

# THE PROTECTION OF JURASSIC SITES AND FOSSILS: CHALLENGES FOR GLOBAL JURASSIC SCIENCE (INCLUDING A PROPOSED STATEMENT ON THE CONSERVATION OF PALAEOONTOLOGICAL HERITAGE AND STRATOTYPES)

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**Key-words:** Conservation, GSSP, Geosites, Jurassic, palaeontology, ProGEO, stratigraphy, stratotypes.

**Abstract.** Effective geoconservation systems are crucial to the activities of subcommissions of the International Subcommission on Stratigraphy, such as the Jurassic Subcommission (ISJS). Fundamentally, the core activity of any Subcommission, the establishment of Global Stratotype Sections and Points (GSSPs) is a conservation activity in itself, involving the selection of key sites, to be maintained as references for subsequent consultation. Without adequate national site protection and management systems this fundamental function is liable to fail as the selected site remains vulnerable to loss and damage. In addition, strict conservation systems applied without adequate understanding of the needs of research and education can also prevent or significantly inhibit geological science and the use of sites such as GSSPs. To address these extreme scenarios and assist the development of a more scientific approach to conservation of geological sites of stratigraphical and palaeontological importance during dialogues with administrative authorities, a Statement defining categories of palaeontological heritage requiring protection and the basic requirements needed to achieve the conservation of stratotype localities is here proposed. The context of the protection of Jurassic sites within other international projects is also reviewed, in particular the IUGS Geosites project, within which all GSSPs will be listed.

**Riassunto.** Efficaci sistemi di geoconservazione sono cruciali per le attività delle sottocommissioni della Sottocommissione Internazionale di Stratigrafia, come la Sottocommissione Giurassico (ISJS). Fondamentalmente, il cuore dell'attività di ogni Sottocommissione, l'istituzione di Sezioni e Punti di Stratotipo Globali (GSSP), è in se stessa un'attività di conservazione, includendo la selezione di siti chiave che debbano essere mantenuti come riferimento per successive consultazioni. Senza degli adeguati sistemi nazionali di protezione e gestione dei siti, questa funzione fondamentale è destinata a venir meno, dato che il sito prescelto rimane vulnerabile a perdite e danneggiamenti. In aggiunta, sistemi di conservazione rigidi applicati senza un'adeguata comprensione delle necessità della ricerca e dell'educazione possono anche ostacolare od inibire significativamente le scienze geologiche e l'uso di siti come GSSP. Per indirizzare questi scenari estremi ed assistere lo sviluppo di un

approccio maggiormente scientifico alla conservazione dei siti geologici d'importanza stratigrafica e paleontologica nel dialogo con le autorità amministrative, viene qui proposta una Dichiarazione che definisce le categorie di bene paleontologico necessitanti protezione ed i requisiti basilari richiesti per ottenere la conservazione di località stratotipo. Viene inoltre passata in rassegna la protezione dei siti giurassici nel contesto di altri progetti internazionali, in particolare il progetto Geositi IUGS, al cui interno saranno elencati tutti i GSSP.

## Introduction

Geoconservation, the protection of sites and features of geological and geomorphological importance, is now becoming established as a discipline requiring integration into natural heritage protection systems. This is largely due to an increased awareness amongst heritage managers and concerned politicians that environmental degradation as a result of human activity is not only a threat to ecological and cultural heritage, it can also lead to the loss of the Earth's own archive of its development through geological time - in other words its geological heritage (cf. the "Digne Declaration"; Premier Symposium International Sur La Protection Du Patrimoine Geologique, 1991/1994).

Crucially, effective geoconservation systems are fundamental to the activities of the ISJS, as the establishment and ongoing use of GSSPs is a conservation activity in itself, involving not only site selection but also requiring the establishment of long-term site protection and management systems to fulfil the requirements of the International Commission on Stratigraphy (Remane et al. 1996; Page et al. 2000). The latter include requirements under Section 4.4 for "(m) Permanently fixed marker",

*“(n) Accessibility”, “(o) Free access” and “(p) Guarantees from the respective authority concerning free access for research and permanent protection of the site”* - all of which are only possible on a designated and appropriately managed conserved site (Page 2001).

