Photographing the Structure and Form of Ammonites

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History and Biology

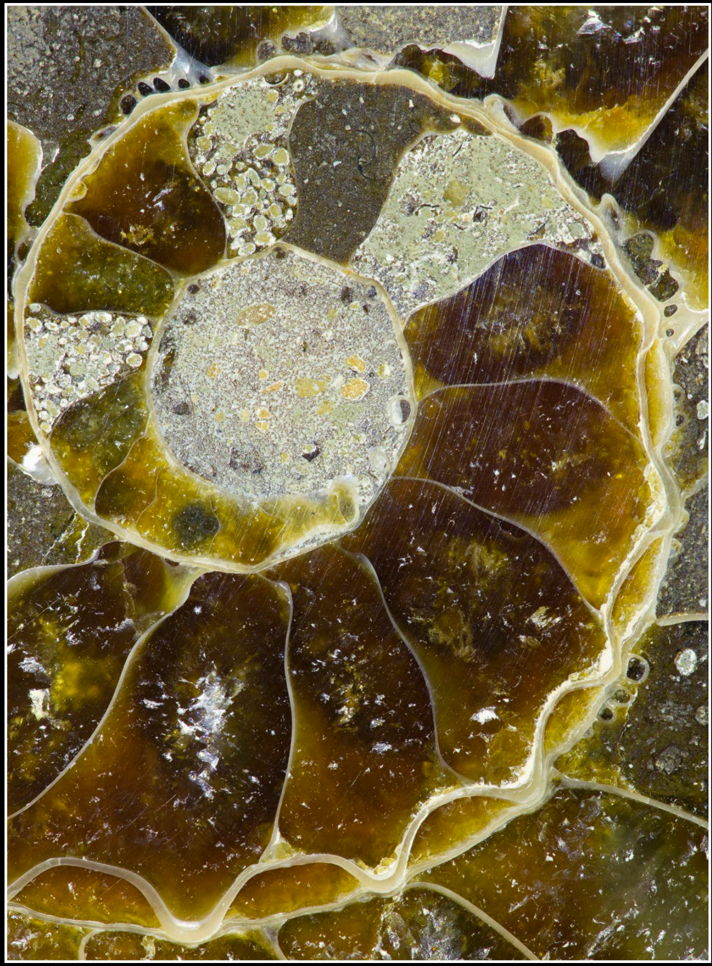
Ammonites are extinct cephalopods that existed from the Devonian Period to the Cretaceous Period. The most recognizable ammonite form is of a curled shell (see left), although many ammonites don't have the prominent curling pattern. As soft body tissue is nearly impossible to preserve for millions of years through fossilization and weathering, the shell is the main part of the ammonite that remains somewhat intact. Weathering can show certain structures, such as sutures, that can identify ammonites as well as help show internal structure. Suture patterns became more complex as the ammonite evolved, although the exact purpose of the sutures is unknown. The exterior patterns and structures of the shell also became more complex as well. Another structure of the ammonite is the septa.

Septa are the walls of the chambers of the shell. They were filled with seawater to change elevation.

The process of fossilization is done through mineral replacement. Pyrite can replace the septa of an ammonite (right). Original material can remain in the ammonite, such as a mother-of-pearl coating from the original shell. This iridescent layer can make for valuable and brilliantly colored fossils. Quartz is one of the most common minerals to replace the ammonite interior. While quartz is an abundant mineral, it is capable of an incredible amount of variation and can ensure that two ammonite specimens never look too similar. Some chambers may fill entirely with quartz, while others will fill partially, leaving a vug in the center. Vugs show off the crystal structure of the fossil, but detract from the value. Quartz is birefringent, which allows for rainbow patterns, but also can cause some odd optical problems and can be mistaken for artifacts in an image.

Sample Preparation

Ammonites are excavated with care, in order to not break or harm the outside shell. Preservation of fine detail is the primary goal when uncovering fossils. After fully excavating the fossil, often the ammonite is sliced in half by a specialized rock saw. The inner part of the two halves is then highly polished. As the magnification gets higher, the scratches on the surface of the ammonite become more apparent (see right). The higher level of grit used to polish the ammonite results in less visible scratches. Polishing can be a time-consuming process, and the act of polishing removes material from the fossil. A high polish reveals the most vibrant colors of the fossil as well as the most detail of the internal structure. Cleaning the surface of a polished ammonite with a damp cloth is recommended to remove any accumulated dust or stray particles. Ammonites should only be cleaned with water, and should be dried after cleaning to prevent mold.



