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Title: Earliest Art in the Americas: Incised Image of a Proboscidean on a Mineralized Extinct Animal Bone from Vero Beach, Florida

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7 **Earliest Art in the Americas: Incised Image of a Proboscidean on a Mineralized Extinct**
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9 **Animal Bone from Vero Beach, Florida**

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ABSTRACT

A fragmented fossil bone incised with the figure of a proboscidean was recently found at Vero Beach, Florida near the location where Late Pleistocene fauna and human bones were recovered from 1913–1916. This engraving may represent the oldest and only existing example of Terminal Pleistocene art depicting a proboscidean in the Americas. Because of the uniqueness, rarity, and potential antiquity of this specimen, caution demanded that a variety of tests be used in an attempt to verify its authenticity. The mineralized bone was identified as mammoth, mastodon, or giant sloth. Rare earth element analysis was consistent with the fossil bone being ancient and originating at or near the Old Vero site (8-IR-9). Forensic analysis suggests the markings on the bone are not recent. Optical microscopy results show no discontinuity in coloration between the carved grooves and the surrounding material indicating that both surfaces aged simultaneously. Scanning electron microscopy (SEM) revealed that the edges of the inscription are worn and show no signs of being incised recently or that the grooves were made with metal tools. In addition, the backscattered SEM images suggest there is no discontinuity in the distribution of light and heavy elements between the scribed region and the surrounding bone indicating that both surfaces aged in the same environment. This is very different from an intentional mark made on the bone for comparison. Energy dispersive x-ray spectroscopy (EDXS) shows that the surface contains significant amounts of calcium, phosphorus, oxygen, and carbon typical of a mineralized bone surface. Examination of a cast and mold of the incised bone by Reflectance Transformation Imaging (RTI) also provided no evidence that the engraving was made recently. All of these results are consistent with the mammoth engraving being authentic.

Key words: Old Vero Site; Incised Art; Terminal Pleistocene; Mammoth; Mastodon

1. Introduction

The dorsal surface of a fragmented fossil bone recovered from Vero Beach, Florida contains a carving of a proboscidean (Figure 1). Never before in the Western Hemisphere has there been found and validated a bone from an extinct faunal species incised with a recognizable

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4 image of a proboscidean.¹ The shortened, high-domed skull and longer forelimbs than hind limbs
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6 are consistent with the image being a mammoth (Lister and Bahn 1994). If genuine, this rare and
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8 spectacular specimen provides evidence that people living in the Americas during the Terminal
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10 Pleistocene created artistic images of the animals they hunted. The incising would have to be at
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12 least 13,000 years old as this is the date for the last appearance of these animals in eastern North
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14 America (Faith and Surovell 2009; Grayson and Meltzer 2003; Steadman et al. 2005), and more
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16 recent Precolumbian people would not have seen a mammoth or mastodon to draw.
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21 The image of the proboscidean is not readily apparent and could easily be overlooked; in
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23 fact, it was overlooked at first. The bone was collected by avocational fossil hunter, James
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25 Kennedy, from a location in northern Vero Beach sometime in 2006 or 2007. In February 2009,
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27 Kennedy discovered the engraving of the proboscidean while cleaning the bone which had been
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29 stored at his home along with others he had found. Recognizing the potential importance of the
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31 bone, Kennedy contacted several of the authors of this paper which in turn initiated the research
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33 described herein. The fragment of bone is 40.1 cm (ca. 15.75 inches) long, 10.2 cm (4 inches)
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35 wide (width is variable), and 4.0 cm (ca. 1.6 inches) thick (thickness is variable). The length of
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37 the design is ca. 7.5 cm (3 inches) from the top of the head to the tip of the tail; the height of the
38
39 design is ca. 4.5 cm (1.75 inches) from the top of the head to the bottom of the right foreleg. The
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41 fossil bone is a fragment from the shaft of a long bone of a large mammal (based on thickness of
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43 the cortical bone layer and the degree of curvature which indicates the original circumference of
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45 the bone), most likely either a mammoth (*Mammuthus*) or mastodon (*Mammut*), or less likely a
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47 giant sloth (*Eremotherium*). A precise identification is not possible because of its fragmented
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49 condition and lack of diagnostic morphologic features. It is certainly derived from a much larger
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51 land mammal than any known to have been alive in Florida during the Holocene interval (e.g.,
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4 bear, bison, deer), and the thickness of the cortical bone precludes a cetacean origin. Because the
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6 bone is mineralized, it is improbable that it can be identified by DNA analysis or dated by ^{14}C .
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9 This is usually the case for Late Pleistocene fossils from Florida (e.g., Hulbert et al. 2009).
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11 12 13 14 **2. Background**

