

Elemental Analysis of Smithsonian Building Stones and Brick by Prompt Gamma and Delayed Gamma Neutron Activation Analysis

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A systematic characterization was undertaken of the lithology and physical properties of eight building stones used in the monumental architecture of the Smithsonian Institution in Washington, D.C., from 1847 onward. The Smithsonian building stones make up a representative sample of the American dimension stone industry with respect to style, quarrying techniques and geology. The stones selected include Holston marble, Mt Airy granite, two types of Vermont marble, Seneca sandstone, Mankato dolomite, Salem limestone and hydraulic pressed brick. This characterization included both instrumental neutron activation analysis (INAA) and prompt gamma neutron activation analysis (PGNA). The former is typically used for provenance studies, while PGNA is of interest because it can be used in a nondestructive method mode, either at a reactor or, with portable neutron sources, used on site. The characterization of the same set of samples by both methods makes comparisons possible. Over the entire set of specimens INAA detected a total of 33 elements, and PGNA, 29 elements. For the silicate rocks and brick in the rare earth elements group typically used for provenance studies, INAA detected 9 of the 14: La, Ce, Nd, Sm, Eu, Tb, Dy, Yb and Lu. PGNA detected 4 of these 9: Nd, Sm, Dy and Yb, and in addition, Gd. Of the fourth period transition metals INAA detected all except Cu, and PGNA detected all except Ni, Cu and Zn. PGNA also detected Si, which INAA is unable to measure. For the carbonate stones, both INAA and PGNA detected the elements Mg, Ca, Sr and Mn, which are major formers of carbonate minerals. In addition, PGNA detected B, which could be useful for limestone and marble provenance.

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