NANOVEA

FOSSIL MICROSTRUCTURE

USING 3D PROFILOMETRY

Prepared by

DUANJIE LI, PhD

INTRODUCTION

Fossils are the preserved remains of traces of plants, animals and other organisms buried in sediment under ancient seas, lakes and rivers. The soft body tissue usually decays after death, but the hard shells, bones and teeth fossilize. Microstructure surface features are often preserved when mineral replacement of the original shells and bones takes place, which provides an insight into the evolution of weather and the formation mechanism of fossils.

IMPORTANCE OF A 3D NON-CONTACT PROFILOMETER FOR FOSSIL EXAMINATION

3D profiles of the fossil enable us to observe the detailed surface features of the fossil sample from a closer angle. The high resolution and accuracy of the ***NANOVEA*** profilometer may not be discernible by the naked eye. The profilometer's analysis software offers a wide range of studies applicable to these unique surfaces. Unlike other techniques such as touch probes, the ***NANOVEA*** 3D Non-Contact Profilometer measures the surface features without touching the sample. This allows for the preservation of the true surface features of certain delicate fossil samples. Moreover, the portable model Jr25 profilometer enables 3D measurement on fossil sites, which substantially facilitates fossil analysis and protection after excavation.

MEASUREMENT OBJECTIVE

*In this study, the **NANOVEA** Jr25 Profilometer is used to measure the surface of two representative fossil samples. The entire surface of each fossil was scanned and analyzed in order to characterize its surface features which include roughness, contour and texture direction.*

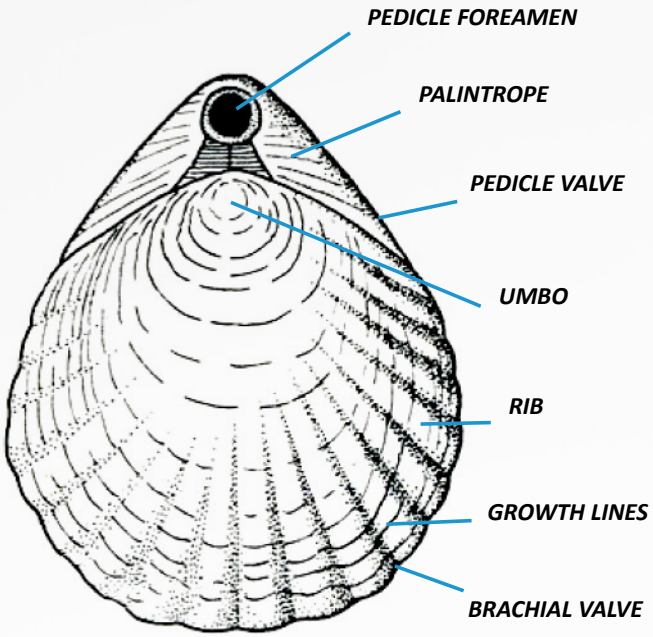
CLICK HERE TO LEARN MORE ABOUT THE INSTRUMENT

NANOVEA
Jr25

BRACHIOPOD FOSSIL

The first fossil sample presented in this report is a Brachiopod fossil, which came from a marine animal that has hard "valves" (shells) on its upper and lower surfaces. They first appeared in the Cambrian period, which is more than 550 million years ago.

The 3D View of the scan is shown in ***FIGURE 1*** and False Color View is shown in ***FIGURE 2***.