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16 For more than one hundred years, art objects, purportedly fashioned by aboriginal
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18 Americans, have been forged. Meltzer for example, summarizes the fraud of the Holly Oak shell
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20 pendant engraved with the image of a mammoth (Meltzer and Sturtevant 1983; Meltzer 2009).
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22 First announced in 1889, the image was suspected immediately as a copy of a specimen
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24 described by Lartet (1865) from the La Madeleine site in France, but the hoax was not exposed
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26 in print until the 1980s (Griffin et al. 1988).
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31 Hundreds of depictions of proboscideans are known today from European caves and
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33 portable bone art (Delporte 1990; Guthrie 2005), but none from America (Meltzer 2009:76),
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35 until the recent find from Vero Beach, Florida. Since 1913, people have collected fossils of Late
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37 Pleistocene vertebrate fauna from a streambed, Van Valkenburg Creek, intersected by the
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39 construction of the Vero canal that extends several miles westward from the Indian River on the
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41 eastern coast of Florida (Sellards 1916, 1918; Sellards et al. 1917; Weigel 1962). The fauna
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43 include many of the typical members of the now extinct Late Pleistocene North American
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45 megafauna, such as mammoth, mastodon, ground sloth (three species), tapir, horse, llama, dire
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47 wolf, and sabertooth cat (*Smilodon*). Large numbers of these fossils are stored or exhibited at the
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49 Florida Museum of Natural History (FLMNH) in Gainesville and the Smithsonian's National
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51 Museum of Natural History; others are in private collections, such as the incised bone discussed
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58 herein. In 1915 and 1916, human skeletal remains were found in the same vicinity of the Vero
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4 canal, engendering disagreement about their contemporaneity with the fossil animals that has
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6 never been resolved. Many of the human bones also reside at the FLMNH (Sellards 1916; Purdy
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8 2008). Impending construction in the area of the original finds at the Vero site and the recent
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10 discovery of the incised bone have re-opened long-unanswered questions about human
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12 occupation on the east coast of Florida during the Terminal Pleistocene.
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16 There is a significant scientific literature addressing the gross and microscopic
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18 characteristics of cut marks in bone. These studies have utilized both experimental and
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20 observational approaches to attempt to differentiate human agency from other taphonomic
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22 agents, including carnivore and scavenger activity, trampling, weathering and thermal damage
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24 (Gibert and Jimenez 1991; Fisher 1984; Shipman and Rose 1983a, 1983b). The aforementioned
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26 research has made great strides in establishing criteria for interpreting cut marks in bone, with
27
28 special emphasis on the use of scanning electron microscopy (SEM) as the best diagnostic tool.
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30 A second body of literature exists within the subfield of forensic anthropology. These studies
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32 focus on the immediate postmortem interval and serve to provide insight into the differentiation
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34 of perimortem trauma from postmortem taphonomic changes to human bone. This most often is
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36 accomplished by examination of the margins, floor, and kerf wall under light microscopy. In this
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38 case, the question is not with cut mark mimics produced by non-human agents, since the image
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40 of the proboscidean is evidence enough that a human produced the engraving. The only
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42 consideration here is the timing of the engraving—is it ancient or was it recently incised to
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44 mimic an example of prehistoric art?
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3. Methods

Several different analytical methods were employed to examine the incisions on the bone. To help verify that the bone had come from the Vero area of Florida, rare earth element analysis (REE) was conducted on powdered bone samples using a Thermo Finnigan ELEMENT2 inductively coupled plasma-mass spectrometer in the University of Florida Department of Geological Sciences (for methods see MacFadden et al. 2007). Optical microscopy was undertaken using an Olympus microscope with an Olympus CCD camera for image capture. A Tescan Vega II XMU variable pressure SEM at an accelerating voltage of 10kV was used for both secondary imaging and backscattered imaging. A small sample from the surface of the bone was removed and energy dispersive X-ray spectroscopy (EDS) was performed on a JEOL 6400 SEM. Finally, a cast and mold of the specimen were examined by Reflectance Transformation Imaging (RTI) and microscopy at the Smithsonian Institution in Washington, D.C.

