

## THE BGS 'BUILDING STONE DATA CAPTURE' MODULE: A PLANNING TOOL FOR CONSERVING OUR STONE BUILT ENVIRONMENT

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### ABSTRACT

Organisations responsible for conserving the stone-built heritage of the UK need accurate information about buildings, building stone and stone condition in order to plan effective repair and maintenance strategies. To meet this need, the British Geological Survey (BGS) has developed a 'Building Stone Data Capture' module in its System for Integrated GeoScience Mapping (SIGMA); the BGS preferred tool for digital field capture of geoscience data. Data are captured in the field on hand-held PC tablets running the SIGMA application. Individual stone structures are recorded as separate entities and identified uniquely by GPS location. A set of predetermined data fields and supporting dictionaries guide and restrict the range of building and stone properties that can be recorded, ensuring a high degree of consistency in the dataset. The wide range of data for each building can be sorted, selected and combined quickly and easily, and presented as tabulations, statistical results, or in map form. GIS presentation of the data provides a powerful and versatile tool for planning and research. When used in combination with geographical information on bedrock geology and quarry locations, the system allows original sources of stone to be identified, maintenance and repair issues to be categorized and prioritised, and the types of replacement stone needed for repairs to be determined. A survey of 380 stone-built structures in the Callander Conservation Area (part of Loch Lomond & The Trossachs National Park) is used in this paper to demonstrate the utility and GIS output of the Building Stone Data Capture module.

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### INTRODUCTION

The rich and varied bedrock geology of the UK is reflected in the diversity of its stone-built heritage. As a result, stone-built structures play a significant role in defining the distinctive character and 'sense of place' that distinguishes different parts of the UK at local and regional scales. Organisations responsible for conserving our stone-built heritage need accurate information about the structures, the building stone used in them, and the stone condition, in order to design and implement effective repair and maintenance strategies.

Many conservation charters require that the physical features of a built site, and every stage of work (including repairs) is recorded before intervention (e.g. Burra Charter [Article 23], 1979) and after (Venice Charter [Article 16], 1964) (charters found in reference: Bell, 1997). Finding ways to record data for stone-built structures efficiently, accurately and consistently is therefore becoming increasingly important. However, the considerable variability of stone-built structures, and their three-dimensional form, present significant challenges; a successful data collection system needs to be able to cope with this variability, and should be easy to use.

Over the past two decades, several systems for mapping stone type and stone condition in built structures have been developed. A system using a classification of weathering forms to map stone

deterioration across building façades (Fitzner et al., 1997; Fitzner, 2004) has been applied to several stone-built World Heritage Sites. Simpler systems have also been developed; some use digital image processing to map different forms of surface decay (Zeza, 1994 and 2002), and others use a Geographic Information System (GIS) to store, display and analyse captured information (in one instance, to characterise the stability of rock art; Dorn et al., 2008).

Most of the existing documentation systems tend to focus on classification and terminology for specific tasks, and are not particularly flexible. None are suited to rapid surveys of multiple structures of varying type; the kind of survey that local authorities or conservation organisations (for example) may require in order to develop repair and maintenance strategies for a group of built sites (e.g. a conservation area).

To meet this need in the UK, the British Geological Survey (BGS) has developed a 'Building Stone Data Capture' module in its System for Integrated GeoScience Mapping (SIGMA)<sup>1</sup> that incorporates some elements of

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<sup>1</sup> SIGMA is the BGS preferred tool for digital field capture of geoscience data. It is an open-source relational database system built under the BGS Spatial GeoScience Technology Programme. Data are currently captured on Xplore iX104 tablet PCs running Microsoft XP.

existing systems to document stone type and stone condition data. The module was developed as a portable, flexible system for digital field data capture that can be used for any number of stone-built structures in any setting.

terms that guide and restrict the way they can be populated. A simplified representation of the hierarchical structure of the module is shown in Figure 1 and a screenshot of the module, with predetermined data fields and supporting dictionaries, is presented in Figure 2. Both images are explained further in the Callander Conservation Area survey case study presented below.

