WELCOME

to our spring edition of Envirotalk.

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Mark Outerbridge - Editor

COLOURING OUTSIDE THE LINES WITH BEES IN BERMUDA

My name is Nichol Piniak and I am an independent honeybee researcher and beehive designer. I apply an intuitive and creative approach in my research, with a focus on the effect bee habitat has on colony health. It has been my observation that most beehive models contain fundamental design flaws, leading to many challenges beekeepers face today. Currently, all hive models are prone to mold growth and work against the organisms' best efforts to self-govern. Human manipulations intended as management strategies are often in vain because of construction materials bee hives are built from, leading to deterioration and decomposition with exposure to moisture. The insight gained through studying hive designs and failures has led to my current interest and research of humidity, pH, and mineral depletion inside the hive cavity. To my knowledge, this is not a common approach, but I am convinced that these areas have the potential to solve many challenges faced by beekeepers and agriculture today. Honeybees have the potential to recover, no matter the climate or location if we embrace these less explored avenues.

When I visited Bermuda in April 2023, I coordinated with the Bermudian and Canadian authorities to collect honeybee specimens and bring them home to have assessed for Africanized DNA at a bee research facility in my home province of Alberta, Canada. Having confirmed the absence of African DNA, I felt confident in proceeding with further research and development of my concepts. Before investing too heavily into this theory, it was essential to ensure that Bermuda's isolated honeybee population did not contain African DNA. This is because African genetics are known to augment honeybee health, making them more resistant to disease and pests and this could have been an explanation for why Bermuda's honeybees are coping with high populations of the *Varroa destructor*[1], parasitic mites that are undermining the health of honeybees worldwide. These mites are the greatest challenge for all beekeepers and may bring the organism to collapse in regions where humans have no secondary solutions for crop pollination.

A bee colony inside an 'urban cave' (hollow brick pillar). Credit: N. Piniak

Years ago, I intuited that if one could regulate the flow of moisture within a manufactured beehive there was potential to aid bees in managing their own pests. This idea is inspired by my volunteer work, discovering honeybees in the cold harsh climate of my region not just surviving but thriving within brick and stone columns. Each time I removed these nests I had the same response: pure amazement that honeybees could be so healthy in a dry winter climate with overcrowded populations containing high mite-loads and viral contagions. A colony in a dry climate has many workers foraging for water, just to meet bare requirements. The water evaporates quickly during hot days and the dry wooden interiors are not receptacles for moisture, contrasted to honeybee-nests in nature. The bee nests removed by me were surviving despite no human intervention to ease their effort and some as old as 7 seasons. I decided to stop keeping honeybees when I

[1]*Editor's note: varroa mites are small external parasites that feed on honey bees and reproduce within the bee colony. They are a serious pest and were first discovered on Bermuda in 2009 (read 2010 Envirotalk vol.78 no.1 to learn more*).

realized how badly they struggled. Instead, I desire to help them and do whatever I can to share what I have learned.

Bermudian honeybees have a unique advantage over and above the possibility that they may have a genetic edge. In 2016, five queen-bees bred by Dr. John Harbo, located in the United States, were introduced into Bermuda's honeybee population. The key behavior of these queens is to instill the urge to seek and destroy reproducing varroa mites. Bermuda would have lower numbers of varroa mites if Dr. Harbos' queens had passed on their genetic traits. However, Bermuda beekeepers report high numbers of mites, indicating they are breeding well. Something else is occurring because the bees are coexisting with parasites and Bermuda beekeepers do not even rely on chemical controls. Coral islands like Bermuda and Fernando de Noronha, Brazil, are sedimentary archipelagos, with naturally alkaline compositions; there are other similar locations too. These islands have honeybee populations containing reproducing varroa mites, but a common theme suggests the bees are less impacted by diseases carried by the mites. Is it possible that pH plays a role in controlling viral pathogens, passed on by varroa destructor? If the concept is true and viruses cannot mature, this might explain why mites remain high while diseases are within manageable levels for resident bee colonies. For years, there has been an obscure practice by some beekeepers who use apple cider vinegar to adjust pH levels in sugar feed during times of nectar shortages. At one point someone had the idea to address pH, understanding that, while sugar syrup is neutral, it becomes acidic when entering the digestive track. I hypothesized that lime-based masonry might also contribute this way, helping to form a protective barrier, much like propolis forms a medicinal layer, serving as the honeybees' immune system.

Honeybees use many unknown substances and pH measuring is beginning to garner attention in the scientific community. It was proven that several common honeybee viruses can be eliminated by increasing alkalinity within the hive structure or bee's cavity. Imagine a single viral cell, growing in the safety of a protein shell called a *capsid*[2] waiting to infect a honeybee population. When mature, the capsid opens and releases its genetic material into the bee population, thus infecting the colony. The study concluded that high acid is favored by viruses, presenting the perfect conditions to reproduce, but more interesting is what happens when the environment is alkaline. By using apple cider vinegar to adjust the pH in sugar feed, researchers witnessed that, although the viruses (as were mites) were still present, in alkaline conditions the viral capsid opened prematurely, disarming its ability to spread most infections. I am excited by this discovery and see it as detail worth exploring through hive design and interior substrate.

Lime fortified bricks being used to build a beehive. Credit: N. Piniak

Unfortunately, modern beekeeping practices lead to increases in acidity, ideal conditions for viruses and varroa mite reproduction. In fact, many beekeepers in my area chuckle self-deprecatingly, saying 'we are a mite breeding facility'. Sugar syrup feed, mold, and decomposition within the hive structure all lead to increased acid, working against human effort to support

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[2] Capsid opening enables genome release of iflaviruses - PMC (nih.gov)

bees in their recovery process. These issues are serious in climates where there are no options but to carry on the way things are, compounded with growing concern for future crop pollination.

