

# Jurassic Global Stratotype Section and Points (GSSPs) – a potential serial World Heritage Site?

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**ABSTRACT:** The Operation Guidelines for the UNESCO World Heritage Convention state that proposed areas should: “..be outstanding examples representing major stages of Earth’s history, including the record of life”, “..contain all or most of the key interrelated and interdependent elements in their natural relationships”, “..have a management plan...” and “..have adequate long-term legislative, regulatory, institutional or traditional protection..”. By definition, Global Stratotype Sections and Points (GSSPs) should satisfy all these criteria, although in isolation, the proposal of any single GSSP is unlikely to succeed, however, as an individual site may lack a broader context. Nevertheless, combining a suite of GSSPs sites for a System within a ‘serial’ World Heritage site proposal would satisfy such a concern and could be an ultimate goal for the International Subcommittee on Jurassic Stratigraphy.

## INTRODUCTION

The Operational Guidelines for the World Heritage Convention 1972 include the following criteria for the selection of natural heritage sites, which state that they should:

- “be outstanding examples representing major stages of Earth’s history, including the record of life, significant ongoing geological processes in the development of land forms, or significant geomorphic or physiographic features” (Criteria a (i)).
- “The sites listed in a (i) should contain all or most of the key interrelated and interdependent elements in their natural relationships” (Criteria b (i))

- “The site described in paragraph (a) should have a management plan” (Criteria b (v))
- “A site described in paragraph (a) should have adequate long-term legislative, regulatory, institutional or traditional protection...” (Criteria b (vi)).

Global Stratotype Sections and Points (GSSPs) are selected to act as global standards through which the geological timescale is internationally defined. They therefore represent the localities with the globally, most complete stratigraphically record (palaeontological, geochemical, magnetostratigraphical, *etc*) across a geological time boundary at level of stage (Remane *et al.* 1996). As such, a GSSP would fully satisfy World Heritage

criterion (i). Crucially, their identification and ratification is regulated globally by the International Union of Geological Sciences (IUGS) which also advises UNESCO on the selection of World Heritage Sites for geological features – such ratification can be taken as confirmation of global significance in more than just a technical or scientific sense.

In addition, as part of the GSSP selection process aspects of the site's conservation status and safeguard for future study are also taken into consideration. For instance under "4.4 Other requirements" (Remane *et al.* 1996) in addition to the full range of scientific qualities, a candidate GSSP should also have:

- "Permanently fixed marker" (requirement (m)),
- "Accessibility" (requirement (n)),
- "Free access" (requirement (o)),
- "Guarantees from the respective authority concerning free access for research and permanent protection of the site" (requirement (p)).

Although requirement (m) is unlikely to be possible in all natural and therefore eroding sites, the satisfaction of ICS criteria (n) to (p) would also satisfy criterion b (vi) of the World Heritage guidelines, if not b (v) as well.

The proposal of any single GSSP in isolation as a World Heritage site is unlikely to succeed, however, as individually such sites may lack a broader context. Combining a suite of GSSPs sites in a 'serial' World Heritage site proposal – a well established approach in other contexts – is however, conceptually much more likely to succeed. In particular a proposal incorporating all the applicable GSSPs for a single system could certainly satisfy Criterion b (i), especially as it would then include "all key interrelated and interdependent elements", *i.e.* all the component stages of that system.

A review of the ratified and current candidate GSSPs which could be included in such a proposal is given below. Accessory, supporting sites, are also included where approved as these are crucial to the global correlation process. An assessment of their conservation status and management regime is also included where such information is readily available. This information is crucial to both the GSSP and WH process and, of course, to any would-be site user.

## THE POTENTIAL COMPONENT SITES: JURASSIC GSSPS AND CANDIDATE GSSPS REVIEWED

### Hettangian (basal Jurassic)

Selecting a basal Jurassic GSSP had been an ongoing issue for many years and although five candidates are under discussion (see below), universal agreement on which site is the most suitable has yet to be achieved. A sixth proposal of a section in Peru (Utcubamba valley, Hillebrandt 1994) was subsequently withdrawn. Issues include incomplete documentation of accessory, multidisciplinary features, international correlations of endemic or localised ammonite faunas and accessibility. \*

NAME OF SITE/AREA: **St Audries Bay**, West Somerset coast, West Somerset, England, UK.