Reflectance Transformation Imaging (RTI) (Dellepiane et al. 2006; Earl et al. 2010; Mudge et al. 2006; Mudge et al. 2010) is a newer imaging technique in which multiple digital images (ca. 40–50 images) of a subject, in a fixed position, are collected from a fixed camera position. During the acquisition of the images, the light source is moved from point to point to create a hemisphere of light. The images are then stored as Digital Negatives (DNGs) on the hard drive and formatted as jpegs for data processing using the open source software, RTI Builder, which creates a single Polynomial Texture Map (PTM) file. The software processes the multiple images into a single file that derives all possible light positions within the virtual hemisphere of light. The final image looks like a 2D photograph, but is actually the documentation of the subject's surface interaction with the light positions, at the individual pixel level. By moving a

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4 mouse (or other pointing device), the viewer can control the light direction, zoom in and out, and
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6 select data enhancement options that increase sharpness and contrast.
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10 11 **4. Results**

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14 Rare earth elements (REE) of extinct mammalian bones from the Old Vero site (8-IR-9)
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16 in the FLMNH collection were analyzed in conjunction with a sample from the incised bone to
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18 determine (1) if the incised bone was a fossil (true fossils have REE concentrations two or more
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20 orders of magnitude greater than modern bone [Trueman et al. 2004]), and (2) if the bone
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22 actually came from Vero Beach deposits based on similarities in REE signatures (MacFadden et
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24 al. 2007). Samples from different strata at the site were compared to the incised bone: stratum 1
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26 (bottom) is a thick deposit of marine shell and sand called the Anastasia Formation; stratum 2 is
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28 the Melbourne Formation where most of the extinct fauna occur; stratum 3 is the overlying Van
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30 Valkenburg Formation. An erosional zone with some mixing of deposits between strata 2 and 3
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32 is called the Melbourne-Van Valkenburg. A majority of the fossils used for the REE analysis
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34 came from this contact zone. Samples of modern bone recovered from the surface at the site
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36 were analyzed along with the extinct fauna. The results of the REE analysis are shown in Figure
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38 2. The elevated concentrations of REE indicate that the bone is fossil, not modern. The deviation
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40 of the light REE (LREE) relative to most of the Vero specimens might suggest a different
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42 geographic and/or diagenetic environment. However, LREE tend to be more variable within a
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44 population than medium or heavy REE; at least two of the analyzed samples have similar LREE
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46 distributions. It is clear from Figure 2 that the heavier REE signature between the incised bone
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48 and samples from strata 2/3 of the site are a very close match and are significantly different from
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4 a modern sample. These results support the premise that the bone is ancient and came from the
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6 Vero region of Florida.
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9 The incised bone was examined using several visual approaches. First, it was inspected
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11 using an optical microscope. Figure 3a shows two incised grooves from the trunk of the
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13 proboscidean engraving. Figure 3b shows another optical microscope image of the upper part of
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15 the leg. Both images reveal that the damage that occurs to incisions as part of the taphonomic
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17 alteration of a bone indicates signs of wear and erosion. The margins of the cut mark on the bone
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19 are smoothed and rounded and the floor of the cut mark shows the same coloration and
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21 environmental inclusions as the rest of the bone. It is known that as bone becomes more and
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23 more eroded (e.g., soil, wind, water, or a combination of these), the defect (e.g., cut mark)
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25 becomes wider and the margins become more rounded. The marks on this specimen display the
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27 latter characteristics. In addition, the cut marks lack any subtle differences in color and texture
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29 within the margins of the engraving in comparison with the remainder of the bone that would
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31 occur if the incision were done recently.
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38 SEM imaging of the incision also was conducted. A section of the lower tusk was imaged
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40 in secondary electron mode and is depicted in Figure 4a. The arrow indicates the location of the
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42 incised line. Figure 4b shows the backscattered image of the exact same region as 4a. The arrow
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44 in each figure can be used as a reference point between the two figures. In the secondary electron
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46 image in 4a, the groove readily is apparent and there is no sign of a debris field along the edge of
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48 the scribe. In the backscattered image 4b, the incised line can no longer be seen. This indicates
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50 the relative masses of the elements on the surface show no discontinuity; that is, the composition
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52 in the bottom of the groove is consistent with the surrounding matrix. It appears that the
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54 mineralization occurred across the indentations caused by the scribing. This supports the
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4 probability that the indentations occurred before the bone was mineralized and the bottom of the
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6 incised line and the surrounding materials aged at the same time in the same environment.
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9 In an adjacent region, the surface of the bone was intentionally incised using a razor
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11 blade. This mark was subsequently examined in both secondary electron (Figure 4c) and
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13 backscattered electron mode (Figure 4d). In contrast to Figure 4a, the secondary electron image
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15 for the recent scratch (Figure 4c) shows an extensive debris field and a jagged edge. Finally, in
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17 contrast to Figure 4b, the backscattered image in 4d shows a discontinuity in the average atomic
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19 number of the elements on the surface surrounding the groove and the region at the bottom of the
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21 groove. The light and dark patterns in the surrounding material (indicative of minor elemental
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23 variations) are not reproduced in the bottom of the groove (no dark and light contrast, only light
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25 contrast).
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31 D'Errico et al. (1998) used similar imaging methods to study the Sherborne bone—a
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33 purported example of Paleolithic art containing the engraving of a horse's head on bone. The
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35 object was *discovered* by schoolchildren in Sherborne, England, in the early 1900's and
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37 subsequently proved to be fake on the basis of AMS dating which showed the bone to be about
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39 600 years old (Stringer et al. 1995) and through microscopic analysis. Of particular relevance
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41 here is that D'Errico et al. (1998) used the microscopy and backscattered electron imaging to
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43 demonstrate that the scribe, in that case, produced a debris field inside the inscription as well as a
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45 clear discontinuity between the incision and the surrounding bone. The authors argued that the
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47 debris field and discontinuity demonstrated that the bone was engraved after burial, rather than
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49 reburial after engraving. In our study, the discontinuities and debris fields were not observed.
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4 To eliminate the possibility that someone had inscribed the surface and then coated the
5 surface with a polymer to make it look the same inside and outside the carved area, energy
6 dispersive x-ray spectroscopy (EDS) analysis of the surface showed the elemental composition
7 of the surface was 21% Ca, 10% P, 56% O, and 13% C. All values are atomic %. This is
8 consistent with mineralized bone and no presence of a polymer coating was observed. A
9 specimen from the FLMNH collections that had been in storage for decades was analyzed for
10 comparison; the results are shown in Figure 5. It is likewise important to point out that the SEM
11 EDS analysis identified no traces of metal that would be indicative of the use of metal tools to
12 make the incisions.
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26 As a final imaging approach, Reflectance Transformation Imaging (RTI) was employed
27 on a cast and mold of the bone. The results of the RTI supports the microscopy work described
28 above, that is, there is no evidence that the engraving was made recently. Interestingly, the RTI
29 reveals the presence of a diamond pattern/cross hatched lines that frame the mammoth
30 engraving—particularly on the left side. These lines extend up to the edges of the bone, but do
31 not extend onto the rounded and weathered edge (Figure 6). This suggests that the engraving
32 occurred before the bone broke and/or weathered.
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45 **5. Discussion**

