



ABSTRACT

As co-instructors of an undergraduate course in Archaeological Geology, we have developed an interpretive exercise using the Scanning Electron Microscope (SEM). This exercise requires preliminary background or instruction in basic principles of percussion and pressure flaking, geological materials suited for chipped stone tool manufacture, use-wear on chipped stone tools, contextual analysis and post-depositional processes, particularly natural wear due to wind and water abrasion. After hands-on discussion of chipped stone tool manufacture and suitability of geologic materials, we explained and demonstrated the research potential of the SEM in the Department of Entomology at Kansas State University. Using the secondary electron detector, students acquired images of four surface or edge locations of an artifact recovered from an archaeological site in north-central Kansas. EDS semi-quantitative analysis and macroscopic observations demonstrated to the students that the object was made of chert. We asked students to write a description of the analytical techniques, the data and then formulate an interpretive history of this artifact. Most concluded that after the initial flaking, use, and discard, the object was subjected to extensive weathering that all but obliterated the original flake scars. At a later point, the discarded object was picked up and retouched twice along one edge for use as a cutting implement. Although most students were able to recognize that the artifact had multiple stages of use, additional comparative images of water and wind-worn cherts would give students greater confidence in their ability to interpret the history of tools affected by natural processes after the tool had been discarded (post-depositional processes). Students expressed enthusiasm about the project and indicated a high level of engagement on evaluations (average score=4.3 on a scale of 1 [low] to 5 [high]).

COURSE AND PROJECT GOALS

During the Spring 2004 semester at Kansas State University, we co-taught an interdisciplinary undergraduate course in Archaeological Geology (listed for credit in anthropology and geology). Students enrolled in the course were primarily sophomores or juniors with limited background in archaeology and geology. Many had taken only an introductory course in one of these study areas.

Course content goals included:

- * understanding geological processes that affected past human societies as well as the archaeological record,
- * introducing geological methods that aid in the interpretation of our human past, and
- * understanding geologic time and radiometric techniques.

In order to reach these goals we designed seven activities that stressed critical evaluation of geologic and archaeological data. Semi-quantitative and quantitative data were analyzed. Students completed a group project that reviewed analytical techniques and emphasized concept synthesis.

Through this exercise, we sought to:

- * introduce students to the collection of compositional data and high resolution images using a scanning electron microscope (SEM),
- * distinguish between collection of careful observations (data) and interpretation of those observations, and
- * have students complete a mini-research project in which they collect data, evaluate those data, and interpret the history of the study artifact.

Ideally the project encouraged students to use higher level thinking skills (Bloom, 1956) during their synthesis of information about geologic materials, methods of stone tool manufacture, and geologic processes that may affect cultural materials. use higher level thinking skills as defined by Bloom's taxonomy (Bloom, 1956).

SAMPLE DESCRIPTION

The study artifact was recovered from the surface of a site situated along the shore of a modern reservoir in north-central Kansas. Before construction of the reservoir, this site was located near the confluence of a small perennial stream and one of its tributaries. The artifact was formed of chert, most likely originating from Permian-age deposits from the Flint Hills of eastern Kansas. Although formed originally through percussion flaking, this is an unusual lithic artifact for this region because of its polished surface. Grinding or cultural or natural wear obliterated most of the original flake scars. More recent flaking is evident along one edge, which exhibits evidence of two different stages of retouch.