A secondary factor to bee health and pest management is the role of humidity at the innermost location of a honeybee cavity. Bermuda is reputed for having healthy bee stock, both managed and feral. Regardless of human management, Bermudian honeybees somehow cope with mites well, contrasted with other geographic locations - even tropical ones. Bermuda does not take risks, prohibiting bee importation and has no Africanized genetics. This suggests something else is occurring and I have a theory of my own. My earliest insights were taken from bee nests, reported by citizens in my cold and dry city; Calgary, Alberta. Most of the nests were inside stone and brick columns and active for multiple seasons. All the nests were healthy with no visible sign of mites or disease and living independent of human care. This is not studied or documented in my region and thought of as impossible. But I noticed a common denominator - they all achieved the ability to trap and store water in the walls of the nest cavity. This is unique from what is achieved inside modern beekeeping equipment or any man-made hive I have seen, including ones I have designed.

The effect of humidity within the hive is an understudied topic and sometimes advances are made by happy accident. For example, a lab located in the United States was exploring humidity, evaluating the survivable threshold of varroa mite reproduction. A postdoctoral assistant incorrectly set an incubator, increasing the relative humidity (RH) to 75%. While this was accidental, the researchers discovered it heavily impeded the ability for varroa mites to reproduce[3]. They further hypothesized that if there was a way to artificially increase RH to 80%, then varroa mites would never increase to damaging levels at all. How can we do this in a way that feels natural to honeybees? Several years ago, I began to work out designs using older red bricks and exploring lime fortified recipes to create my own model. I always assumed that commercial products contain additives that can be detrimental for honeybees, respecting that they are storage receptacles for nano-toxins. I do not want to inadvertently make recovery harder than it is already – so I am overly cautious.

Wattle and daub constructed beehive. Credit: N. Piniak

If the walls of the bee nest served to capture the natural water produced by the organisms' own heat, the bees can raise and lower temperatures through cardiovascular activity. What we struggle to understand is that, even in a humid climate, the mechanism must be in direct contact with the bee colony. When discussed I often hear remarks like 'the bees have all the humidity they need, I live in Hawaii, for example'. It does not work this way. Humans feel the humidity in the tropics, the bees are in a cavity, trying to regulate a micro-climate. The bees are the operators, knowing when and how to generate temperature changes that impede developing varroa, neutralize spores, and control viral outbreaks. A viable solution in this department could be significant.

I have built and evaluated many hive designs, and now focus my efforts on a model that can test some of these ideas, allowing honeybees to control humidity and pH within a cavity. For this reason, I was drawn to the honeybee colonies in Bermuda that live free in rock crevices and caves. These cavities are somewhat like the stone

[3] Varroa Mite Reproductive Biology – Bee Health (extension.org)

and brick columns that honeybees in my home region of southern Alberta are attracted to. What is even more amazing is this natural choice towards stone structures despite the drastic difference in climates, but this is the crux of my theory. The inspiration from my Bermuda visit has pioneered further research and ideas for a new hive design. My Bermudian inspired cavity is made of a local, sedimentary rock called *tufa.* Although we have a cold, dry climate, I am still hopeful. I believe one must never forget that honeybees are tropical insects, needing high humidity, which they use to regulate cooling and heating, in addition to floral diversity and mineral sources. Honeybees are masters at adapting, when given access to the correct tools to do so. I feel it's up to honeybee advocates and research alike, to hand over a little trust to the bees - perhaps function as co-pilots rather than trying to force an outcome through genetics. Bermuda is positioned very well for formalized study of honeybees living freely amongst high populations of managed colonies. This density of colonies is much like what happens in a city that permits urban beekeeping within its limits.

The unique conditions within Bermuda provide a controlled environment that allows for proving and assessing many theories. Bermuda has several existing and emerging conservation incentives, and I learned a lot from educators while snorkeling and taking in the sights during my 2023 visit. I even had the privilege of accompanying Spencer Field, a Bermudian beekeeper, while he captured a swarm just hours before I returned home. It was a once-in a lifetime experience that I will have forever. Bermuda is a remarkable place to visit, making research seem like fun, rather than work and I would return in a minute. I am excited to share these ideas because Bermuda is an attractive place for researchers to explore the science behind pH and collaborate in the security of an insulated honeybee population, with no African DNA. I would be proud to have contributed any ideas to help sustain honeybees, essential for food security everywhere. For all these reasons and more I have a great deal of gratitude towards Bermuda and the people who helped my trip to be successful and fun; I hope the island feels proud of what I have learned and shared.

Bermudian inspired tufa block constructed beehive.
Credit: N. Piniak

Nichol Piniak
Independent Honeybee Researcher

USING SWARM TRAPS TO CATCH WILD HONEYBEES

Spring time means different things to different people. If you happen to be a beekeeper then you may find yourself thinking about expanding your apiary (bee yard). This is usually done in Bermuda by catching a swarm of bees or by splitting a robust, healthy colony. April is traditionally the month when Bermuda's bee colonies cast off swarms. Bees swarm when they run out of space in their hive; the colony divides itself and part of it leaves with the queen in search of a new home. The remaining bees stay and wait for their princess to hatch, mate, and take over the existing hive. Meanwhile the old queen and her swarm will settle somewhere nearby and wait for the scouting bees to find a suitable space to occupy. This can take a few hours or a few days, depending on local availability, and this is when they are most readily available for capture by a beekeeper. An alternative method to manual capture is setting up a swarm trap (also known as a swarm hive or bait box) to lure in the homeless bees.