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48 There exists the possibility that the incised bone is a forgery since it was found by an
49 avocational fossil hunter. In addition, the long-term taphonomic effects of soil, water and
50 weather on the cut marks are unknown. Finally, it is always possible that a forgery was done and
51 then altered by artificial processes that impacted the surficial character of the bone. However, at
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4 this point all scientific evidence is consistent with the incisions mineralizing simultaneously with
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6 the surrounding bone surface.
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9 In 1916, Dr. E.H. Sellards, the State Geologist of Florida, announced the discovery of
10 human skeletal remains in apparent association with numerous species of extinct late Ice Age
11 animals from the main canal at Vero Beach, Florida. His claim has been disputed for 95 years,
12 even though it is now well known that people were in the Western Hemisphere and hunted those
13 animals during the Terminal Pleistocene (e.g., Anderson 2005; Johnson 2005; Meltzer 2009;
14 Purdy 2008). The results of the testing done in this work of the recently discovered fragmented
15 fossil bone bearing the unmistakable engraving of an ancient proboscidean recovered from the
16 same area of the canal as the human and animal fossils reported in 1916 appear to support E.H.
17 Sellards argument that the Vero site provided evidence of a Pleistocene human presence in North
18 America.
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33 Of broader significance is the similarity of the engraving on the Vero bone to Upper
34 Paleolithic art styles and subjects of the Old World. The issue of when, how, and from where
35 people first entered the Western Hemisphere and dispersed has long been debated and is not
36 likely to be resolved anytime soon. Nonetheless, for many years similarities have been noted
37 between Paleoindian chipped stone tool assemblages and certain ivory and bone tools with
38 nearly identical specimens in Western and Eastern Europe and beyond (e.g., Stanford and
39 Bradley 2004). The similarity of the Vero engraving with Upper Paleolithic European art begs
40 the question of whether this similarity is simply due to coincidence or if there exists a more
41 direct Ice Age connection between North America and Europe as Stanford and Bradley (2004)
42 have argued. The debate over this connection will not likely be decided anytime soon. But,
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58 hopefully, in the near future modern scientific investigation will occur at the Vero Beach site that
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4 will provide additional data to address this important question and others. Additionally, the
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6 development of a method to date mineralized bone is needed and, if successful, would furnish a
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8 valuable means to solve persisting problems about America's ancient inhabitants.
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10 11 12 13 14 **6. Conclusion**

