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12.1 Introduction

This chapter introduces the concept of RIGS in urban areas and looks at examples of educational sites accessible to the majority of the population of Britain. The geodiversity of towns and cities is immense, with people, landscape and culture intertwining with history to shape the development of urban areas. Monuments, graveyards, public toilets and building fronts provide a large and untapped resource.

12.2 RIGS and the built environment

More than 80 per cent of people in the United Kingdom live in urban areas, and yet only a fraction of the nation's Earth heritage SSSIs (Sites of Special Scientific Interest) are located in these areas. This is hardly surprising, given the rapid development of Britain's population centres; the few studies that have been completed show that the number of urban Earth heritage sites – quarries, natural exposures, semi-natural landforms – has been steadily declining since the 19th century.

Yet the potential for urban RIGS is high. In recent years there has been an increased awareness of the importance of the urban environment in promoting the Earth sciences through its fabric of building stones and parks, and a proliferation of urban geological trails and building stones guides. In many ways, towns and cities provide the greatest challenges and opportunities for Earth heritage conservation, and it is essential that an open mind is maintained in the selection and promotion of urban RIGS sites. This is particularly so in lowland Britain, where there may not be much clear evidence of the original geological foundations of the city, and where the opportunities for study of exposed geology in urban sites are limited.

12.3 Science, education, culture?

It is essential to recognise that, while sites can be of the highest geological and scientific significance, their value as an educational resource is often one of the most powerful reasons for their designation. Clearly, there has to be scientific merit in the designation of urban RIGS, but the creation and promotion of a resource which is accessible to the majority of the British public - a majority that is largely unmoved by geology - could be seen as one of the most significant tasks facing RIGS groups today. On this basis a wider remit, taking into account the educational aspects of the resource, has to be taken seriously. The site may also be of cultural significance, and this can be included in its interpretation. The challenge for RIGS in the urban environment is to recognise diversity in its Earth heritage resource.

12.4 The nature of the urban Earth heritage resource

There are three basic categories of urban Earth heritage resource, all of which provide the potential for RIGS designations:

- Remnants of the primary geology/geomorphology of a region prior to construction
- Quarries, pits and mines on the outskirts of the urban conurbation, but often engulfed by it
- The built environment - buildings, statues and monuments, graveyards, roads and other constructions which are composed primarily of materials derived from the geological resource, in the form of building stones and other construction materials.

12.4.1 Remnants of primary geology

The growth of urban centres following the Industrial Revolution left a legacy of remnant quarries, cuttings, outcrops and landforms in the centre or suburbs of many towns and cities. Some of these may be preserved in a semi-natural state in city parks or in the grounds of large private houses which have since been incorporated into the fabric of the city.

These remnants often have an aesthetic and cultural significance, although their scientific importance may be less evident. However, there is no doubt about the educational benefit of having such open spaces located within the inner city, close to schools and other educational centres. These locations provide the closest approximations to rural RIGS sites, and may be referred to as standard RIGS designations.

Given that parks and open spaces are usually in the care of local authorities, standard RIGS designations can help increase the status of the park and help in attracting funding, for example for interpretative signage.

In London, a region where there is very little natural geological exposure, opportunities exist for the promotion of geology in parks. A good example is Springfield Park in Hackney, on the banks of the River Lea. This is an urban RIGS site in which geology and remnant geomorphology are both present in an otherwise relatively depressed inner city area. See appendix 12.3.

12.4.2 Marginal quarries, pits and mines

These are to be found on the outskirts of the town or city, and once provided the construction materials or industrial resources for its growth. Such sites would be representative of standard RIGS. Very often these are disused and may be the target for out-of-town shopping centres, waste disposal sites or other development, dependent on their density and proximity to a transport system. A good example of this kind of development is seen around Plymouth, where many Devonian limestone quarries, some of them SSSIs, are being used for industrial and commercial developments. Such afteruse is not necessarily incompatible with Earth heritage conservation, but quarry floor developments would require negotiation of a conservation corridor for access, while a conservation void would have to be maintained where waste disposal was proposed.