Without adequate national and local conservation systems guaranteeing these principles, the rationale of GSSP selection can fail, as the stratotype will remain vulnerable to damage or even loss. In addition, Jurassic stratigraphy has an almost unique problem, as the key correlative tools for most marine sequences – ammonites – are traded internationally as ornaments, potentially, therefore, placing all Jurassic GSSPs at particular risk. Ironically, the development of legal frameworks in some countries to address this issue have the potential to turn against geoscientists and especially palaeontologists, when restrictions begin to inhibit ongoing research and educational programmes. As fossils also comprise a “moveable heritage”, conservation issues do not stop when a specimen leaves a protected site – indeed many existing conservation systems fail as legal frameworks tend to concentrate on either site protection or specimen protection, and very rarely both (Page et al. 1999).

Despite the importance of geoconservation systems to GSSP selection and use, there appear to be no formal ICS/IUGS guidelines on appropriate conservation systems, or even minimum requirements; this consideration is left to each Subcommission. Indeed, a general lack of formal international conservation systems and frameworks within which geological sites can be incorporated compounds this problem. As a result, national governments and managers of geological sites have no agreed reference through which to guide their legislative and policy frameworks. Where geoscientists, and especially palaeontologists are engaged at the highest level, conservation systems can be soundly based, but where institutions and administrators confuse the highly restrictive philosophies of biological or archaeological conservation, the result can virtually prevent all geological study.

An exception to the lack of international conservation frameworks for geological heritage sites, however, is listing as **World Heritage**, under the UNESCO 1972. Naturally, such a status is only really conceivably for truly globally exceptional sites, but as issues of site management are left to local administrative authorities, the measures implemented may not be the most appropriate for international scientific purposes (Page 2002). Other designations such as **European Geoparks** ([www.europeangeoparks.maestrazgo.org](http://www.europeangeoparks.maestrazgo.org)), with their origins in the UNESCO Geoparks concept (Eder 1999), provide a context for the sustainable management of geologically important regions, and detailed conservation guidance is provided. These projects, however, also emphasise hu-

man interaction and are not designed for purely scientific conservation aims.

In contrast, the IUGS **Geosites** programme is the first global initiative which aims to establish an inventory of geological heritage sites of high scientific importance which, almost by definition, would include all ratified GSSPs. The Geosites initiative has been developed by the Working Group on Geological and Palaeobiological Sites, established within IUGS and with support from both UNESCO and IUCN. The aim of the initiative is to produce a global indicative list of Earth Heritage sites of significant international importance and support individual country-based, or other international initiatives, which aim to establish similar inventories (Wimbledon 1999, Wimbledon et al. 2000; Poli 1999). Inevitably such initiatives will include the promotion of site-protection mechanisms and the group already advises IUGS and UNESCO on priorities for conservation in the global context, including World Heritage listing. Geosites listing does not in itself automatically confer protection, however, but can provide a stimulus for, or recommendation to national or regional governments or administrators to establish some form of natural monument protection for the listed sites. Elsewhere in IUGS, however, despite its promotion of site-based studies, such as through the International Geological Correlation Programme and especially through the Subcommissions of the International Commission on Stratigraphy, geoconservation initiatives are currently remarkably lacking, as indicated above.

Within the European Union, at least, international initiatives in part driven by the non-governmental organisation ProGEO (The European Association for the Preservation of the Geological Heritage; [www.sgn.se/hotel/progeo](http://www.sgn.se/hotel/progeo)) could ultimately provide a sound framework for the protection of geological heritage sites of Europe-wide importance. The organisation provides Europe's only forum for the discussion of the selection, management and use of geological heritage sites. It convenes international conferences every 3 years, promotes additional meetings of regional and other groups and publishes discussion and reports through its website, newsletter and conference proceedings (e.g. Gisotti & Zarlenga 1999; Baretino et al. 1999, 2000). Direct contact with EU projects have already included contributions to the Council of Europe, 1996 Pan European Biological and Landscape Diversity Strategy (“PEBLDS”), which fully recognises the importance of geology and physical landscapes and their intimate links to biodiversity conservation. In the longer term, contributing to or promoting the development of some form of Community-wide geological heritage Directive, analogous to that already in place to protect habitats and species, is a role which ProGEO is very well placed to play.

