Can Bedrock fix it?

A study on which type of bedrock can raise pH after acid rain has lowered it

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Abstract:

If the pH of water in the environment is too high or too low, the aquatic organisms living within it will die. The majority of aquatic creatures prefer a pH range of 6.5-9.0. As pH levels move away from this range (up or down) it can stress animal systems and reduce hatching and survival rates. But, because bedrock can be found near bodies of water like lakes and rivers, it can correct the pH of the water so that the body of water is still a healthy environment and water source. An experiment will be conducted where 10 grams of granite, limestone, and sandstone are all submerged separately in 400 mL of water with a pH of 4.3, which would be the result of acid rain. This solution will be made with hydrochloric acid and tap water because it is the closest to fresh water. At the end of the experiment, the water with the closest pH to 7, determined which type of bedrock is the most effective at buffering pH. My study overall reveals bedrock's positive effects on water in the environment.

Introduction:

Acid rain is a broad term for any form of precipitation with acidic components. Acid rain results when sulfur dioxide (SO_2) and nitrogen oxides (NO_X) are emitted into the atmosphere and transported by wind and air currents. The SO2 and NOX react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground. (Environmental Protection Agency, 2022) If the pH of water in the environment is too high or too low, the aquatic organisms living within it will die. The majority of aquatic creatures prefer a pH range of 6.5-9.0. (Fondriest Environmental, Inc. 2013) As pH levels move away from this range (up or down) it can stress animal systems and reduce hatching and survival rates. The further outside of the optimum pH range a value is, the higher the mortality rates. The more sensitive a species, the more affected it is by changes in pH. (Fondriest Environmental, Inc. 2013) But, because bedrock can be found near bodies of water like lakes and rivers, it corrects the pH of the water so that the body of water is still a healthy environment and water source.

What is Bedrock?

Bedrock is the hard, solid rock beneath surface materials such as soil and gravel. Bedrock also underlies sand and other sediments on the ocean floor. Bedrock is consolidated rock, meaning it is solid and tightly bound. (n.d. 2022) Bedrock can extend hundreds of meters below the surface of the Earth, toward the base of Earth's crust. Exposed bedrock can be seen on some mountaintops, along rocky coastlines, in stone quarries, along natural bodies of water, and on plateaus. Often, these visible exposures of bedrock are called outcroppings or outcrops. Outcrops can be exposed through natural processes such as erosion or tectonic uplift. Outcrops can also be reached through deliberate drilling. (n.d. 2022) There are three main types of bedrock, Granite, Sandstone, and Limestone.

Granite:

Granite is one of the three main types of bedrock. Granite is commonly used for countertops (granite countertops), construction/building materials, and architectural stone. (M.E.C. 2018) The chemical composition of granite is typically 70-77% silica, 11-13% alumina, 3-5% potassium oxide, 3-5% soda, 1% lime, 2-3% total iron, and less than 1% magnesia and titania. Granite is the most widespread of igneous rocks, underlying much of the continental crust.

Sandstone:

Sandstone is made of sand grains that may have been deposited in the sea, by rivers, or in deserts, and later cemented together by minerals precipitated from groundwater. Most sandstones are made up largely of quartz grains, because quartz is a very hard and chemically-resistant mineral. (Geological Study) sandstone is used for liners for steel furnaces; as building stone, as an abrasive, for golf-course trap sand, and in making glass, computer chips, fiberglass, TV screens, and paint.

Limestone:

Limestone is a source of lime (calcium oxide), which is used in steel manufacturing, mining, paper production, water treatment and purification, and plastic production. Lime also has major applications in the manufacture of glass and in agriculture. Limestone is used as a filler in a variety of products, including paper, plastic, and paint. The purest limestone is even used in foods and medicines such as breakfast cereals and calcium pills. Limestone is also the raw material for making lime that is used to treat soils, purify water, and smelt copper.

Hypothesis:

My hypothesis was that if the three main types of bedrock, limestone, granite, and sandstone, were to be tested on which had the most effective correction of the water's pH after being lowered by acid rain, then limestone would be the best option because of its amount of calcium.

