

Introduction

- Ground water samples were collected from Abe's Creek and Jefferson's Run at Abernathy Field Station (AFS) in Washington, PA.
- Titrimetric, colorimetric, and gravimetric analyses were performed to determine the alkalinity, hardness, iron, phosphorus, and sulfur levels.
- AFS is of interest due to its close proximity to both a natural gas extraction station and a longwall coal mining operation.
- The natural gas extraction derives from the Marcellus Shale, which extends through New York, Pennsylvania, West Virginia, and Ohio, and holds one of the most substantial natural gas reserves.¹



- Problems with the gas extraction arise from drilling techniques, including the use of large amounts of fresh water and fracking fluid, a chemical-rich mixture used to widen cracks in the rock.²
- At the Marcellus Shale, horizontal wells are drilled, using large amounts of water and sand to blast the shale and create fractures; the water is then pumped out of the ground. However, some of the polluted water remains in the fractures and can leach back into the ground water, tainting it with harmful chemicals.²
- Longwall coal mining is a high-extraction mining method used to extract underground coal beds.³
- Since longwall mining utilizes planned subsidence, there are profound social and environmental impacts.

People living in areas affected by the mining experience devastating shock waves that reportedly feel like "living through an earthquake that happens in slow motion."⁴

- Environmentally, this technique diminishes water sources, and it can alter the course or flow of streams.⁴
- These data will contribute to a long term ecological monitoring database, evaluating the evolution of the environment at Abernathy Field Station.

The Gravimetric Determination of Sulfur in Water

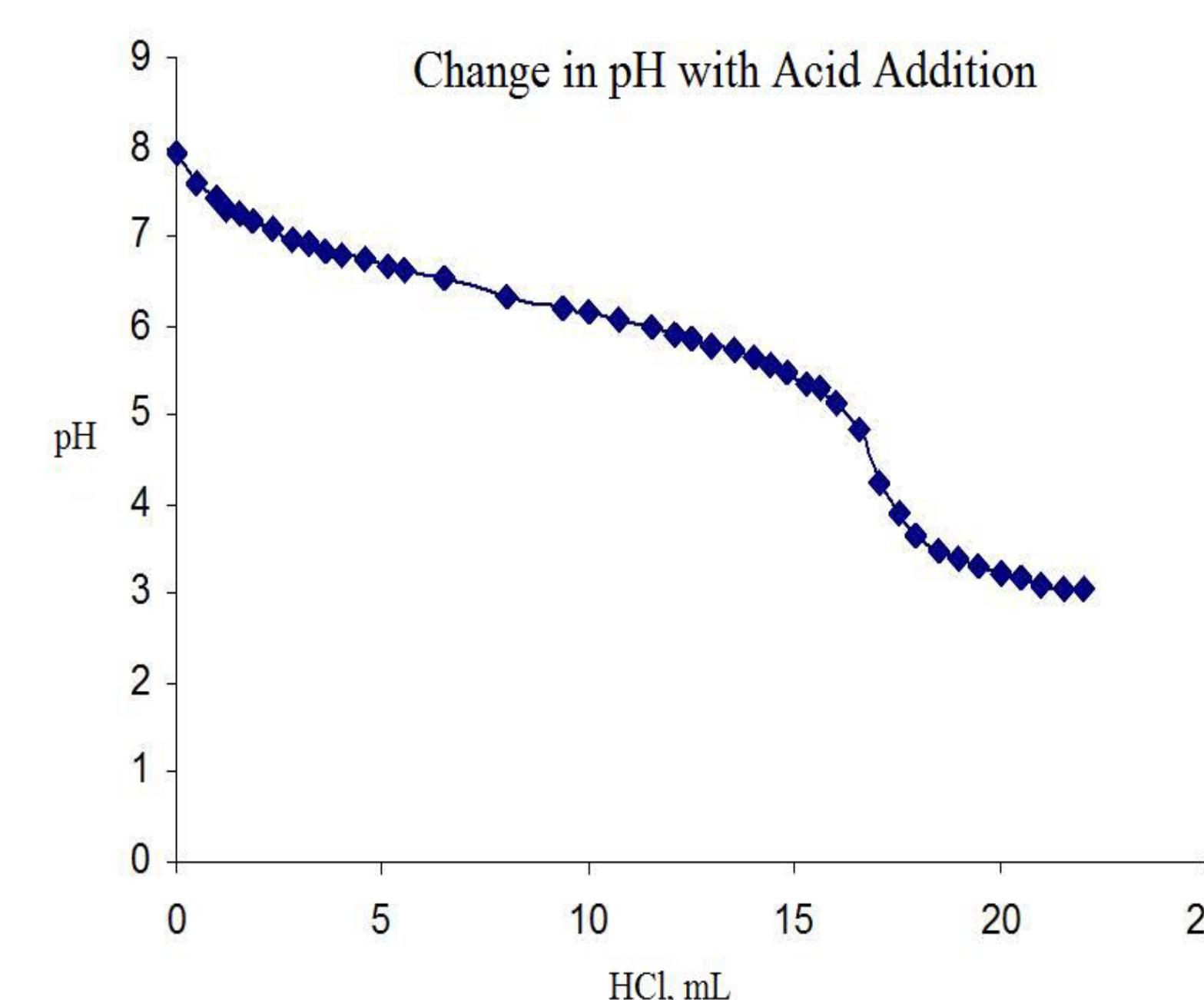
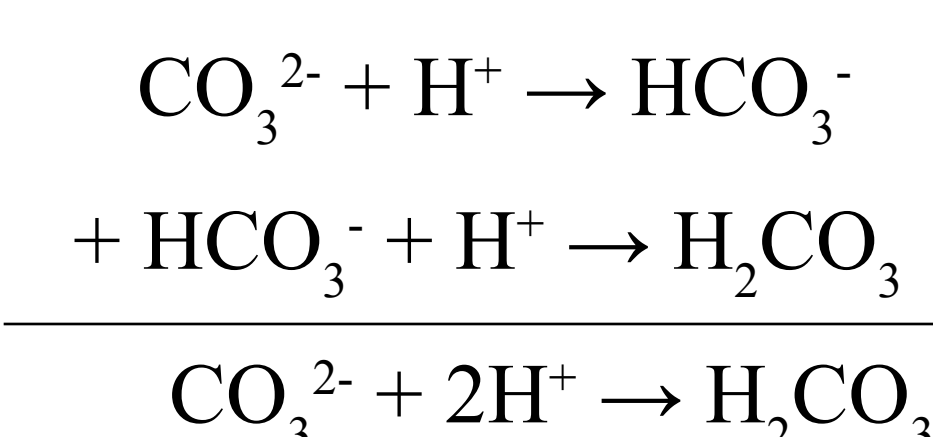