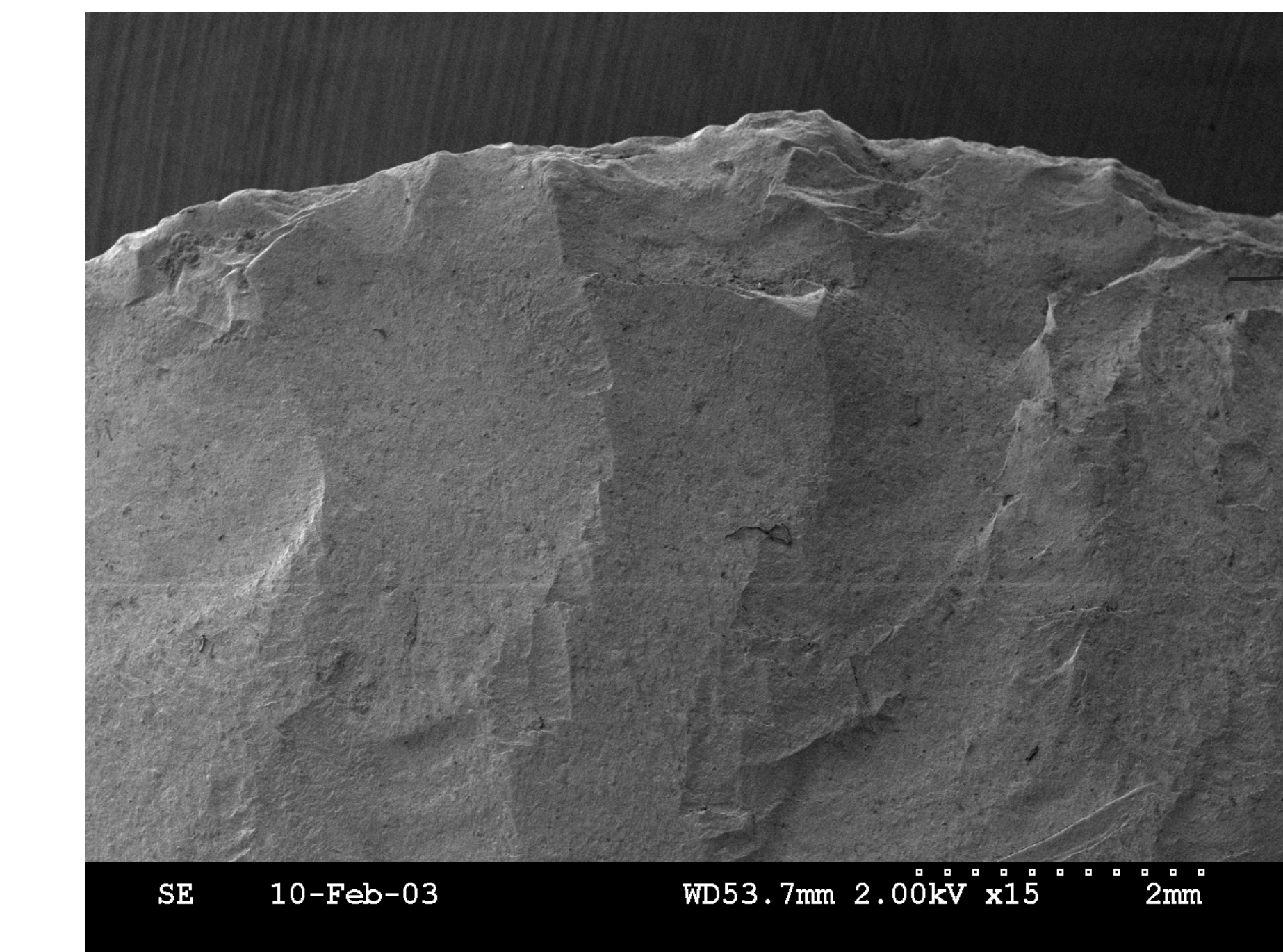
PROJECT OUTLINE

In class students:

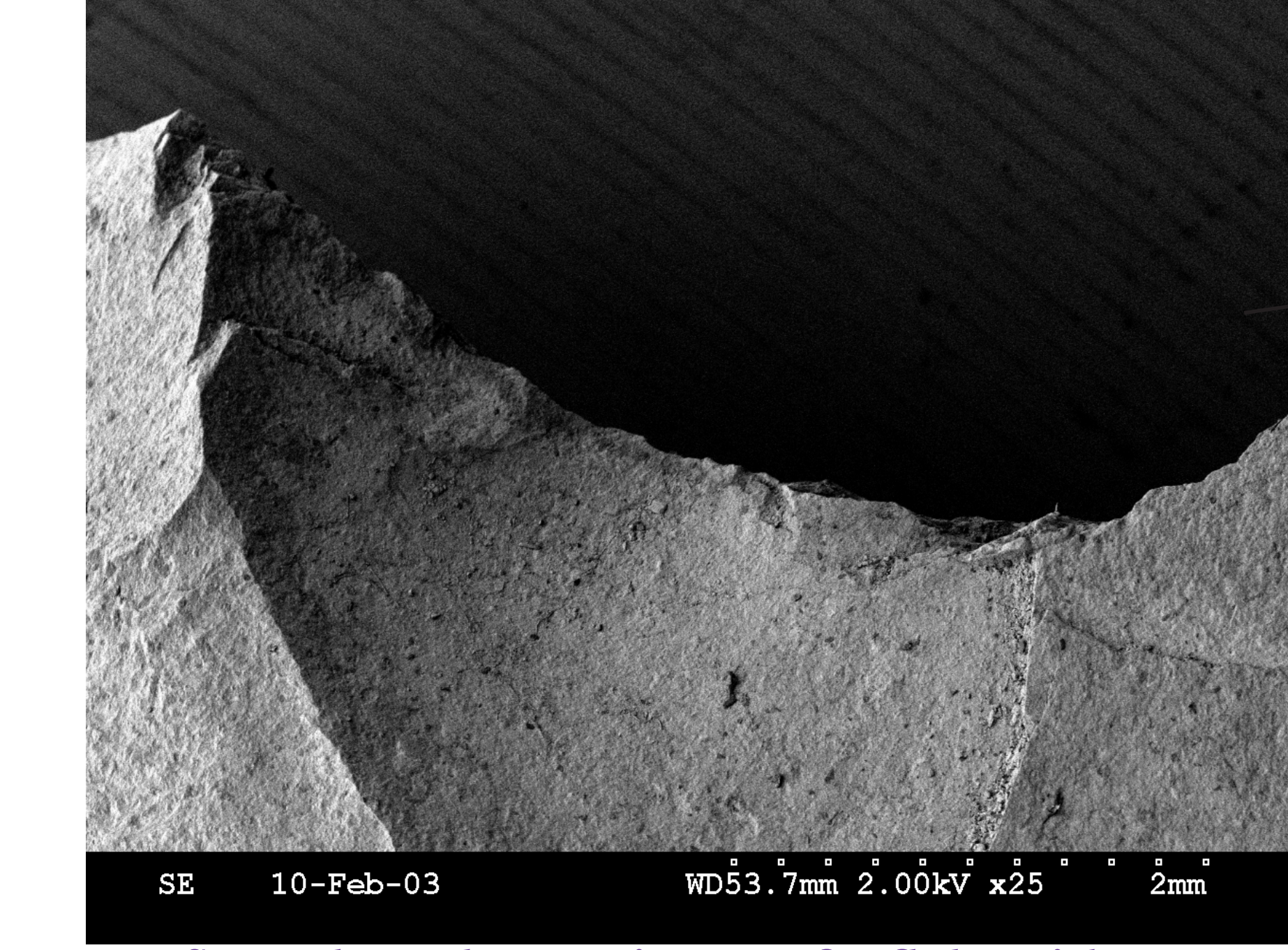
- * described and measured macroscopic attributes of the artifact,
- * used EDS to obtain semi-quantitative compositional data for the material from which the artifact was made,
- * chose target locations on the artifact for SEM imaging, and
- * acquired secondary electron (SE) images of the surface of the artifact and selected flake scars.

The resultant data were made available to the students, who individually

- * evaluated the compositional data to determine that it was chert,
- * described, compared, and evaluated the SE images,
- * hypothesized what processes may have produced the polish, and
- * wrote an interpretation of the history of the artifact.



Secondary electron image of well-developed flake scars with some crushing from tool use. Magnification is 15x.



Secondary electron image of a flake without much evidence of use wear. 25x magnification.

INTERPRETATION OF ARTIFACT HISTORY

Most students recognized from the overall form of the study object that it was shaped through human actions. With more time to visually inspect the artifact, we expect that students would describe the remnant flake scars evident on a portion of the artifact. They could use those observations to support an argument that the original manufacturing process was percussion flaking prior to the polishing. The students noted that the artifact had been smoothed and later re-sharpened along one edge. Most explained the origin of the smooth surface resulting from abrasion by water-borne sediments. One student offered the interpretation that humans had purposely ground and polished the artifact. Macroscopic inspection of the artifact reveals that part of one edge was flaked after smoothing. Secondary electron images of the retouched edge show differences in use wear. Few students noted this subtle variation, which suggests initial reshaping, use of the artifact and finally an additional retouch of part of the edge.

Although this project served primarily as a class exercise, it also caused us to look at the artifact more closely and further develop our own interpretation of the object. Initially our working hypothesis was that the polished surface formed through natural abrasion in a stream. However, faint, parallel grooves on the surface of the artifact and the high degree of polish may indicate that humans purposely ground a previously flaked tool to produce the smooth surface. Although argillite artifacts of similar form, are known in other portions of North America, finely ground chert artifacts are not common in the Great Plains.



The study artifact is a chert tool unusual because of its high polish and subsequent reshaping for use as a knife. As a class research project, archaeological geology students tried to determine whether humans or natural processes polished the artifact. They proposed interpretations of the complex event sequence that shaped the artifact.