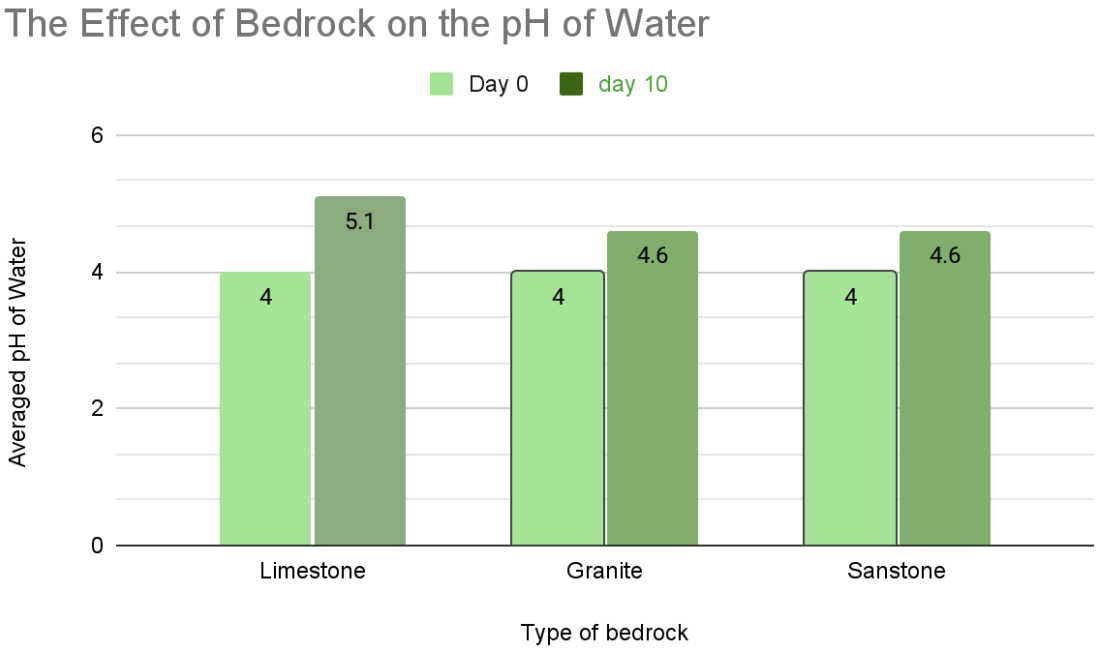
Methods:

An experiment was conducted where 10 grams of granite, limestone, and sandstone are all submerged in 400 mL of water with a pH of 4.3, which was the representation of the results of acid rain. This solution was made with hydrochloric acid and tap water because it is the closest to fresh water. Water was put into the beaker first, then after around 8 drops of hydrochloric acid were dropped into the water with a pipette. This was performed under a hood which is also where the beakers stayed throughout the experiment. Each type of bedrock had three different groups for validity. The rocks were each submerged in different beakers. The rocks will be completely submerged in the water and the pH of the water will be tested every 24 hours for one week. At the end of the experiment, the water with the closest pH to 7, will determine which type of bedrock is the most effective.