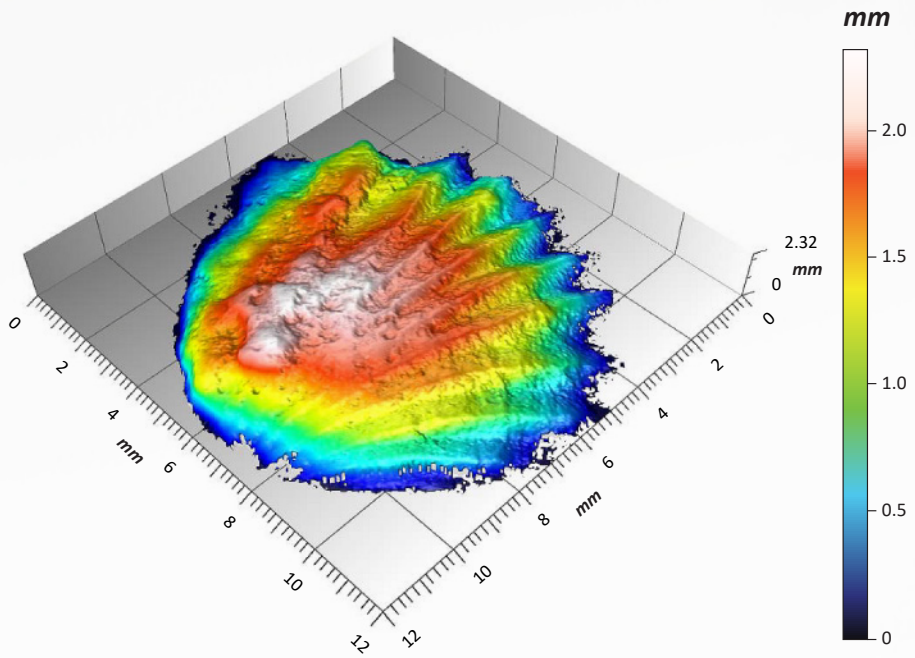


FIGURE 1: ***3D View of the Brachiopod fossil sample.***

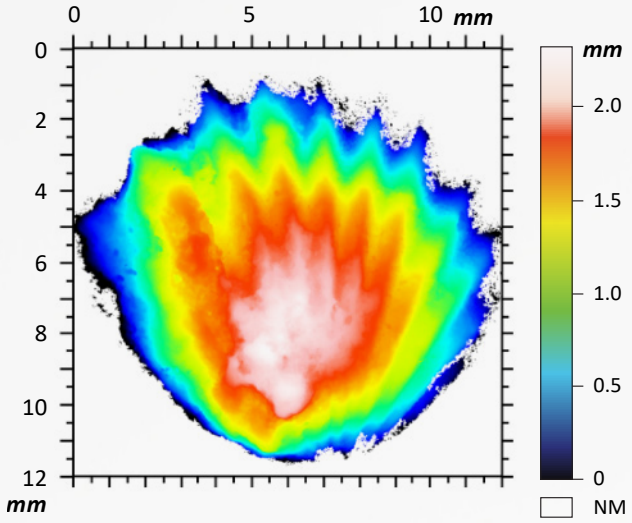


FIGURE 2: ***False Color View of the Brachiopod fossil sample.***

The overall form was then removed from the surface in order to investigate the local surface morphology and contour of the Brachiopod fossil as shown in ***FIGURE 3***. A peculiar divergent groove texture can now be observed on the Brachiopod fossil sample.

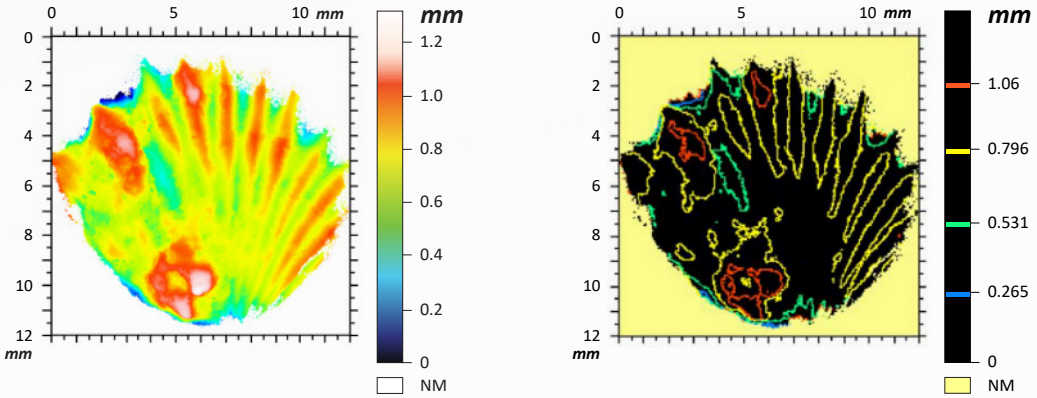
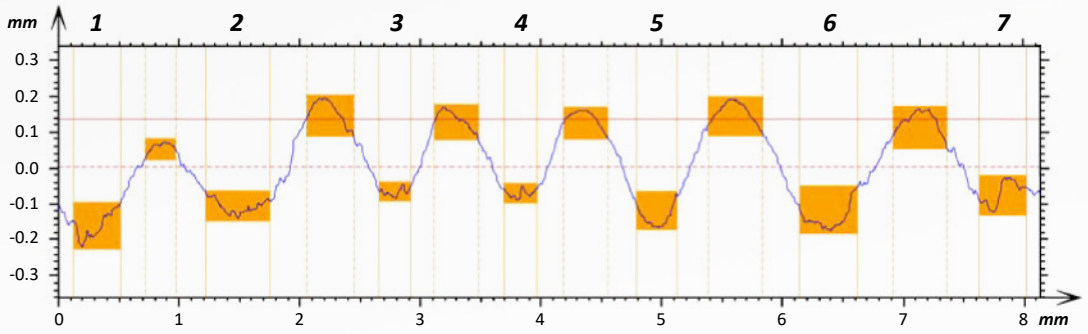
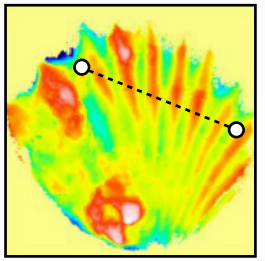


FIGURE 3: ***False Color View and Contour Lines View after form removal.***

A line profile is extracted from the textured area to show a crossectional view of the fossil surface in ***FIGURE 4***. The Step Height study measures precise dimensions of the surface features. The grooves possess an average width of ~0.38 mm and depth of ~0.25 mm.





