Lingering Acid Chemical Toxicity in the Animas, San Juan, and Durango Rivers after the Gold King Spill

-by-
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ABSTRACT

The 2015 Gold King Spill was revisited along the Animas, San Juan, and Durango Rivers. The research was conducted for the people of the San Juan County area and the people of the Navajo Nation that were affected by the Gold King Mine Spill. This research is to understand the health issues concerning the contaminants in the rivers. It is also to advocate for changes in the lives of these people to ensure a sustainable and healthy future.
This study focused on pH and Molarities.

The purpose of this study was to test the concentration (molarity) and pH of the Animas, San Juan, and Durango rivers after the Gold King mine spill, will it be more basic or acidic.

The three river water samples from Durango river, Animas river and San Juan river were analyzed using titration with a strong base – sodium hydroxide (0.1 M NAOH) and a strong acid -hydrochloric acid (0.1M HCl) and molarity or concentration were calculated with the formula

MaVa = MbVb , as well as the pH using the pH sensor though out the experimentation. Final pH was calculated using the formula $pH = - \log [H^+]$.

The results of this study showed that the concentration/molarity and pH of the three river water samples were very low whether using using titration with a strong base or a strong acid. This indicates that the three river water samples are very acidic and highly concentrated with acid. This indicated that the gold King mine spill in 2015 continues to affect the leaching of acids into the Animas, San Juan, and Durango rivers.

INTRODUCTION

The research was conducted for the people of the San Juan County area and the people of the Navajo Nation that were affected by the Gold King Mine Spill. This research is to understand the health issues concerning the contaminants in the rivers. It is also to advocate for changes in the lives of these people to ensure a sustainable and healthy future.

Animas River

The Animas River is a tributary of the San Juan River which starts in the San Juan Mountains of Colorado. The river flows near Silverton, Colorado and into Durango, Colorado. The Animas River has a history of mining in the Upper Animas Mining District near Silverton. In the 1990's, the US EPA conducted a Superfund Site Assessment. They Identified the severe impacts of mining-related heavy metals. A community-based collaborative effort and the US EPA agreed on postponing the recognition of this site on the Superfund National Priorities List, due to the risk of lowering tourist level. Figure 1 and Figure 2 shows the test site.

HISTORY

On August 5th, 2015, the United States Environmental Protection Agency was investigating the abandoned Gold King Mine near Silverton, Colorado. The equipment they were using disturbed a plug-like structure made of soil near the mine entrance, behind the plug was built up acid mine drainage system. The water gave way due to the water pressure in the

mine and this spill resulted in an estimated amount of three million gallons of acid mine drainage into Cement Creek, the Animas River, and into the San Juan River, and ultimately the Colorado River Basin. This drainage contained metals like lead, cadmium, zinc and iron. See Figure 3

Figure 3: Animas River a day after The Spill

Reason for Selection

The Gold King Mine spillage affected the environment within the Colorado River Basin and thus highly affected our community, the Navajo Nation, as it contaminated water we use to feed livestock, and grow traditional plants. The communities that surround the river are very vulnerable to the toxins in the water and many are dependent on the water for income (farms) and as a water source. We wanted to study this water and how one accident such as this mine spill could affect the entire way of life of many civilians. This was close to home (literally and figuratively) and thus our project was in consideration of the city of Farmington, the Navajo Nation, and the Colorado River Basin residents.

The Issue

Since it was an acid mine, the study will deal with chemical quality of the river water, especially its acidity and basicity. I will test the molarity or concentration of the water in the animas river, San Juan river and Durango river after the Gold King Mine spill.

RESAERCH QUESTION

If I test the concentration (molarity) and pH of the Animas, San Juan, and Durango rivers after the Gold King mine spill, will it be more basic or acidic?

HYPOTHESIS

If I use titration method to test the concentration of the river water samples then the pH will decrease, causing the river water to be highly concentrated (molarity).

VARIABLES

Independent Variables:
River water Samples: Animas River, Durango River, San Juan River
Dependent Variables:
pH, molarity (concentration)

MATERIALS

Funnel
Flask
Graduated Cylinder 50mL
Graduated Cylinder 25mL
Beaker 80mL
Beaker 200mL
Pipette
Burette holder
Burette
Sodium Hydroxide (NaOH) solution 0.10 M
Hydrochloric Acid (HCl) solution 0.10 M
Distilled Water
Phenolphthalein indicator solution (1% alcohol solution)
Lab Coat
Goggles
River Water Sample 1: Durango River Water, 500mL
River Water Sample 2: Animas River Water, 500mL
River Water Sample 3: San Juan (Kirtland) River Water, 500mL
pH meter