Swarm traps are essentially empty containers which have been made to be as attractive as possible to the scout bees. They come in many different shapes and sizes but to increase your chances of successfully attracting a swarm they should have a number of key features. Dr Thomas Seeley is a renowned bee scientist in North America and an expert on honeybee behavior, including those which govern swarming. His research[1,2] suggests that the ideal volume of empty space preferred by swarming bees is around 42-45 liters, which just happens to be the size of a typical Langstroth 10 frame deep box. Alternatively, two nucleus boxes can be placed one on top of the other (a 5 over 5 stack) and secured together.

Ideally, the boxes should be well-seasoned, meaning they have been used to house bees before and carry the scent of a bee colony. They should also contain one full frame of old brood comb to act as an additional olfactory attractant. The remaining 9 frames should be empty (i.e. foundationless) to preserve the feeling of space inside the box. Some beekeepers choose to fix a one inch starter strip of plastic foundation to the top bar of these empty frames so that the newly arrived bees can start drawing out comb immediately after settling into the box. It is also good practice to use some kind of support for the freely drawn comb (e.g. bamboo skewers, thin wire, or ever monofilament line). Swarm bees are primed to build a new colony quickly and they are capable of creating quite a bit of fragile, fresh comb in a short amount of time. Encouraging them to draw comb inside of frames makes transferring them into a permanent hive much easier.

An old 10 frame deep box being used as a swarm trap. Internet image

Fresh comb being drawn from a starter strip inside a foundationless frame. Note the two bamboo support skewers. Credit: David Evans

Additional attractants include the use of commercial spray products or lemongrass essential oil; both replicate the scent of bee pheromones and will greatly increase your chances of luring in a swarm. One lemongrass swarm lure recipe I found online suggests melting 2 tablespoons of beeswax with ¼ cup of olive oil in a clean tin can placed in boiling water. Remove it from the heat and add 40 drops (2 mls) of lemongrass essential oil. Stir the mixture as it cools until it begins to thicken. To use it simply rub some of the mixture on the inside walls of the swarm trap. Place a small amount of the mixture just inside the entrance as well.

If you decide to use an old 10 frame deep you will need to attach a solid bottom board to it with nails or screws and secure a telescoping cover on top to help keep the rain out. A dry, snug cavity is another important feature of a new home to prospecting bees. Entrances come in many different shapes and styles but Dr Seeley's research emphasizes using something relatively small, approx. 1.5 – 2 square inches. A simple entrance can be created by drilling a 1.5 inch hole into the front of the hive and close to the bottom of the box; about 2 inches off the floor. Be sure to angle the drill bit upwards slightly to minimize the chances of rain getting into the hive. You can also drill a 1/8th inch weep-hole into each of the 4 corners of the base board which will drain away any water, should it penetrate the box.

To be fully effective the swarm trap needs to be installed in a suitable location, ideally in a tree 10-15 feet off the ground in a shaded location. It is important to ensure that the box is level before securing it in position, especially if you are using foundationless frames. Swarm traps should be checked relatively frequently (at least twice a month) during the swarm season. Once you have confirmed that a swarm is in residence it is time to move the trap. This should be done at night when all the foragers have returned, and don't forget to block the entrance before moving the box! (A note about light: it is better to use a flashlight with a red filter. The bees will react much more strongly to white light).

References:

[1] Seeley, T.D., Morse, R.A., and Nowogrodzki, R. 1989. Bait hives for honey bees. Information Bulletin 187, Cornell University. 8 pp. https://ecommons.cornell.edu/handle/1813/2653

[2] Seeley, T.D. 2010. Honeybee democracy. Princeton Press University. 280 pp.

Dr Mark Outerbridge
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WE DON'T (YET) KNOW WHERE THE BLACK SAND LAYERS AT WHALEBONE BAY CAME FROM…BUT WE ARE WORKING ON IT

Bermuda sits on top of a large extinct volcanic seamount, but our knowledge of how and when this volcano formed has been limited by the number of igneous rock samples available for study. Much of the volcano is buried beneath layers of sedimentary rocks, known informally as "carbonates," and comprising fossilised sand dunes (eolianties), fossil soils (paleosols) and minor marine and beach deposits. The depth to the seamount in the central and western parishes is approximately 45 m (150 ft) below sea level (bsl) and depths at the east end of Bermuda range from 23 m (75 ft) to 32 m (104 ft) bsl[1].

There are no surface exposures of igneous rock, although layers of sand containing dark-coloured igneous minerals are well known at Whale Bone Bay (Fig. 1) and a few gravel-sized pieces of volcanic rock have been found at Stokes Point and Government Quarry[1]. Also of note, Woolard and Ewing[2] described a calcareous sandstone containing dark bands of igneous minerals that was "brought up from twenty feet below water in constructing a bridge pier" during the 1930s. These authors also described a limestone conglomerate (a type of rock containing rounded rock fragments of various sizes) that occurs at several localities also at about 20 ft below sea level that contained a 4 inch diameter volcanic pebble. Unfortunately, the locations of the pier and the conglomerate were not given.

Figure 1. Outcrop at Whalebone Bay showing carbonate beach deposits (the white/grey rock) and layers of black sand-bearing rock. Photograph by S. Lavis.