STATUS: Candidate GSSP.

NATURE OF SITE: Natural coastal cliff and foreshore exposures.

ACCESS AND OWNERSHIP: (ICS criteria (n), (o) and (p), part): Public access guaranteed under English law although cliffs and foreshore are privately owned. Permission may be required for sampling and all enquiries should be directed to: Natural England, Riverside Chambers, Castle Street, Taunton, Somerset, TA1 4AP, UK ([www.naturalengland.org.uk](http://www.naturalengland.org.uk)).

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY (ICS criteria (p), part): Blue Anchor to Lilstock Coast Site of Special Scientific Interest (SSSI, part) (Wildlife and Countryside Act 1981; Countryside and Rights of Way Act 2000) (administered by Natural England).

KEY REFERENCES: Warrington *et al.* (1994), Bloos and Page (2000).

NAME OF SITE/AREA: **Ferguson Hill**, New York Canyon, Gabb's Valley Range, Nevada, USA.

STATUS: Candidate GSSP.

NATURE OF SITE: Natural exposures in hill slope and gullies in remote and arid mountainous terrain.

ACCESS AND OWNERSHIP: Open access, although suitable vehicles essential. State owned land, managed by the Bureau of Land Management (USA).

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Bureau of Land Management

\* Quite recently (2008), Karwendal section was accepted by ISJS as GSSP, similarly as that of Ferguson Hills as ASSP.

(BLM) managed land, no other specific designation.

KEY REFERENCES: Lucas *et al.* (2007).

NAME OF SITE/AREA: **Kunga Island**, Queen Charlotte Islands, British Columbia, Canada.

STATUS: Proposed Auxiliary Section.

NATURE OF SITE: Coastal exposures, including foreshore.

ACCESS AND OWNERSHIP: Haida nation, permission may be required for access, but is essential for any sampling.

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Locality lies within the Gwaii Haanas National Park Reserve and Haida Heritage Site. For further information consult the Gwaii Haanas National Park administration.

KEY REFERENCES: Carter and Tipper (1999), Longridge *et al.* (2007).

NAME OF SITE/AREA: **Waterloo Bay**, Larne, Ulster, UK.

NATURE OF SITE: Coastal foreshore exposures.

ACCESS AND OWNERSHIP: Public access guaranteed under UK law. Permission is required, however, for sampling; all enquiries should be directed towards the Environment and Heritage Service (Northern Ireland; see address below).

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Included within an Area of Special Scientific Interest (Waterloo ASSI), administered by the Environment and Heritage Service (Department of the Environment, Klondyke Building, Cromac Avenue, Gasworks Business Park, Lower Ormeau Road, Belfast, BT7 2JA, UK).

KEY REFERENCES: Simms and Jeram (2006). For further information see: <http://www.habitas.org.uk/escr/summary.asp?item=16>

NAME OF SITE/AREA: **Karwendel**, Northern Calcareous Alps, Austria.

NATURE OF SITE: Exposures, in part natural, in hilly terrain (near tree-line).

ACCESS AND OWNERSHIP: Republik Austria (public land). Permission is required for all sampling.

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Located in the Karwendel Naturpark (natural reserve) administered by the Österreichische Bundesforste AG (Forstbe-

trieb Oberinntal, Lendgasse 10a, A-6060 Hall in Tirol, Austria).

KEY REFERENCES: Hillebrandt *et al.* (2006).

### **Sinemurian**

NAME OF SITE/AREA: **East Quantoxhead**, West Somerset coast, Somerset, England, UK.

STATUS: Ratified GSSP (2000).

NATURE OF SITE: Natural coastal cliff and foreshore exposures.

ACCESS AND OWNERSHIP: Public access guaranteed under English law although cliffs and foreshore are privately owned. Permission is required for sampling and all enquiries should be directed to: Natural England, Riverside Chambers, Castle Street, Taunton, Somerset, TA1 4AP, UK ([www.naturalengland.org.uk](http://www.naturalengland.org.uk)).

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Blue Anchor to Lilstock Coast SSSI (part) (Wildlife and Countryside Act 1981; Countryside and Rights of Way Act 2000) (administered by Natural England).