Quarries, pits and mines provide many challenges to the urban RIGS group. Although they may be within greenbelt, they may well be targeted for some form of development. This is particularly true of the London-M25 area, where all quarries are seriously considered for waste disposal. In rarer cases, underground mines may also provide opportunities for the urban RIGS group, and although this in itself may cause problems through safety issues, there may well be mileage in this area. Interestingly, in Greater London both Pinner Chalk mines in the north and Chislehurst Caves in the south east are underground workings with the greatest potential for standard geological conservation.

12.4.3 The built environment

The fabric of our towns and cities provides important aesthetic and cultural associations, and an educational opportunity, and as discussed above, this may outweigh considerations of a purely scientific nature. Often, the early, pre-Industrial Revolution and transport-age building stones were locally derived and are in harmony with the local landscape and geology. The built environment may therefore mirror local geology, and the vernacular architecture in particular, using local stone, has a strong appeal. In other cases, imaginative use of geological materials in the urban environment has led to the creation of 'geological theme parks' or 'problem walls/wall games' and these features, constructed from early Victorian times, are perhaps some of the most innovative aspects of potential urban RIGS (see section 12.7.1). Educationally, the built environment offers a great challenge, in displaying a wide range of geological materials which are subjected to stringent weathering effects of the often hostile urban atmosphere, and which can be of primary scientific value. Buildings, monuments and graveyards may be in private or local government hands and the recognition of non-standard RIGS sites which might encompass them is a challenge to any urban RIGS group.

12.5 Standard and non-standard RIGS: recognising urban types

The richness of the resource will inevitably vary from town to town, affecting the number and balance of standard and non-standard RIGS sites that are identified. On this basis it is possible to group urban developments according to their visible natural geological resources, and recognition can help in establishing priority in RIGS designations.

Three groups are apparent:

- **Type 1: Those areas with a striking or visible natural geological resource**. A classic example is Edinburgh, with Arthur's Seat and Castle Rock. Such areas are likely to have a greater potential for standard RIGS sites, and public awareness of geology in such areas may be strong.
- **Type 2: Those areas with some naturally outcropping geology**. In such areas, geology may have a subdued presence, and public awareness of geology may be low, present only as a subliminal recognition of geological features which the local population may take for granted.
- **Type 3: Those areas with little or no exposed or visible geology**. Most inland towns in lowland Britain fall into this category, including most of the major conurbations. Awareness of geology in these locations is usually low, and the potential for standard RIGS sites poor, although that for non-standard RIGS is high.

The recognition of the existence of the three types of urban area is important in guiding approaches to RIGS designation. Typically, standard RIGS sites (such as quarries, natural exposures and relict landforms) will be more easily recognisable in type 1 and 2 towns, with greater potential for the preservation of original features. However, type 3 locations have little or no visible geology, and therefore the potential for standard RIGS is lower, requiring exploitation of existing artificial resources.

12.6 Promoting awareness: Urban Geological Promotional Plans

In recent years local geological societies and RIGS groups have had considerable success in getting Earth science sites accepted as worthy of protection by local planning authorities, leading to their incorporation as conservation sites in local structure plans. In some cases, particularly where there is a strong local action group, such as in the Black Country, there has been a move towards the development of strategic plans for the conservation of standard urban geological sites. These plans set out good conservation practice as well as identifying the type of natural geological site resource within an area.

Such strategic plans are rare, but those that do exist provide a model which could be mirrored by the production of local strategies for the enhancement of geological awareness in an urban environment. Using this model, Urban Geological Promotional Plans could be drawn up, each one setting out a list of generic objectives focused towards the single aim of promoting public awareness of the available geology within a town. The aim of the promotional plan concept is simply to get geology promoted within a town at the same level, and in the same way, that cultural heritage is packaged. It involves crossing the communication gulf that often exists between special interest groups and the local population.

