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A vision of 'deep time': the 'Geological Illustrations' of Crystal Palace Park, London

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Abstract: Crystal Palace Park in the London Borough of Bromley is a masterpiece of park design by the visionary Sir Joseph Paxton. Created to house the iron and glass 'Crystal Palace' (the temporary structure built for the 1851 Great Exhibition in Hyde Park), the park was developed on a series of themed terraces, with the palace itself at the top of Sydenham Hill. The terraces were linked by a grand central walkway, and massive fountains played in gigantic fountain bowls. Today, the palace is gone, destroyed by fire in 1936; the fountains are quiet and their bowls occupied by the stadia of the National Sports Centre; and the central walk is interrupted by intrusive twentieth century concrete architecture. But one jewel of the original remains. In the SE corner lies a remnant of Paxton's original English landscape garden, a fragment populated with 'antediluvian monsters' and geological cliffs. This remnant is arguably the world's first attempt at recreating, in a systematic, scientific and ordered way, the geology of the United Kingdom, and its survival and subsequent restoration in 2001 is a remarkable testimony to its constructors and originators.

This paper examines the background and achievement of this first accurate recreation of geology in a public park, a Victorian monument to the relevance of promoting awareness of the science as a foundation to effective geoconservation.

Geology: the new science of the masses

The birth of geology—the science of the composition, structure and history of the Earth—can be traced back to at least the seventeenth century, but the explosion of popular and professional interest in the science can be placed at around the turn of the eighteenth century (Rudwick 1985, 1992). At this time, geologists and palaeontologists in France, Germany and Britain were shaping the new science, with men such as Georges Cuvier in Paris, catastrophist and identifier of extinction; James Hutton, a Scot, the originator of the concept of uniformitarianism, and discoverer of the vastness of geological time (since dubbed 'deep time'), and the Englishman William Smith, creator of the geological map and interpreter of 'strata' identified by fossils (e.g. see Gould 1990; Rudwick 1985, 1992; Winchester 2001). From the turn of the century through to the 1860s scientific advances came thick and fast in Britain, most published by the Geological Society of London, the world's first geological society, set up in (1807). In the *Transactions of the Geological Society of London* came the first notices of dinosaurs and other extinct organisms (in Buckland (1824) was the first formal description of what became known as a dinosaur, *Megalosaurus*); and the establishment of the formal stratigraphy of the British Isles (in Buckland (1835), the stratigraphy of the Portland and Purbeck was established, a model of which was later made in Crystal Palace Park).

By the 1860s geology was so popular that it was included as one of the eight 'greater sciences' on the Albert Memorial in London (the other seven being agriculture, geometry, physiology, astronomy, rhetoric, chemistry and medicine; Brooks 1995). The subject found favour with the masses, and people turned out in their hundreds to hear notables such as Sir Roderick Murchison speaking on his 'Silurian system' underground in Dudley (Barber 1980). Barber's thesis is that geology and palaeontology were part of the popular Victorian obsession with the natural sciences. Geology was available to anyone with access to the countryside, and even, from the mid-nineteenth century onwards, within the confines of the urban park.

Geology in public parks

The birth of the public park has been adequately described elsewhere, and it is sufficient to say that from the early 1840s onwards, formally laid out urban parks were a feature of urban planning (Conway 1991). From the beginning, geology was included in such parks, usually as aspects of 'hard landscape', but also increasingly representative of 'scientific specimens' (Conway 1991; Taylor 1995; Doyle *et al.* 1996). In fact, the history of

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the representation of geological artefacts and of geology *per se* in private gardens and parks can, arguably, be traced back to the 'Grand European Tour' and the development of grottoes on private estates. The eighteenth century Goldney Garden grotto in Bristol is an excellent example (Savage 1989). In public parks, many representations of geology are associated with Joseph Paxton, who had earlier used the concept to good effect in the private estate of Chatsworth. In Birkenhead Park (1847), rockworks represented The Strid in Yorkshire, a rocky gorge cut through Millstone Grit (Taylor 1995). Interestingly, Paxton imported this stone into Birkenhead Park, a park actually founded on other, younger and more brightly coloured red sandstones. This desire for accuracy was to become a focal point for Paxton in developing his gardens, and also, for other designers who used accurate representations of geology in later parks. Good examples include the Khyber Pass in East Park, Hull (1887), the 'Pulhamite' cliffs and crags in Battersea Park (1866–70), and the representation of Thornton Force in Lister Park, Bradford (1903) (see Festing 1984; Conway 1991; Robinson 1994; Taylor 1995; Doyle *et al.* 1996). It was against this backdrop that Paxton was to create his masterpiece; Crystal Palace Park, at the time on the outskirts of SE London.