Ignoring the formation of the oceanic crust on which it rests, two main phases of igneous activity are thought to have led to the formation of the Bermuda Seamount. Data for the first phase is not particularly reliable, but it indicates an age of about 91 million years[3]. More reliable data are available for the second phase of activity, which took place about 30 million years ago[3,4,5]. It is not clear how closely the younger age estimate corresponds with the end of igneous activity though, because the volcano may have reached around 1000 m above sea level[4] before it was weathered back to its current elevation. The age of the fossilised beach deposits that the black sand occurs within at Whalebone Bay is around 300,000 years[6], which is essentially 30 million years younger than the youngest known volcanic activity.

Although the black sand at Whalebone Bay, and similar rocks discovered below ground level elsewhere[2], have been studied before, they have never been analysed using modern equipment and so samples were sent to Smith College, USA for analysis. The chemical characterization of these samples was completed by A. Elvidge during his final year of undergraduate education at Smith College, and the results were presented at a conference of the Geological Society America in March 2023[7]. This article outlines some of these findings.

Methods

To identify the minerals present in the black sand, samples were first analysed by microscope and by using x-ray diffraction (XRD). XRD analysis works by firing x-rays at precise angles at a mineral sample. The x-rays are diffracted by minerals (i.e. the path taken by the x-ray is "bent"), and the diffracted x-ray beams are detected. The angle of diffraction is dependent on the crystal lattice structure of the sample. Minerals in the Whalebone Bay samples were identified by comparing their measured diffraction angles to a database of diffraction angles of known minerals.

The samples were then analysed by scanning electron microscope with an energy dispersive spectrometer (SEM-EDS), which can identify the chemical composition of minerals. SEM-EDS analysis works by firing a beam of electrons at a sample, which excites (increases the energy of) the electrons in the atoms making up the sample. When the electrons in the sample become de-excited, they release their energy in the form of x-rays. These x-rays are detected by the EDS, which then matches the energy of the x-ray signal to specific elements. A map can then be created showing the distribution of elements within a sample.

Results

Analysis by XRD and SEM-EDS identified the presence of several kinds of igneous minerals, including perovskite, garnet, titanite, and magnesiochromite, together with a small number of grains of apatite, zircon, pyroxene and rutile. These igneous minerals were present as individual grains dispersed within typical Bermudian carbonate beach sand (Fig. 2).

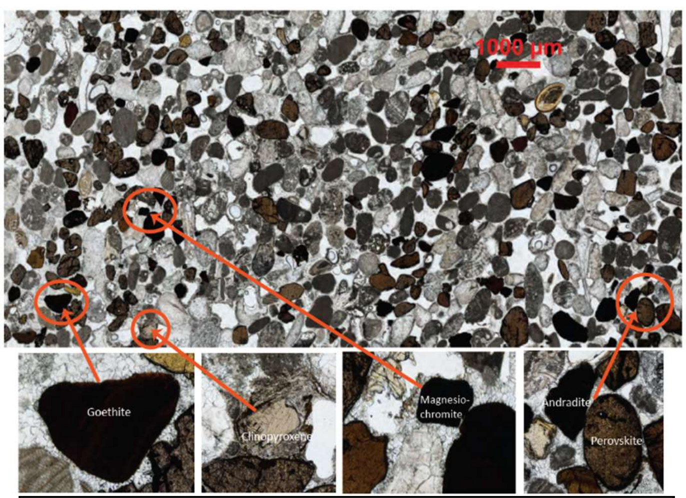


Figure 2. Photomicrograph of typical black sand-bearing rock sample from Whalebone Bay. From left to right: goethite, clinopyroxene, magnesiochromite, andradite, perovskite. The colourless minerals are typical sedimentary carbonate sand grains.

Some of the igneous minerals were previously identified in the rock sample described by Woolard and Ewing[2] in paleosol samples[8] and rock core samples from Bermuda[5], but garnet has not been found in any rock samples recovered from drilling into the seamount. Further analysis revealed additional information. There were at least three types of garnet, namely andradite, grossular and almandine, with this being the first time the latter two types have been identified on Bermuda (andradite was identified by Woolard and Ewing in 1939). Garnets are around 7 on the Mohs hardness scale, hard enough to scratch glass, and often used in jewellery. The majority of the garnets found at Whalebone Bay were andradite, with the general chemical formula of $Ca_3Fe_2(SiO_4)_3$. They were dark green to black in colour (Fig. 3) and about 0.5 mm in diameter. The andradite garnet was of particular interest because this mineral has not been found in any seamount samples; why then were they in the black sand layers of Whale Bone Bay?

Figure 3. Angular grains of andradite garnet separated from the Whalebone Bay samples. The average grain size is ~0.5 mm across.

Origin of andradite garnet

Andradite can form by either igneous (formed from the cooling of magma or lava) or by high temperature post-igneous (metamorphic) processes. The type of metamorphic rock commonly associated with andradite is known as a skarn.

The first step in working out the origin of the andradite was to determine if they were of igneous or metamorphic origin. This was undertaken by determining whether the andradite had a 'zoned' pattern. Zoning refers to changes in the optical or chemical properties of a mineral from its core to the rim (Fig. 4).

Zoning occurs as a mineral grows. Minerals grow by adding elements from their surroundings to their surfaces. Changes to the chemical composition (and/or physical conditions) of the surroundings, will change which elements (or their proportions) are added to the growing mineral's surface. Zoning occurs because the chemical composition of a mineral varies across the grain, reflecting the changing chemical (or physical) conditions during its growth. This is very common in metamorphic garnets, but less common in igneous rocks.