Each promotional plan will be different depending on the nature of the geological resource present and opportunities available to local RIGS groups. Two generic examples are given below, one for type 1 and 2 towns, and another for type 3.

Promotional Plan: Type 1 and 2

Aim:

- to promote the natural geological resource within the town and to demonstrate the links with its historical, social and cultural development. Standard RIGS sites are most likely in these centres.

Objectives:

- recognition and development of standard RIGS sites (relict quarries, natural outcrops, relict landforms)
- interpretative strategy which promotes the incorporation of geology into every leaflet, display or exhibition depicting the history of urban development, especially where the development was particularly governed by the nature of the local geology
- promotion of the use of the traditional/local building stone in street furniture in keeping with its local environment. These links can be made stronger by the inclusion of occasional stone inscriptions giving its name and local source
- promotion of landscaped ground in harmony with the local geology. In particular rockeries should use local stone where possible, and should be organised so that the dip and strike of the placed stone mimics or reflects that of the naturally outcropping geology which surrounds the town
- the education potential of local quarries, natural exposures and other site resources should be exploited. Educational packages for local schools can be developed through consultation with teachers, taking into account the needs of appropriate key stages of the National Curriculum.

Promotional Plan: Type 3

Aim:

- to create a geological resource where no obvious one exists, and to encourage the exploitation of the urban fabric as a resource. Non-standard RIGS sites are more likely.

Objectives:

- recognition and promotion of predominantly artificial resources (building stones, parks, graveyards, problem walls)
- promote the creation of geology where no obvious evidence of it exists, through the use of artificial reconstructions, sculptural features which are made from geological materials, or which are in harmony with geological structure, and in problem walls intended to demonstrate the richness of lithology or geological structure
- encourage the link between geology and architecture through promotion of the good practice of stone labelling, or in the development of interpretative leaflets distributed to local schools and museums
- development of high street building stone trails and cemetery 'visitor centres' in which the geology and weathering of gravestones can be interpreted and understood
- construction of problem walls to demonstrate geology in parks and playgrounds.

12.7 Non-standard RIGS: geodiversity in the built environment?

In many ways the greatest challenge to urban RIGS groups is where the urban environment belongs to type 3, and natural, standard RIGS sites are few. This is common in the mostly heavily populated cities of the United Kingdom, and it is here that the communication gulf between specialist interest groups and the general public is at its widest. We need, therefore, to consider adopting more innovative, non-standard RIGS 'sites', and to promote them to the widest possible public. Four examples are given below:

12.7.1 The Wall Game

The Wall Game was devised by Eric Robinson as a way of using the built environment to teach basic petrology. It requires only an accessible, stone-built wall, often – but not always – located in historic conservation locations. Simply, it requires a basic reconnaissance by a given RIGS group and the construction of a simple stone 'map' of the wall. Participants in the game are asked to identify observable differences in stone through colour, grain/crystal size, texture and so on, and through this activity basic principles can be taught. Perhaps the most important wall is the ballast wall he described from Battersea Park in London. See appendix 12.2.

12.7.2 Labelling the built environment

The built environment is incredibly rich in natural stone, and the trend towards using such stone is increasing. Urban RIGS groups have an essential role to play in identifying and lobbying potential areas where natural stones in appropriate juxtapositions could be used to create a greater awareness of geology. One particularly important example of the above approach is a set of four stone benches outside Euston Station in London, which are labelled with location, rock type and age. As is often the case, a precursor to this is provided by an example of Victorian ingenuity. In a graveyard in Rochdale, an amazing set of labelled stone markers help the visitor to not only identify the gravestone type, but also to understand the stratigraphy of Britain.

Fig 1: Labelling the built environment is nothing new – this remarkable example in a Rochdale graveyard dates back to Victorian times.