PROJECT ASSESSMENT

We assessed student learning in the course by evaluating individual performance on activities, group performance on the final poster project, mid-term and final evaluations, and comparison of pre- and post-test results (e.g., Nuhfer, 1993, 1996). Because the SEM activity evolved after the class had started, the pre-test/post-test assessment mechanism did not adequately evaluate student learning during the SEM activity. However, students were asked to evaluate this exercise on a mid-term evaluation by ranking their response to this exercise using the following scale:

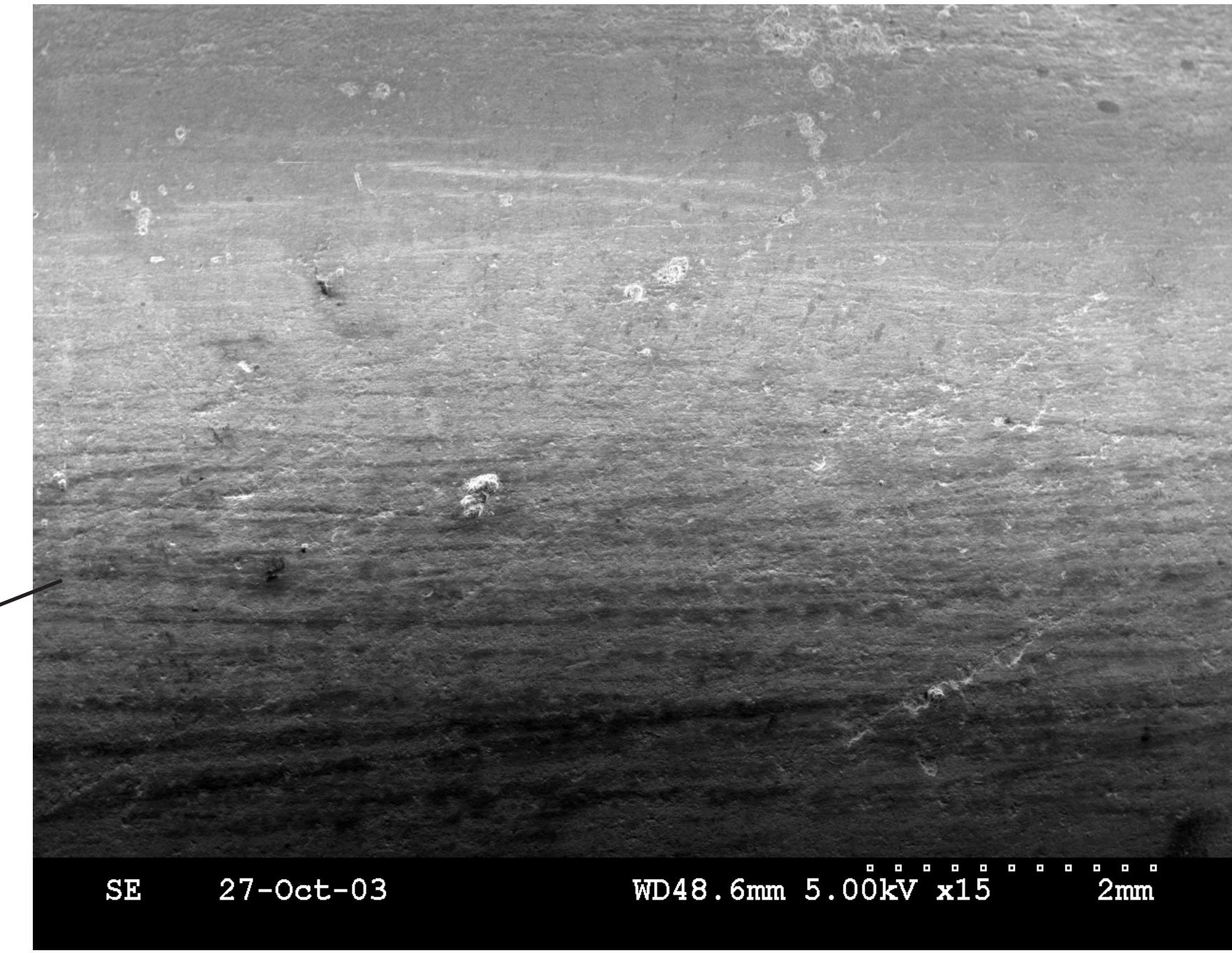
- 5 - strongly agree, 4 - agree, 3 - neither agree nor disagree, 2 - disagree, 1 - strongly disagree

The in-class SEM demonstration provided me with a useful introduction to the use of the SEM. [Response: mean=4.35, n=17 respondents]

