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Statistical Count of Invertebrata from Ordovician West Spring Creek Formation, Arbuckle Group, Kiowa County, OK

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Abstract

Several Ordovician (early Paleozoic) exposures dating from 443.7 – 488.3 Ma (+/- 1.5) with little or no published research were identified south of Mountain View, Oklahoma on hiway 115. This study surveyed the West Spring Creek formation (Ows) of the Arbuckle Group and performed an invertebrate identification and count, and environment interpretation. Twenty rock samples from this exposure were cleaned, cut, and analyzed for invertebrate fossils. Organisms including: brachiopods, cephalopods, foraminifera, gastropods, and crinoids were identified. Finding crinoid ossicles in the abundance we did was surprising, as little reference to them has been documented in the Ows. Trace fossils in the form of borrows, though uncommon, were identified in a few samples. Also surprising was the discovery of small pyrite crystals, fine limey sandstone, and chert nodules. Of the identified fossils, brachiopods and gastropods were the most common. From the fossils and matrix, we concluded the Ows was a shallow, warm marine environment, relatively high energy, with a limey mud substrate. Life was common, but not abundant. Many fossils found in the rocks likely lived in the area, but not the exact location they were found as signs of transport were evident. There were some indications of predation. In short, a limited, yet complex shallow photic marine ecosystem is indicated having existed between 444 and 488 Million years ago, just south of present day Mountain View, Oklahoma.

Keywords: Ordovician, Statistics, Invertebrata

1. Introduction

Phase one of the Ows Project was to collect and clean the samples and identify invertebrate fossils. Having completed this, the next task was to perform a systematic count of these fossils and interpret the environment at the time the organisms were alive.

This phase had three objectives: 1) perform an invertebrate identification; 2) perform specimen count and statistical analysis of identified specimens; 3) perform an environment interpretation based on fossil analysis and matrix rock.

The West Spring Creek Formation (Ows = *"O" O*rdovician, *"w", "s" W*est *S*pring), Lower Ordovician dates between 443.7 – 488.3 Ma (+/- 1.5) (Taff, 1928; Donovan, 1986). The organisms were preserved in fine to medium-grained organic rich sediments which, over time, compressed into sedimentary rock, primarily limestone and dolomitic limestone (Beach, English, 1940). The samples were collected from three locations.

1.1 Location of the sample collection sites:

1. 34˚54'26.34" N - 98˚42'29.78" W elevation = 480m
2. 34˚55'14.34" N - 98˚43'54.03" W elevation = 478m
3. 34˚53'40.21" N - 98˚40'05.04" W elevation = 509m

These exposures have only cursory literature references; no extensive studies have been conducted at any of these sites.

Samples collected varied at each location and from site to site. Some samples were fossil rich while others fossil poor. Some samples showed a variety of organisms while others contained only one or two types.

Advances in remote sensing software such as iExtMap, Google Earth, and Arc-GIS: Geographic Information System technology and hand held devices such as smart phones and GPS units allowed us to input the location of sampling locations onto paleogeographic maps, and store and coordinate large amounts of data. This software and hardware also allowed us to view the locations remotely, through various filters and with various base maps (extmap.com; google.earth.com; arcgis.com).

The Ows program employed two undergraduate research students with an interest in paleontology and science education. One worked during the summer of 2011. She spent most of her time with the literature review and initial sample collecting. The other student worked during the spring semester of 2012. She spent an average of seven hours per week in the lab cleaning the samples, identifying organisms, and interpreting the data.

During the summer and fall semesters of 2011, Southwestern Oklahoma State University provided support through the Proposal Development Award (PDA) grant program for a pilot study. The PI and an undergraduate student visited the three Ows exposures to collect samples.

During the spring semester of 2012, Southwestern Oklahoma State University provided support for continuation of the research through an Endowed Research Grant (ERG). The PI was given funds to support a student who continued sample cleaning, thin slicing, fauna identification and statistical work. An extensive NSF grant to continue this research and fund three undergraduate students was submitted early spring 2012.

1.2 Paleoenvironment

We were able to confirm the Ows sites investigated were shallow, warm, salt water environments. This could be determined from the rock types (limestone and dolostone with evaporitic chert nodules) and organisms living in that environment. Only marine fossils were found. The environment was likely a shallow, smooth, limey mud floor, scattered with small shell fragments from a few organisms.