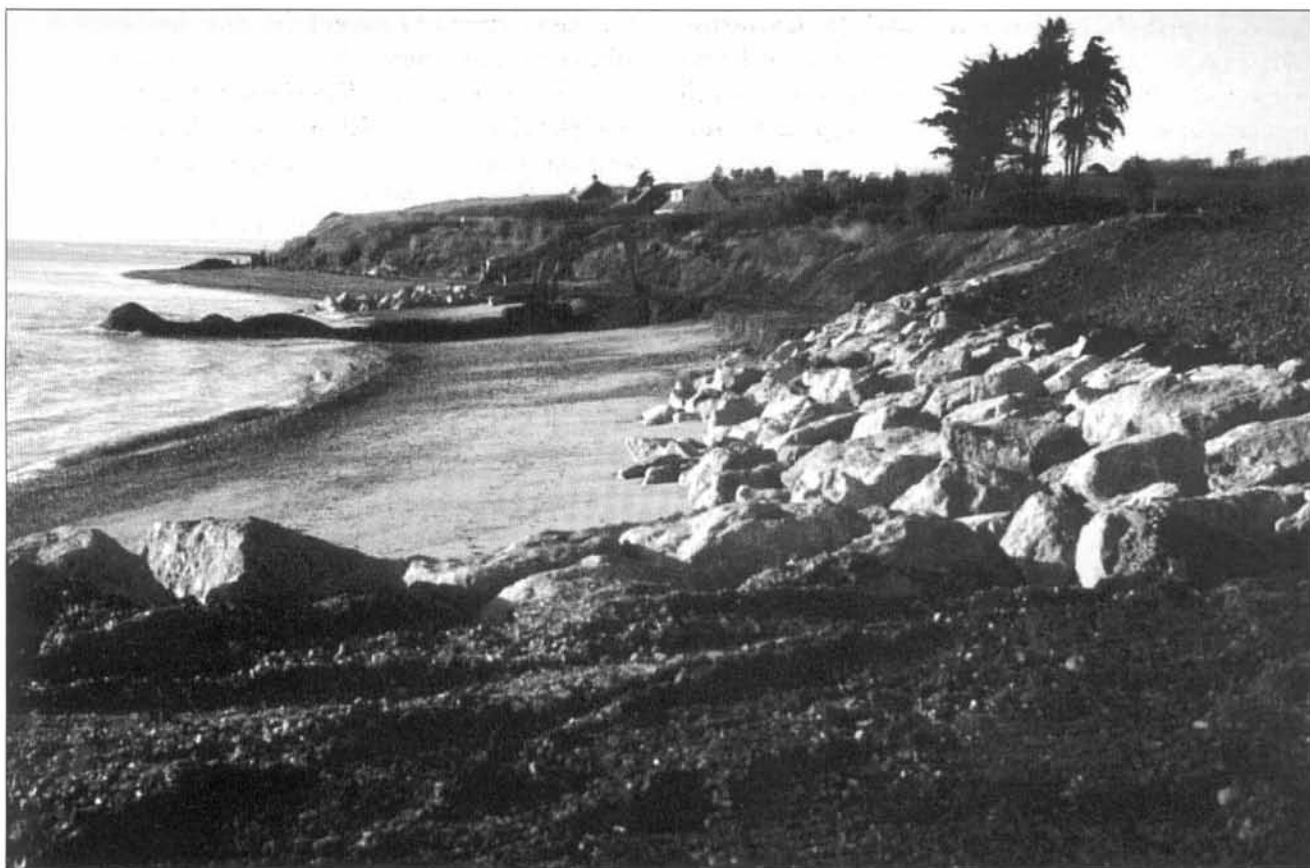


Fig. 1 - The construction of coastal defence structures in progress on a historical stratotype for the base of the Kimmeridgian Stage at Ringstead in Dorset (south west England) – the site is the type locality of the terminal Oxfordian, Evoluta Subzone and the basal Kimmeridgian, Baylei Zone.