KEY REFERENCES: Page *et al.* (2000), Bloos and Page (2002).

### **Pliensbachian**

NAME OF SITE/AREA: **Millers Nab**, Robin Hoods Bay, North Yorkshire, England.

STATUS: Ratified GSSP (2005).

NATURE OF SITE: Coastal cliff and foreshore exposures.

ACCESS AND OWNERSHIP: Public access guaranteed under English law. Although cliffs and foreshore include several ownerships, some private, a significant part of the area is owned by the National Trust, a non-governmental conservation organisation. Permission may be required for sampling and all enquiries should be directed to: Natural England, Genesis 1, University Road, Heslington, York, YO105ZQ, UK ([www.defra.gov.uk](http://www.defra.gov.uk)).

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Robin Hoods Bay: Maw Wyke to Beast Cliff SSSI, Robin Hood's Bay: Beast Cliff to Whitby Special Area of Conservation (SAC) (Wildlife and Countryside Act 1981; Countryside and Rights of Way Act 2000; The Conservation (Natural Habitats, &c.) Regulations 1994) (administered by Natural England).

KEY REFERENCES: Meister *et al.* (2003, 2006).

**Toarcian**

NAME OF SITE/AREA: **Peniche**, Lusitanian Basin, central Portugal.

STATUS: Candidate GSSP.

NATURE OF SITE: Coastal exposures including cliff and foreshore.

ACCESS AND OWNERSHIP: Public access guaranteed under Portuguese law to littoral areas (from shoreline to 50 m inland are considered "public domain").

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Responsibility for Portuguese littoral areas is shared between the Instituto da Água ([www.inag.pt](http://www.inag.pt)) and the Instituto para a Conservação da Natureza ([www.icn.pt](http://www.icn.pt)). Permissions are required for all sampling.

KEY REFERENCES: Duarte (coord.) *et al.* (2004), Elmi (2006).

NAME OF SITE/AREA: **La Almunia de Doña Godina**, Iberian Range, Zaragoza Province, Aragón, Spain.

STATUS: Potential Auxiliary section (Elmi 2006, p. 7).

NATURE OF SITE: Natural inland exposures in gullies and slopes in semi-arid terrain.

ACCESS AND OWNERSHIP: Community owned land with free access.

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: No specific designation, although as palaeontological heritage is protected in Spain by national historical heritage and regional laws, official permissions are required from the regional government (Servicio de Patrimonio Cultural, Departamento de Educación y Cultura, Diputación General de Aragón, Zaragoza, Spain) before any sampling can be carried out.

KEY REFERENCES: Comas Rengifo *et al.* (1999), Goy *et al.* (2006).

**Aalenian**

NAME OF SITE/AREA: **Fuentelsaz**, Castillian Branch of the Iberian Cordillera, Guadalajara Province, Spain.

STATUS: Ratified GSSP (2000).

NATURE OF SITE: Natural inland exposures in hill slope and associated gullies in semi-arid terrain.

ACCESS AND OWNERSHIP: Community owned land with free access.

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Nominated as non-statutory *Punto de Interés Geológico* (P.I.G.) and proposed as a *Global Geosite* by the *Instituto Geológico y Minero* (I.G.M.E.). As palaeontological heritage is protected in Spain by national historical heritage and regional laws, official permissions are required from the regional government before any sampling can be carried out.

KEY REFERENCES: Cresta *et al.* (2001).

**Bajocian**

NAME OF SITE/AREA: **Cabo Mondego**, Lusitanian Basin, central Portugal.

STATUS: Ratified GSSP (1996).

NATURE OF SITE: Coastal exposures, including cliff, foreshore and coastal slope.

ACCESS AND OWNERSHIP: Classified as a Natural Monument by the Portuguese government. Public access guaranteed under Portuguese law to littoral areas (from shoreline to 50 m inland are considered as "public domain").

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Portuguese protected areas are administered by Instituto para a Conservação da Natureza ([www.icn.pt](http://www.icn.pt)). Permissions are required for all sampling.

KEY REFERENCES: Pavia and Enay (1997).

NAME OF SITE/AREA: **Beareraig Bay**, Isle of Skye, Scotland.

STATUS: Ratified Auxiliary Section and Point (1996).

NATURE OF SITE: Coastal cliff and foreshore exposures.