An important role for urban RIGS groups would be to not only identify such historic examples, but also to actively promote labelling, a concept in keeping with English Heritage's conception of the urban cityscape (see *Streets for all. A guide to the management of London's streets*, published by English Heritage).

12.7.3 Rockworks

Rockworks comprise artificially constructed geological features which may be of sufficient merit to be able to demonstrate geological principles. These can vary from the humble rockery, appropriately constructed, through to the grand civic structures of the Victorian age. In fact, any structure which is capable of demonstrating a geological principle is available as a RIGS site. On the largest scale this would include the complex geological 'theme park' of Crystal Palace Park in South East London, civic rockworks often, but not always, in public parks such as those in Battersea Park, London, Ramsgate town centre, Kent and Lister Park, Bradford. Smaller scale versions can be observed in many urban centres.

12.7.4 Graveyards and burial grounds

The potential for graveyards as geological resources has long been recognised, and valuable primary research, particularly on weathering, has been carried out. There is a richness of geological resources in our urban burial grounds, and these should be seriously considered as RIGS sites of the future.

Urban RIGS: streets ahead?

Urban RIGS groups need to recognise that geodiversity has to include the built environment. The development of awareness and education strategies, through Promotional Plans, represents an important role for every RIGS group with an urban focus.

Appendix 12.1 – Useful reading

The most important recent general works are *Geology on your Doorstep* (Bennett et al. 1996) and *Urban geoscience* (McCall et al. 1996), which provide general introductions to the principles and methods of urban geology and its conservation.

Baldwin, A. & Alderson, D.M. 1996. 'A remarkable survivor: a nineteenth century geological trail in Rochdale, England.' *The Geological Curator*, **6**, 227-232.

Bennett, M.R. & Doyle, P. 1996. 'The introduction of geology into the urban environment: principles and methods.' In: Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds). *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London, 239-262.

Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds) 1996. *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London.

Bennett, M.R., Doyle, P., Glasser, N.F. & Larwood, J.G. 1997. 'An assessment of the 'Conservation Void' as a management technique for geological conservation in disused quarries.' *Journal of Environmental Management*, **50**, 223-233.

Dove, J. 1996. 'Exeter and Norwich: their urban geology compared during medieval, Victorian and Edwardian periods.' In: Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds). *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London, 171-180.

Doyle, P. & Bennett, M.R. 1997. 'Earth-heritage conservation in the new millennium: the importance of urban geology.' *Geology Today*, **13**, 29-35.

Doyle, P. & Bennett, M.R. 1998. 'Earth-heritage conservation: past, present and future agendas.' In: Bennett, M.R. & Doyle, P. *Issues in environmental geology: a British perspective*. The Geological Society, London, 303-332.

Doyle, P. & Bennett, M.R. 1999. 'Fragile Resources: labelling the built environment.' *Urban Design Studies*, **5**, 47-56.

Doyle, P., Bennett, M.R. & Robinson, E. 1996. 'Creating urban geology: a record of Victorian innovation in park design.' In: Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds). *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London, 74-84.

Doyle, P. & Robinson, J.E. 1993. 'The Victorian 'geological illustrations' of Crystal Palace Park.' *Proceedings of the Geologists' Association*, **104**, 181-194.

English Heritage. *Streets for all. A guide to the management of London's streets*. English Heritage, London.

Ingham, S.M., Doyle, P. & Bennett, M.R. 1996. 'The changing nature of the urban earth heritage site resource.' In: Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds). *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London, 31-38.

Mason, R. 1996. 'Heathen, xenoliths and enclaves: kerbstone petrology in Kentish Town, London.' In: Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds). *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London, 47-58.

McCall, G.J.H., De Mulder, E.F.J. & Marker, B.R. (eds). 1996. *Urban geoscience*. A.A. Balkema, Rotterdam.

McKirdy, A.P. 1990. Earth science conservation – a strategy. Appendices. *A handbook of Earth science conservation techniques*. Nature Conservancy Council, Peterborough.

