SEM vs micro-Reflectance Transformation Imaging (RTI) for examining tool marks on Jade

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Introduction: The use of SEM imaging as a method for the examination of tool marks on stone to distinguish between marks left by ancient or modern tools, is well established. Traditionally though, the imaging of those tool marks is often done at magnifications as low as 18-25x, which is at the very lowest end of the imaging capabilities of the SEM. The question posed here is if RTI can provide similar information to SEM, it could be an important relatively inexpensive tool for authentication for those without access to SEM.

Costa Rican Jades in the collection of the Walters Art Museum

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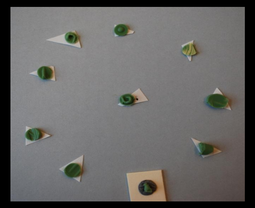
E. Keats Webb

Paul Messier

Acquiring Data:

1. Silicon impressions were taken from tool marks on several Costa Rican Jades in the Walters Collection. Each impression was then examined with micro-RTI and SEM to compare their imaging capabilities at relatively low magnifications.

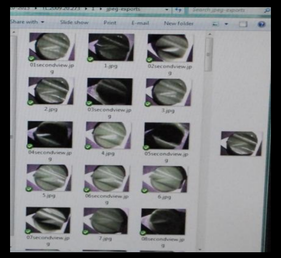


Polysiloxane impression material by Affinis, Coltene Light Body 6501, used for taking impressions and the impressions seen above.

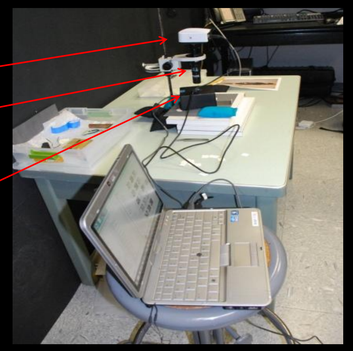
Jade crocodile from Costa Rica with locations where impressions of tool marks were taken.

2. Paul Messier and his brother Andrew have developed a micro-RTI set up they call the “Monkey Brain.” Using a low-power microscope with camera attachment, it automatically acquires 48 images in less than one minute.

Keats Webb beginning to acquire images from the “Monkey Brain.”



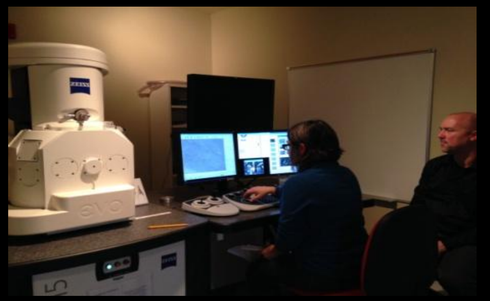
Individual images collected before processing with free RTI software available from the Cultural Heritage Imaging website.



The underside of the Monkey Brain. The programed software automatically snaps a photo as each LED lights up in sequence.

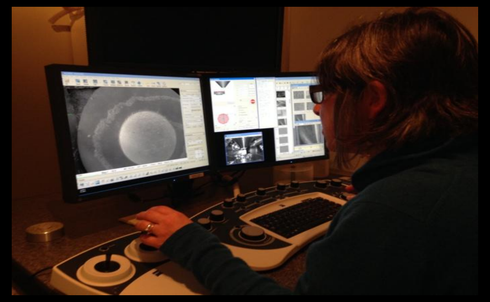
3. At the Smithsonian National Museum of Natural History, imaging was done using secondary beam electron imaging. Tool marks were imaged at lowest end of the magnification capabilities of the SEM.

1.



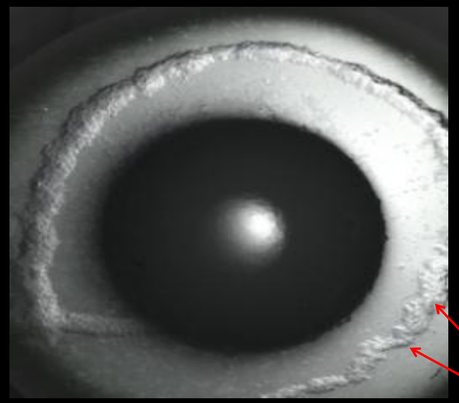
2.