### THE BGS 'BUILDING STONE DATA CAPTURE' MODULE

The 'Building Stone Data Capture' module consists of a database of hierarchically arranged attribute fields, many of which are supported by dictionaries of defined

Capturing accurate survey data for stone-built sites in a concise, consistent way is made difficult because built sites vary enormously in many ways, including their physical attributes, materials and construction history. For example, an effective data capture system needs to be

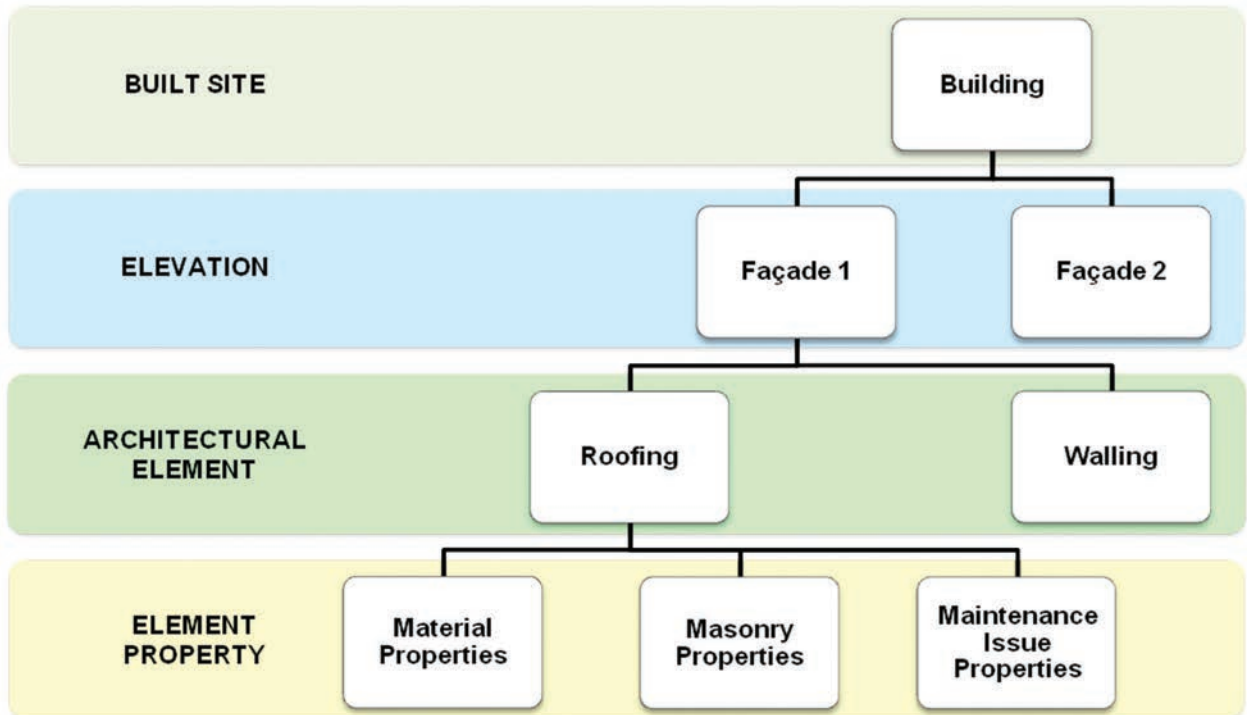


Figure 1. Simplified hierarchical structure of the Building Stone Data Capture module.

Parent Rock	Basic Lith	Mat Thick	Mat Width	Mat Size	Misc	Colour	Condition	Origin
MET	SLTE	VARIABLE	VARIABLE	SMALL	CRENU	GREY	REPAI	SCOTUN
?	CDNG	Not Entered						
*	GN	Conglomerate						
	GNSS	Granite						
	IGRU	Gneiss						
	LMST	Igneous Rock						
	MDST	Limestone						
	MSDST	Mudstone						
	QZITE	Metasandstone						
	SCHM	Quartzite						
	SDST	Mica Schist						
	SLST	Sandstone						
	SLTE	Siltstone						
	WACKE	Slate						
		Wacke						

Figure 2. Module input form, as seen on tablet PCs used during survey, with hierarchy labelled on left hand side. The form is used to enter data into the relational database. The number of elevations and elements are selected, and properties are recorded for each element using a number of pre-defined fields with supporting drop-down dictionaries.

able to deal with any type of built structure (e.g. buildings, monuments, bridges, paved areas), and for buildings alone it needs to be able to deal with any number of façades, roof pitches and corresponding architectural elements (walling, dressings, chimneys, carvings, etc.).