EXPERIMENTAL PROCEDURES

A. Titration with a Strong Base (NaOH-Sodium Hydroxide)

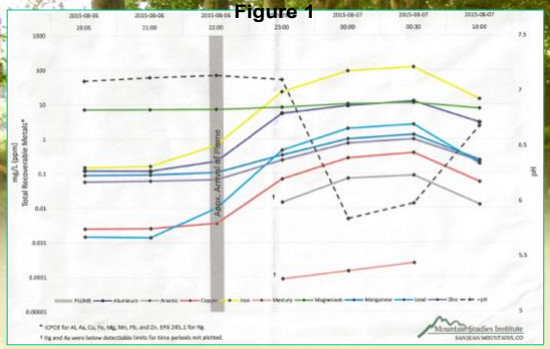
1. Place 50mL of the River water sample in a clean 250-mL beaker
2. Use a clean pipet, transfer 25.0 mL of the river water sample to a clean 150-mL beaker.
3. Obtain 100mL of the 0.10 M NaOH solution in a clean, 250-ml beaker.
4. Clean 50-mL burette through with tap water, then rinse it with several small portions of the standard NaOH solution, being sure to rune some through the tip.
5. Attach the burette clamp to the ring stand, Place the burette in the burette clamp.
6. Fill the burette to above the 0-mL mark, then lower the meniscus back to the 0-mL mark

7. **Set up the pH meter on the ring stand and calibrate the pH with a buffer solution of pH 7.00**
8. Once the pH has stabilized, record the initial pH of the solution.
9. Add three drops of the indicator solution for the titration. Record the color change.
10. Add 1-mL of sodium hydroxide solution to the beaker. Record findings.
11. **Record the pH and the color of the solution.**
12. Continue adding sodium hydroxide in 1-mL portions. Record the burette reading and color.
13. Stop when the titration when the pH of the solution is greater than 12.
14. Repeat 1-14 for Trail 1 and 2
15. Repeat the whole titration experiment with the other samples of river water.
16. Retest with Hydrochloric Acid (HCl) 0.10 M in place of the Sodium Hydroxide (NaOH) 0.10 M solution.
17. Then repeat procedures 1-14 again using all three water samples.

DATA ANALYSIS

Results: One month after the Gold King Mine Spill (2015)

Figure 1



During the Gold King Mine Spill in 2015, the chemical content of the Animas river was monitored every hour by the Mountain Studies Institute (Figure 1), right after the spillage. The results show that , the following toxic chemicals were at high levels, (Aluminum, Arsenic, Copper, Iron, Mercury, Magnesium, Manganese, Lead, and Zinc). The highest was Iron. The contaminant that made the greatest impact on the overall toxicity of the river is Zinc (Figure 2). This brought an uproar to the whole of the San Juan County including the Navajo Nation. Recently, action has been taken by multiple cities including Farmington NM, and Silverton CO, as well as the Navajo Nation. We are increasing community outlook in order to improve conditions.

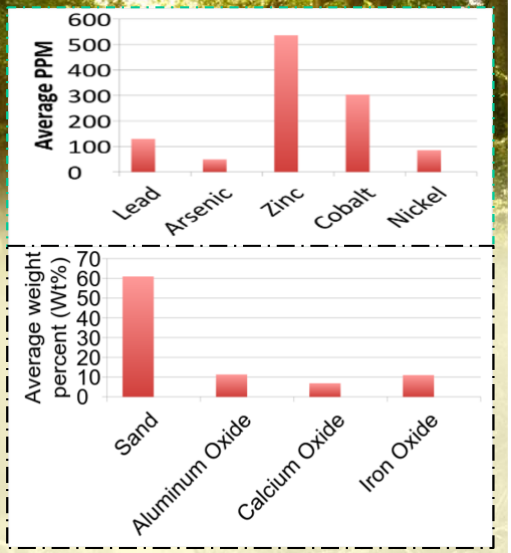


Figure 4

Table 1 : Molarity and pH Titration Using Strong Base		
River Water Samples	Concentration /Molarity	pH
Durango River	0.044	1.36
Animas River	0.045	1.35
San Juan River	0.043	1.37
Molarity and pH Titration Using Strong Base	Acid	
River Water Samples	Concentration /Molarity	pH
Durango River	0.052	1.28
Animas River	0.052	1.28
San Juan River	0.051	1.29