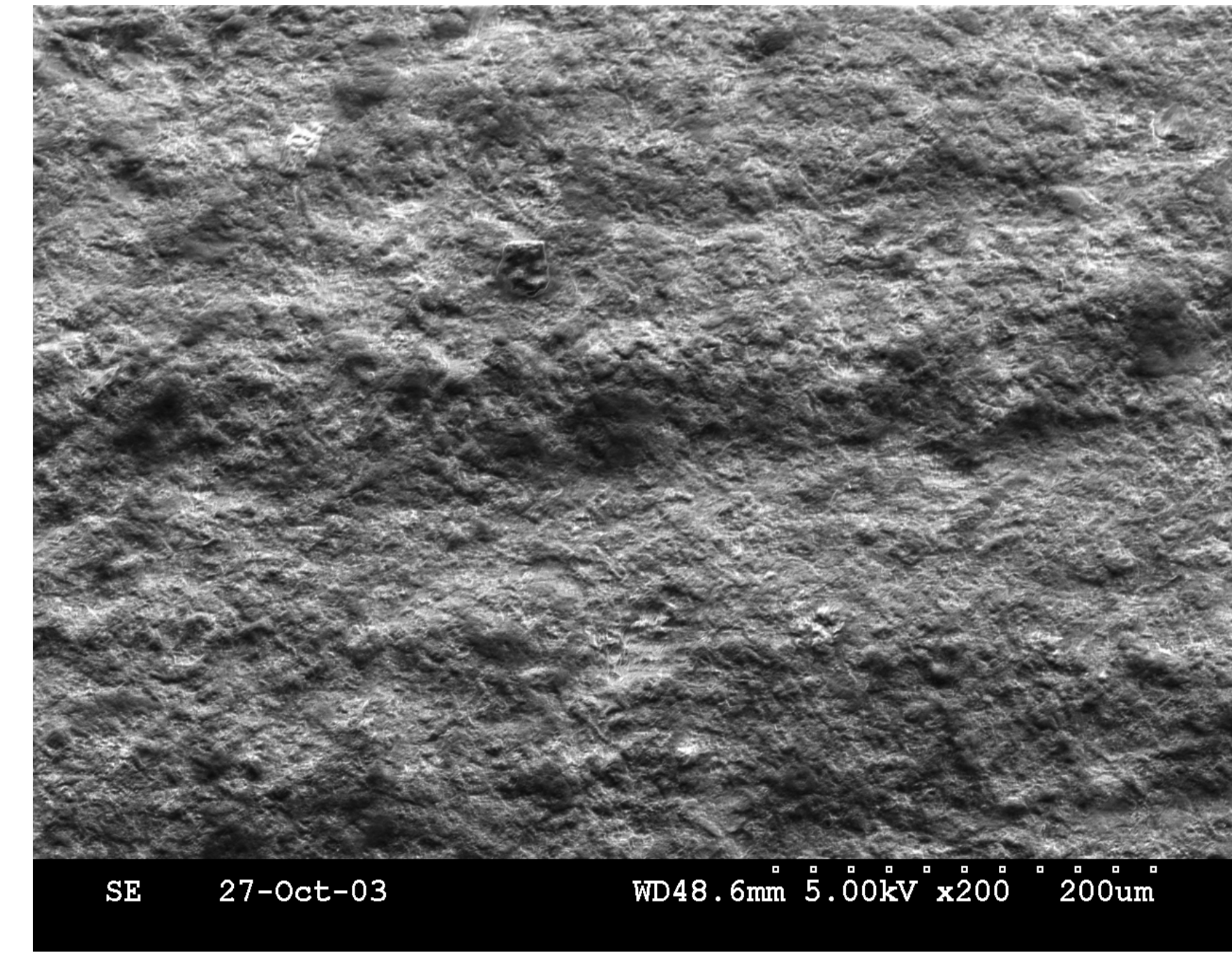
The SEM assignment was useful in making me think more deeply about how artifacts are interpreted. [Response: mean=4.24, n=17 respondents]

The SEM assignment was well designed. [Response: mean=4.24, n=17 respondents]