The embodiment of a Victorian ideal

In June 1854, Crystal Palace Park was opened to the public for the first time. Paxton intended it to be a complex of pleasure grounds to rival those of the Palace of Versailles, housing the reconstructed Crystal Palace—the innovative glass and steel structure built by Paxton for the Great Exhibition of 1851 in Hyde Park (Beaver 1986). Crystal Palace Park was laid out on Sydenham Hill, within the 200-acre grounds previously occupied by Penge Place. The Palace itself was rebuilt on the crest, and a series of terraces were constructed on its slopes, including immense fountains and a large boating lake (Fig. 1). The vision was a complex one, as it led from the delights and peculiarities of the immense interior of the palace itself, to a variety of experiences laid out for the visitor in the surrounding parkland; a perfect embodiment of the Victorian ideal of the continuity of knowledge.

The central grand walkway was the axis of the park, bisecting the formal italianate gardens of the top terrace, the large twin fountains and finally the English landscape garden at the base of the slope. The division of the park into terraces created a subset of gardens that encompassed several of the categories discussed by the influential park designer John Loudon twenty years before (Loudon 1835) in which gardens were classified according to the intention of the designer into scientific, landscape, recreation and burial categories.

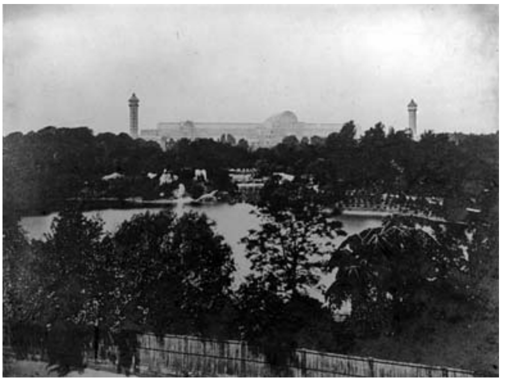

Fig. 1. Late Victorian photograph of the 'Crystal Palace' with the 'Geological Illustrations' just on the other side of the lake: to the left, the Secondary Island (with its dinosaurs and other reptiles), to the right, the Tertiary Island. Between them may be seen the Coal Measures.

Perhaps most important of these was the English landscape garden, which was found to the east of the formal gardens and encompassed the lower part of the park, including the lakes, part of the waterworks and ultimately linked to the great fountain systems. Within it, and associated with the lakes, the manifestations of geology were to be constructed, and they remain there today, a unique component of this extraordinary public park.

What is not clear, however, is who originally had the idea to reconstruct geological environments within the park. The issue is still much debated, and requires further research (McCarthy & Gilbert 1994). Suggested authors of the scheme include Sir Richard Owen, Prince Albert and Sir Joseph Paxton himself. Paxton is the most likely. Whatever the origin of the idea, the Board of the Crystal Palace Company sanctioned the construction of what might now be termed a complex geological 'theme park' in the SW quadrant of the park within the English landscape garden:

> It is here that one of the most original features of the Crystal Palace Company's grand plan of visual education has been carried out. There, all the leading features of Geology are found displayed, in so practical and popular a manner, that a child may discern the characteristic points of that truly useful branch of the history of nature. (Anon. 1893, p. 29)

The Crystal Palace Company directors were no strangers to geology (H. Torrens, pers comm.), as several of them were involved in the large civil engineering schemes of the day, and at least one was also the director of a mine company in Clay Cross in Derbyshire. As such it is not unreasonable to expect that they would wish to see representation of what was termed 'that most useful branch of the history of nature', and this is underlined by the fact that many of the geological features were modelled on the geology of Derbyshire. Another contemporary guide to the park points to the author of the scheme as a whole, David Thomas Ansted, late Professor of Geology at Kings College, London, and subsequently at the College of Civil Engineers at Putney:

> The original plan of the whole was suggested by Professor Ansted, and arranged with Sir Joseph Paxton at an early period of the laying out of the grounds; and as soon as the state of affairs permitted and the actual earthworks of the Plateau were in progress, a model of the intended structure was completed and coloured geologically by Professor Ansted. The works have been ably constructed from this model by Mr James Campbell, who also procured the stone and other minerals from different parts of the country. (Phillips 1855, pp. 191–192)

There was evidently a close working relationship between Ansted and Paxton. 'The series was carefully tabulated by Professor Ansted, to ensure its geological accuracy, according to Sir Joseph Paxton's designs for the picturesque arrangement of this interesting portion of the grounds' (Anon. 1893, p. 29).

The whereabouts of Ansted's model is not known, and as far as can be ascertained, no plans of Ansted's own vision exist, but it is clear that the landscape was to include a representation of the successive ages of the geology of Britain from the Primary (Precambrian–Palaeozoic today) rocks through to the Secondary (Mesozoic) and Tertiary (Cenozoic–Quaternary today). This is also apparent from Ansted's own writings, which echo the existing materials in the park, and from recent 'geological' mapping of the remaining structures in the park (Ansted 1858; Doyle & Robinson 1993, 1995). Ansted's book displays many similarities to the Crystal Palace tableaux.

Given the industrial links of the company directors, it is not surprising that this vision of the geology of Britain was to include economic rocks and geological structures, together with the remains of relatively newly discovered fossil organisms constructed in a full-size and three-dimensional form. The task of constructing these was the duty and vision of Benjamin Waterhouse Hawkins, who had illustrated the published work and treatises of some of the leading palaeontologists of the day. As 'Director of the Fossil Department of the Crystal Palace', Hawkins, advised by Sir Richard Owen, constructed his full-sized extinct mammals and reptiles arranged stratigraphically in Ansted's geological landscape; a vivid recreation of the most recent discoveries in a new and exciting science (McCarthy & Gilbert 1994).

In fact, it was Gideon Mantell (to many the discoverer of the dinosaurs) who was originally asked to assist. The Alexander Turnbull Library, Wellington, New Zealand, contains a manuscript extract from the minutes of a meeting of the Board of Directors of the Crystal Palace Company, held on 10 August 1852 at which it was resolved:

> that a geological court be constructed containing a collection of full-sized models of the animals and plants of certain geological periods, and that Dr Mantell be requested to superintend the formation of that collection ... (Alexander Turnbull Library MS papers 83, folder 32)

The contemporary guides were well aware of its significance as the most extensive educational endeavour ever in a public park: 'the spectator standing on the upper terrace of the Plateau has before him the largest educational model ever attempted in any part of the world' (Anon. 1893, p. 29).

Constructing a vision of 'deep time'

Ansted's geological framework was completed with the exception of the older Cambrian and Silurian 'greywacke' rocks; a framework intended to illustrate the geological development of Britain on its journey through the 'deep time' of geological history. The younger 'Primary' rocks had a special place adjacent to a vibrant water-course, and here a Mountain Limestone cliff overlain by Millstone Grit and faulted against Coal Measures was constructed, modelled on the Derbyshire Peaks (Fig. 2). All of these geological units were founded on the Devonian rocks of the Old Red Sandstone forming the framework for the main

Fig. 2. 'Primary' rocks in Crystal Palace Park: the restored Mountain Limestone Cliff and cave.

water feature and 'rustic' bridge (McDermott 1854; Anon. 1893).