**The establishment of a Geoconservation Working Group in the ISJS and the proposed statement on “The Conservation of Palaeontological Heritage and the protection of the Global Geological Time Scale”**

The establishment of a formal Working Group committed to sharing information and developing guidance on geological conservation philosophy and practice is a somewhat radical approach for a scientific subcommission of IUGS (Page 2001). Nevertheless, it is probably not surprising that it should be the Jurassic Subcommission to break new ground in this field – Jurassic rocks are well developed in many densely populated areas, such as northern Europe, and industrialisation and urbanisation have taken their toll of famous scientific important exposures. One of the first expressions of concern on this matter is by J. Leckenby in 1859 in connection with coastal defence works at Scarborough (north east England), which had destroyed one of the richest sources of well preserved Callovian ammonites in Britain (including the type locality of the index fossil of the first subzone of the Oxfordian Stage, *Cardioceras scarburgense* (Young & Bird)). Even W.J. Arkell demonstrated an awareness of such matters, in his classic monograph of Oxfordian ammonites (1935–1948), having witnessed the loss of many

of his important quarry sites around Oxford itself, as a consequence of infill operations.

Ironically, these are still two of today’s greatest threats to geological sites, with recent damage to historically important Oxfordian–Kimmeridgian boundary localities near Weymouth in Dorset (south west England) by coastal defence works (Fig.1; localities as described by Arkell, 1947 and Cox in Wright & Cox 2000) and the complete infill of the famous Woodham Pit in eastern central England by landfill with domestic refuse (locality described by Arkell 1939 and Callomon 1968), leading to the loss of one of the UK’s most important Callovian–Oxfordian boundary sites (Page, this volume).

Of equal concern, however, to many colleagues in the field today, is the threat posed to sites and palaeontological heritage by the great popularity of fossils as ornaments, leading to a blossoming international trade which touches even the remotest geological localities. The virtual destruction of some such sites and stratigraphical levels by illegal collectors is well known (Fig.2; cf. Webber 2001), but even palaeontological institutions have been targeted – the sad story of theft from the Palaeontological Institute in Moscow being well documented (Cockburn 2001; Karis 2001). In a sense palaeontology is a victim



Fig. 2 - "Strip mining" of ammonite-bearing Lower Jurassic shales by commercial fossil collectors - the type horizon of *Caloceras johnstoni* (Sowerby), the index species of the second subzone of the Jurassic System (Donoford Bay, West Somerset coast, south-west England).

of its own popularity, with films such as "Jurassic Park" making dinosaur fossils, in particular, highly sought after. With the Jurassic being a major source of the latter and also a rich source of ammonites - considered by some to be no more than "bread and butter" fossils for collectors (i.e. providing a basic financial income; Page 2002), but in scientific reality, the most important stratigraphical indicator species for marine sequences of this age - it is hardly surprising that the Jurassic subcommission should establish a Geoconservation Working Group.

Beyond providing a forum to exchange information and facilitate discussion on matters relating to the conservation of sites and fossils of Jurassic age, a key function of such a Working Group should be to produce management guidelines and minimum requirements, for the effective conservation and continued truly international scientific use of GSSPs and other stratotype localities (including aspects of palaeontological heritage management and data or specimen curation and accessibility). Crucially, these guidelines could also provide a credible framework for Jurassic specialists to negotiate within, should liaison with governmental authorities and administrators be necessary to establish an appropriate level of protection for a threatened site. Conversely, they could also be

used to promote greater scientific access when existing restrictions effectively prevent or inappropriately inhibit continued research.