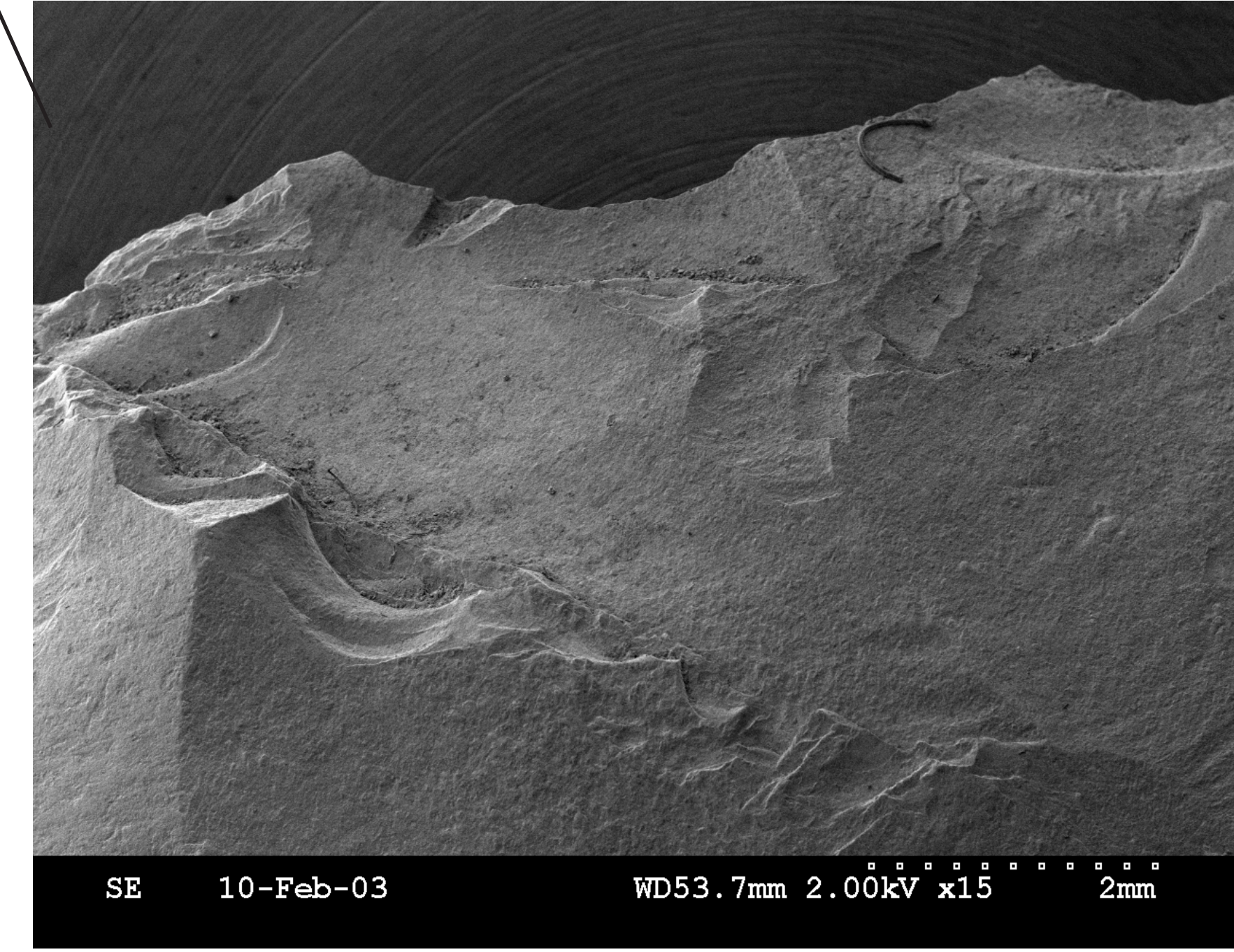
Written comments from students included: "I enjoyed this exercise", "Great intro to SEM", and "I was very interested in it [the exercise] and would have liked to [do] more with it". Student response to the SEM activity was positive compared to the other activities and assigned readings. Rankings for the latter ranged from 3.35 to 4.41.



A 15x magnification of the polished surface shows parallel to subparallel grooves.



A 200x magnification of one of the grooves (above).