Adding realism to the Mountain Limestone was the construction of a three-quarters scale lead mine and cave, complete with stalactites. As noted in the guidebooks of the day, this element of Derbyshire realism was created by James Campbell, a mining engineer and member of the Crystal Palace Company board (Phillips 1855). What is surprising about this construction is the sheer technical complexity of the structure. The limestone cliff and mine was completely destroyed in the 1960s during remodelling of the watercourse as a 'water garden', but enough remained to be able to carry out archaeological investigations in 2001. These showed the presence of a stepped limestone cliff constructed over a brick-arched tunnel. The tunnel contained extensive modelling of stalactites and other features associated with the karst landscape of Derbyshire. Importantly, these investigations also revealed that complex mineral veins had been built into the scheme to enhance realism, together with large crystals of typical minerals found in the lead mines that flourished in Derbyshire in the mid-nineteenth century; an echo of the crystal grottoes of the previous century. The coal face also demonstrated considerable complexity, with coal cut in blocks and reconstructed in accurate relations with sandstones and ironstones typical of the Clay Cross Pit (Fig. 3; Doyle & Robinson 1993, pp. 184–7).

Overlying gently tilted Carboniferous rocks was the New Red Sandstone, deliberately placed in unconformity: these sandstones provide continuity with the first of two islands intended to carry the reconstructions of extinct animals, constructed by Hawkins (Doyle & Robinson 1993, pp. 188–9). Downslope from this tableau was the 'Secondary island' itself commencing with tilted New Red Sandstone. Conformable with these were representations of the other major 'Secondary' (Mesozoic) geological units of southern Britain. In turn Lias, Oolite and Wealden rocks succeeded each other, surmounted by Chalk at the head of the island. In place on top of these rocks were reconstructions of animals that had been recovered from the Mesozoic formations during the previous fifty years, and beyond, on a separate island, the mammals of the Cenozoic and Quaternary, on rather more uncertain footings consequent upon the weaker sands, clays and gravels that typify these geological units in Europe (Doyle & Robinson 1993, 1995).

As has been argued by Martin Rudwick, Hawkin's representation of extinct animals in a stratigraphical arrangement was not unique. In fact, it was part of a developing tradition of pictorial representation of geological time in the mid-nineteenth century. But what was unique, and remains so to this day, is the accurate portrayal of those animals in three dimensions, and set within a framework of rocks that once contained their fossil bones (Rudwick 1992). However, since the restoration, the observer can see the stratigraphy as a backdrop and stage to the recreated animals, with perspective providing continuity to that stratigraphy.

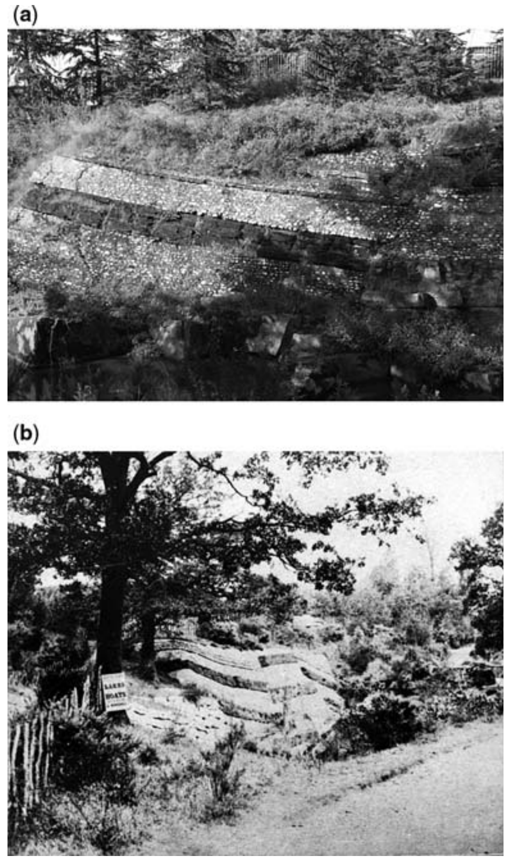

Fig. 3. 'Primary' rocks in Crystal Palace Park: (**a**) the Coal Measures cliff as it appears today; (**b**) the Coal Measures cliff from a Victorian photograph (Courtesy Mick Gilbert).