The key features of the BGS ‘Building Stone Data Capture’ module are:

- Individual sites (e.g. buildings) are recorded as separate entities, with a unique identifier and GPS location.
- A set of predetermined data fields and supporting dictionaries guide and restrict the range of building and stone properties that can be recorded, ensuring a high degree of consistency in the dataset.
- Fields and dictionaries can be adapted to suit project requirements.
- Stone type and stone condition data can be recorded at any scale, e.g. for different architectural elements over a single façade, for a whole building, or for an entire settlement.
- Once the survey is completed, the recorded data can be transferred to data files that can be interrogated independently or used within a Geographic Information System (GIS).

The combined SIGMA-GIS approach provides a convenient means of systematically recording, storing, updating, interrogating and displaying a wide range of spatially referenced data. In its GIS form the dataset can be presented as tabulations, statistical results, or on a map. Queries can be used to quickly select, organise and view subsets of data, or to compare and contrast different aspects of the data, thereby providing a powerful and versatile planning tool.

The digital, hierarchical method of data capture and storage has two important advantages over traditional ‘analogue’ methods: (i) the pre-determined hierarchy of fields and the supporting dictionaries ensure a high degree of consistency in the dataset; (ii) data recorded for single attributes or combinations of attributes can be selected and manipulated easily, allowing statistical or geospatial patterns to be drawn from the data.

### CALLANDER CONSERVATION AREA CASE STUDY

A building stone and slate survey of Callander Conservation Area (CCA), Loch Lomond & The Trossachs National Park, UK (Tracey et al., 2011) provides a useful case study to demonstrate the utility and GIS output of the BGS ‘Building Stone Data Capture’ module. The aim of the project was to inform planning decisions regarding repairs to, and construction of, stone-built structures within the Callander Conservation Area. The project objectives included (but were not limited to) the following:

- Provide an inventory of the stone and slate types used in the CCA.
- Illustrate the distribution of the identified stone and slate types.
- Identify stone and slate maintenance issues for the CCA.

These objectives were tackled by conducting a detailed survey of the stone-built structures within the conservation area using the ‘Building Stone Data Capture’ module, followed by a process of data interrogation and interpretation.

### The survey

The project was designed to include all stone-built structures with street-facing façades in the Conservation Area. Prior to the survey, all stone-built structures were identified and recorded as individual ‘polygons’ in a geospatial vector data format (shapefile) for use in the SIGMA-GIS software (Figure 3). Each polygon was assigned a ‘Field Observation Point’ (FOP) or unique reference number for identification.



**Figure 3.** GIS view of an aerial photograph with georeferenced polygons representing the limits of each built site. Each polygon has a Field Observation Point, or unique reference number, used for identification and data attribution.

For each FOP, stone and slate details (or ‘properties’) were recorded for three architectural elements: roofing, walling and dressings (in this instance dressings were defined as window and door surrounds). Properties were categorised into three groups: material, masonry style and maintenance issues. Table 1 presents the lists of material and masonry style properties, and this is followed by a brief description of maintenance issue properties. Supporting dictionaries were prepared for each recorded property to ensure consistency within the dataset and between surveyors. This also allows for data sorting and statistical analysis upon survey completion.