- Sulfur is naturally present as sulfate (SO_4^{2-}) in water.
- It also comes from mine drainage wastes through pyrite oxidation.⁵
- High levels can cause a bitter taste and have laxative effects, resulting in diarrhea.⁵
- Elevated levels can endanger an ecosystem by altering the sediment composition, wiping out native plants that once thrived.
- Reaction: $\text{SO}_4^{2-} + \text{Ba}^{2+} \rightarrow \text{BaSO}_4(s)$

Collection Site	Number of Trials	Sulfur Average (\pm Std Dev) mg/L SO_4^{2-}
Abe's Creek	17	72.6 \pm 48.4
Jefferson's Run	4	60.6 \pm 34.5

Titrimetric Determination of the Alkalinity of Water

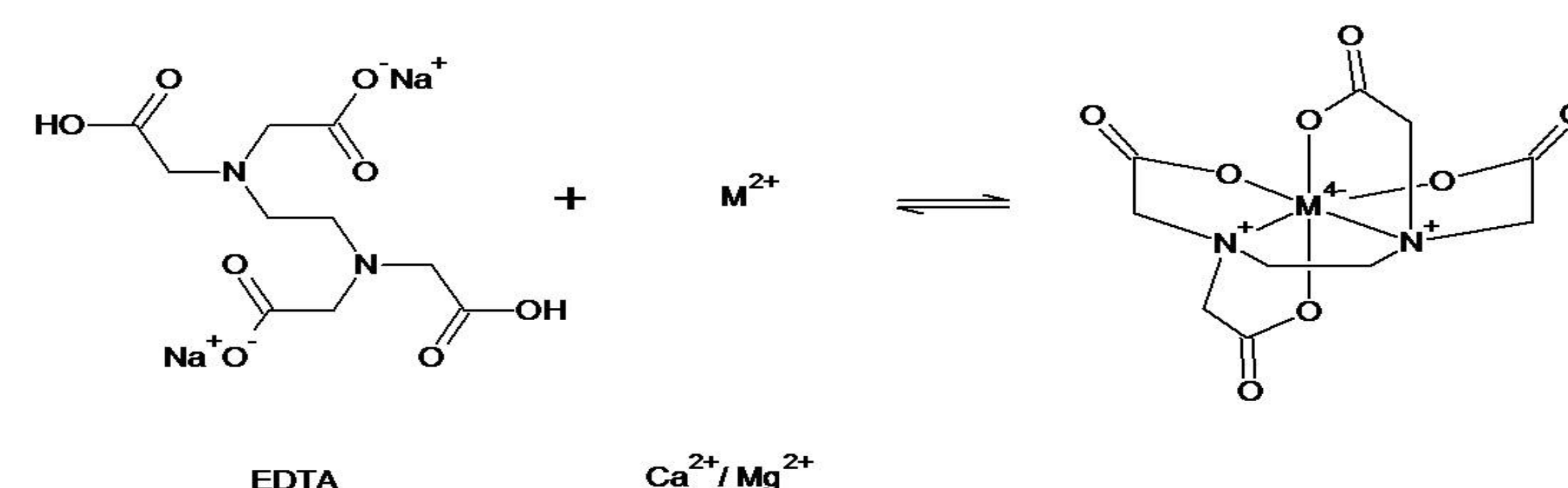
- Alkalinity is the measure of water's ability to neutralize an acid.
- It is determined by titrating all of titratable bases in water (OH^- , CO_3^{2-} , and HCO_3^-).
 - Diverse aquatic life is best supported by an alkalinity between 100-120 mg/L CaCO_3 .⁶



Collection Site	Number of Trials	Average (\pm Std Dev) mg/L CaCO_3
Abe's Creek	15	139.9 \pm 31.2
Jefferson's Run	4	89.2 \pm 27.0

Titrimetric Determination of Water Hardness

- Hardness reflects the concentrations of dissolved calcium and magnesium, which are the most common multivalent metal ions in natural waters.
- It is related to water's ability to withstand pH change due to acid rain.
- Ca^{2+} comes from limestone in the form of CaCO_3 .



Collection Site	Number of Trials	Total Hardness Avg (\pm Std dev) mg/L CaCO_3
Abe's Creek	18	180.0 \pm 44.2
Jefferson's Run	6	149.8 \pm 82.2

The Spectrophotometric Determination of Iron in Water



- These measurements reflect the concentration of iron, which is naturally present in Earth's soil and water.
- Elevated levels from local mining operations cause plumbing, laundry, and cooking utensil stains, and it can result in bad tastes in food.⁷
- Typical values: 0.1-10 mg/L in groundwater; 0.7 mg/L in stream water.⁷

Collection Site	Number of Trials	Iron Avg (\pm Std dev) mg/L Fe
Abe's Creek	12	0.106 \pm 0.361
Jefferson's Run	1	3.12 \pm na

The Spectrophotometric Determination of Phosphorus

- Phosphorus occurs in natural and waste waters almost solely as phosphates.
- It also comes from water treatment, laundry products, fertilizers, and sewage (body wastes and food residues).⁶
- This element is essential to organism growth; too much can cause an excess of algae and other photosynthetic organisms.⁶



Collection Site	Number of Trials	Phosphorus Avg (\pm Std dev) mg/L P
Abe's Creek	6	-0.38 \pm 0.41
Jefferson's Run	4	-0.18 \pm 0.41

Conclusions

- "Low" levels of sulfate were detected; however, this method cannot be considered very reliable.
- While the detection limit for sulfur was reported to be 10 mg/L, there were other issues with the lab. The ashless filter paper did not completely combust, resulting in higher readings and thus higher standard deviations.
- The alkalinity levels were found to be reasonable for this area of the state.⁶
- Research has shown that areas in which the soil is constantly disturbed have higher alkalinity contents. Moreover, coal forms in sedimentary rock, which naturally has more CaCO_3 , and this area, as mentioned, is near to a coal mine.
- The water was found to be in the classification of hard water. EDTA was problematic as the titrant for these determinations.
- The iron levels were on the lower end of the expected range. The method limit for both iron and phosphorus was reported to be 0.050 mg/L.
- It was difficult to detect the iron levels, as they were essentially zero, and there were several negative readings. This led to the large standard deviation. Similarly, the phosphorus levels were undetectable with this method.
- Considering that this was the first year of the study, methods need to be refined to provide more accurate data. Additional years' data are needed for comparison purposes. This study, however, establishes a firm base for continuing research.

mg/L CaCO_3	Classification ⁶
0-75	soft
75-150	moderately hard
150-300	hard
300+	very hard

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