Pounder, E.J. 1996. 'Geomorphological conservation: opportunities afforded in Greater Bristol.' In: Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds). *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London, 85-95.

Robinson, J. E. 1994. 'The mystery of Pulhamite and an outcrop in Battersea Park.' *Proceedings of the Geologists' Association*, 105, 141-143.

Robinson, J.E. 1996a. 'The paths of glory.' In: Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds). *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London, 39-46.

Robinson, J.E. 1996b. 'A version of the 'wall game' in Battersea Park.' In: Bennett, M.R., Doyle, P., Larwood, J.G. & Prosser, C.D. (eds). *Geology on your doorstep. The role of urban geology in earth heritage conservation*. The Geological Society, London, 163-170.

Robinson, J.E. & McCall, G.J.H. 1996. 'Geoscience education in the urban setting.' In: McCall, G.J.H., De Mulder, E.F.J. & Marker, B.R. (eds). *Urban geoscience*. A.A. Balkema, Rotterdam, 235-252.

Appendix 12.2 - The Wall Game

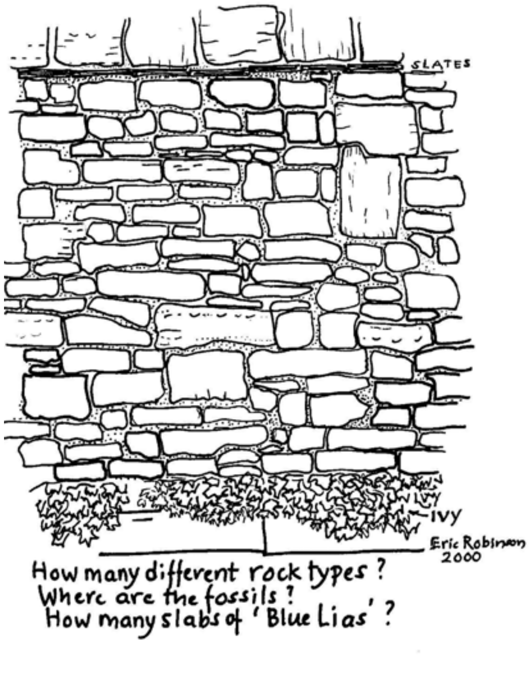
The weathered stone of any aged wall can provide a wealth of opportunities for observations which can be the first steps towards an understanding and an appreciation of geology. There is nothing wrong with new stone walls, but, patched and rebuilt, there is ample scope for distinguishing one stone from another.

If people are finding different stones, it doesn't really matter if they can't be named as precisely as a geologist would prefer. It is enough for a beginner to be able to separate sandstone from limestone, and to defend this identification. The next step is to spot the stones which contain fossils. Perhaps it will be possible to classify those shells. Are they brachiopods or bivalves? Are they complete or fragmented? On that evidence, opinions can be offered about conditions of sedimentation.

Bedding and sedimentary structures give an easy means of deciding whether blocks in the wall have been laid with an orientation which would correspond with bedding in an outcrop or quarry. This is a small detail, but it allows recognition of what might be the Jurassic sea bed. Once again, we are giving the beginner the opportunity of reasoning and thinking as a geologist simply on the basis of observations they can make on a wall.

The work sheet

When devising a work sheet for a wall game, it is tempting to draw and shade the outlines of individual stones as if creating a work of art. It is better to have a cartoon with recognisable outlines, but allowing the distinctive details to be applied to the blanks (see example below). This requires the student to look for themselves, decide what are the salient features, and then improve the sheet with their idea of effective representation of rugged bedding or prominent fossil outlines. It is up to the player whether they choose colour felt tips or pencil shading to distinguish what they see as different rock types. It might be that they recognise many more than you would expect. It is then up to them to justify their actions to you.



Appendix 12.3 – Case study: Springfield Park geology leaflet

Anyone reading the name Springfield Park on a map of Hackney would probably get the idea that this was ground marked by the presence of springs. Water bubbling from the ground and trickling into small streams flows downslope to join the River Lea.