‘Maintenance issue properties’ were also attributed to each surveyed architectural element. More than one

Building Stone		Slate	
Material Properties	Masonry Style	Material Properties	Masonry Style
visibility (e.g. visible, partially visible, not visible)	block shape	visibility	coursing
rock type (e.g. sedimentary)	coursing	rock type	width
basic lithology (e.g. sandstone)	tooling	basic lithology	
texture		thickness	
grain size		size	
colour		lustre	
source (if known)		colour	
		source (if known)	

**Table 1.** List of material and masonry style properties that can be recorded for stone and slate, as predetermined for the CCA survey. Each property also has a supporting dictionary.

maintenance issue can be recorded where necessary. Both causes and effects of stone deterioration (e.g. cause: structural subsidence, effect: cracks to masonry) were included in the dictionary.

The 'Building Stone Data Capture' module has no limitation on the number of façades and architectural elements to which data can be attributed. Attributes, fields and dictionaries can be adapted according to project requirements. For example, the date of construction, structure type (i.e. residential, commercial, infrastructural, etc.), current use (i.e. vacant, occupied) and listing status were also recorded for every surveyed site in CCA. In this case, the rock type dictionary was based on the BGS Rock Classification Scheme, and the stone deterioration dictionary was based on the ICOMOS-ISCS Illustrated Glossary on Stone Deterioration Patterns (Vergès-Belmin, 2008).

### Data interpretation

On completing the field survey, all data were imported into a project database, checked for consistency, validated and then uploaded to a project GIS for interpretation and delivery. The complete work flow diagram and conceptual diagram of the module is presented in Figure 4.

Large, complex datasets stored in relational databases are difficult to display on 2-dimensional maps. However,

with the data uploaded to a GIS, it is easy to quantify material requirements, categorise maintenance issues and display a wide range of spatially referenced data. Users are able to select and view data associated with each surveyed built site (or 'polygon') in attribute tables. Supplementary data relevant to the site can be uploaded (e.g. geological, historical and photographic information) and viewed as additional GIS layers. When surveyed data of individual built sites are used in combination with geographical information on bedrock geology and quarry locations, the system allows original sources of stone to be identified (or at least constrained). All data can be interrogated to produce useful datasets for planners (see Figures 5 and 6 for example outputs of GIS queries).

The building stone data collected during the CCA survey were used to assign a unique stone or slate 'code' to represent each of the different stone and slate types recorded in the Conservation Area. The appropriate code was then assigned to each corresponding architectural element (walling, dressing or roofing) allowing the distribution of stone and slate types to be displayed in GIS. The distribution of maintenance issues could also be displayed (Figure 6). Cross queries of stone or slate type with maintenance issues identified the most common conservation problems in Callander. Such presentations make it possible to devise maintenance strategies and conservation techniques to mitigate damage and prevent further stone deterioration.