Populating a geological landscape

Hawkins set out his method of working in a lecture delivered to the Society of Arts in 1854, subsequently reprinted for separate distribution by James Tennant, who was later to supply small-scale models of the dinosaurs to educational establishments and museums. Working closely with Sir Richard Owen, Hawkins first created a clay model that was then altered in line with the scientist's vision (Hawkins 1854). This was particularly significant in relation to the reptiles, where active debate raged, a debate well rehearsed by Deborah Cadbury (2001), whose book deals with the antagonism between Mantell and Owen. Much of the battle was fought over the relative size and form of dinosaurs such as *Iguanodon*, Mantell's own discovery. With Mantell's withdrawal from Crystal Palace, it was Owen's vision that was completed.

Having gained agreement, most of the larger animals were constructed as buildings with strong brick piers to support their massive bodies. A range of commonly available building materials were then used to create the overall framework, onto which were attached the carefully moulded outer layers of the dinosaurs, for example. Smaller reptiles were built up carefully *in situ* (Fig. 4) and several of the mammals were built around iron armatures, with delicately moulded lead heads and limbs. One of the largest of the mammals, the *Megatherium*, a gigantic ground sloth, illustrates a fourth technique used by Hawkins, that of careful sculpture from limestone blocks, rather than moulding of cements.

The retinue of animals represented the brightest and best discoveries by mostly British scientists: New Red Sandstone dicynodonts and labyrinthodons from the Cape Province of South Africa and the Midlands of England, respectively (Fig. 4); Liassic ichthyosaurs and plesiosaurs from Lyme Regis, based almost exclusively upon the discoveries of the collector Mary Anning (Fig. 5); the alligator-like *Teleosaurus* from the Lias of Whitby and pterodactyls of the Oolite and Chalk (Fig. 6); the Stonesfield Slate dinosaur *Megalosaurus*, the first of the 'terrible lizards' described by William Buckland in 1824 (Fig. 7), and its prey from the

Fig. 4. The labyrinthodons under construction in 1854 (Courtesy Mick Gilbert).

Fig. 6. *Teleosaurus* (foreground) with Jurassic pterodactyls in the background, after recent restoration.

Fig. 5. The Secondary Island. Ichthyosaurs and plesiosaurs under construction in 1854 (Courtesy Mick Gilbert).

Fig. 7. Close up of the *Megalosaurus*, as it appears today.