Further liaison and potential collaboration with other international geoconservation projects and organisations, including ICS, IUGS, ProGEO and UNESCO's Earth Science Division, has the potential to increase the authority of any statement on these matters and its potential for international administrative acceptance. Nevertheless, although a crucial long term goal, full inter-organisational agreement on the wording of guidelines for the protection of palaeontological heritage and stratotypes could take several years to achieve and it is believed, therefore, that the circulation of a "working version" as developed within the ISJS, is now essential to allow progress in this field to be achieved, at least on a local scale.

The challenge, therefore, is to produce a document which promotes the establishment of effective conservation systems to prevent the damage or loss of sites and specimens whilst maintaining access and utility for international scientific study, both in the field and in an institutional or museological context. In addition the document must recognise the great diversity of cultural philosophies of heritage management and the uniqueness of

the development of the legal systems of every nation - no universal guidelines for palaeontological heritage and palaeontological sites can therefore be too prescriptive.

The proposed wording of these Guidelines is provided in the Appendix to this paper and comprises two parts: the first presents an objective and scientific classification of palaeontological heritage, as a guide to the level of protection appropriate for specific categories of palaeontological specimen; the second part identifies the minimum requirements for the effective protection of a geological locality of international stratigraphical and/or palaeontological importance. As they stand, the Guidelines can provide a working document or framework for discussion on matters of palaeontological heritage and site protection. As discussion continues, however, the wording of these Guidelines will naturally be refined, but the real challenge now is raise awareness elsewhere within

ICS and IUGS of the need to develop a united approach to matters of geological, including palaeontological, heritage protection. Should formal adoption of such Guidelines be achieved, in full or in part, through this route, it is hoped that they can then be used to stimulate rational national and international discussion on these issues and, ultimately, the establishment of clear and simple procedures for the continued and truly global use of GSSPs and other sites of recognised international stratigraphical and especially biostratigraphical importance.

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## REFERENCES

- Arkell W.J. (1935-1948) - A monograph of the ammonites of the English Corallian Beds. *Monogr. Palaeontogr. Soc.*, 420 pp, London.
- Arkell W.J. (1939) - The ammonite succession in the Oxford Clay at the Woodham Brick Pit, Akeman Street, Buckinghamshire, and its bearing on the classification of the Oxford Clay. *Quart. Jl. geol. Soc. Lond.*, 95: 135-122, London.
- Arkell W.J. (1947) - The geology of the country around Weymouth, Swanage, Corfe and Lulworth. *Mem. Geol. Surv. Eng. and Wales*, V. of 386 pp, HMSO, London.
- Barettino D., Vallejo M. & Gallego E. (eds) (1999) - Towards the balanced management and conservation of the Geological Heritage in the new Millenium, Sociedad Geológica de Espana, Madrid, V. of 459 pp., Madrid.
- Barettino D., Wimbledon W. A. P. & Gallego E. (eds) (2000) - Geological Heritage: It's conservation and management. Instituto Tecnológico GeoMinero de España, Madrid, V. of 212 pp., Madrid.
- Callomon J.H. (1968) - The Kellaways Beds and Oxford Clay. In: Sylvester-Bradley, P.D., And Ford, T.D. (eds.), The geology of the east Midlands: 264-290, Leicester University Press, Leicester.
- Cockburn P. (2001) - Trade in rare fossils robs Russia of natural heritage. *The Independent*, July 23, 2001, London.
- Eder W. (1999) - "UNESCO Geoparks" - A new initiative for protection and sustainable development of the Earth's heritage. *N. Jb. Geol. Paläont. Abb.* 214 (1/2): 353-358, Stuttgart.
- Gisotti G. & Zarlunga F. (coord. eds.) (1999) - The Second international Symposium on the Geological Heritage / World Heritage: Geotope conservation world-wide, European and Italian Experiences; Rome, May 20-22, 1996. *Memorie descrittive della Carta Geologica d'Italia*, 54 (1999), V. of 527 pp., Roma.
- Karis L. (2001) - A future for fossils - the Russian perspective. *ProGEO news*, 1/2001: 8, Oslo.
- Leckenby J. (1859) - On the Kelloway Rock of the Yorkshire coast. *Quart. Jl. geol. Soc. Lond.*, 15: 4-15, London.
- Page K.N. (2001) - Geoconservation Working Group. *International Subcommission on Jurassic Stratigraphy, Newsletter* 28: 11-13 (electronically published).
- Page K.N. (2002) - Geoconservation Working Group. *International Subcommission on Jurassic Stratigraphy, Newsletter* 29: (electronically published).
- Page K. N. (this volume) - The Callovian-Oxfordian Boundary In Britain: A Review Of Key Sections And Their Correlation With The Proposed Global Stratotype Section And Point For The Oxfordian In Haute Provence, France. *Riv. It. Pal. Strat.*, 110 (1): 201-208, Milano.
- Page K.N., Bloos, G., Bessa J.L., Fitzpatrick M., Hart M., Hesselbo S., Hylton M., Morris A. & Randall D.E. (1999) - East Quantoxhead, Somerset: A candidate Global Stratotype Section and Point for the base of the Sinemurian Stage (Lower Jurassic). In: Hall, R.L. & Smith, P.L. (eds.), *Advances in Jurassic Research 2000. Proceedings of the Fifth International Symposium on the Jurassic System, GeoResearch Forum* 6: 163-172, Trans Tech Publications, Zurich.
- Page K.N. & Melendez G. (1996) - Protecting the Jurassic: global boundary stratotypes and conservation. *Geology Today*, November-December 1995: 226-228, London.
- Page K.N., Melendez G. & Gonera M. (1999) - Protected sites or protected heritage? - Systems and opinions for palaeontological conservation from a trans-european perspective. In: Barettino, D., Vallejo, M & Gallego (eds), *Towards the balanced management and conservation of the Geological Heritage in the new Millenium*, Sociedad Geologica de Espana, Madrid: 45-51, Madrid.