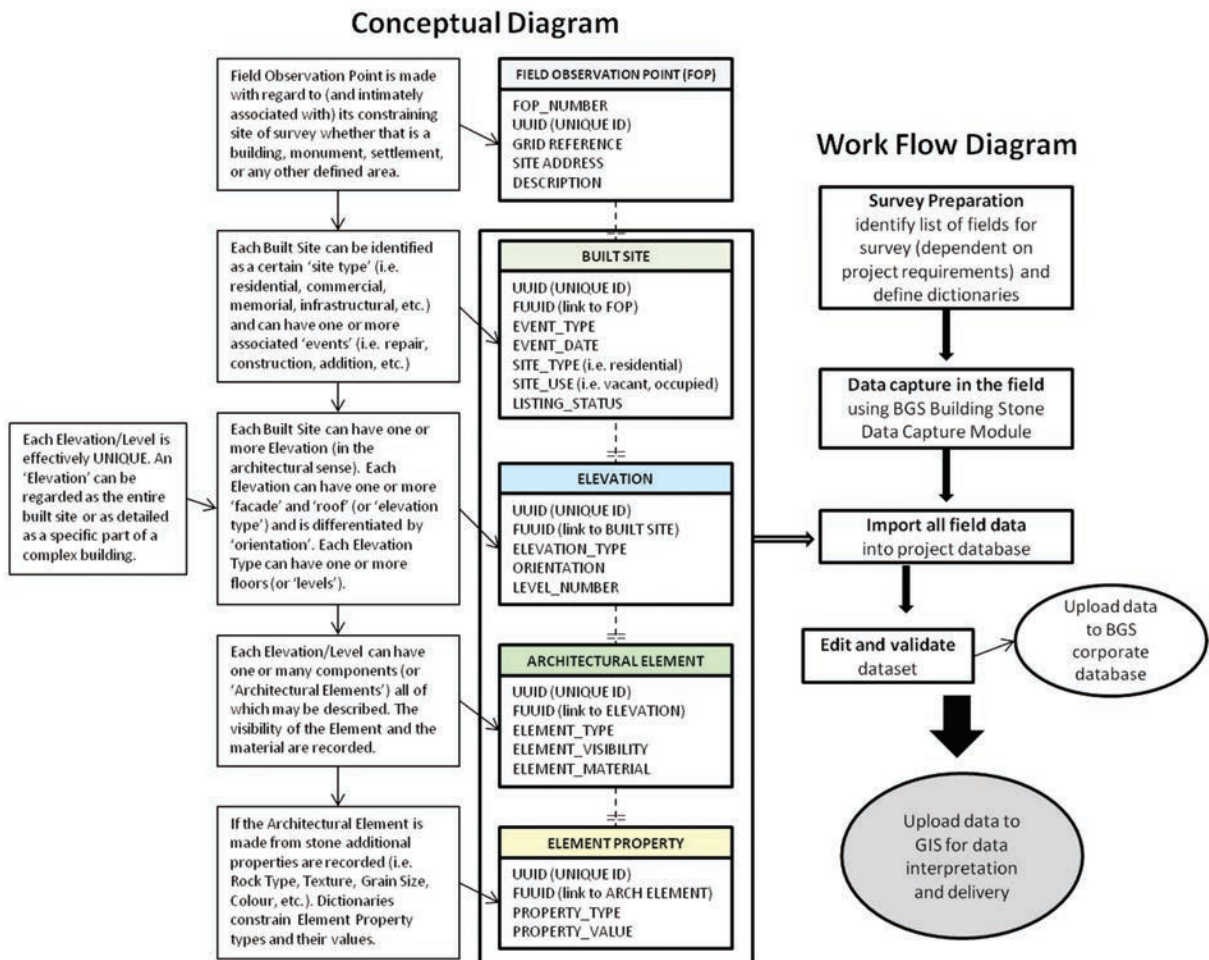
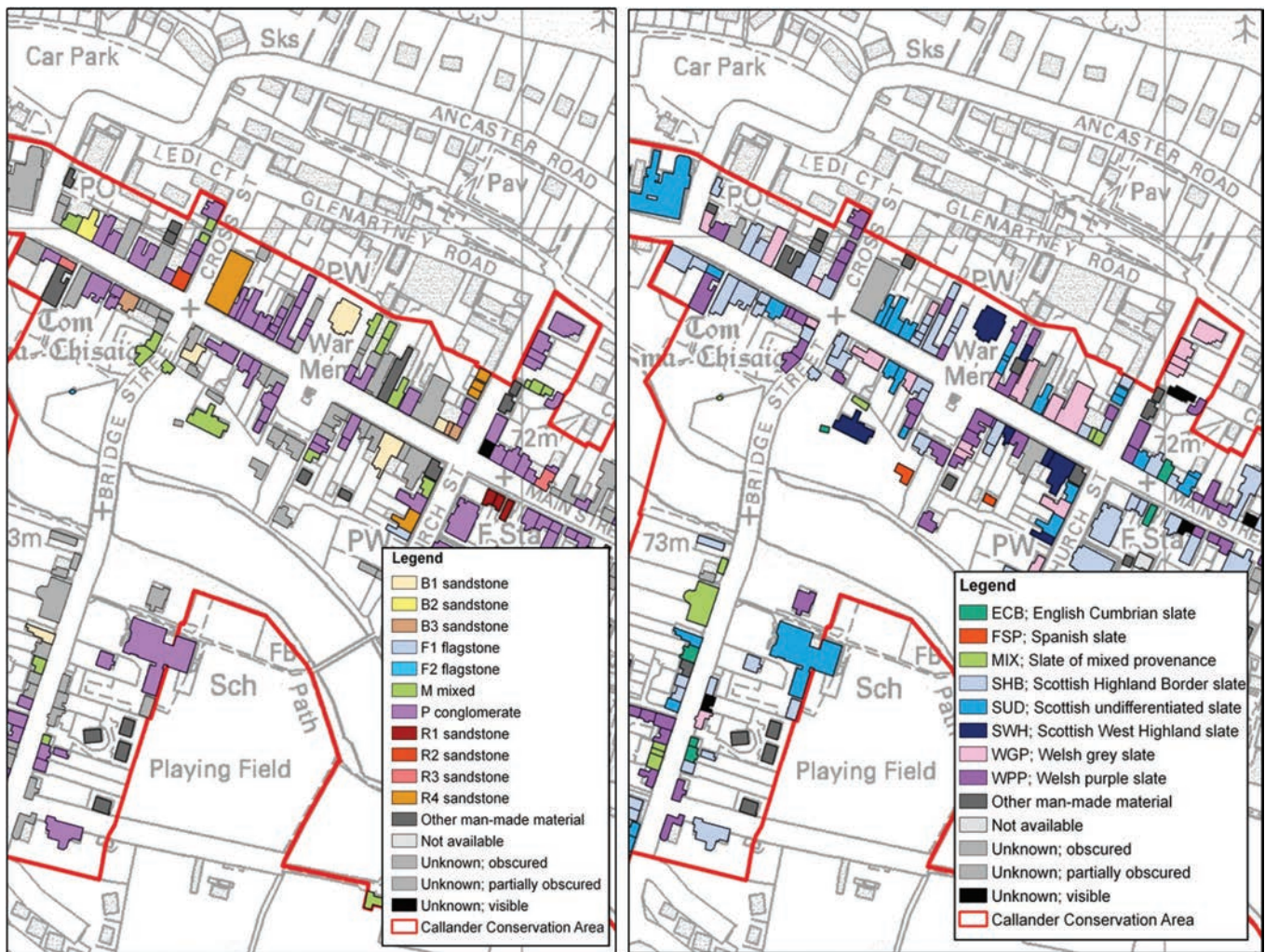