When cutting and polishing the specimen, it is also important to make sure the specimen is as flat as possible. Depth of field is a problem in most types of macro photography, and keeping the specimen flat will result in less work. If using a flatbed scanner in order to image an ammonite, parts of an ammonite that stick out can scratch the glass.

Ammonites can range in size from around 2 cm to over 2 meters. For larger ammonites, weight can be a factor when photographing in batches or if placed on a delicate surface. The smaller ammonites can easily get lost, or to an untrained eye get mixed with other ammonite halves. Stickers with labels are often used to organize large collections of fossils, however stickers can leave residue after removal. Ammonites should be stored so that fossils do not scratch or harm the surfaces of other fossils.

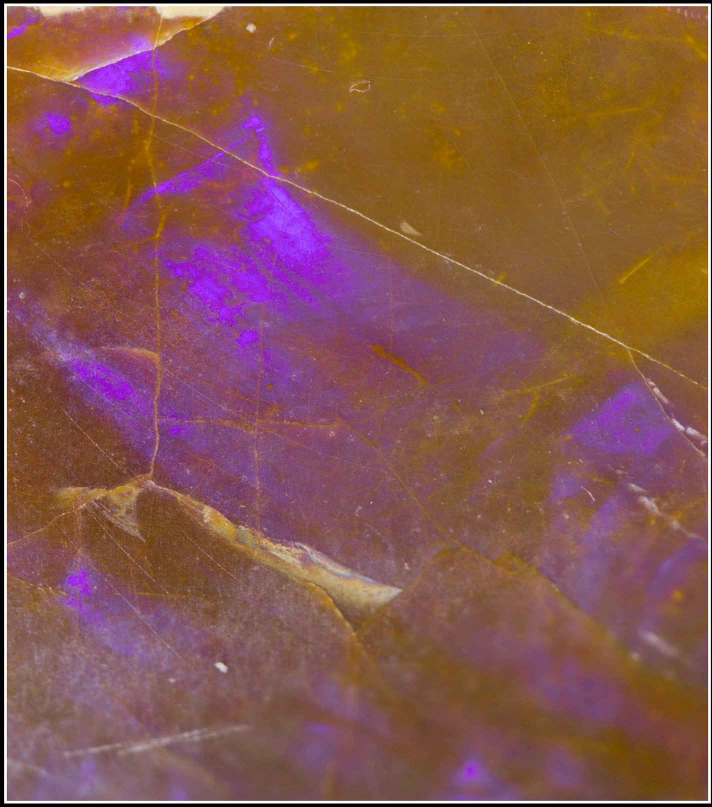
Materials

Canon T2i camera
100mm Canon macro lens
65mm 1x-5x Canon macro lens
Canon tripod slider mount
Olympus copy stand
Epson v500 Perfection Scanner
SparkleLite Mini-Lite ML-700