- Poli G. (ed.) (1999) - Geositi Testimoni del Tempo: Fondamenti per la conservazione del patrimonio geologico. Servizio Paesaggio, Parchi e Patrimonio Naturale, Regione Emilia-Romagna, V. of 259 pp., Bologna.
- Premier Symposium International Sur La Protection Du Patrimoine Geologique, (1991/1994) - Déclaration Internationale Des Droits De La Mémoire De La Terre / International declaration of the rights of the memory of the Earth (Digne, 13<sup>th</sup> Juin 1991), In: Martini G. & Pagès J.-S. (eds) 1994. Actes du Premier Symposium International sur la protection du Patrimoine Geologique, Digne-les-Bains, 11-16 juin, 1991. *Mém. Soc. Géol. France, Nouvelle Série* 165: 270-274, Paris.
- Remane J., Bassett M.G., Cowie J.W., Gohrbandt K.H., Lane R.H. Michelsen O. & Naiwen W. (1996) - Revised guidelines for the establishment of global chronostratigraphical standards by the International Commission on Stratigraphy (ICS). *Episodes* 19/3,
- Webber M (2001) - The sustainability of a threatened fossil resource: Lower Jurassic *Caloceras* Beds of Doniford Bay, Somerset. In: Bassett, M. G., King, A. H., Larwood, J. G. & Deisler, V. K. (2001) - A Future for Fossils. National Museums and Galleries of Wales, Geological Series 19: 108-113, Cardiff.
- Wimbledon W.A. (1999) - L'identificazione e la selezione dei siti geologici, una priorità per la geoconservazione. In: Poli, G. & Previdi, G. (eds), Geositi, Testimoni del Tempo: Fondamenti per la conservazione del patrimonio geologico. Servizio paesaggio, Parchi e Patrimonio Naturale, Regione Emilia-Romagna: 52-63, Bologna.
- Wimbledon W. A. P., Ischenko A. A., Gerasimenko N.P., Karis L. O., Suominen V., Johansson C. E. & Freden, C. (2000) - Geosites - An IUGS initiative: Science supported by Conservation. In: Baretino, D., Wimbledon, W. A. P. & Gallego, E. (Eds), Geological Heritage: Its Conservation And Management. Instituto Tecnológico Geominero de España, Madrid, 69-94, Madrid.
- Wright J. K. & Cox B. M. (2000) - British Upper Jurassic Stratigraphy: Oxfrodian to Kimmeridgian. Geological Conservation Review Series, Joint Nature Conservation Committee, 266 pp., Peterborough.