ACCESS AND OWNERSHIP: Public access is guaranteed under Scottish law. Permission is required for sampling and all enquiries should be directed to: Scottish Natural Heritage, Bridge Road, Portree, Isle of Skye, IV519ER, Scotland, UK ([www.snh.gov.uk](http://www.snh.gov.uk)).

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Rigg-Bile SSSI, Rigg-Bile SAC (Wildlife and Countryside Act 1981, Nature Conservation Act 2004, The Conservation (Natural Habitats, &c.) Regulations 1994), administered by Scottish Natural Heritage.

KEY REFERENCES: Pavia and Enay (1997).

### Bathonian

NAME OF SITE/AREA: **Ravin du Bés**, Bas Auran area, Haute-Provence, SE France.

STATUS: Ratified GSSP (2008).

NATURE OF SITE: Natural exposures in steep sides of stream valleys in mountainous terrain.

ACCESS AND OWNERSHIP: Open access to community land.

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: Included within the Réserve géologique de Haute-Provence and protected under national conservation law. All geological sampling requires an official permit: Enquiries should be addressed to the Réserve géologique de Haute Provence, Centre St Benoit, 04000 Digneles-Bains, France ([www.reservegeologique.fr](http://www.reservegeologique.fr)).

KEY REFERENCES: Innocenti *et al.* (1988), Fernández López *et al.* (2006).

### Callovian

Selection of a Callovian GSSP which fully satisfies ICS requirements has proved problematic as most European sites are stratigraphically condensed in the level of the Bathonian-Callovian boundary. Such a site is the candidate GSSP in southern Germany at Albstadt-Pfeffingen, although more expanded sections in East Greenland and Russia may provide alternatives or at least a candidate auxiliary section.

NAME OF SITE/AREA: **Albstadt-Pfeffingen**, Württemberg, southern Germany.

STATUS: Proposed GSSP (not ratified).

NATURE OF SITE: Temporary excavations in a forest. No permanent exposure present.

ACCESS AND OWNERSHIP: Public access is permitted to the forest area although any excavation to expose the boundary interval requires a formal permission.

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: The site has legal protection under state law; enquiries can be directed to the Staatliches Museum für Naturkunde, Rosenstein DE70191, Stuttgart, Germany.

KEY REFERENCES: Callomon and Dietl (2000).

### Oxfordian

Two candidate Oxfordian GSSPs have been recognised and documented. A formal proposal for a GSSP is imminent.

NAME OF SITE/AREA: **Redcliff Point/Hamcliff**, near Weymouth, Dorset, England, UK

STATUS: Candidate GSSP.

NATURE OF SITE: Coastal cliff and slope exposures. Foreshore exposures only seen after extreme storm events.

ACCESS AND OWNERSHIP: Public access to foreshore only is guaranteed under English law. Cliffs and coastal slope areas are privately owned and any excavation of material requires permission. All enquiries should be directed to: Natural England, Slepe Farm, Wareham, Dorset, UK ([www.naturaleangland.org.uk](http://www.naturaleangland.org.uk)).

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: South Dorset Coast SSSI (Wildlife and Countryside Act 1981; Countryside and Rights of Way Act 2001; The Conservation (Natural Habitats, &c.) Regulations 1994), administered by Natural England. Included within the Dorset and East Devon ('Jurassic Coast') World Heritage Site.

KEY REFERENCES: Page *et al.* (2009a), Page *et al.* (2009b).

NAME OF SITE/AREA: **Peyrale**, Savournon, near Serres, Haute-Provence, SE France.

STATUS: Candidate GSSP.

NATURE OF SITE: Natural exposures in slopes and gullies in valley within mountainous terrain.

ACCESS AND OWNERSHIP: Open access.

CONSERVATION STATUS AND RESPONSIBLE AUTHORITY: No specific conservation designation in place.

KEY REFERENCES: Fortwengler and Marchand (1997), Atrops and Meléndez (2003), Meléndez *et al.* (2007).

### Kimmeridgian

NAME OF SITE/AREA: **Flodigarry shore**, Staffin Bay, Isle of Skye, Scotland, UK.

STATUS: Candidate GSSP.

NATURE OF SITE: Natural foreshore exposures, variable beach cover of parts.