1. Silicone impressions ready for the SEM
2. Julie working with Scott Whittaker at the Museum of Natural History
3. Studying single images of impressions at magnifications of 18x.

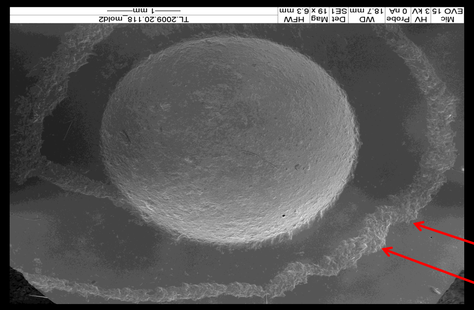


3.

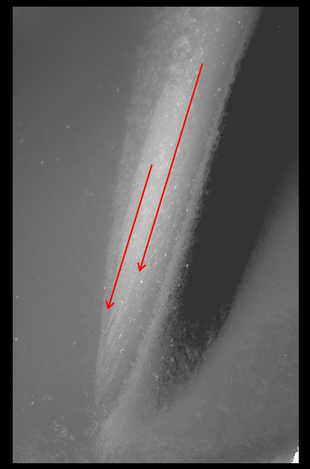
Analyzing the Data: Comparing images taken with micro-RTI and SEM



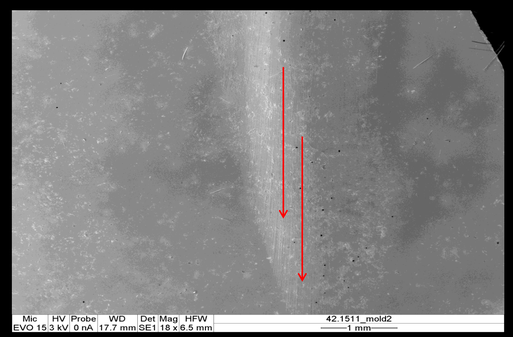
Micro-RTI image showing small changes in direction indicative of the use of a hand held tool.



SEM image taken at 19x magnification showing the same shifts in direction as seen in the micro-RTI.

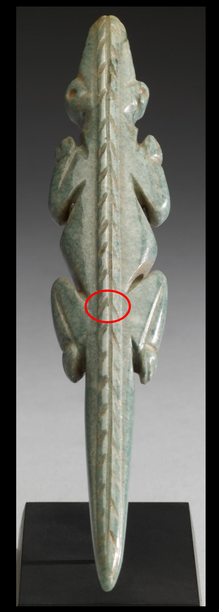


Micro RTI image showing repeating parallel lines of consistent width indicating the use of a tool with a fixed abrasive.



SEM imaging at 18x showing the same repeating parallel lines in even sharper detail.

Macro-RTI imaged with a full-frame DSLR with a higher resolution and higher quality optics than the camera used with the Monkey Brain.



Micro-RTI image showing small variations in line direction and line width indicative of the use of loose abrasive powder in with a hand held tool.

SEM imaging at 17X showing same variations seen in the micro-RTI.

Observations and Conclusions:

1. Micro-RTI is capable of imaging differences in tool marks on stone at magnifications of approximately 20x, typical of magnifications used with SEM imaging.
2. These images, once processed with the RTI software, were able to provide sufficient imaging power to distinguish between modern and ancient tool marks.
3. The optical resolution of the SEM is superior to the micro-RTI but even with this early prototype of the Monkey Brain, the resulting RTI images were clear enough to see the distinguishing stone working features identified in the SEM images.
4. Micro-RTI can provide a lower cost alternative to SEM imaging as a tool in the authentication of worked stone objects.
5. The new version of the Monkey Brain incorporates 52 light positions, higher intensity LEDs, more versatile mounting capabilities and a higher resolution camera.

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PAULMESSIER
Conservation of Photographs & Works on Paper

**With thanks to Ariel O'Connor for her technical expertise and assistance with the RTI imaging at the Walters.