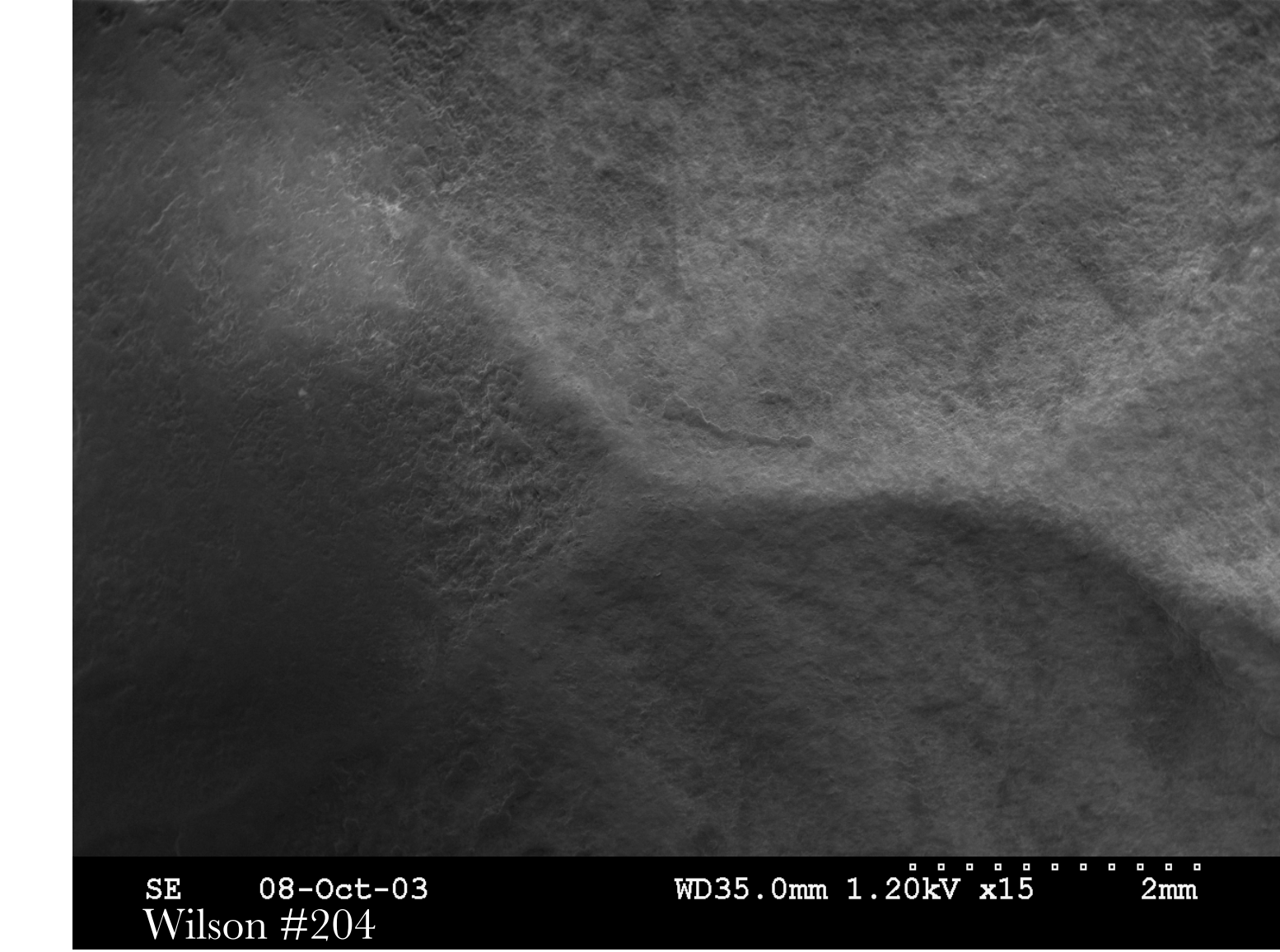
What do you think this image reveals about the artifact's history?