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16 A partial bone of a large mammal (probably mammoth, mastodon or giant sloth) has been
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18 discovered. The bone contains an incised, accurate drawing of a proboscidean, most likely a
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20 mammoth, on the dorsal surface. Rare earth element analysis is consistent with the bone being a
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22 fossil from the Vero region of Florida. Optical and electron microscopy results are consistent
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24 with the engraving being old, i.e., the mineralization of the bottom of the inscriptions matches
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26 the surrounding bone. EDS results are consistent with mineralized bone, and REE signatures are
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28 comparable to vouchered samples from the Vero site. Reflectance Transformation Imaging (RTI)
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30 corroborated evidence from other analyses. Apparently, the drawing was made prior to the
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32 extinction of the mammoth, based on anatomical details, such as the relative sizes of the tusks
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34 and trunk, the high-domed head, and the long forelimbs. This bone likely represents one of the
35
36 first verified Paleoindian representations of a proboscidean in the Western hemisphere.
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5
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7
8 James Kennedy, the discoverer of the bone, for bringing it to the attention of the authors and for
9
10 permitting the analyses that are described herein.
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18 Notes

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20 1. In 1959, Juan Armenta Camacho discovered a mastodon pelvis at Valsequillo, Mexico
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22 engraved with multiple Ice Age animals, including a mammoth (Scott 1999, Fig. 1.2). The object
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24 has since disappeared (Meltzer 2009:106). See Hardaker (2007) for an in depth description of the
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26 artifact and the controversy surrounding dating issues of sites in the area where it was found.
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Figure Captions

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8 1a. Photograph of the fragmented fossil bone; 1b. close-up of the engraving. Photo credit: Chip
9 Clark, Smithsonian National Museum of Natural History.

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11 2. Rare earth element (REE) concentrations of the incised bone compared to the average values
12 by stratum at the Old Vero Site (8-IR-9).