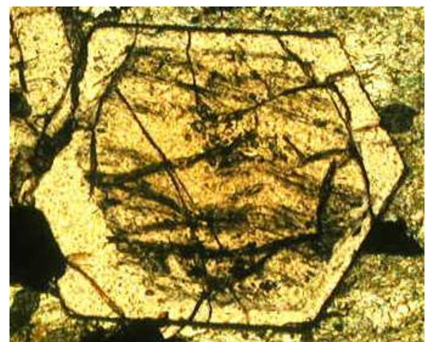


Figure 4. Photomicrograph of a zoned garnet in a metamorphic rock from the Tian Shan Mountains, China (Lavis 2005[9]). The diameter of the garnet is about 1 mm. The type of zoning, together with other factors such as what minerals are present inside a mineral as 'inclusions' can reveal a lot of information about how a rock was formed.

Garnet is a mineral with the general chemical formula $X_3Z_2(SiO_4)_3$, where metal ions with a +2 charge can be found in the 'X' position, and metal ions with a +3 charge can be found in the 'Z' position. This means that although the ideal chemical composition of andradite is $Ca_3Fe_2(SiO_4)_3$, titanium ions (Ti^{+3}) can substitute for the iron (Fe^{+3}) during the mineral's formation. The andradites were around 3-10% titanium by weight. If the titanium was distributed evenly in the andradites, then there would be no zoning and they would likely be igneous in origin. If areas of the mineral grain had concentric rings of high and low titanium bands, then the zoning pattern would indicate that the andradites are most likely metamorphic in origin[10].

Zoning patterns were investigated using SEM-EDS mapping. The SEM-EDS maps of the andradite showed that there was no zoning within the mineral grains for any of the elements investigated (Fig. 5). They had a homogenous composition and therefore are most likely igneous in origin (as are most of the other dark-coloured minerals in the black sand-bearing samples from Whalebone Bay).

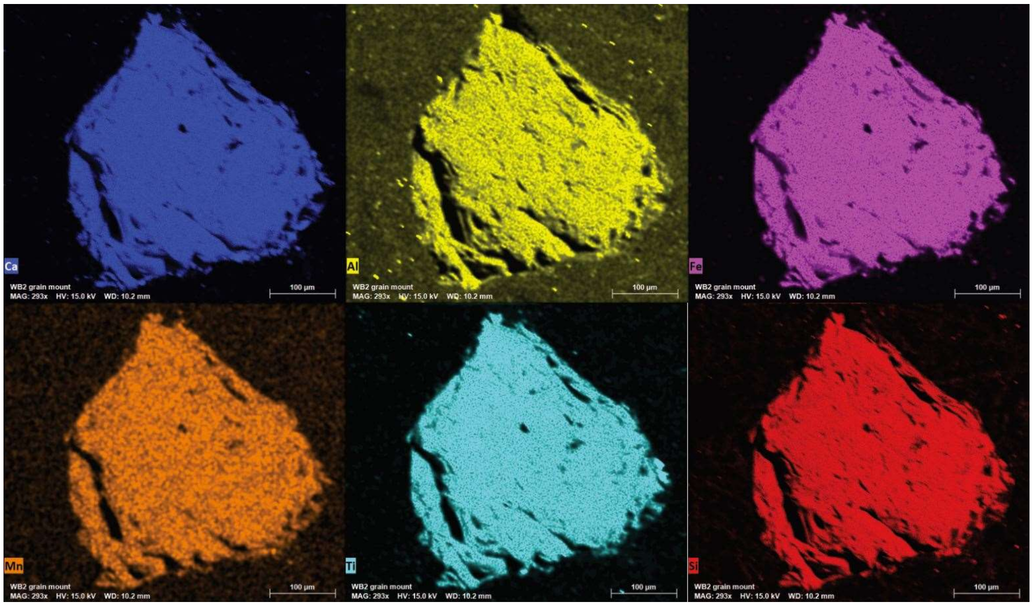


Figure 5. SEM-EDS false-colour images of andradite grain with 10.64 wt% titanium. The bottom middle image shows titanium distribution.

How did andradite end up at Whalebone Bay?

Before concluding that the andradite (and the other igneous minerals found at Whale Bone Bay) came from the Bermuda Seamount, other possibilities needed to be investigated by considering possible transportation methods from other locations. Many of the mineral grains in the sample, including the andradites, are not rounded (see Figs. 2 and 3), which rules out transportation methods by water or by air, as grains moved by these systems would weather to become rounder. This leaves open the possibility of transportation by ice. Glaciers and icebergs can transport sediments without rounding them through weathering and there have been many glacial periods since the formation of the Bermuda Seamount. It’s possible that icebergs from the glaciers of North America could have deposited sediment from the mainland onto Bermuda. This is unlikely, however, because this depositional mechanism should have left much more extensive deposits and deposited a significantly wider range of minerals and rock fragments.

It's possible that there are as-yet undiscovered igneous rocks on Bermuda that contain andradite. If so, this would offer stronger evidence that the black sand at Whalebone Bay is igneous in origin. In the absence of such rocks, further work is being undertaken at Smith College to add to our understanding of how the black sand formed and how it came to be incorporated into rocks about 30 million years younger than the most recent volcanic activity. This work includes analysis of trace elements and isotopes within the andradite. The trace element and isotopic compositions of the andradites will be compared with those from North America to further test the transportation by iceberg hypothesis. The isotopic compositions will also be used to calculate when the andradite formed and it’s possible that a third phase of igneous activity will be revealed by their age.