IMPROVEMENTS TO PROJECT DESIGN

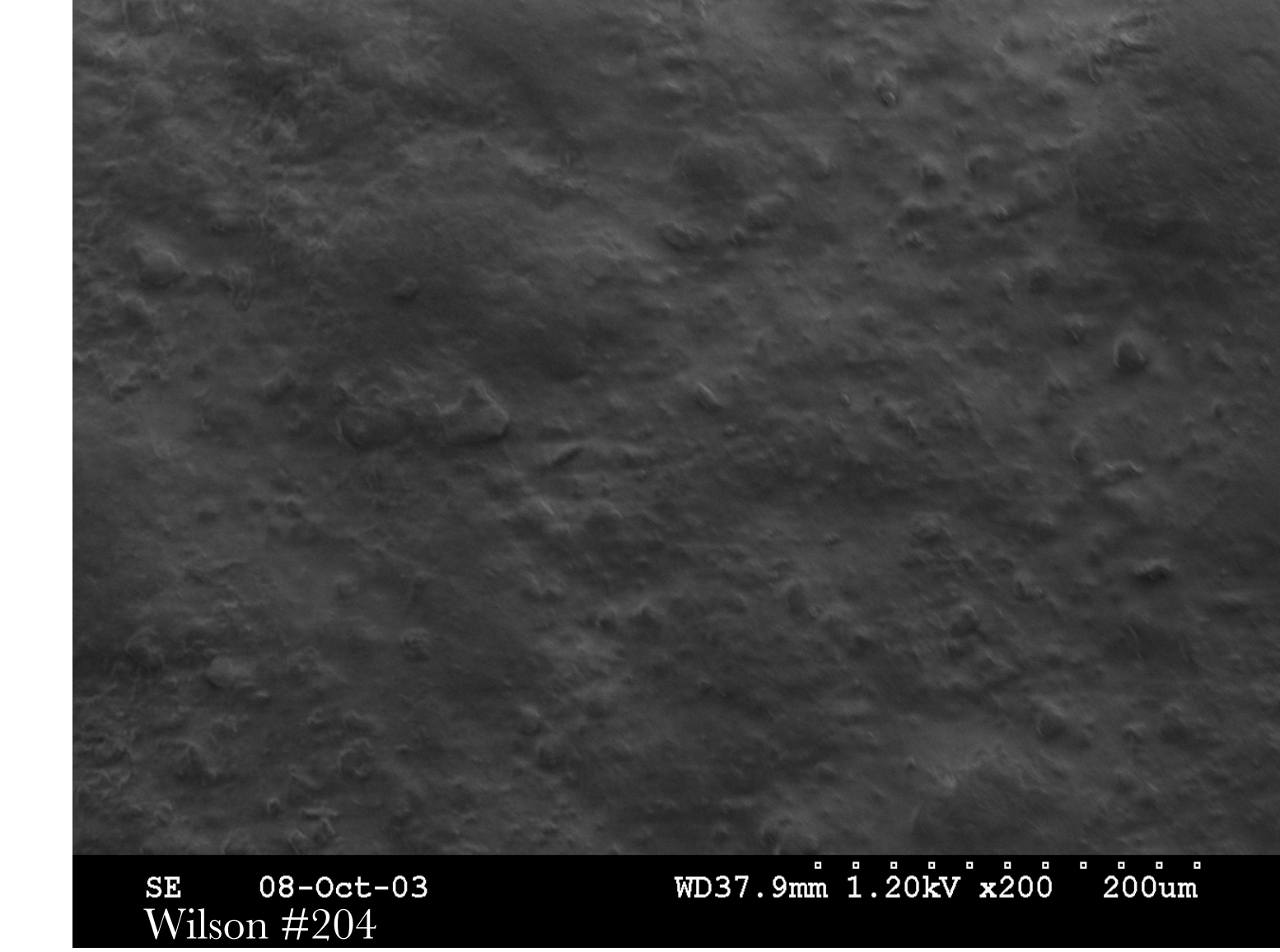
Because of time limitations, we did not have reference SEM images of typical fresh and worn, chipped-stone artifacts. We also did not have comparison images of wind- and water-worn objects, or purposely ground chert for comparison with the SEM images of the project artifact. One student suggested such reference images for future studies of this artifact. Since this exercise, we have collected comparative images of two artifacts recovered by local collectors from stream environments. Additionally, we have collected wind-abraded materials and freshly flaked chert should future classes choose to acquire SEM images of these.

The activity will benefit from more time spent covering background archaeology information and analyzing images. We will augment the presentation of use wear to help students recognize the sequence of post-polishing events. Finally, based on our assessment and some comments of students – e.g., "I could have used [more] information on how exactly the microscope worked and definitely would have liked to have had more time observing it in action" – we plan to spend three instead of two class periods on the activity. We plan to make this project and images available via the Digital Library for Earth System Education (DLESE, www.dlese.org/).

REFERENCE IMAGES OF A CHIPPED-STONE TOOL FOUND IN A RIVER BED



Wilson 204 shows an extremely rounded arris (ridge between flake scars) (15x).



A 200x magnification of the smooth surface of Wilson 204 shows some pitting but no evidence of elongated grooves.



Wilson 204 is a chipped-stone tool subjected to weathering and erosion in a river after discard. The material is chert but probably not the same chert as the study artifact.

ACKNOWLEDGEMENTS

We extend our thanks to the Bureau of Reclamation, Kansas-Nebraska Area Office, Grand Island, Nebraska, and archaeologist Bill Chada for allowing us access to the study artifact. Thanks go also to the KSU Department of Entomology for providing SEM time for teaching. Kent Hampton ably operated the SEM and assisted with image acquisition. Dick Eckles and Darrel Wilson kindly provided water-worn artifacts, and Dana Van Burgh Jr. and B. Ed Strube obtained wind-abraded glass from sand dunes near Casper WY.

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- Nuhfer, E., 1993, Bottom-Line Disclosure and Assessment: Teach. Prof., 7:8.
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