Figure 4. The conceptual diagram defines the relationship of the data elements in the Building Stone Data Capture module and the structure between them. The Work Flow diagram defines the process of population and data delivery.



**Figure 5.** GIS topographic map of Callander town centre with coloured polygons representing surveyed sites displaying the distribution of stone types used in WALLING (left) and the distribution of slate types (right) used in ROOFING in the Callander Conservation Area.



**Figure 6.** GIS view of an aerial photograph of Callander Conservation Area displaying the result of a cross query to identify all surveyed built sites with CONGLOMERATE (building stone) walling and CEMENT POINTING AND PATCHING (maintenance issue).

## CONCLUSION

A building stone survey methodology and associated data capture module has been developed (based on the BGS System for Integrated GeoScience Mapping [SIGMA]) that allows a wide range of attributes describing stone type and stone condition to be linked to architectural elements within single geospatially referenced sites, rapidly and consistently, in a digital, hierarchical form, in the field.

The SIGMA-GIS approach provides the considerable flexibility required for surveying stone-built structures. The module is able to adapt to any type of structure and it applies to any scale (ranging from an entire town, to a single building, architectural element, or single block of stone). A range of expertise is needed to fully populate the module; however, the data can be presented in a user-friendly visual manner in GIS or map form, creating a powerful heritage planning tool.

Additionally, the spatially referenced digital data can easily exploit the power of queries and be converted into statistical form due to the use of pre-determined, hierarchical fields and supporting dictionaries, which ensure a high degree of accuracy and consistency in the dataset. Other spatially referenced data can be imported into the GIS interface for comparison and further analysis.

BGS will use this survey methodology in future projects to ensure a consistency of approach and terminology. The data will be stored in the 'Building Stone Database of the United Kingdom', which is currently being built by the British Geological Survey.

## ACKNOWLEDGEMENTS

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