Other Bermuda Seamount samples are being investigated in parallel with the analysis of andradite. Samples of core from recent drilling near the Causeway are being analysed and several thin sections (samples of rock thin enough to let light through) are being analysed and digitised by other students at Smith College.

Also, samples recovered during deep submersible dives off South Shore have been provided to Smith College by the Natural History Museum. It is hoped that these unusual samples will provide new insights into the formation of the Bermuda Seamount and, perhaps, shed further light on the unusual mineralogy at Whale Bone Bay. We hope to have more news to share soon.

By Aphelion Elvidge, Shaun Lavis and Sarah Mazza

References:

[1]Rowe, M. (2021). The Geology of Bermuda. Self-published Ebook available here: https://www.blurb.com/b/10589751-the-geology-of-bermuda?ebook=749667&token_id=pb109f5902c5d69ae7ded

[2]Woolard, G., Ewing, M. (1939). Structural Geology of the Bermuda Islands. Nature 143, 898. https://doi.org/10.1038/143898a0

[3]Reynolds, P.R., and F.A. Aumento, (1974). Deep Drill 1972: Potassium-argon dating of the Bermuda drill core, Can. J. Earth Sci., 11, 1269-1273.

[4]Vogt, P. R. and Jung, W.-Y. (2007). Origin of the Bermuda volcanoes and Bermuda Rise: History, Observations, Models, and Puzzles. In Plates, Plumes and Planetary Processes Vol. 430 (eds Foulger, G. R. & Jurdy, D. M.) 553–591 (Geological Society of America, 2007).

[5]Mazza, S. E., Gazel, E., Bizimis, M., Moucha, R., Béguelin, P., Johnson, E. A., McAleer, R. J., Sobolev, A. V. (2019). Sampling the Volatile-Rich Transition Zone beneath Bermuda. Nature, 569 (7756), 398–403. https://doi.org/10.1038/s41586-019-1183-6.

[6]Volbrecht, R. and Meischner, D. (1993). Sea level and diagenesis: a case study on Pleistocene beaches, Whalebone Bay, Bermuda. Geologgische Rundschau, 82 (2), 248-262.

[7]Elvidge, A., Lavis, S and Mazza, S. E. (2023). Evidence of an Eroded Volcano: Origin Of Mafic Grains In Whalebone Bay, Bermuda. Poster presentation at the Joint 72nd Annual Southeastern/ 58th Annual Northeastern Section Meeting of the Geological Society of America.

[8]Prognon, F., Cojan, I., Kindler, P., Thiry, M., Demange, M. (2011). Mineralogical Evidence for a Local Volcanic Origin of the Parent Material of Bermuda Quaternary Paleosols. Quaternary Research, 75 (1), 256–266. https://doi.org/10.1016/j.yqres.2010.08.002.

[9]Lavis, S (2005). Recycling in subduction zones: Evidence from eclogites and blueschists of NW China. Unpublished PhD Thesis, Cardiff University. https://orca.cardiff.ac.uk/id/eprint/55992/

[10]Dingwell, D. B. and Brearley, M. (1985). Mineral Chemistry of Igneous Melanite Garnets from Analcite-Bearing Volcanic Rocks, Alberta, Canada. Contributions to Mineralogy and Petrology, 90 (1), 29–35. https://doi.org/10.1007/bf00373038

OIL SPILL COURSE – SHORELINE CLEANUP AND ASSESSMENT

The Pollution Control Section of the Department of Environment and Natural Resources recently hosted a course for the Bermuda Government, Keep Bermuda Beautiful, and colleagues from four UK Overseas Territories in the Caribbean on how to clean a shoreline oil spill. Dr Edward Owens, an expert in the field who has provided technical support in responding to shoreline oil spill operations since 1970 and has assisted with over 40 significant spills, including the Exxon Valdez and the more recent Deepwater Horizon Well blowout, led the course.

There were 13 participants from Bermuda, which included representatives from DENR, the Royal Bermuda Regiment Coast Guard, the Department of Parks, and KBB, as well as eight participants from the Cayman Islands, the British Virgin Islands, Anguilla, and the Turks and Caicos Islands.

The public will recall that ensuring we maintain the necessary skills on the island to respond to, and manage, an oil spill was identified in the National Oil Spill Contingency Plan for Bermuda (https://www.gov.bm/spills-on-the-sea). To that end, and through previous training courses, Bermuda Government personnel were already up to date and knowledgeable on how to prevent oil spills from reaching our coastline (see summer 2013 EnviroTalk Vol.81 No.2), including appropriate use of booms, skimmers, and dispersants. The latest course focused on cleanup strategies, monitoring, and reporting oil spills once they have reached and impacted various marine intertidal environments, including mangroves, sand beaches, and rocky coastlines, further strengthening our ability to manage oil spills should they occur in local waters.

The three-day course was fully funded through the Conflict Stability and Security Fund (CSSF), administered by the UK Maritime and Coastguard Agency (MCA).