At the same locations, we found some rocks with few fossils and other rocks with an abundance of fossils. One possible explanation for this is, at the time the sediments were set, slow localized currents focused the shell fragments into conglomerations. Several rocks show directional preference in the fossils indicating some external force driving the shells into that orientation. This could indicate the current direction.

This research also led to the uncovering of undocumented pyrite crystals, rock veins of quartz rich sandstone, and chert nodules will be of interest to researchers who specialize in paleoenvironments.

2. Methods

During the summer and fall months of 2011, four trips were taken to the three Ows exposures listed in the Introduction. GPS records were taken of in situ locations of the exposures. Upon returning to the laboratory, the rock samples were cleaned with warm, soapy water and a soft brush. Many of the samples we cut into thin slices using the Hillquist RF 14-16 Slab Saw. These slices ranged from 1.0 mm to > 8.0 mm.

These cuts were made to remove rotted overlying rock and expose fresh, unaltered fossils. Some samples were secondarily prepared on a Hillquist Ratopax I Thin Section Grinder. This was done to further clean away contamination and expose individual specimens.

The tools used were:

- Hillquist RF 14-16 Slab Saw
- Hillquist Ratopax I Thin Section Grinder using:
-15 micron
-45 micron
-100 mesh
-220 mesh
- Hacker Instruments Stereo Microscope, 10X - 30X
- Wolfe Instruments Stereo Microscope, 15X
- DinoXcope AM2011 Digital Microscope Camera running DinoXcope Version 1.7.1 Software

- Novel H9D Digital Microscope Camera running ScopeImage 9.0 Imaging Software

Once the rock samples were cleaned and prepared, they were examined under stereo microscopes: Hacker Instruments, 10X - 30X and Wolfe Instruments 15X.

We would take a sample of rock and closely examine it primarily with the Hacker Microscope to determine the fauna. We would use the comparative analysis tools we made to help with identification. In some cases, a small dental pick or probe was needed to scratch away the limestone matrix to uncover certain fossils. After doing so, we would use diluted 10.0% HCl, water, and compressed air to clean the sample again. The dilute 10.0% HCl would dissolve the soft matrix, leaving behind the harder fossil material. After finding clean examples of fossils, which could be identified, we would use the DinoXcope or Novel to take pictures while using a metric ruler to determine the size. Figure 1. Below shows the equipment used to examine the samples. Figure 2. Below shows rock samples.