ACCESS AND OWNERSHIP: Public access is guaranteed under Scottish law. Ownership is public and administered by the Scottish Executive Environment and Rural Affairs Department – SERAD).

CONSERVATION STATUS: Included within the Trotternish Ridge SSSI (Wildlife and Countryside Act 1981; Nature Conservation Act 2004), administered by Scottish Natural

Heritage. Permission is required for sampling and all enquiries should be directed to: Scottish Natural Heritage, Bridge Road, Portree, Isle of Skye, IV519ER, Scotland, UK ([www.snh.gov.uk](http://www.snh.gov.uk)).

KEY REFERENCES: Matyja *et al.* (2006), Wierzbowski *et al.* (2006).

### Tithonian

NAME OF SITE/AREA: **Contrada Fornazzo**; NW Sicily (Trapani Province, Italy).

STATUS: Candidate GSSP.

NATURE OF SITE: Natural inland exposure and adjacent disused quarry.

ACCESS AND OWNERSHIP: Open access to quarry access road; access to the privately owned quarry would may require permission.

CONSERVATION STATUS: The outcrop is within the Monte Inici protected area and development is controlled. Palaeontological heritage has a protected status in Italy and permissions may be required for sampling.

KEY REFERENCES: Pavia *et al.* (2004).

NAME OF SITE/AREA: **Canjuers**; SE France (Provence Area).

STATUS: Candidate GSSP.

NATURE OF SITE: Natural inland exposure and disused quarry in military training area. Subject to changes in nature and location of exposures due to latter activities.

ACCESS AND OWNERSHIP: French army/NATO training area; access consequently restricted and requires permission from military authorities.

CONSERVATION STATUS: No formal conservation status.

KEY REFERENCES: Studies in progress (2007): ammonite and calpionellid faunas known to be well developed (F. Atrops, *pers. com.*). The former are regarded as potentially representing the most complete sequence known in Europe at this level.

### DISCUSSION

Justifying appropriateness as a candidate serial World Heritage site and demonstrating fulfilment of UNESCO guidelines is one thing, but proposing such a site is quite another. UNESCO procedures typically require that the national government takes on this latter role and therefore liaison at a

national level in each State implicated would be necessary. In most cases, however, established links between researchers and national and regional conservation bodies provides the context through which such representations could be made. The necessary negotiations at a community or landowner level could also be achieved through such links.

Inevitably, however, there are both time and funding implications for such a project, although the core work necessary to document and obtain the ratification of a GSSP will have already been carried out. The high profile of any World Heritage designation, however, has always been attractive to administrative authorities and possibilities for support and funding are therefore promising. In addition, as all ratified and the majority of candidate GSSPs lie within countries of the European Community – an inevitable consequence of the historical origins of the Jurassic stages through the work of pioneers such as Alcide d'Orbigny (1842-1849) – EU projects and funding sources may be appropriate to support such work.

International collaboration remains essential, however, and the links forged through the activities of the ISJS's working groups are therefore crucial. Indeed, the proposal of a Jurassic serial World Heritage site could be an ultimately goal for the ISJS, as a celebration of decades of intensive work by many colleagues from many countries – once ratification of all the systems GSSPs has been achieved of course. Such a proposal would also be a celebration of Jurassic science, demonstrating its links to global heritage and society itself. Courtesy of the director Stephen Spielberg, the name of the System has become part of popular culture through the success of the film 'Jurassic Park': now it is time to demonstrate the science and sites that underpin the interpretation of this most famous of geological time periods.

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## REFERENCES:

- Atrops F. and Meléndez G. 2003. The section of Peyral at Savournon, Provence, SE France, as a potential GSSP candidate for the Callovian – Oxfordian boundary at a global scale. *XIX Jornadas de la Sociedad Española de Paleontología; Morella, Octubre 2003, Libro de Resúmenes*, Pardo-Alonso M. V, Gozalo R. (Eds): 30-31.
- Bloos G. and Page K. N. 2000. The basal Jurassic ammonite succession in the North-West European Province – review and new results. *GeoResearch Forum*, **6**: 27-40.
- Bloos G. and Page K. N. 2002. Global Stratotype Section and Point for base of the Sinemurian Stage (Lower Jurassic). *Episodes*, **25**, 1: 22-28.
- Callomon J. H. and Dietl G. 2000. On the proposed basal stratotype GSSP of the Middle Jurassic Callovian Stage. *GeoResearch Forum*, **6**: 41-54.
- Carter E. S. and Tipper H. W. 1999. Proposal of Kunga island, Queen Charlotte Islands, British Columbia, Canada, as Triassic/Jurassic boundary global stratotype. *International Subcommission on Jurassic Stratigraphy, Newsletter*, **27**: 20.
- Comas Rengifo M. J., Gomez J. J., Goy A., Herrero C., Perilli N. and Rodrigo A. 1999. El Jurásico Inferior en la sección Almonicid de la Cuba (sector central de la Cordillera Iberica, Zaragoza, España). *Cuadernos de Geología Ibérica*, **25**: 27-57.
- Cresta S., Goy A., Ureta S., Arias C., Barrón E., Bernad J., Canales M. L., García Joral F., García-Romero E., Gialanella P. R., Gómez J. J., González J. A., Herrero C., Martínez G., Osete M. L., Perilla N. and Villalain J. J. 2001. The Global Boundary Stratotype Section and Point (GSSP) of the Toarcian-Aalenian Boundary (Lower-Middle Jurassic), *Episodes*, **24**, 3: 166-175.
- Duarte L. V. (Coord.), Wright P., Fernández López S., Elmi S., Krautter M., Azerêdo A., Henriques M. -H., Rodrigues R. and Perilli N. 2004. Early Jurassic Carbonate Evolution in the Lusitanian Basin (Portugal): Fácies, Sequence Stratigraphy and Cyclicity”. In: L. V. Duarte and M. -H. Henriques (Eds) 2004, *Carboniferous and Jurassic Carbonate Platforms of Iberia*, 23<sup>rd</sup> IAS Meeting of Sedimentology, Coimbra, 2004, Field Trip Guide Book, 1: 45-71.
- Elmi S. 2006. Pliensbachian/Toarcian boundary: the proposed GSSP of Peniche (Portugal). *Volumina Jurassica*, **4**: 5-16.
- Fernández López S. (Conv.) 2006. Reports of Working Groups. Bathonian. *International Subcommission on Jurassic Stratigraphy, Newsletter*, **33**: 14-15.
- Fortwengler D. and Marchand D. 1997. Les coupes de Thuoux et de Savournon (SE de la France) et la limite Callovien-Oxfordien. *Geobios*, **30**: 519-540.
- Goy A., Comas Rengifo M. J., Arias C., Gomez J. J., González J. A., Herrero C., Palencia A., Perilli N., and Rodrigo A. 2006. The Pliensbachian/Toarcian boundary in the Almonicid de la Cuba section (Iberian Range), Spain. *Volumina Jurassica*, **4**: 164-166.
- Hillebrandt A. von 1994. The Triassic-Jurassic boundary and Hettangian biostratigraphy of the Utcubamba valley, northern Peru. *Geobios*, **17**: 297-307.
- Hillebrandt A. von, Krystyn L. and Kuerschner W. M. 2006. The Triassic/Jurassic boundary beds of the Karwendel syncline (Austria) – initial report of a new GSSP candidate for the base of the Jurassic. *Volumina Jurassica*, **4**: 287-288.
- Innocenti M., Mangold C., Pavia G. and Torrens H. S. 1988. A proposal for the formal ratification of the boundary stratotype of the Bathonian stage based on a Bas Auran section (SE France). 2<sup>nd</sup> *International Symposium on Jurassic Stratigraphy, Lisboa*, **1**: 333-346.
- Longridge L. M., Carter E. S., Smith P. L. and Tipper H. W. 2007. Early Hettangian ammonites and radiolarians from the Queen Charlotte Islands, British Columbia and their bearing on the definition of the Triassic-Jurassic boundary. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **244**: 142-169.
- Lucas S. G., Taylor D. G., Guex J., Tanner L. H. and Krainer K. 2007. The proposed Global Stratotype Section and Point for the base of the Jurassic System in the New York Canyon Area, Nevada, USA. In: S. G. Lucas and J. A. Spielmann (Eds), *Triassic of the American West, New Mexico Museum of Natural History and Science Bulletin*, **40**: 139-168.
- Matyja B. A., Wierzbowski A. and Wright J. K. 2006. The Sub-Boreal/Boreal ammonite succession at the Oxfordian/Kimmeridgian boundary in the Flodigarry section, Staffin Bay (Isle of Skye), Scotland. *Transactions of the Royal Society of Edinburgh, Earth Sciences*, **96**: 309-318.
- Meister C., Blau J., Dommergues J.-L., Feist-Burkhardt S., Hart M., Hesselbo S. P., Hylton M., Page K. and Price G. 2003. A proposal for the