#### APPENDIX: Proposed Statement of Guidelines for the Conservation of Palaeontological Heritage and the Protection of the Global Geological Time Scale.

**Preamble:** The following statement has been developed to provide guidelines and recommendations for national, regional and local community administrations, heritage conservation services and officials, and all owners and managers of geological heritage sites and palaeontological heritage resources, both in natural outcrop and in public and private institutions. It recommends the adoption of legal systems, methodologies and policies which promote the protection and responsible management of geological, including palaeontological, heritage for future generations. Fundamentally and in the spirit of international collaboration and co-operation, this management should permit ongoing site-based research and study, in order to facilitate the continuing education and scientific development of global societies as a whole. As a framework for the wise and responsible management of this global geological heritage, a scheme of principles is recommended which, if adopted, could assist in the decision-making process as to which mechanisms and statutes are necessary, within the context of national legal process and policy, to achieve such ends. The principles recommended would apply not only to natural monuments of geological, including palaeontological, importance, but also to the moveable heritage that these sites have yielded, that is rock, fossil and mineral specimens of significant scientific importance. These two schemes of principles are outlined below:

For **PALAEONTOLOGICAL HERITAGE**, the following classification scheme for fossil specimens, as a guide for decision making processes, is proposed:

**Category 1:** *Specimens of typological importance for the definition of fossil species as regulated by the International Commission on Zoological Nomenclature (a UNESCO project), including holotypes, lectotypes, neotypes and syntypes.* Every type specimen is a global reference for the species it defines, it is therefore irreplaceable. The type specimen of even the smallest oyster species is more important, in heritage protection terms, than a skeleton of a large dinosaur, if the latter has no typologi-

cal significance. *Scientific method therefore dictates that all Category 1 fossils must be deposited and protected in nationally recognised scientific and cultural institutions and legal systems should aim to achieve such ends.* Specimens only become types, however, after scientific study, which can only be facilitated by free and open access to palaeontological localities for *bone fide* geological study. Legal systems should on the one hand ensure that such access can take place and on the other hand seek to guarantee that institutional deposition and full protection of the relevant specimens is achieved once study is completed.

**Category 2:** *Specimens figured or cited in scientific papers or unique, rare or exceptionally complete specimens or assemblages of specimens of fundamental importance to actual or future scientific studies.* Specimens belonging to Category 2 are fundamental to the science of palaeontology, both as the evidence for published studies and as the raw material for ongoing or future studies. *Conservation and legal systems or practice should, therefore, ensure, including through the use of expert advisors or assessors, that such specimens are deposited and protected within nationally recognised institutions, where they will remain accessible for future study and appreciation.*

**Category 3:** *Key specimens of stratigraphical or palaeobiological significance, material complementary to ongoing scientific studies, specimens of especial suitability for museum display or educational use, by virtue of completeness or other features of instructive value.* Category 3 specimens are not only important for ongoing scientific research, they are also important for scientific education. They would include rare records of important taxa better known at other localities and assemblages of ecological or stratigraphical importance in place in natural outcrops. Specimens of high educational value are included, even if their research potential is more limited. *Conservation and legal systems or practice should aim, therefore, to promote the wise management of this resource by preventing the over-exploitation of Category 3 fossils and ensuring that the needs of educational and research are not prejudiced by activities such as commercial or unregulated recreational collecting. Wherever possible, these procedures should encourage the deposition of Category 3 fossils in national or regional institutions, to maximise availability for future scientific study or educational use.*