Image 1

Image 2

Image 3

Image 4

Figure 1. Equipment and Set -up

Image A

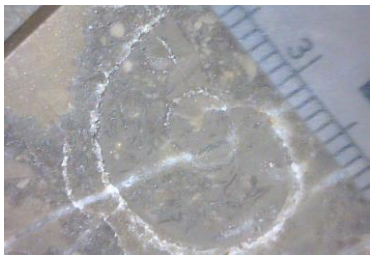


Image B

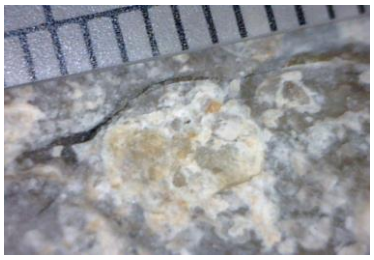


Image C

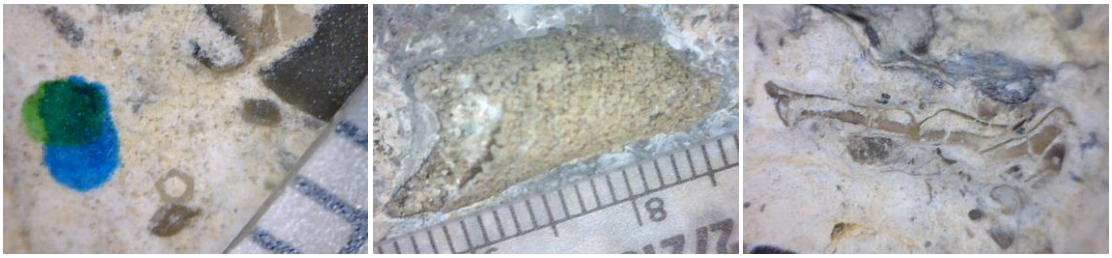


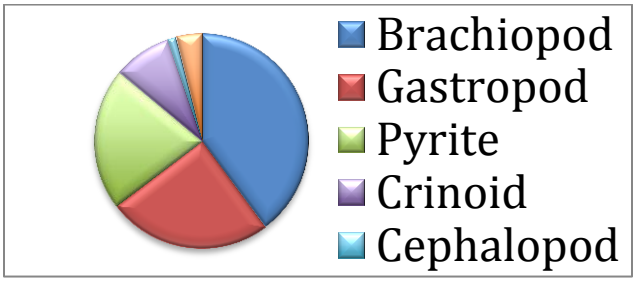
Image D Image E Image F

Figure 2. Rock Samples

3. Results

Table 1.. A Statistical count of the fauna and Pyrite found in forty-eight rock samples in the West Spring Creek formation.

Type of Fauna	Count	Percent (%)	Image
Brachiopod	186	41.2	A
Gastropod	116	25.7	B
Pyrite	100	22.2	C
Crinoid	41	9.1	D
Cephalopod	6	1.3	E
Trilobite	2	0.4	F

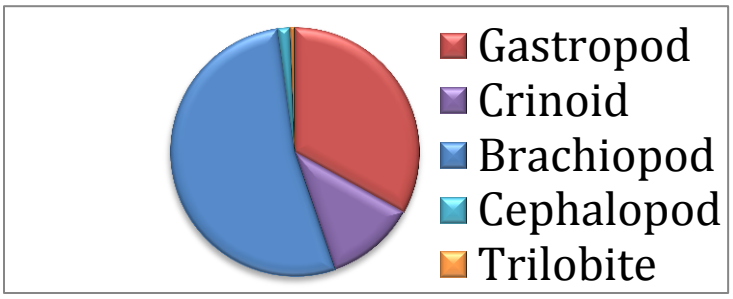


We have concluded, based on the data, that this area of the Ows was a shallow, stagnant to low current flow marine environment. We can tell this due to the abundance of benthonic and sessile creatures such as brachiopods, gastropods, crinoids, and trilobites. The benthonic and sessile fauna we observed were relatively small in size ranging from sub-millimeters to tens of millimeters. They generally ate plankton or ploughed through the mud to find nutrients unlike the nektonic fauna like cephalopods which we observed as having a low percentage of 1.7% - see Figure 2**.** We concluded that since there was such a low number of nektonic fauna, that the environment was not conducive to supporting these organisms. A current could have also brought these fossils into the Ows. There was no terrestrial life during the Ordovician period; this eliminates the possibility of run off or contamination. Pyrite is of interest and included in Figure 1 because of lack of reference documentation. However, pyrite is irrelevant to the fossil count due to being of none organic origin – see Figure 2.

In the predatory literature review, trilobites have been often found in the lower Oklahoman Ordovician. We were expecting to find trilobite fossils, but after almost fifty samples were examined, none were found. After looking in the literature we confirmed it was the molted glabella from the cephalon of a trilobite. Sample "A" yielded two trilobite fragments.

Table 2: A statistical count of only the fauna present in the forty-eight rock samples from the West Spring Creek Formation

Type of Fauna	Count	Percent (%)
Brachiopod	186	53.0
Gastropod	116	33.0
Crinoid	41	11.7
Cephalopod	6	1.7
Trilobite	2	0.6



4. Follow Up Study

Dr. Campbell applied for a National Science Foundation grant in efforts to continue to build the Geology and Paleontology programs at SWOSU. The proposed research project would accomplish this goal by employing three SWOSU students: Two biology students with an interest in invertebrate paleontology to assist with the identification of fauna, and one chemistry student to assist with rock type, composition, and age dating samples via isotopic ratio mass spectrometry. These students, plus the supervisor, will aim to accomplish the following goals: 1) to do a complete paleontological survey of Oklahoma's Ows 2) Identify fauna from this formation and 3) Compare fauna from the Ows to predict an evolutionary timeline.

5. Acknowledgements:

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