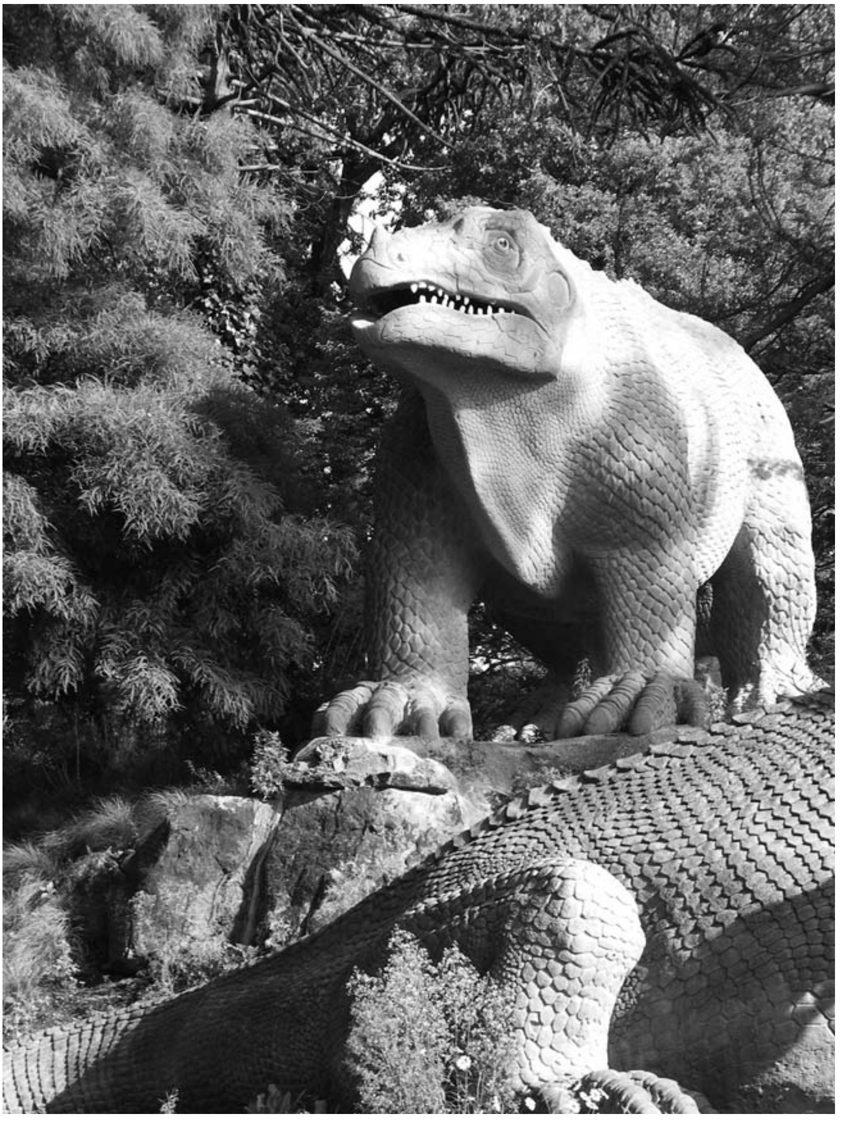

Fig. 8. *Iguanodon* standing on Wealden sandstones, as it appears today.

Weald *Iguanodon* (Fig. 8) and *Hyaelosaurus*, both described by Gideon Mantell (e.g. Mantell 1825); and the Chalk marine reptile *Mosasaurus* (Fig. 9). All were constructed on representations of the very rocks that yielded their bones, and described by Owen himself in his own guide to the display, published by the park authorities in 1854 (Owen 1854).

Separated from the Secondary island by a weir was the 'Tertiary' island. A symbolic end to the 'Age of Reptiles', the weir marked the beginnings of the 'Age of the Mammals'. The 'Tertiary' island was to be populated with mammals from the Cenozoic (and early Quaternary), but surviving records show that just a fraction of the mammals originally intended were built, due to financial difficulties (Doyle & Robinson 1993, 1995; McCarthy & Gilbert 1994). A letter from Hawkins to Sir Richard Owen dated 24 October 1855 illustrates what was completed and what was intended (Owen papers 14/534, Natural History Museum; Fig. 10). Notable mammals constructed were: Cuvier's Paris Basin *Palaeotherium* and *Anoplotherium*; *Megatherium*, a giant ground sloth

Fig. 9. *Mosasaurus* as it appears today.

from South America (Fig. 11); and *Megaceros*, the 'Irish Elk' (Fig. 12). Amongst the other mammals intended were the mammoth, mastodon, *Dinotherium*, and the giant armadillo *Glyptodon*. Birds driven to extinction by human activity, the Dodo the Moa (*Dinornis*)—upon which Richard Owen had built his reputation—were also to be built. All were to be placed upon a geological backdrop of worked aggregates intended to represent the relatively unconsolidated rocks of this interval of geological time. They were never completed.

Changing fortunes, changing fashions

From the 1860s onwards, the park had mixed fortunes, and one-by-one the visionary nature of the park's landscape began to fail or become obscure. The changing nature of park activities—including the garrisoning of troops in two world wars—and changes in local government priorities also took their toll. By the 1970s the continuity and integrity of the grand idea had become broken and fragmented, and some major features, such as the impressive cliff of Mountain Limestone, had been completely destroyed.

Fig. 11. *Megatherium* as it appears today.

Today, the reconstructed animals are 'buildings' protected by law, and have mostly survived, despite neglect, scorn and derision. Most general accounts of dinosaurs have as a start point the discoveries of Mantell and Buckland, the work of Owen and

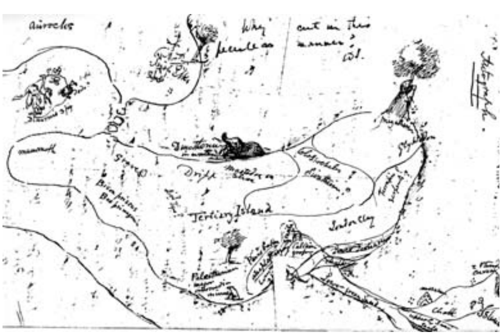

Fig. 10. Manuscript map of the Tertiary Island, reproduced from a letter from Hawkins to Owen preserved in the Owen papers at the Natural History Museum, London. The maps show the extent of what was planned for this island, a fraction of which was constructed.

