Diagnosing 'art acne' in Georgia O'Keeffe's paintings

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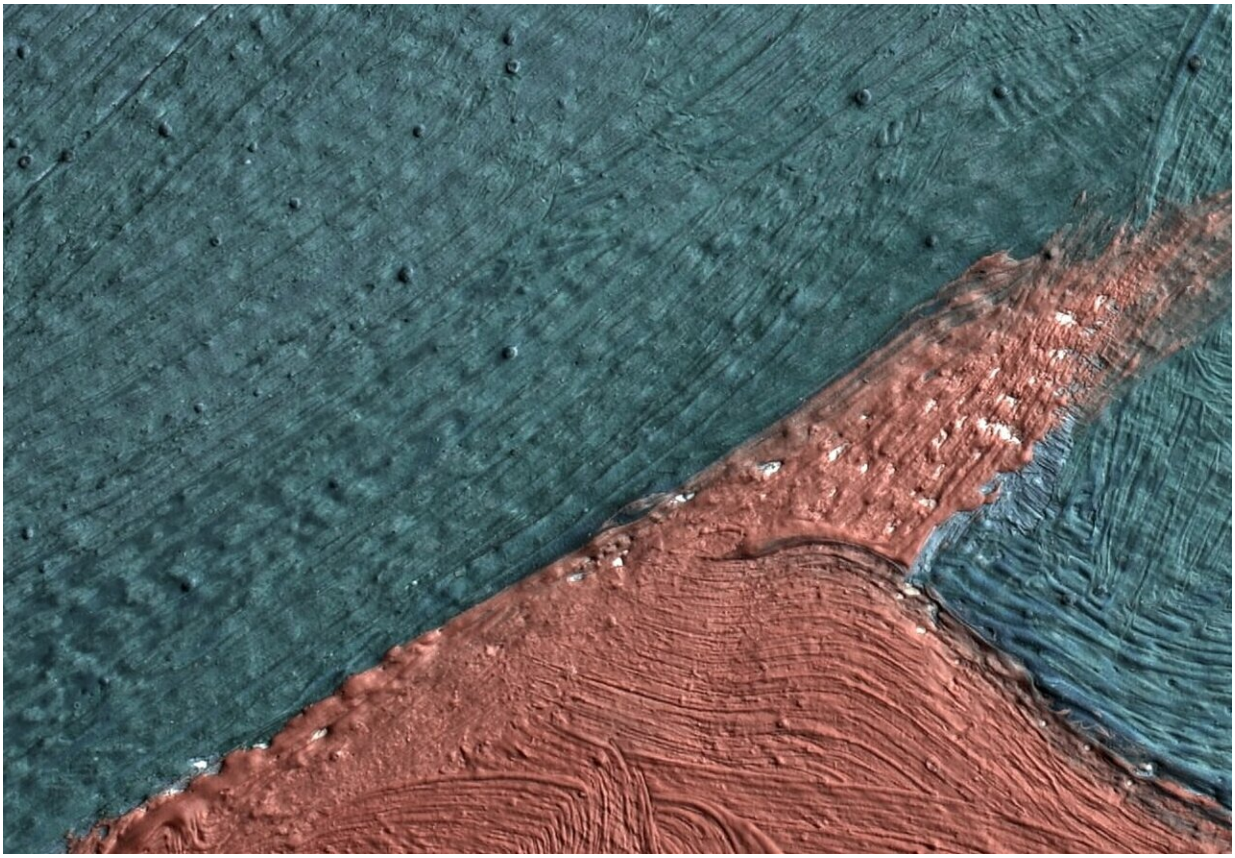

Up-close look at a detailed section of 'Pedernal' shows micron-sized protrusions from metal soaps.Georgia O'Keeffe. Pedernal, 1941. Oil on canvas, 19 x 30 1/4 inches. Georgia O'Keeffe Museum. Gift of The Georgia O'Keeffe Foundation. © Georgia O'Keeffe Museum. [2006.5.172] Credit: Dale Kronkright/Georgia O'Keeffe Museum

Even Georgia O'Keeffe noticed the pin-sized blisters bubbling on the surface of her paintings. For decades, conservationists and scholars assumed these tiny protrusions were grains of sand, kicked up from the New Mexico desert where O'Keeffe lived and worked. But as the protrusions began to grow, spread and eventually flake off, people shifted from curious to concerned.

A multidisciplinary team from Northwestern University and the Georgia O'Keeffe Museum in Santa Fe, New Mexico has now diagnosed the strange paint disease: The micron-sized protrusions are metal soaps, resulting from a chemical reaction between the metal ions and fatty acids commonly used as binder in paints.

Inspired by the research, the team developed a novel, hand-held tool that can easily and effortlessly map and monitor works of art. The tool enables researchers to carefully watch the protrusions in order to better understand what conditions make the protrusions grow, shrink or erupt.