Dr Geoff Smith
Environmental Engineer

EATING INVASIVE SPECIES: ESCARGOT WITH BUTTER GARLIC SAUCE

Milk snails
Photo: M. Outerbridge

The milk snail *Otala lactea* is the largest land snail regularly encountered on Bermuda and is a common food snail found in markets around the world. Indeed it was for this very reason that someone brought them to Bermuda in 1928[1]. The founding snails allegedly came from New York's Fulton Fish Market and “won their liberty by crawling out of a paper bag” that had been left on a porch in Fairylands[2]. The descendants of those escapees quickly spread across Bermuda and firmly established themselves as a garden pest. These herbivorous snails are usually nocturnal, although a heavy rain during daylight hours can make them quite active. The sunny, hot hours of the day are typically spent in aestivation (taking a long snail nap). The shell generally has a pale background over which dark stripes spiral along the shell whorls. The inner rim of the shell opening is dark brown or black. Shells can grow up to 40 mm in diameter and 25 mm in height. This species should not be confused with Bermuda’s endemic greater land snail (*Poecilozonites bermudensis*)[3,4].

Pre-cooking instructions:
The freshly collected snails require a bit of preparation before you decide to eat them because their preferred diet in nature doesn't always agree with our digestive system. Begin by feeding them something that does agree with humans (e.g. lettuce, bran, or sliced apples and carrots). The goal is simple; you want to remove all traces of their natural diet before you cook and consume them. After about a week the snails can be thoroughly rinsed in a large bowl of water containing a generous pinch of salt and a splash of white vinegar. Throw away any snails which float.

Ingredients:
At least 24 large snails (I say collect as many as you can!)
1 stick unsalted butter at room temperature
1 tablespoon dry white wine
½ teaspoon kosher salt
½ teaspoon freshly ground black pepper
2-3 garlic cloves, very finely chopped
1 large shallot, finely chopped
1 tablespoon Italian seasoning

Internet image

Preparation:
- Drop the cleaned snails into a pot of heavily salted boiling water and cook for about 10 minutes.
- Meanwhile, melt the butter and sauté the shallot, garlic, Italian seasoning, salt and pepper. Add the wine.
- Drain the snails and rinse with cold water.
- When cool to the touch use a pair of tweezers or a skewer to drag the cooked snails out of their shells (feel free to cut away the digestive tract of each snail). Discard the shells.

- Refill the pot with 3 parts water to 1 part white vinegar and bring to a boil.
- Place the snails in the boiling water/vinegar and cook until the slime is gone from the meat (approx. 3-5 mins) then drain.
- Add the snails to the butter garlic sauce and bake at 375-400 °F until the snails are sizzling (about 10–15 minutes).

Serve on toasted slices of crusty French bread drizzled with plenty of the butter garlic sauce or use as a topping on home-made pizza. They are delicious as an accoutrement to pizza blanca or three cheese pizza.

Escargot make an ideal pizza topping
Photo: M. Outerbridge

References:

[1] Bennett, F.D., & Hughes, I.W. 1959. Biological control of insect pests in Bermuda. Bulletin of Entomological Research 50(3): 423-434.

[2] Gould, S.J. 1969. An evolutionary microcosm: Pleistocene and recent history of the land snail *Poecilozonites* in Bermuda. Bulletin of the Museum of Comparative Zoology 138(7): 407-532.

[3] Outerbridge, M. 2019. Bermuda's endemic *Poecilozonites* lands snails; one million years old and counting! Envirotalk 83.3

[4] Outerbridge, M. and Ovaska, K. 2023. Saving Bermuda's endemic *Poecilozonites* land snails. Envirotalk 83.1

Dr Mark Outerbridge
Senior Biodiversity Officer

NEWS & NOTICES

Winter Lionfish Tournament Results

The 10th annual winter lionfish tournament was once again held during the month of January. Participants collectively culled 1003 lionfish from local waters during the 31 day derby. The top 10 divers were: John Hauser (131 fish), James Adderley (102), Chris Cabral (96), Sean Correia (64), Luke Foster (64), Mark Lewis (56), Trevor Rawson (37), Tim Price (35), Alexander Montarsolo (27), and Gordon Loader (21). DENR and the Bermuda Lionfish Task Force are grateful to lead sponsor Makin' Waves for organising the event, and the more than 20 additional sponsors that contributed to its success. For more information see https://www.lionfish.bm/bermuda-winter-lionfish-derby-2024

Locations where lionfish were caught in January '24

Lobster Statistics Reminder

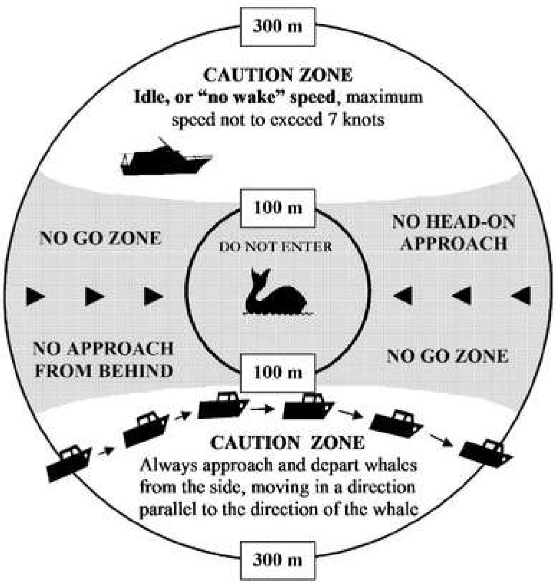
Recreational lobster divers are reminded that their catch statistics for the 2023-2024 season must be submitted online (using the portal at www.fisheries.gov.bm) **by the end of April**. There should be an entry for each date / location that you fished, and a "No fishing" entry for any month in which you did not fish. Anyone failing to submit catch statistics for the season will not be issued a recreational lobster diver license for the upcoming lobster season. Please call 293-5600 or email fisheries@gov.bm if you are having difficulties accessing the portal.

