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Marble Dissolution by Acid Rain and Sulphur Dioxide

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Acid rain and dry deposition of sulphur dioxide (and nitric compounds or NO_x) accelerate damage to carbonate-stone monuments and building materials. Quantitative marble dissolution measurements during storms are essential for understanding carbonate-stone damage processes. Two prerequisites are necessary for reliable and reproducible estimates of environmental damage to carbonate stone: standard methods and appropriate reference materials. We discuss here a physico-chemical method to characterize environmental damage to marble. This paper summarizes the acid rain/carbonate-stone damage studies developed during the U.S. National Acid Precipitation Program (NAPAP, 1990; Reddy et al., 1985; Reddy and Youngdahl, 1987). We identify and quantify environmental damage to a potential reference sample, Vermont Marble, during storms and during dry periods prior to those storms. Rain runoff from marble and glass micro-catchments revealed that rain rate and chemical concentrations fluctuated three to tenfold during storms. Net calcium concentrations from marble rain runoff typically fluctuated twofold during storms. Large net sulphate and calcium concentrations in stone runoff at the start of a storm indicate the dry deposition of sulphur dioxide to the marble surface during dry periods. Episodes of low rain rate (less than 5 mm/hr) were often coincident with decreased rainfall pH (less than 4.0) and as much as a twofold increase in marble dissolution. Episodes of high rain rate (cloudbursts) to values greater of 16 mm/hr or more were coincident with a rapid increase in rainfall pH (often to more than 4.5) and a decrease in marble dissolution. Measurements of sulphate accumulation on the marble surface show moderate agreement with concentrations calculated using dry deposition algorithms for sulphur dioxide.

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