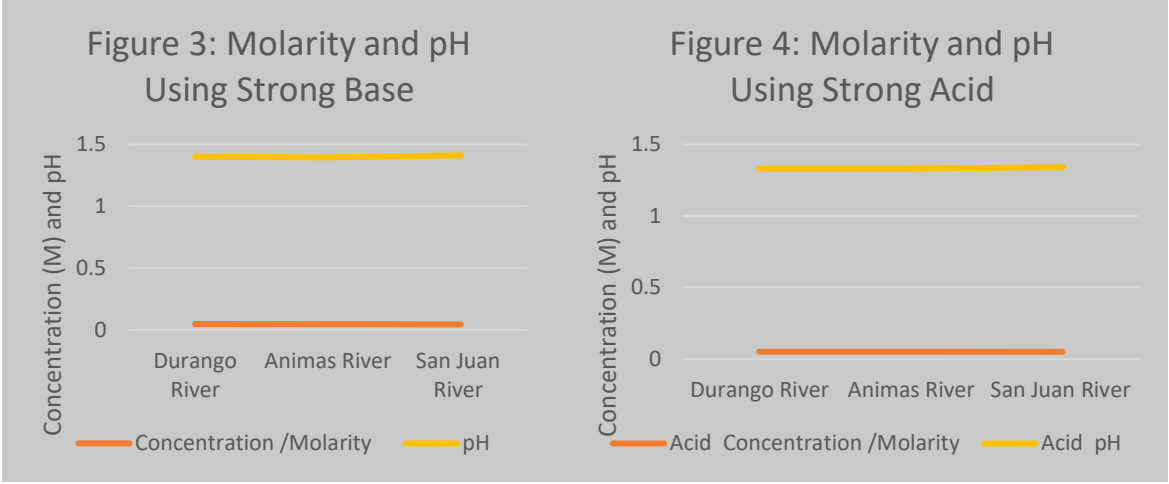


Table 2: Analysis: Concentration 9Molarity) Using Titration of River water samples Using a Strong Base				
UNKNOWN CONCENTRATION FOR RIVER WATER SAMPLE 1- DURANGO RIVER				
	Trial 1	Trial 2	Trial 3	Average
Volume of Acid + River Sample Water 1	50	50	50	50
Final Volume of NaOH in the buret , mL	15	32	49	32
Initial Volume of NaOH in the buret, mL	1	17	34	17.33
Volume of NaOH added ,mL	15	18	32	21.67
Concentration of River Sample Water 1				0.044
UNKNOWN CONCENTRATION FOR RIVER SAMPLE 1- ANIMAS RIVER				
	Trial 1	Trial 2	Trial 3	Average
Volume of Acid + River Sample Water 1	50	50	50	50
Final Volume of NaOH in the buret , mL	15	30	48	31
Initial Volume of NaOH in the buret, mL	1	15	37	17.67
Volume of NaOH added ,mL	16	19	33	22.67
Concentration of River Sample Water 1				0.045
UNKNOWN CONCENTRATION FOR RIVER SAMPLE 3- San Juan River				
	Trial 1	Trial 2	Trial 3	Average
Volume of Acid + River Sample Water 1	50	50	50	50
Final Volume of NaOH in the buret , mL	15	31	47	31
Initial Volume of NaOH in the buret, mL	1	17	38	18.67
Volume of NaOH added ,mL	15	18	33	22
Concentration of River Sample Water 1				0.043

Table 3: Analysis: Concentration (Molarity) of River water Samples Using Titration in Strong Acid				
UNKNOWN CONCENTRATION FOR RIVER WATER SAMPLE 1- DURANGO RIVER				
	Trial 1	Trial 2	Trial 3	Average
Volume of Acid + River Sample Water 1	50	50	50	50
Final Volume of HCL the buret , mL	15	32	49	32
Initial Volume of HCl in the buret, mL	1	17	34	17.33
Volume of HCl added ,mL	15	24	39	26.00
Concentration of River Sample Water 1				0.052
UNKNOWN CONCENTRATION FOR RIVER WATER SAMPLE 2- ANIMAS RIVER				
	Trial 1	Trial 2	Trial 3	Average
Volume of Acid + River Sample Water 1	50	50	50	50
Final Volume of HCL the buret , mL	15	35	50	33.33
Initial Volume of HCl in the buret, mL	1	18	36	18.33
Volume of HCl added ,mL	15	26	37	26.00
Concentration of River Sample Water 1				0.052
UNKNOWN CONCENTRATION FOR RIVER WATER SAMPLE 3- SAN JUAN RIVER				
	Trial 1	Trial 2	Trial 3	Average
Volume of Acid + River Sample Water 1	50	50	50	50
Final Volume of HCL the buret , mL	15	33	48	32
Initial Volume of HCl in the buret, mL	1	16	35	17.33
Volume of HCl added ,mL	15	26	36	25.67
Concentration of River Sample Water 1				0.051

CONCLUSION

Tables 1, 2, and 3, as well as Figures 5 , shows that the concentration/molarity and pH of the three river water samples were very low whether using titration with a strong base (NaOH) or a strong acid (HCl). This indicates that the three river water samples are very acidic and highly concentrated with acid. This indicated that the gold King mine spill in 2015 continues to affect the leaching of acids into the Animas, San Juan, and Durango rivers. The hypothesis is accepted.

FUTURE RESEARCH AND RECOMMENDATIONS

For further research, I'll expand my research more into EPA's standards into safe levels of drinking water. These factors include testing for nitrates, chlorides, chloride, fluoride, iron, manganese, sulfates, zinc, conductivity or total hardness. I will also look into testing the river water samples in plants.

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