Springs usually result from rainwater draining down into the ground soaking through the soil and subsoil to a point at which it reaches a material which prevents it flowing further. Soil and subsoil are usually made up of grains of sand, small and large pebbles – all materials in which there are plentiful spaces between the solid particles, spaces which can be filled up with water which will flow with slopes. In contrast, clay is a rock which has no such spaces as a rule. Clay particles press closely together with no pathways for escape. Meeting clay, flowing water passing down from surface soil is forced to flow along the clay top surface to a point where it emerges to the outside world as a spring. It is just such a situation that we have in Springfield Park, Hackney.

Coming to the park from Clapton Road or Stamford Hill, you will notice that this is flat ground which connects up with Hackney Downs to the south. That flat ground continues into the top of the park, with **Springfield House** standing very close to the edge facing the Lea Valley. Just in front of the House, the ground falls away quickly to the lower flat area of the park, including the space of the football pitches. The flat platform is a great spread of sand and gravel which covers much of Hackney and is recognised as the river bed deposits of an ancient River Thames flowing about 10-15 metres above the present course at Wapping. The sands are called the **Hackney Terrace** by geologists and can reach a thickness of about five metres below that flat top surface.

Underneath the Terrace lies a very thick clay deposit which is much older – roughly 50 million years old.

This is the London Clay, a very sticky grey-brown clay with all those properties which prevent water sinking down through it. So here is the situation. Up to five metres of sand and gravel containing thousands of gallons of water sitting on a thick and tight clay. The result? A line of springs oozing out from the base of that slope in front of the House and running on to the top end of the rugby pitches. If you trace the line of springs as you walk along the face of the slope, you are tracing the contact between the Terrace gravels and the underlying London Clay. This is how the geologists make geological maps.

Things to look for

Unfortunately, we can't see any of the sands or gravels of the Hackney Terrace, or the clay of the London Clay outcrop. All we can do is to look at the ground and read the signs which hint what is below the surface.

Starting with the sands and gravels, if you walk across the flat top surface of the park, notice the short springy turf of low growing grasses. These usually indicate well-drained light soils which we would expect to develop from the sands and gravels of the Hackney Terrace. If you run, notice how the ground 'gives' underfoot and makes you bounce. This too tells us that there is yielding sand below surface rather than shock-absorbing clays.

Moving down the slope towards what should be the top of the London Clay, notice increasing wetness. Water oozes from the ground after heavy rain. In places, the oozes become visible flow. These are the **springs**. Rich crops of buttercups also help to pick out wet areas.

Moist clays can become quite plastic, almost like plasticine. As such they can flow down quite low angle slopes. If we look at the tarmac-covered paths which run across the slopes of the park, they often show tear-apart cracks which tell us that the ground beneath has moved and taken the path with it up to the point where the surface broke. It can look like earthquake damage, but these cracks are evidence of clay moving downslope with clay underneath – London Clay in this case.

Down on the flat spread of the park, notice how wet the ground is in winter and spring, making the ground heavy for the footballers. In summer, after dry spells, the same ground shrinks as it dries out; cracks appear as the soil is torn apart. Some trees, such as willows and poplars, prefer heavy clay soils. See if you can discover these trees in any part of the park.

It is the same clay which floors the bed of the River Lea. When you stand on the flat top surface and look eastwards across the Lea Valley, the wetness created by the same clay floor has been the cause of the important nature reserve of **Wanstead Marshes**. The broad valley was created many thousands of years ago during the Ice Age. When glaciers melted, the local rivers including the Lea were much increased in volume and had the power to excavate wide valleys through the clay outcrop we have been discussing in the bottom of the park. Try to think of any part of the present world where ice and meltwaters occur (bones of reindeer and polar bear have been found in the Lea Valley just to prove that the local climate was once as cold as the present-day Arctic).

Eric Robinson