Shale is a sedimentary rock that develops in a deep marine environment. The coloration of shales varies between greens, blues, greys, and blacks. This Devonian aged formation was an alternation of shale and sand stone, which shows evidence of a deep marine environment that was being altered over time. This study was done to discover the coloration of shales throughout the Devonian formation in Huntingdon Pennsylvania. The rock samples were tested using a Munsell rock color chart and analyzed. The samples were randomly selected and then later dried before analyzed. Many shades of greys, blacks, and browns appeared throughout the samples. I later found out that the darker the color the more carbon rich the sample was. Different samples contained different levels of carbon and different minerals to change the colorations of the shale. The study showed that weathering as well as carbon content could alter the coloration. The carbon and oxygen levels alter the oxidation of the shale causes rusting and chemical weathering.

Keywords. –Shale; Organic carbon; Devonian; Coloration; Huntingdon

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INTRODUCTION

For millions of years rocks have been formed and altered in many ways. Today we can analyze the different formations and interpret the environments that these rocks have come from. The colorations of shale differ based on the minerals present and the carbon content of the rock. The colors of the shale in Huntingdon Pennsylvania are in a wide variety and differ throughout the formations. The study was done to discover the different colorations of shale, and to discover why they are the color that they are.

This study was completed in a random fashion, which showed the many different colors throughout the shales in a Devonian aged formation.

The Devonian period is considered a part of the Paleozoic era. The Devonian period is broken up into seven different ages. These ages are Lockhovian, Pragian, Emsian, Eifelian, Givetian, Frasnian, and Famennian. The ages start at 417 million years ago and range to 364 million years ago (Tucker, 1998), as shown in Figure 1.
The Devonian period was formed in many different environments from deep water to shallow water. As shown in Figure 2, most of the Devonian rocks were formed from in a flysch environment, which is deep marine deposition. Flysch is the sediment that is eroded and dumped into the basin, as shown in Figure 4 (Stanley, 1999). The Flysch deposits show evidence of a mountain building period in the area. The Devonian period was formed during a mountain building period, which started as a deep marine environment and later filled in to form mountains. The shale and sandstones that make up the Devonian period show evidence of a deep marine environment. Shales form in deep marine environments with some occurrences of turbidites. Turbidites, are sediments transported by turbidity currents that deposit fine grained sediment underwater. Turbidites normally show evidence of transgression and regression of the sea level (Weaver, 1983). Also, turbidites explain the sandstones mixed throughout the formation due to the fine-grained sediment distribution into deep water. The Devonian was at the beginning of a mountain building period. As the mountain building forms the basin begins to fill in with sediment and form land. As the mountain building process begins the earth acts as a trampoline, and the earth sinks a little as the weight increases. This also happens in reverse when the mountains begin to weather. As the mountains weather the earth raises because the weight is being decreased. The Shale is at a deep marine environment, which happened in the beginning of the Devonian era.

The formation consisted of alternating shale and sandstone bedding. The Sandstone shows evidence of the deep marine mudslides. The outcrop was altered and consisted of many cracks. The outcrop was heavily weathered and had vegetation throughout. The alternating beds show signs of a deep-water formation. The outcrop was not made up of any exposed fossils.

On the other hand, the alternating beds could be a result of transgression regression series. The Devonian system contains at least 14-transgression regression series. These series are of the eustatic origin. The alternating sandstone shale beds could show evidence of transgression regressions cycles. The shales would be a result...
METHODS

The shale that was used in the study was randomly selected from an outcrop behind AutoZone in Huntingdon, Pennsylvania. The rocks were then dried due to a consistent snowstorm. Once the rocks dried out, and colors were easier to distinguish. They were analyzed using a rock-coloring chart from the Geological Society of America (shown in figure 5). Using the chart I was able to collect the data needed to show the different colors of shale throughout the formation. The Shale was randomly selected because the coloration of the shale was random throughout the formation. Some of the different colorations of the shale are shown in Figure 3.

After drying I was able to break the rocks open and analyze the colors on the fresh surfaces of the rocks more accurately. Also after drying the rocks the rocks showed an extreme amount of rust on the outside, which was easily removed. The outside surface of the shale was altered by weathering and exposure to the air. By breaking the rock I was able to get a fresh surface and this made it easier to differentiate the colors of the actual rock itself. The shale was very easy to break due to its thin layers.

RESULTS

The rocks had to be dried because the outcrop was covered in snow alternating the colorations of the rocks. After drying the rocks colorations changed and allowed me to read them a lot easier and more accurately. The color chart consisted of many different shades and colors. For this shale of Devonian age I only had to look at two different pages of the color chart. The first page was different shades of reds to browns. The second page consisted of greys to blacks. The greys on the chart seemed a lot more in depth, which made it harder to interpret and compare the rocks to the chart.
The shale varied in color from a deep red to a grey black. The shale was in nine different shades. The most dominant color from the formations was a dark grey, which was shown in most samples. Then, a greyish black coloration was shown in some samples. Also, a few samples showed a coloration of greyish brown. Some other colors that were not dominate but still showed up were Dusky brown, blackish red, dark reddish brown, medium dark grey, brownish black, and a medium grey.