Spearfishing Reminder

Recreational spear fishers are reminded that spearfishing statistics should be submitted **monthly** using the online portal at www.fisheries.gov.bm. Please call 293-5600 or email fisheries@gov.bm if you are having difficulties accessing the portal.

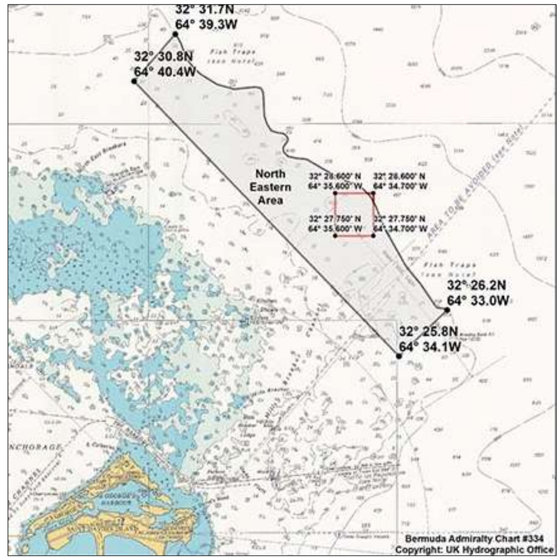
Whale Watching Guidelines

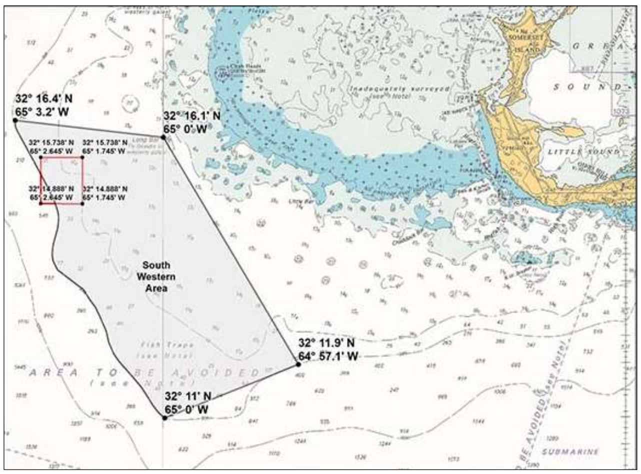
Whale watching can be enjoyed in Bermuda's waters during the winter and spring months. The public are reminded that all whales and dolphins are protected by law. Boaters are requested to follow the local whale watching guidance found at https://environment.bm/whale-watching-guidelines



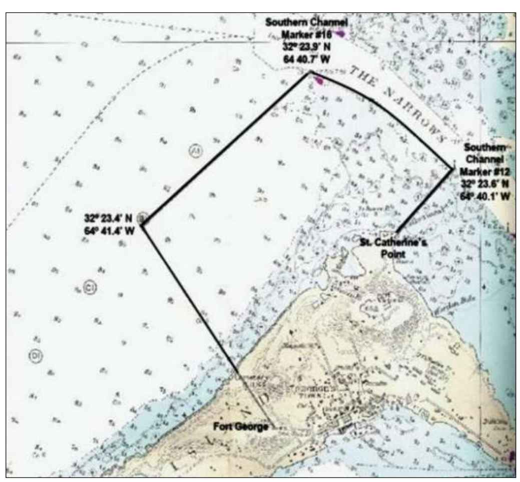
Seasonal Fishing Closures to Protect Spawning Groupers and Grunts

Please remember that fishing is prohibited in the northeastern and southwestern Seasonally Protected Areas (aka the 'Hind Grounds') from **April 15th through August 14th**. Within each of these areas there is an extended closure box (shown red on maps) that aims to protect black groupers, and these two areas are closed to fishing through the end of November.





Fishing is also prohibited in the blue striped grunt aggregation area, off Fort St. Catherine, for the months of **May and June.**



The blue striped grunt seasonally protected area

PLANTING CALENDAR – WHAT TO PLANT IN THE SPRING

VEGETABLES

March & April

Beans, beets, broccoli, cabbage, carrots, cassava, cauliflower, chard, christophine, collards, corn, cucumber, eggplant, kale, leeks, lettuce, muskmelon (cantaloupe), mustard greens, okra, pepper, potatoes, pumpkin, radish, rutabaga, squash, sweet potato, spinach, tomato, turnip, watermelon

May

Beans, cucumber, okra, pumpkin, radish, squash, sweet potato, tomato

June

Beans, cucumber, squash, tomato




FLOWERS

March & April

Acrolinium, ageratum, alyssum, antirrhinum, aster, aubrietia, baby blue eyes, bachelor's buttons, bird's eyes, blanket flower, begonia, bells of Ireland, calendula, candytuft, carnation, centaurea, chrysanthemum, cineraria, coreopsis, dahlia, African daisy, dianthus, forget-me-not, geranium, gerbera, globe amaranth, globe gilia, godeita, gypsophila, hollyhock, impatiens, larkspur, lathyrus, marigold (African & French), nasturtium, nicotiana, pansy, petunia, phlox, red tassel flower, rose everlasting, rudbeckia, salipiglossis, salvia, scabiosa, statice, snow-on-the-mountain, spider flower (cleome), star-of-the-veldt, stock, sweet pea, sweet William, verbena, viola

May & June

Amaranthus, balsam, calendula, celosia, coreopsis, cosmos, gaillardia, gazania, globe amaranth, hollyhock, marigold, portulaca, rudbeckia, vinca, zinnia