13
14
15 3a. Two inscribed lines (trunk of proboscidean) showing that the coloration is the same inside the
16 lines as well as on the surface; 3b. inscribed line on incised bone (upper front leg) showing the
17 smooth edges of the incised line.
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19
20 4a. Secondary electron SEM image of tusk region of incised image; 4b. backscattered electron
21 SEM image of identical region as Figure 4a showing identical backscattered contrast inside the
22 incision as surrounding material; 4c. secondary image of intentional scratch made by authors on
23 the surface showing debris field and rough edges; 4d. backscattered image of exact same region
24 as 4c showing a clear difference in the backscattered contrast inside the scratch compared to the
25 surrounding material (note lack of any dark contrast inside scratch).
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29 Figure 5. EDS spectra confirming that no polymer was use to coat the surface of the incised
30 bone. Top: Engraved bone from Vero; Bottom: comparison proboscidean bone from Vero.
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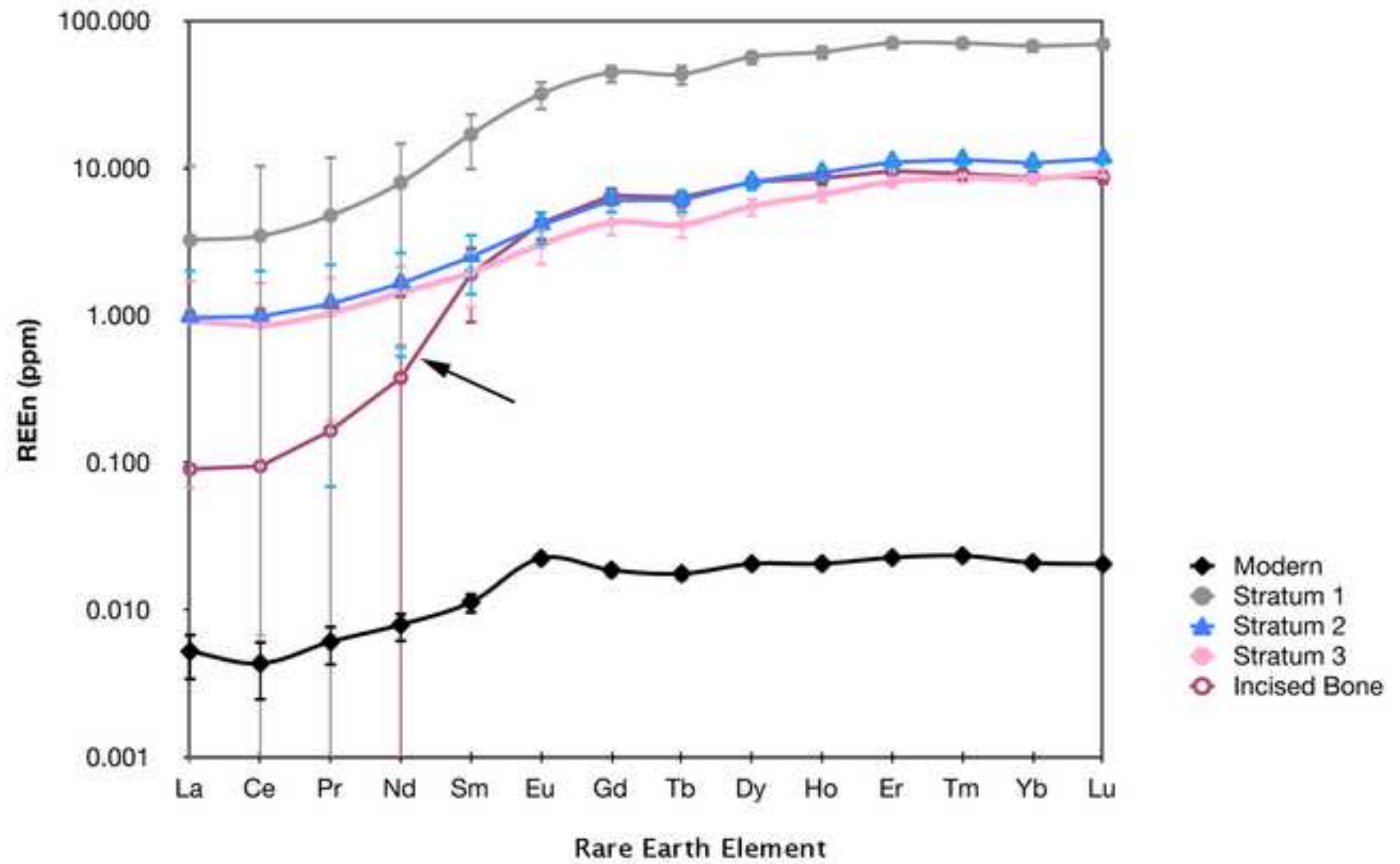
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33 6. RTI screenshot of a cast of the bone showing the cross hatched lines that occur to the left of
34 the incised proboscidean image.
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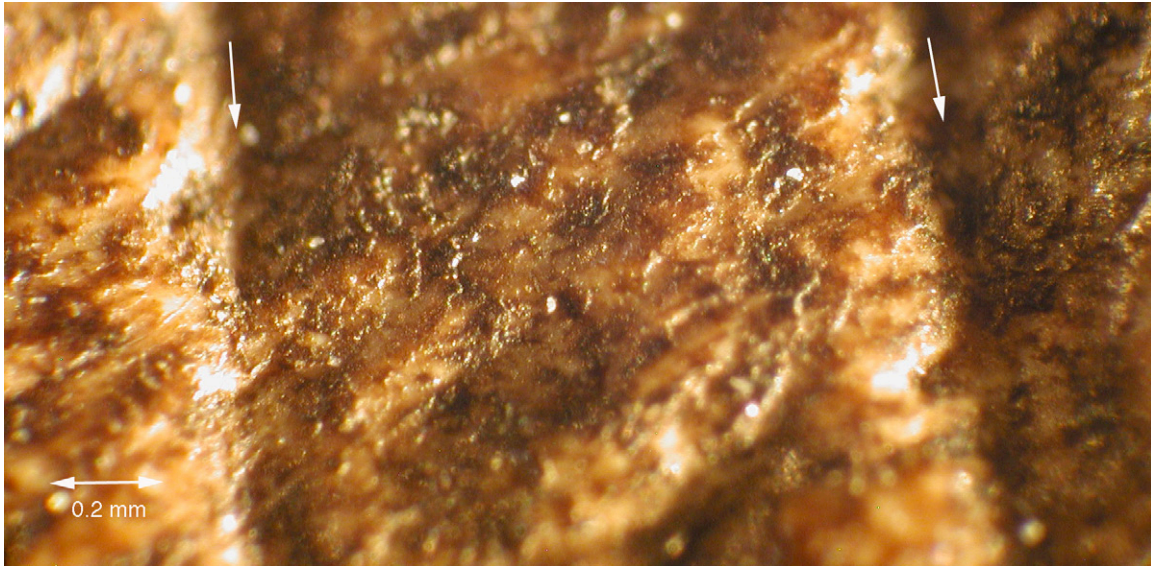




