act—for example an increase of carbon dioxide—the *dissolving depth* would rise and all shells in the upper layer might start dissolving.[9]

As excess carbon dioxide accumulation in the atmosphere and then dissolves into the ocean, this causes a rapid tilting of the pH of the seawater toward acid. Both in lab experiments and by direct observations in the high-latitude oceans, researchers note that calcifying organisms like shelled mollusks and reef-building corals show a decline in their ability to make shells and skeletal structures in water with elevated acid.[10]

*Cry*stallization

Together with calcium carbonate, marine shells are bult form a small quantity of protein. When they form their protective armor, the shellfish secretes proteins and mineral extra-cellularly from mantle tissue that is located under and in contact with the shell. The seashell grows from the bottom up—by adding material at their outer edge. This way, the molluscan shells are enlarging as they grow, as opposed to crabs and lobsters that shed their exoskeleton. The abalone (Haliotidae) for instance, add new organic matrix and mineral to the outer parts of its shell, more precisely around its mouth or apertural. The role of the proteins is to bind calcium ions while guiding and directing calcification. In this process the protein and calcium ions are crystalised into precise hierarchical arrangements. The shells of mollusks such as snails, clams, oysters, and many others, have three distinct layers. First, an outer uncalcified layer consisting of complex conchiolin protein and chitin. From this a strengthening, naturally produced polymer emerges. Next comes the highly calcified prismatic layer followed by the inner pearly layer of calcified nacre. In the abalone's mother-of-pearl, the prismatic layer is made from aragonite: a crystal form of calcium carbonate differing from the crystal shape of calcite—which is the building block in the nacre of other seashells such as blue mussels (*Mytilus edulis*). The magnificent iridescence of the nacre occurs, incidentally, because crystal aragonite platelets function like a diffraction grating in dispersing visible light.[11]

Kaleidoscopic Architecture

From the shimmering play of colours lining the inside of the mollusks protective shell, the abalone tales have most likely been ignited. To some Native Californian tribes, this hidden wondrous world, serve as a looking glass reflecting visions for the future.[12]

Iridescence arises from the basic principles of wave optics. As light interacts with periodic structures it diffracts. Periodic structures are the regular arrangement of atoms, particles, or unit cells which results in both dispersion and band gaps. Depending on the wavelength of light, the angle at which the light is diffracted will change. Therefore, a surface that has periodic sub-wavelength structures or thin films will produce a rainbow or multicolour-like reflection changing with the viewing angle: an iridescence property found in shells, insect wings, gemstones, and CDs. The origin of the abalone shell's lustrous interior is the layering architecture of the nacre.[13]

Ratincium earchil ipsandandi aut invendunt, quatem et, vollestiandi odis endam intinusam et adias estionseque occum erunt a nihita im quia inctotatur, nem re, si necto et es ipitaes eum harcid magnihicit que velesci antur ...

9 (Encyclopædia Britannica, 2021)
10 (Vileisis, 2020, pp. 209-210)
11 (Horne, 2006)
12 (Vileisis, 2020, p. 27)
13 (Yu, 2021)

Biomimi*cry*
Ratincium earchil ipsandandi aut invendunt, quatem et, vollestiandi odis endam intinusam et adias estionseque occum erunt a nihita im quia inctotatur, nem re, si necto et es ipitaes eum harcid magnihicit que velesci antur, voloreh entior sum sint essimet quamus, conse conessi millorro ipic tem quam, qui bearchi llore, sunturestem de voluptate eatque nam aut quibus es nobis eum fugias que pe milis sunt exped moluptatur ...