Software: Lightroom, Photoshop, Canon EOS Utility, Helicon Focus

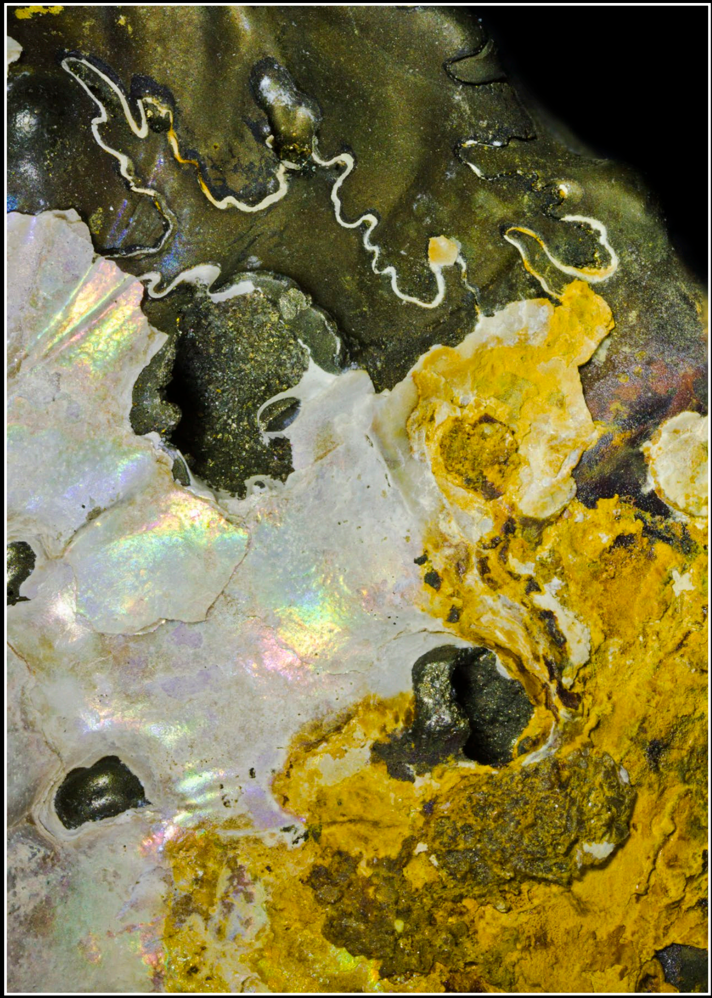
Lighting and Process

One challenge of lighting is showing the iridescence of the nacre (mother of pearl) layer on the outer part of the ammonite. This layer is preserved from the original ammonite specimen when it was alive. Obtrusive specular highlights occur easily in the reflective mother of pearl layer (see bottom image). A polarizing filter helped eliminate some of the specular highlights, as well as reflections on the faces of crystals. Another source of iridescence in ammonites is a natural gemstone called ammolite (see right image). It is rarely found in large quantities and occurs in many colors. Iridescence can be so potent in ammonites that colors can block up due to oversaturation. It becomes necessary to decrease the saturation of the iridescent portion of the ammonite in post-production.



To get the most intense iridescence, using an off-axis light source is the most effective. Another challenge when shooting ammonites was showing the relief of the surface of ammonites. Side lighting was used in order to emphasize the texture of the ammonite. While showing relief is important, it is better to not use such a technique when photographing the polished inner surface of the ammonite, as scratches are visibly distracting. A more diffuse direct lighting approach is appropriate for lighting the highly polished interior of ammonite fossils. When shooting at a lower magnification, such as 1:1, it was difficult to get an even and bright spread of illumination with the fiber optic LED lights that were used. Using reflectors such as paper can help with having illumination that doesn't cover the full field of view.

The pyrite ammonites were also challenging to photograph. When photographing in the crevices, it was problematic getting enough



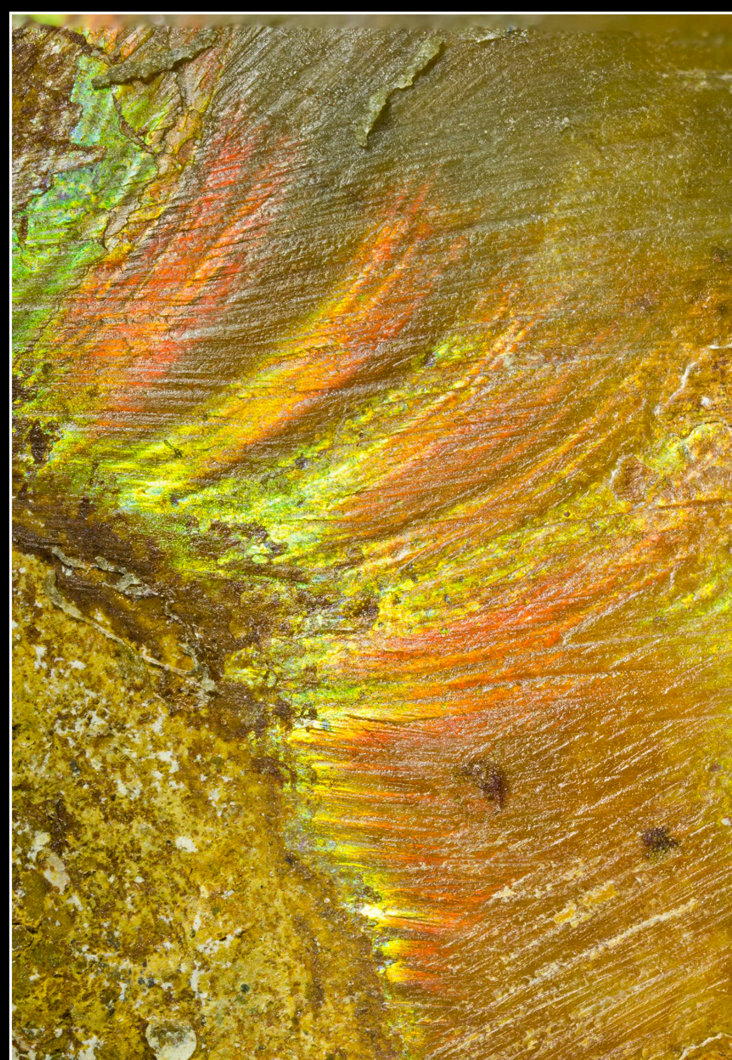
light to expose the shadows as well as have a high enough shutter speed that would show no vibration from the environment.