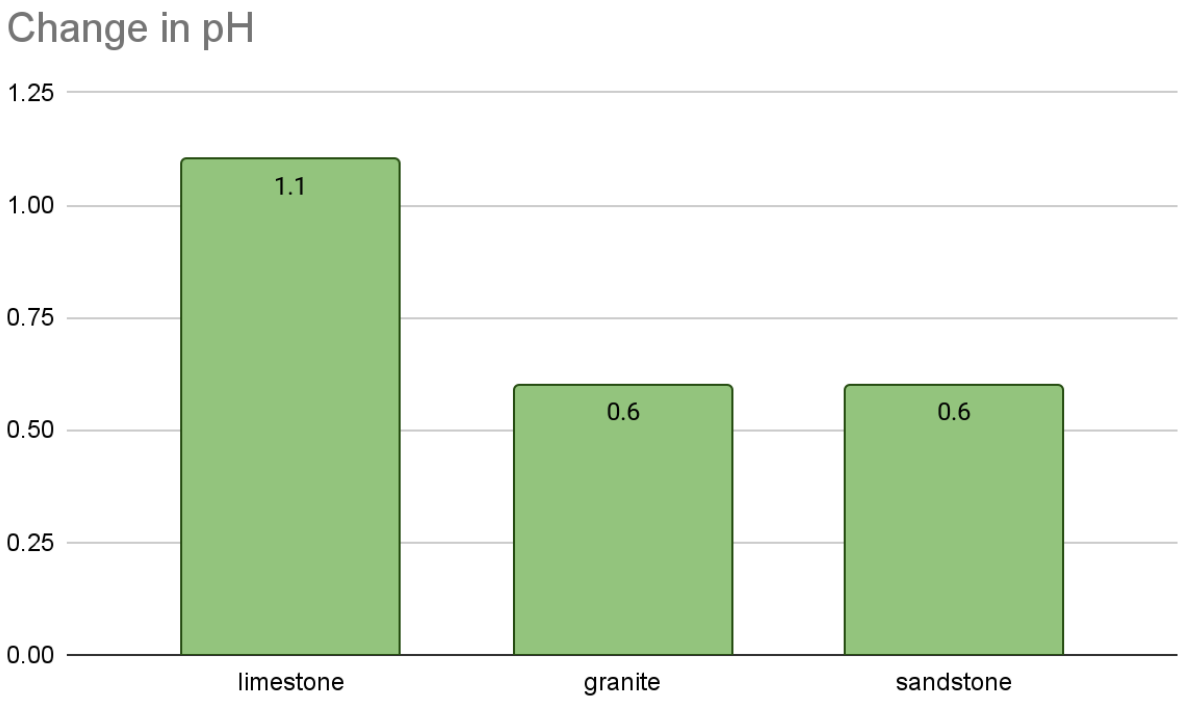
Results:

The graph below states the pH of the water over 7 non consecutive days. Each type of bedrock had three different groups and each piece of bedrock was placed in its own beaker. The data is averaged at the bottom of the table.

Day	**pH of limestone**			**pH of sandstone**			**pH of granite**		
0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
1	4.5	4.3	4.0	4.2	4.4	4.3	4.4	4.0	4.1
2	4.5	4.4	4.2	4.2	4.5	4.3	4.5	4.2	4.1
3	4.7	4.6	4.4	4.4	4.6	4.4	4.5	4.3	4.3
4	4.9	4.7	4.6	4.5	4.6	4.5	4.6	4.4	4.3
5	5.1	4.8	4.7	4.5	4.7	4.6	4.6	4.5	4.4
6	5.3	5.0	4.9	4.6	4.7	4.6	4.7	4.5	4.5
Ending pH Averages	5.1			4.6			4.6		



The graph above displays the average pH for each type of bedrock on day one (beginning) and day 10 (ending). The lighter green bars represent the pH of the water averaged by group before the pieces of bedrock were put in, and the dark green bars represent the average pH of the water at the very end of the experiment.



The graph above represents the change in pH for each type of bedrock after 10 days. The

limestones pH went up by 1.1, and both granite and sandstone's pH went up by 0.6. As can be seen, limestone had the greatest change in pH.

Discussion:

My hypothesis was that out of Limestone, Sandstone, and Granite, then limestone would have the greatest results in raising the pH of the water. I accept my hypothesis because my data suggests that Limestone was the most effective type of bedrock. The limestones pH went up by 1.1, and both granite and sandstone pH went up by 0.6. It wasn't by a lot, but limestone raised the pH slightly more than the other two types, around 0.5. The other two types of bedrock also raised pH slightly less than limestone, but still enough to be recognized. I believe that I got the results I did because of limestone's amount of calcium carbonate, which is over 50 percent, and it reacts with the acidity of the water and raises the pH slowly over time. Sources also say that Limestone is an alkaline agent that can neutralize or partially neutralize strong acid, another effect of the calcium carbonate. This would be why it is also used to purify water.

Limitations:

I feel that I was limited in the fact that I was not able to record data for seven consecutive days, and instead recorded the data of seven more spread out days because my research was conducted at school. The experiment was actually ten days long in total when you include the weekends and days data could not be taken. I was also unable to get the exact pH, only an educated estimate from the pH paper used . I believe that I was also limited timewise in view of the fact that it could take much longer for the pH to raise and get better results.

Future Studies:

The next step in my research would be to research other types of bedrock and other effects that come with it. I could test whether or not living organisms like plants and microorganisms had an effect on pH as well. I could also test limestone further, which had the most results in my experiment, in raising the pH of soil for plants. I could also test whether or not granite lowers pH like some sources say it does.

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