**DISCUSSION**

To continue, why exactly are the shale different colors? The coloration of the grey and black are present because those shales are organic carbon rich samples. The black coloration is due to highly oxidized mature organic carbons. Also, fine-grained iron minerals could cause the black coloration. The Dark grey to black colorations were the most dominant in the formation which shows that the formation is from a rich organic carbon environment (Arthur, 1994).

In addition, a reddish brown coloration was found throughout the formation. The browns were not dominant but they were still pretty common. This brown color is a result of immature amorphous organic matter present throughout the rock (Arthur, 1994). This proves that the difference of coloration could be due to the carbon content of the rocks its self. The rock being brown is due to the organic matter of the samples. The other sub colors were a subset of the main colors because the other colors are reddish, brownish, greyish. The secondary colors are just because of the different makeup of each type of shale but still based on the same materials.

The outside of the shale does not look extremely black, brown, or any distinct color for that matter. The shale was weathered and it was exposed to the outside environment. Black shales weather extremely fast, which causes the black shales to releases carbon and oxygen materials. The compositions of the rocks get altered causing the image of the shale to change.
after weathering (Lixin, 2013). Weathering could have defiantly altered the samples collected.

Furthermore, The outcrop was visited on a cold winter day, which made the formation form icicles throughout. The water was able to seep through the formation because shale is layered and is easily broken. The icicles show evidence of water in the formation, which is also linked to the rust on the outside of the outcrop. Weathering of black shales alters the coloration and the general make up of the rocks. Shale is easily weathered and is also altered very easily. The coloration changes throughout the formation could be due to the weathering of the formation in general. The different shades of black may not just be because of the carbon content originally present in the rock but the composition of the rock after weathering. The variations of the grey in the shale could be due to the chemical weathering and the physical weathering after being exposed to the environment. The iron in some of the shales may cause the rock to show signs of rust and different colorations throughout the samples.

The formation consisted of almost no fossils. The signs of no fossils can be evidence of a low oxygen environment. Being a deep-water formation not much life would be present when the formation was being formed. The carbon levels are because of the dead animals and plants at the bottom of the ocean floor. When this material at the bottom of the ocean is buried and compressed it is decomposed forming a carbon rich environment. This environment is what explains the dark black colorations and the natural gases found in black shale. The black is a high organic material levels. These organic materials are dead plants and animals. Whenever an animal or plant dies in the ocean it will fall to the bottom and decompose. This large amount of dead material is what gives the shale its color. The shale is not metamorphic because it is not put under the extreme heat and pressure. As the decaying material is compressed and heated it is altered and forms different materials. When the heated material is cooled it forms thin dark shale. The shale is compressed with different sediments. The shale is not metamorphic because it is not put under the extreme heat and pressure. If the shale was heated to the extreme it would have been altered and wouldn’t form the shale and sandstone layers of the Devonian formation. Also, the mountain building period would be more likely to form sedimentary rocks because of erosion of materials mixed with organically rich materials. These sediments form the black shale we see today in the Devonian formations.

All in all, the coloration of shale is important in many ways. One way the colorations in shale is important is when talking about black shale, which is black because of high carbon content. Black shale is important to different companies because natural gas, coal, and other natural resources are found in the shale. In saying this, the Devonian shale is dark black shale therefore the formation deep in the ground could contain natural resources. The natural resources are stored in the shale because of the open spaces in between layers. The companies look for black shales when looking for natural resources. (Tourtelot, 1979). Therefore, when looking at shales some coloration is more useful than others. Black shale could be more valuable than brown or red shale. The color all depends on what the shale could be used for in the future.

**CONCLUSION**

In conclusion, The AutoZone formation consists of alternating shale and sandstone beds. The shales of the formation were many different colors, which is a result of many different processes. The shales could have been rich or not rich in organic carbon. When the shales were
rich in organic carbon they were dark grey to black. The black carbons were mature carbons. The brownish rocks were because of immature carbon materials. Also, weathering could alter the coloration. Both physical and chemical weathering can change the makeup or the color in general. Chemical weathering changes the chemical makeup while physical weathering just changes the porosity or color of the shale (jin, 2013). The shale we see today is rich organic carbon material that is easily weathered and altered. The Black shale is very dominant in the area and shows evidence of organic material in the rocks. Also, weathering could alter the coloration. Both physical and chemical weathering can change the makeup or the color in general. Chemical weathering changes the chemical makeup while physical weathering just changes the porosity or color of shale. The sale we see today is rich organic carbons that are easily weathered and altered. The black shale is very dominant in the area and shows evidence of organic material in the rocks.

REFERENCES