"The free fatty acids within the paint's binding media are reacting with lead and zinc pigments," said Marc Walton, a research professor of materials science and engineering in Northwestern's McCormick School of Engineering, who co-led the study. "These metal soaps started to aggregate, push the surface of the painting up and form something that looks like acne."

"If we can easily measure, characterize and document these soap protrusions over and over again with little cost to the museum, then we can watch them as they develop," said Oliver Cossairt, an associate professor of computer science in McCormick, who led the technology development. "That could help conservators diagnose the health and prescribe treatment possibilities for damaged works of art."

Walton, co-director of the Center for Scientific Studies in the Arts, a

collaboration between Northwestern and the Art Institute of Chicago, will discuss the research findings and technology at a Feb. 16 press briefing at the American Association for the Advancement of Science (AAAS) annual meeting in Washington, D.C.

The briefing, "Art Conservation Leverages Advanced Scientific Knowhow," will be held at 9 a.m. EST in Balcony A of the Marriott Wardman Park.

Cossairt will present the research at a scientific session the next day. His talk, "Diagnosing a Paint Disease with Computer Science: The Case of Georgia O'Keeffe," is part of the session "Medicine, Computer Science and Art: Learning Through Technology" (8 to 9:30 a.m. EST on Feb. 17, room 2, Marriott Wardman Park).

Northwestern University professor Oliver Cossairt gathers the surface metrology of Georgia O'Keeffe's 'Ritz Tower' painting with his hand-held device. Credit:

The AAAS scientific session is organized by Francesca Casadio, the Grainger Executive Director of Conservation and Science at the Art Institute and co-director of the Center for Scientific Studies in the Arts.

Dangerous disease

Nearly all of Georgia O'Keeffe's paintings have some degree of damage from metal soap formation. While some of the cases of "acne" are in early stages of development and can only be viewed with ultraviolet imaging, others are more advanced and can be seen with the naked eye. Conservators have restored some of the paintings where the damage is more pronounced, but the protrusions continue to return.

"The rate of deterioration is one of the most important questions of the study," said Dale Kronkright, head of conservation at the Georgia O'Keeffe Museum. "There seems to be some correlation between the number of times the paintings have traveled to public exhibitions and the size and maturity of the surface disruption. The more times the paintings have traveled, the more likely it will be that the protrusions are larger and more numerous."

Walton and his team in the Center for Scientific Studies in the Arts are studying how quickly the process can advance by inducing metal soap deterioration in surrogate paintings. They also have decades of detailed information from the Georgia O'Keeffe Museum, which documents the different environments that various pieces have experienced while traveling and on display.

"After we understand what sort of environmental conditions they have

been in, what sort of relative humidity, what sort of temperatures, whether they have been in direct sunlight, then we can prescribe a particular environment with particular conditions that will allow the art work to survive over a very long period of time," Walton said.

These findings can also be applied more widely beyond O'Keeffe's masterpieces. Soap protrusions are damaging oil paintings from across all time periods.

"If we can solve this problem, we're preserving our cultural heritage for generations to come," Walton said.

From science fiction to non-fiction

Cossairt likens his hand-held tool to a Star Trek "tricorder." Fans of the show will remember watching their favorite characters use the pocket-sized device to scout unfamiliar areas, examine inanimate objects and diagnose disease.

Instead of assessing a human (or alien's) health, the tool developed in Cossairt's laboratory can help diagnose the health of a painting. It uses the LCD display and camera already available on smartphones and tablets. With a simple wave across the surface of a painting, the app quickly digest's the work's precise, 3-D surface structure, or metrology. It can then subtract the work's color to help researchers identify any deviations in surface shape that do not come from brush strokes or canvas texture.

"It's like the 'tricorder' of measurement tools," Cossairt said. "It can give you extremely accurate measurements but is also something you can just pull out of your pocket."

The app uses the light source from a mobile device—either the LED

flash or LCD display—to reflect light off the painting's surface and capture those reflections with the camera. The image is then processed by custom algorithms developed at Northwestern by Aggelos Katsaggelos to extract surface shape information.

"We collect a lot of data in an efficient, successful way, but then the data needs to be processed," said Katsaggelos, the Joseph Cummings Professor of Electrical Engineering and Computer Science at McCormick. "The technology uses machine learning to distinguish whether texture is a soap protrusion or something benign like a brush stroke. Then, for the protrusions, we extract statistics—the density, size and shape."

Compare this hand-held device to the large, cumbersome equipment that is currently needed to map a painting's metrology. The primary technique, called reflectance transformation imaging, requires a large dome of several light sources and an expensive setup. Few museums can invest in purchasing and maintaining such instruments.

"We're trying to make it much simpler, much less expensive and more readily available to lower the barrier to usage," Cossairt said.

The research is supported by the National Endowment for the Humanities.

Provided by Northwestern University