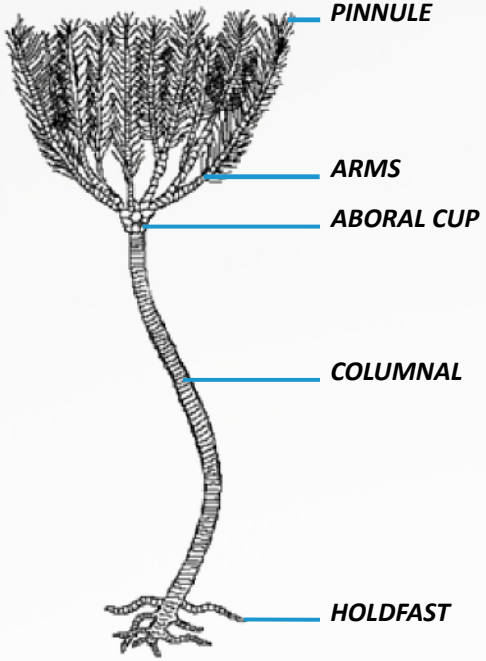
	Unit	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
WIDTH	mm	0.391	0.532	0.258	0.274	0.336	0.477	0.391
MAX DEPTH	mm	0.354	0.276	0.221	0.227	0.301	0.312	0.259
MEAN DEAPTH	mm	0.297	0.243	0.204	0.208	0.276	0.277	0.205

FIGURE 4: ***Line profile and Step Height studies of the textured surface.***

CRINOID STEM FOSSIL

The second fossil sample is a Crinoid stem fossil. Crinoids first appeared in the seas of the Middle Cambrian Period, about 300 million years before dinosaurs.

The 3D View of the scan is shown in ***FIGURE 5*** and False Color View is shown in ***FIGURE 6***.



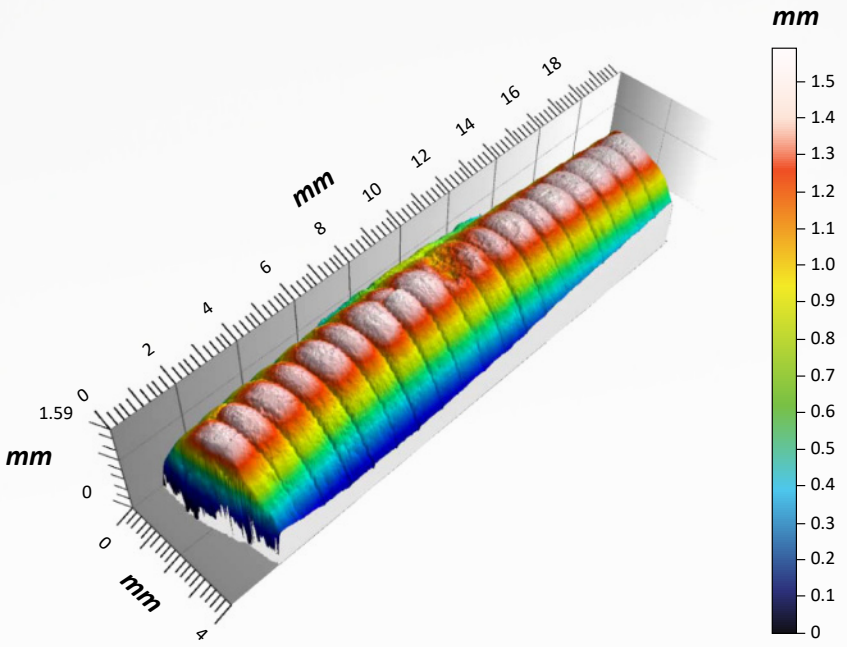


FIGURE 5: ***3D View of the Crinoid stem fossil sample.***

The surface texture isotropy and roughness of the Crinoid stem fossil are analyzed in ***FIGURE 7***.

This fossil has a preferential texture direction in the angle close to 90°, leading to texture isotropy of 69%.