The White Abalone

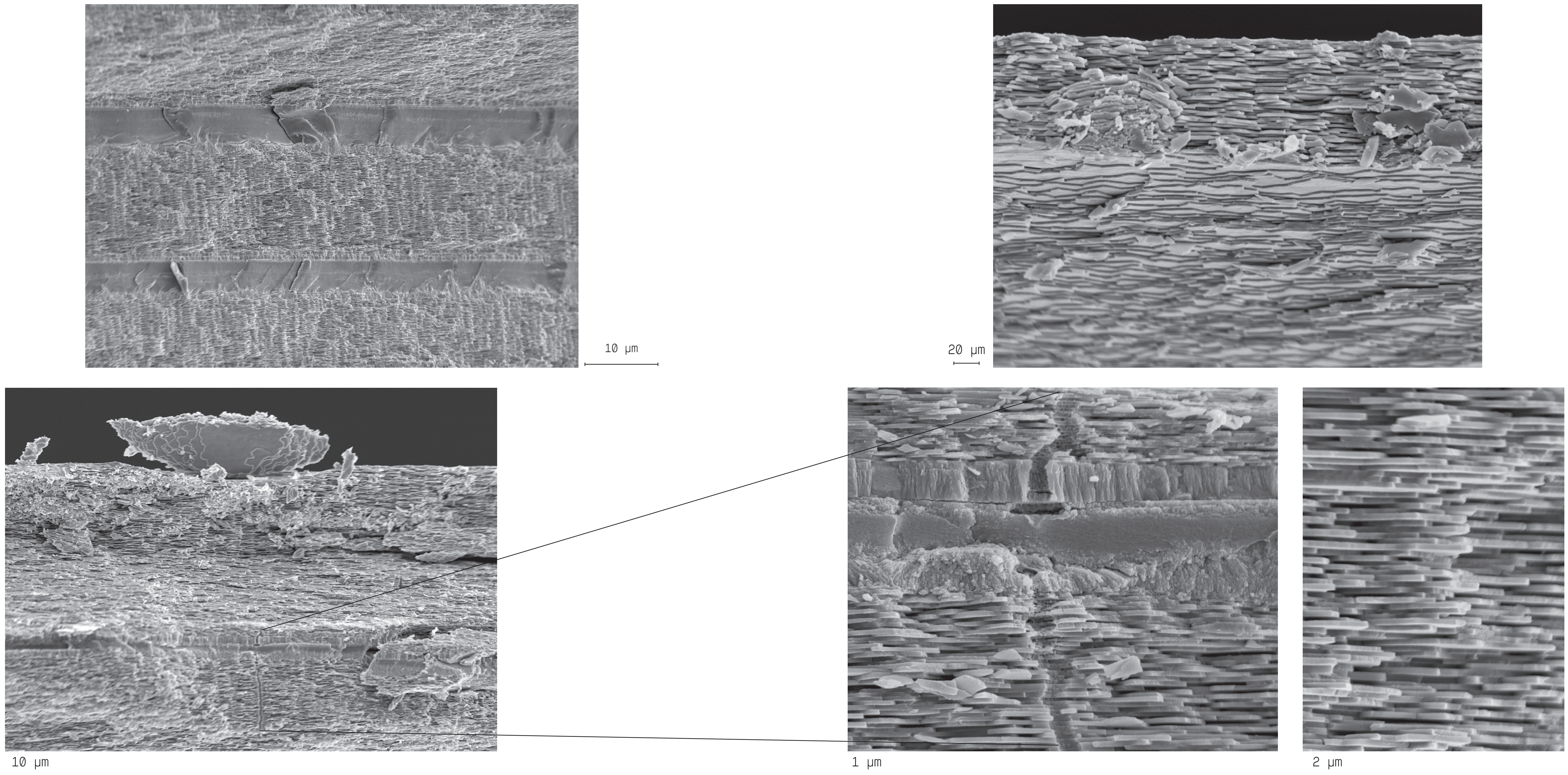
Ratincium earchil ipsandandi aut invendunt, quatem et, vollestiandi odis endam intinusam et adias estionseque occum erunt a nihita im quia inctotatur, nem re, si necto et es ipitaes eum harcid magnihicit que velesci antur, voloreh entior sum sint essimet quamus, conse conessi millorro ipic tem quam, qui bearchi llore, sunturestem de voluptate eatque nam aut quibus es nobis eum fugias que pe milis sunt exped moluptatur ...

Every history has more than one thread,
each thread a story of division[14]

Abalone Woman

As a living myth, the *Abalone Woman*—retold in manifold ways with a plurality of meanings and implications—has relevance extending from today and thousands of years back in time. Ratincium earchil ipsandandi aut invendunt, quatem et, vollestiandi odis endam intinusam et adias estionseque occum erunt a nihita im quia inctotatur, nem re, si necto et es ipitaes eum harcid magnihicit que velesci antur, voloreh entior sum sint essimet quamus, conse conessi millorro ipic tem quam, qui bearchi llore, sunturestem de voluptate eatque nam aut quibus es nobis eum fugias que pe milis sunt exped moluptatur ...

14 (Vuong, 2019, p. 209)



SE micrograph of an abalone shell cross-section recorded in different magnifications, acquired at the Imaging Centre NMBU by Lene Cecilie Hermansen with Zeiss EVO50 EP. Elin T. Sørensen © BONO 2021

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