- Global Stratotype Section and Point (GSSP) for the base of the Pliensbachian Stage (Lower Jurassic). *Eclogae Geologicae Helvetiae*, **96**: 275-297.
- Meister C., Aberhan M., Blau J., Dommergues J. -L., Feist-Burkhardt S., Hailwood E. A., Hart M., Hesselbo S. P., Hounslow M. W., Hylton M., Morton N., Page K. and Price G. D. 2006. The Global Stratotype Section and Point (GSSP) for the base of the Pliensbachian Stage (Lower Jurassic), Wine Haven, Yorkshire, UK. *Episodes*, **29**, 2: 93-114.
- Meléndez G., Atrops F. and Page K. N. 2007. The cardioceratid succession and the recognition of the Callovian-Oxfordian boundary at Savournon (SE France). *23<sup>rd</sup> Annual Meeting of Spanish Palaeontological Society: Caravaca (Murcia); 4-6 October 2007*: Abstract Volume (in press).
- Orbigny A. d' 1842-1849. *Paléontologie Française; terrains jurassiques*. Paris.
- Page K. N., Bloos G., Bessa J. L., Fitzpatrick M., Hart M., Hesselbo S. P., Hylton M., Morri A. and Randall D. E. 2000. East Quantoxhead, Somerset: a candidate Global Stratotype Section and Point for the base of the Sinemurian Stage (Lower Jurassic). *GeoResearch Forum*, **6**: 163-172.
- Page K. N., Meléndez G., Hart M. B., Price G. D., Wright J. K., Bown P. and Bello J. (2009a) Integrated stratigraphical study of the candidate Oxfordian Global Stratotype Section and Point (GSSP) at Redcliff Point, Weymouth, Dorset, UK. *Volumina Jurassica*, **7** (in press).
- Page K. N., Meléndez G. and Wright J. K. 2009b. The ammonite faunas of the Callovian-Oxfordian boundary interval in Europe and their relevance to the establishment of an Oxfordian GSSP. *Volumina Jurassica*, **7** (in press).
- Pavia G. and Enay R., 1997. Definition of the Aalenian-Bajocian Stage Boundary. *Episodes*, **20**: 16-22.
- Pavia G., Lanza R., Lozar F., Martire L., Oloriz F. and Zanella E. 2004. Integrated Stratigraphy from the Contrada Fornazzo section, Monte Inici, Western Sicily, Italy: proposed GSSP for the basal boundary of the Tithonian Stage. *Rivista Italiana di Paleontologia e Stratigrafia*, **110**, 1: 329-338.
- Remane J., Bassett M. G., Cowie J. W., Gohrbandt K. H., Lane R. H., Michelsen O. and Naiwen W. 1996. Revised guidelines for the establishment of global chronostratigraphic standards by the International Commission on Stratigraphy (ICS). *Episodes*, **19**: 77-81.
- Simms M. J. and Jeram A. J. 2006. Waterloo Bay, Larne, Northern Ireland,: A potential GSSP for the base of the Jurassic System. *Volumina Jurassica*, **4**: 297-298.
- Warrington G., Cope J. C. W. and Ivimey-Cook H. C. 1994. St. Audries Bay, Somerset, England: a candidate Global Stratotype Section and Point for the base of the Jurassic System. *Geological Magazine*, **131**: 191-200.
- Wierzbowski A., Coe A. L., Hounslow M. W., Matyja B. A., Ogg J. G., Page K. N., Wierzbowski H. and Wright J. K. 2006. A potential stratotype for the Oxfordian-Kimmeridgian boundary (Upper Jurassic). Staffin Bay, Isle of Skye, U.K. *Volumina Jurassica*, **4**: 17-33.