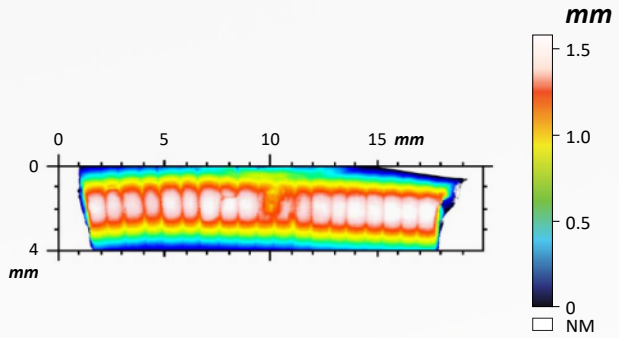
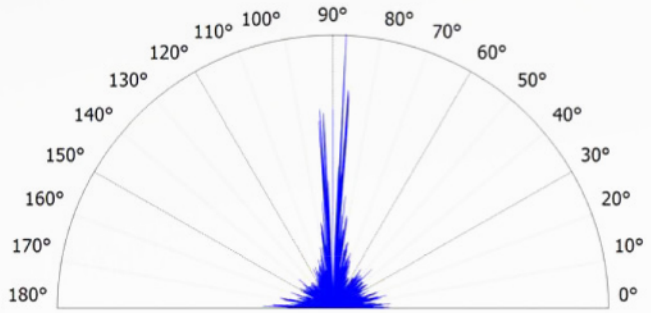


FIGURE 6: ***False Color View of the Crinoid stem fossil.***



ISOTROPY	69.5%
FIRST DIRECTION	87.2°
SECOND DIRECTION	93.8°
THIRD DIRECTION	81.7°

ISO 25178

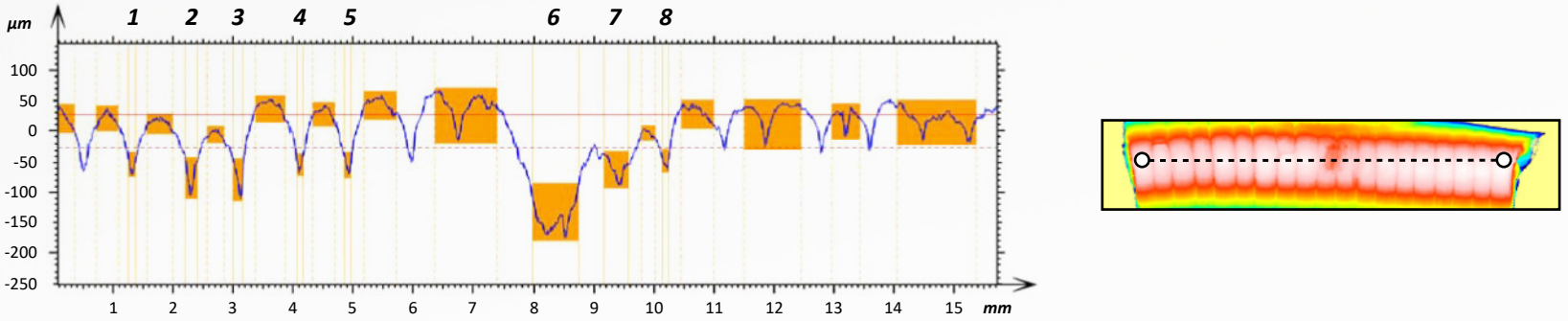
HEIGHT PARAMETERS

Sa	0.0648 mm	Sp	0.309 mm
Sq	0.124 mm	Sv	1.41 mm
Ssk	-4.67	Sz	1.72 mm
Sku	37.5		

FIGURE 7: ***Surface texture isotropy and roughness of the Crinoid stem fossil.***

The 2D profile along the axial direction of the Crinoid stem fossil is shown in ***FIGURE 8***.

The size of the peaks of the surface texture is fairly uniform.



	Unit	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
WIDTH	mm	0.119	0.196	0.154	0.098	0.112	0.763	0.413	0.112
MAX DEPTH	µm	97.3	133	137	95.0	99.2	202	116	90.1
MEAN DEAPTH	µm	86.8	103	107	81.5	84.3	172	88.2	80.9

FIGURE 4: ***2D profile analysis of the Crinoid stem fossil.***

CONCLUSION

In this application, we comprehensively studied the 3D surface features of a Brachiopod and Crinoid stem fossil using the ***NANOVEA*** Jr25 Portable Non-Contact Profilometer. We showcase that the instrument can precisely characterize the 3D morphology of the fossil samples. The interesting surface features and texture of the samples are then further analyzed. The Brachiopod sample possesses a divergent groove texture, while the Crinoid stem fossil shows preferential texture isotropy. The detailed and precise 3D surface scans prove to be ideal tools for palaeontologists and geologists to study the evolution of lives and the formation of fossils.

The data shown here represent only a portion of the calculations available in the analysis software. ***NANOVEA*** Profilometers measure virtually any surface in fields including Semiconductor, Microelectronics, Solar, Fiber Optics, Automotive, Aerospace, Metallurgy, Machining, Coatings, Pharmaceutical, Biomedical, Environmental and many others.

NANOVEA.COM