Fig. 12. The antlers of *Megaceros*, the Irish Elk. The original had fossil antlers, then a common find.

the models in Crystal Palace. The majority make some passing reference to 'inaccuracies' and commonly refer to the quadrupedal stance of Iguanodon and *Megalosaurus*, and the 'mistake' of placing the *Iguanodon*'s thumb-spike on its nose. This trend started in the late nineteenth century, with Henry Woodward of the British Museum (Natural History) being especially scornful:

> the late Mr B. Waterhouse Hawkins (formerly a lithographic artist) was for years occupied in unauthorised restorations . . . discoveries of later years have shown that *Dicynodon* and *Labyrinthodon* . . . were salamander-like reptiles . . . that *Iguanodon* did not usually stand on 'all fours' [and] that the horn on its snout was really on its wrist. (Preface in Hutchinson, H.N. 1892, p. iii)

These views, although strictly accurate, are starkly unimaginative, and contributed to the decline of what is in reality a magnificent adventure in science, a bold step of creating a three-dimensional geological textbook in the heart of a London suburb.

Fortunately, with Heritage Lottery backing, the Borough of Bromley has restored and reconstructed the 'Geological Illustrations', dubbed the 'Time trail', for a more modern audience (Doyle 1994). Conservation of the 'buildings' (dinosaurs and mammals), and reconstruction of the geological features included 110 tonnes of replacement Carboniferous Limestone delivered from a source close to the original in Derbyshire (Fig. 2). This was constructed on geological principles as a replica cliff, complete with the original mineral mine and cave. Cotswold Oolite replaced that destroyed by neglect and natural process, to form the perch for two missing Jurassic pterodactyls (Fig. 6). The pterodactyls themselves were constructed to the highest standards, replicas of the 1854 originals. A cliff of chalk complete with flint lines was constructed for the other pterodactyls. Contemporary photographs and fragments close to the original site demonstrated the original form of this cliff, a cliff that had, in common with the rest of the geological display, literally mouldered away into the undergrowth.

The dinosaurs have been carefully restored, the swellings associated with iron bar and cracks associated with age and settlement repaired with high-specification materials intended to last (Doyle 2001*a*, *b*). The original paint scheme was assessed: a layer of startling pink in the strata of paints forms the base, but the final coat includes muted greens and greys with appropriate glazes (Figs 6–9). Finally, sensitive planting, reflecting the succession of plant life through time as known in the 1850s, complements the animals and their geological setting. Piece by piece the 'geological illustrations' have risen once again from their municipal park setting, almost 150 years after they were first conceived, a striking reminder of Victorian ingenuity and scholarship.

The lesson of Crystal Palace Park

The Victorian ideal of Crystal Palace Park was a means of introducing to an urban public, in a practical sense, a science that could otherwise only be seen in popular books and monthly magazines—as new discoveries were being made, and as geologists became public figures. Using the latest science, published in the best journals of the day, the public were entertained by the juxtaposition of solid geology in correct stratigraphical relationships and reconstructed dinosaurs and large mammals. In this way, the Crystal Palace Park experience transcended the mundane, and became more than a gaudy theme park. It served instead as both visual spectacle and outdoor teaching laboratory, a lesson in the promotion of awareness of geology that is rarely attained, with any success, today (Doyle 1993; Doyle *et al.* 1996). This record of innovation, repeated in other Victorian parks serves as a lesson for today; only through increasing awareness of geology will the public be sufficiently engaged to conserve it (Doyle & Bennett 1998). As such, Crystal Palace Park deserves its place in the annals of geoconservation as an outstanding example of the relevance and importance of enhancing awareness of geology in an urban setting.

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