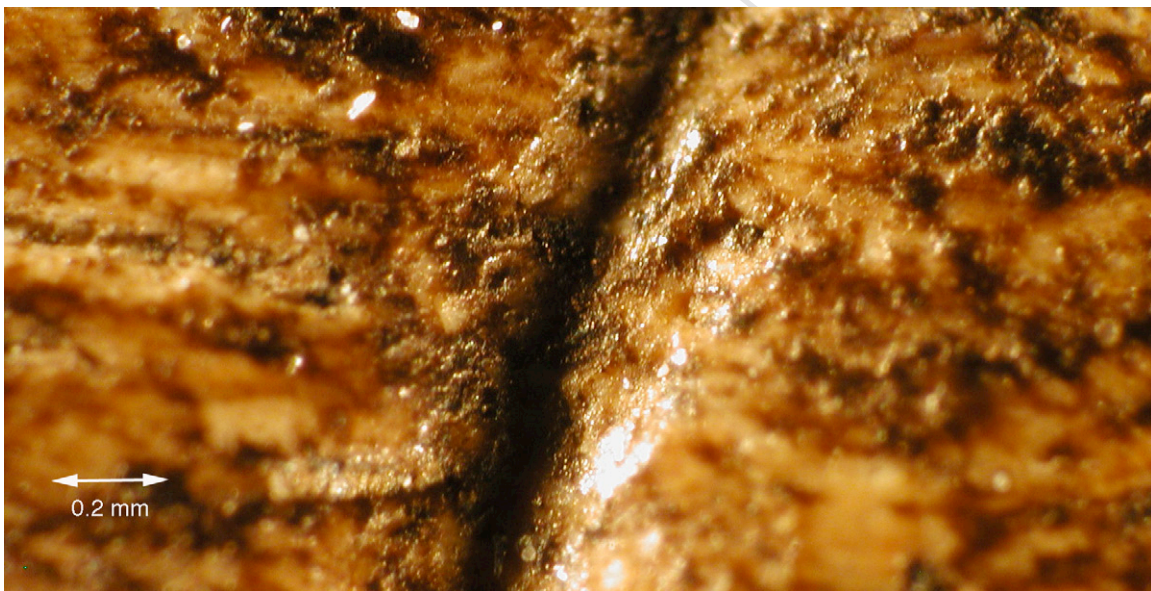
Figure 2

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3b

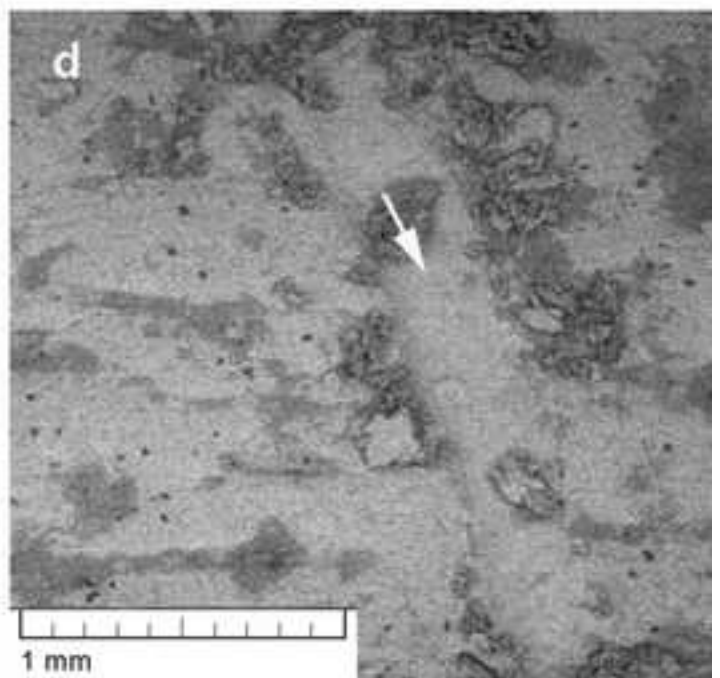