**Category 4:** *Common and representative species and specimens, well represented in national museums and other institutions, or sufficiently abundant that any non-scientific collecting or removal will not prejudice future scientific work; specimens collected loose, for instance from scree, rubble or beach material, where the lack of stratigraphical information significantly reduces scientific use.* Such specimens can be very abundant, even rock-forming and may even become part of a commercial mineral resource, such as limestone or coal. The use of such specimens for teaching, public education and personal enjoyment provides opportunities to promote a respect and understanding for geological heritage, without prejudicing its long-term conservation. *Category 4 fossils do not normally require legal protection, especially when they lie outside of protected areas.* It is therefore recommended that legal systems adopt a degree of flexibility to allow more public experience of palaeontological heritage belonging to Category 4, but at the same time providing guarantees, guidelines and statutes to ensure that any new finds assignable to categories 2 and 3, or potential to Category 1, can be fully protected.

Categories 1-3 would be considered to be of “*significant scientific importance*” in the context of palaeontological heritage management with only Category 4 specimens considered to be as “*not of significant scientific importance*”.

For those geological sites of regional and international importance for the definition and use of a global **GEOLOGICAL TIME SCALE**, including stratotype sections and reference localities, the following framework, as a guide to identification, delineation, protection and managed scientific study is proposed:

**1. Boundary delineation:** *The site is clearly identified and delineated, to its full scientifically relevant extent, both in documents and, as far as is practical, in the field, including through the use of appropriate national procedures relevant to the permanent protection of natural monuments and natural heritage sites, and through governmental development planning, structural and construction-regulation systems.* Site selection is of course, a crucial precursor to site protection, and in many cases national lists compiled by specialists may already exist, for instance linked to the IUGS Geosites programme. Such lists can provide a valuable framework for selecting sites for legal or procedural protection.

**2. Management scheme:** *A clear administration system should be applied or established to oversee the management and protection of the geological site and regulate scientific and educational use.* This admini-

nistration should have the authority the grant permission to any *bone fide* person or group, whether national or foreign, for the genuine and responsible scientific use and sampling of the stratotype locality. The authority should also have the legal power, or access to such systems, that permit appropriate action to be taken to prevent damage, destruction or irresponsible non-scientific removal of the geological features and specimens for which the geological area is protected. The use of internet web-sites to inform would-be visitors of procedures they should follow is beneficial.

**3. Free Access:** *Access procedures, including applications for legal permissions, should be simple and efficiently managed and permit free and open use of the geological site by both national and foreign scientists, for genuine and responsible research and study.* When in doubt as to the *bone fide* status of applicants, the responsible authority can establish suitability through existing national and international scientific networks, including Subcommissions of the International Commission on Stratigraphy.

**4. Collection of specimens:** *The responsible scientific collecting of geological specimens, including rocks, minerals and fossils, is an essential part of the bone-fide scientific use of a stratigraphical locality and should not be unreasonably restricted.* Conversely, steps should be taken to control, restrict or prohibit the non-scientific collection of specimens, for instance for commercial or recreational purposes, should such activities have the potential to impair or damage the scientific utility and heritage value of the site. The principles of palaeontological heritage classification, cited in this statement, can provide a guide for regulating the ultimate destination of any palaeontological specimens collected, but noting that the protection of specimens in foreign institutions, especially those belonging to categories 3 and 4, can benefit science and international understanding and co-operation, without threatening or undermining the goals and responsibilities of national heritage protection agencies and systems.

**Concluding remarks:** The responsible management of sites of regional and international importance for the definition and communication of the Geological Time Scale provides opportunities for all nations to contribute to the global understanding and wise management of the exceptionally rich natural heritage of this unique planet that we share [Further information on global geological heritage can be obtained from: [www.sgn.se/hotel/progeo](http://www.sgn.se/hotel/progeo) and [www.unesco.org/science/earthsciences/geological\\_heritage](http://www.unesco.org/science/earthsciences/geological_heritage)].