Focus stacking allows for a more detailed view of the specimen being photographed. Unfortunately, focus stacking where everything is in focus removes all depth of field cues; this causes less information for visually determining the depth of parts of the specimen. The Canon tripod slider mount allowed for fine control over the distance from the camera to the ammonite specimen. Images taken from different distances were stacked using Helicon Focus.

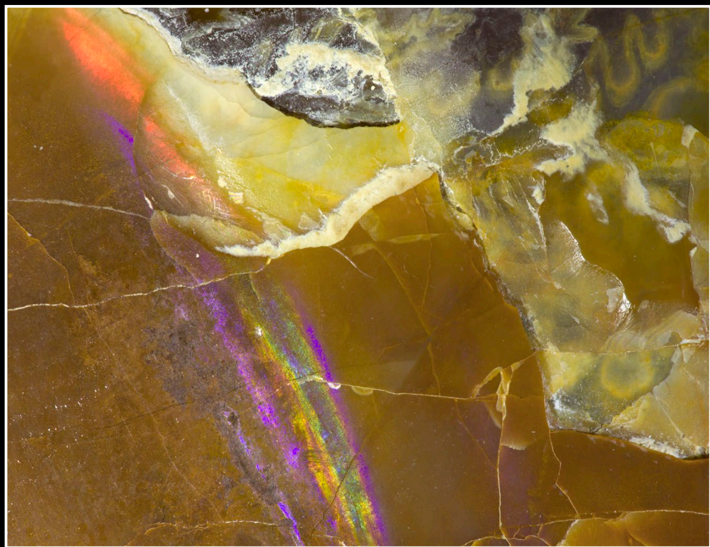
Using a flatbed photo scanner allows for perfect depth of field for completely flat specimens, as well as even illumination.

However, scanning at higher magnifications can take a considerable amount of time, from 2-4 minutes for a single exposure. When placing ammonites on a scanner, some sort of protective cover for the surface of the scanner should be used, such as a clear sheet of acetate. Ammonites can easily scratch the surface of the scanner. Heavy and large ammonites specimens should not be put on a scanner, as the glass could break. If the width of the ammonite is larger than the width of the scanner, it is not advisable to use scanning as an imaging technique for that ammonite. Removing dust from the scanner is another essential part of the scanning process. Using a slightly damp microfiber cloth or compressed air can get rid of dust on a scanner.

Overall, the lighting and process of photographing ammonites is extremely subject dependent. Each ammonite has certain details and properties that, through a variety of imaging and lighting techniques, can be shown for fossil documentation or aesthetic purposes.