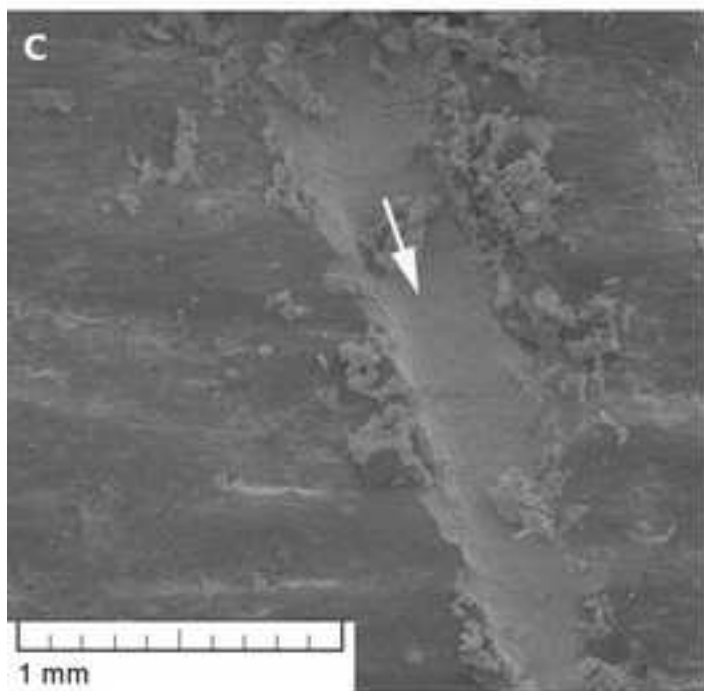
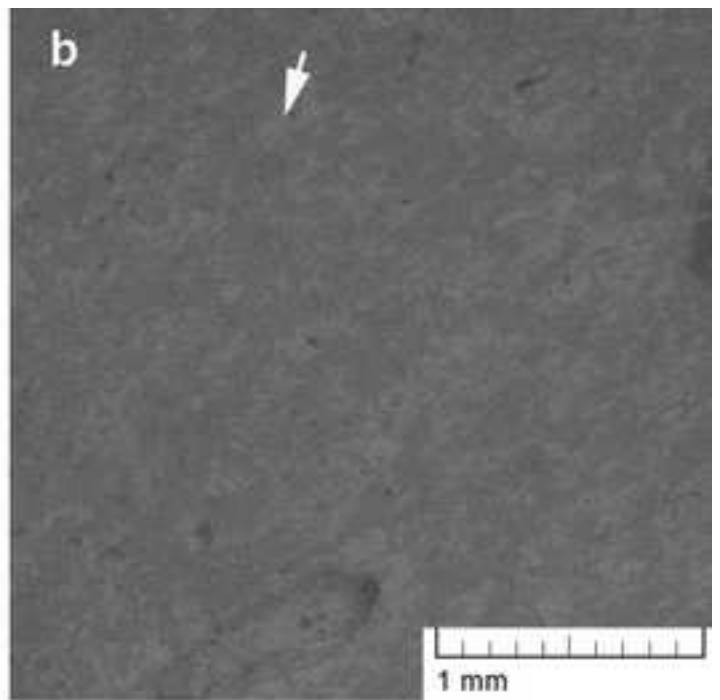
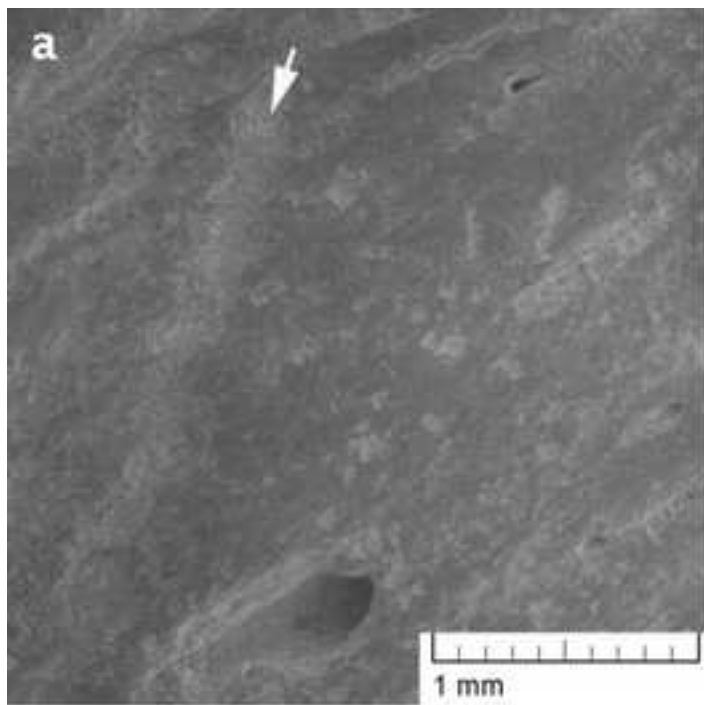


Figure 5

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