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Dissolving History: The Effects of Acid Rain on Marble and Other Building Materials

Historically significant marble and limestone structures, such as the Taj Mahal and Notre Dame, continue to suffer the damaging effects of acid rain. Acid rain results from the burning of fossil fuels that releases sulfur dioxide (SO₂) and nitrogen oxides (NO_x) into the atmosphere. These gases react with water vapor in the air, generating sulfuric and nitric acids, which later fall as acid rain. Acid rain is particularly prevalent in the Northeastern US, Eastern China, Western and Central Europe, and India. Marble and limestone are particularly sensitive to acid, because of their high “buffering capacity”. In an effort to reduce acid rain and its detrimental effects in the United States, laws were enacted in the early 1990’s to regulate the SO₂ and NO_x emissions.

My project was composed of two aims. In the first, I compared the susceptibility of various building materials to acid rain. I used simulated acid rain (SAR) to test chips of marble, granite, sandstone, brick, and concrete. Results show that among these materials, marble is most susceptible to damage by acid rain, followed by sandstone. The second aim was to determine if acid rain remains an issue in the US and around the world. To do this, I arranged collection of rain samples from North America, South America, Europe, Asia, and Australia. For each sample I measured pH and the ability to damage marble. Rain collected from Korea had the lowest pH at 4.6, but minimal capacity to dissolve marble in 24 hours.