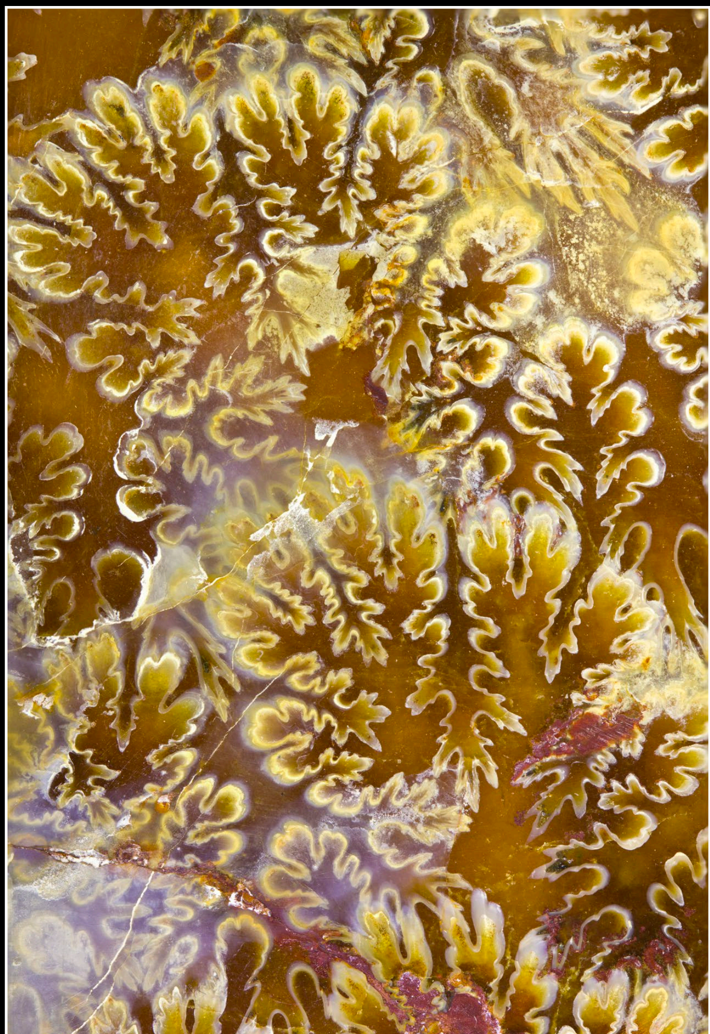
Additional Images



Iridescence in outer layer - 8 image stack, 1x

Iridescence by suture patterns - 25 image stack, 2x

Crystal patterns within chamber - 30 image stack, 2x

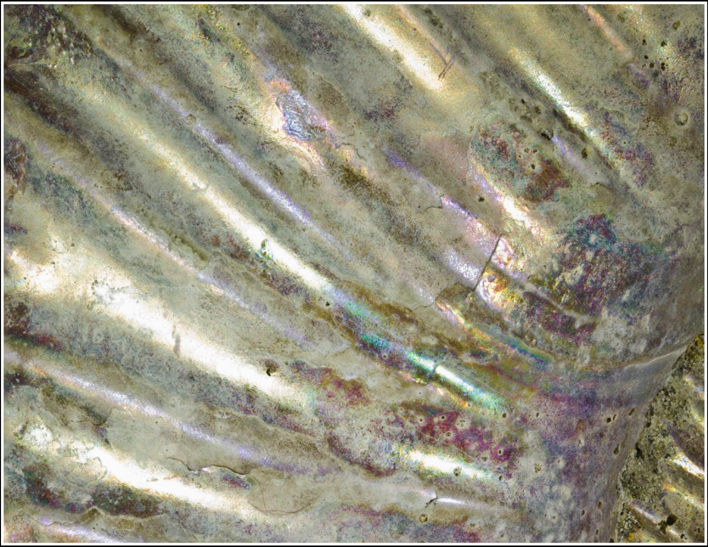


Suture patterns - 20 image stack, .5x

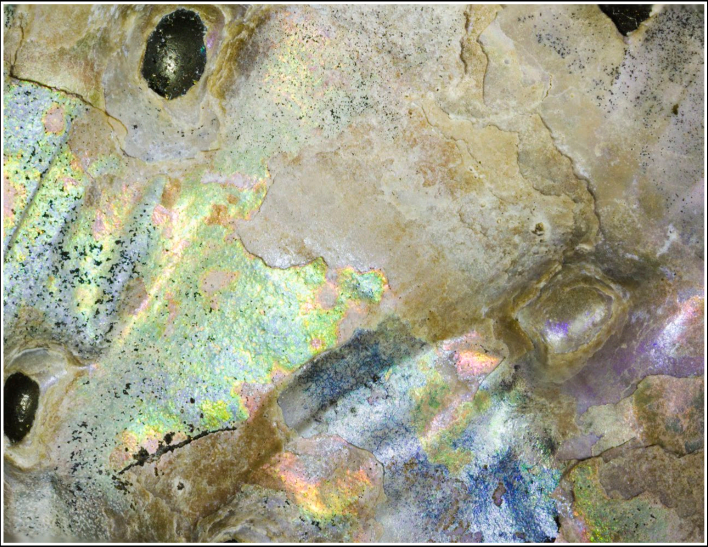
Additional Images

Crystal and septa detail - 15 image stack, 1x

Crystal and septa detail - 24 image stack, 1x



Nacre layer - 29 image stack, 2x



Nacre layer - 25 image stack, 2x

Additional Images

Metallic ammonite - 18 image stack, 2x

Metallic ammonite detail - 40 image stack, 2x

Septa structure detail - 11 image stack, 2x

Septa crystallization - 14 image stack, 1x

Additional Images

Septa crystalsl - scan

Ammonite spiral - scan

Shell texture detail - 17 image stack, 2x

Ammonite with birefringence - 16 image stack, 2x

Additional Images

Ammonite spiral - scan

Ammonite spiral - scan

Nacre layer and suture patterns - 19 image stack, 2x

Septa detail - 13 image stack, 2x

Sources

http://www.paleodirect.com/ammonites.htm

http://petrifiedwoodmuseum.org/Replacement.htm

http://www.amnh.org/science/papers/ammolite.php

http://mamasminerals.com/pages/Ammonites.html

http://skywalker.cochise.edu/wellerr/students/ammonites/ammonites.htm

http://www.ukfossils.co.uk/guides/ammonites.html

About the Author

Sarah Oros is currently in her last year of the Biomedical Photographic Communications program at Rochester Institute of Technology. She has a concentration in Magnified Imaging and is scheduled to graduate in May of 2013. This past summer she completed a co-op at the Paleontological Research Institution in Ithaca, New York. Her interests are paleontology, microscopy, and mineralogy.

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