University of Glasgow

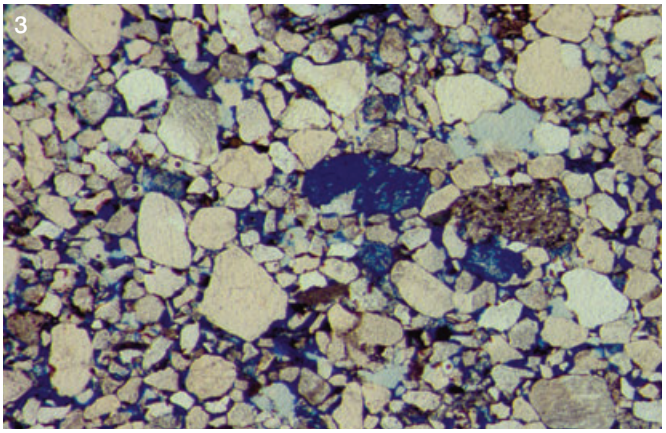
ISAAC
Imaging Spectroscopy And Analysis Centre

# Stone Matching for Historic Buildings

*Tower, University of Glasgow – highlighting both decayed and replaced stones*

## Stone Decay – A Major Concern for Historic Buildings

Historic sandstone buildings throughout Scotland are decaying rapidly as a consequence of their age, together with the impact of long-term pollution from domestic coal burning and the industrial revolution era. This decay manifests itself either in the slow disintegration of the stone or by the catastrophic failure and collapse of parts of a facade. The optimal option is to completely replace the original stone, but unless the new stone is closely matched to the old one, repair may be harmful to the structure itself and the building's appearance can be compromised. Unfortunately, many of the original quarries are no longer in operation. Meanwhile, inappropriate interventions, such as stone cleaning, and poor quality repairs, such as mixing impervious, less porous cement materials with much softer sandstones, have already caused widespread damage to historical buildings that are now in urgent need of attention.



## Stone Matching – A Difficult Challenge

While stone suppliers provide general descriptions of their products, experience has shown that the specific characteristics of each stone are crucial to their performance on a facade. These critical properties include the grain sizes and specific minerals in the stone, as well as the amount of pore space between grains, all of which must be taken into account when selecting a suitable replacement. Some sandstone is more prone to decay than others. In stones where their properties differ, permeability often varies. Permeability barriers are created between the stones. Water penetrates at different rates and collects at points that become a focus for decay. The University of Glasgow's School of Geographical and Earth Sciences (GES) has decades of experience in the study of rocks and minerals, and its staff members are fully qualified to analyse decayed stones and provide advice on suitable replacements.

## Sandstone Examination with Electron Microscopy

GES has fully equipped laboratories dedicated to the preparation and characterisation of a wide range of stone types. An overview of the composition and internal structure of a stone can be obtained by cutting a petrographic thin section for examination using transmitted light microscopy. By impregnating the rock with a blue dye resin prior to cutting thin sections, the pore space can be readily located and quantified. GES offers highly-skilled sample preparation capabilities, which are no longer widely available in the UK, for studying rocks and minerals.

The Imaging Spectroscopy and Analysis Centre (ISAAC), within GES, can undertake more sophisticated analysis. Using high-resolution field-emission scanning electron microscopy (SEM), those minerals in the pre-cut thin section samples, which are of a grain size too fine to study by light microscopy, can be identified from their chemical composition via X-ray microanalysis. High-resolution images can also reveal the size and shape of mineral crystals such as calcite, kaolinite, and illite that may block pore spaces and so impact the rate of stone decay.

## GES and ISAAC Analysis and Expertise Informs Historic Building Preservation

GES's expertise and knowledge, combined with ISAAC's state-of-the-art facilities, enable the University of Glasgow to offer comprehensive characterisation and analysis of sandstone decay and replacement stone matching tailored to the needs of the customer. The impact of long-term industrial pollution is an ongoing issue for the nation's built heritage, and organisations charged with funding and managing preservation activities (Historic Scotland, English Heritage, etc.), as well as specialist stone repair companies appointed to carry out the work, require scientific analysis and expert advice to guide their decision-making with regards to restoration and maintenance. Certain sandstones with particular mineralogy, porosity, and permeability may be proven to be preferable for use in restoration work. Similarly, variations in sandstone mineralogy, including cements, may show that stone from one quarry (or quarry zone) is less susceptible to pollution and/or a better match to existing stones.

## ISAAC Contacts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### *Images*

**1.** *Building stones in states of decay – uncleaned (upper left); self-cleaned by rainwater (upper right); biologically encrusted (horizontal)*
**2.** *Carved piece of stone with weathering rind along its outside edge*
**3.** *Stone thin section with pore spaces impregnated by blue resin*
**4.** *Blocks of juxtaposed 'tooled' and 'untooled' building stones*