



The Italian Geosite Inventory: Past, Present, and Future

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Abstract

The Italian geosites had been inventoried since the first 2000s with the aim of knowing the geoheritage of the Peninsula. Information collected on the basis of published data was stored in a database. Today the inventory is a geodatabase which is published on the ISPRA website, the Italian Institute for Environmental Protection and Research. This includes the Geological Survey of Italy. Consultation is free and all the information collected about each geosite is available. A map is also available to search geosites in a chosen area. Data coming from the first phase of the Italian Geosite Project has been reviewed, and guidelines have been produced to guide the still ongoing process. The inventory is a useful tool for territorial planning at different levels, from local projects to national activities, both naturalistic (protected areas) and for land use. Currently, geoheritage is not protected in Italy by national law, but some regional laws have been approved to protect and enhance the regional geological heritage, waiting, perhaps, for a European law.

Keywords Geosites · Inventory · Guidelines · Website · GSSP

On October 6, 2022, the first Geodiversity Day was celebrated all over the world. In Rome, an award ceremony was held for the winners of a photo contest for high school students. The theme of the photo contest was: “Photograph the geoheritage of your Region.” The generally good photos which were entered focused on geodiversity that was closely linked to human activity and life. The photos successfully incorporated geodiversity with biodiversity for a perfectly naturalistic result and so did the students’ words when they spoke to describe their work during the award ceremony. It was a pleasant surprise. Hitherto, the connection between geodiversity and biodiversity in Italy has not been frequently recognised and their contribution to the naturalistic diversity of an area is very little known.

We should also say that the concept of biodiversity, dealing with the living aspect of the natural environment, is closer to people’s collective imagination. In Italy, the law 394/1991 which regulates the establishment of protected areas, in the second article establishes that “natural heritage is composed of physical, geological, geomorphological, and biological formations (or groups of these) with relevant

naturalistic and environmental value [...]”. In practice, however, all Italian protected areas were established because of their biological heritage, whereas geodiversity is not taken into account.

Geoheritage in Italy: First Steps

A brief history of Italian geoheritage is appropriate, as it allows us to easily understand the current situation. The debate on geological heritage only began in Italy in the early 1990s, although mentions had already appeared in scientific journals in previous years, later than in most other European countries. The discussion began in the academic environment, and these were the years when a geoconservation culture began to form. In Italy, the first international meeting on this issue, the “2nd International ProGeo Symposium,” took place in 1996 in Rome, at the headquarters of the Geological Service. In this context, the idea of a national census of the Italian sites of geological interest took place. One of the main results of the conference was that geologists agreed on a data sheet, created to collect the information needed to describe a geosite, both from a scientific and logistical point of view.

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Italian Geosites Project 2000s

In the early 2000s, the Geological Survey of Italy started the Italian Geosites Project with the collaboration of the University of Genoa. Unlike in other countries, the Project was not determined by the public's interest in undertaking an environmental conservation policy. Rather, it was prompted by a desire in the geological community to increase the knowledge of Italian geoheritage. The primary objective of the Italian Geosite Project was basically to do this by producing a systematically compiled inventory of the most valuable sites of geological interest in Italy.

The inventory was based on published data: scientific papers, PhD theses, guidebooks of scientific field trips, etc., and only a very small amount of them was chosen on the basis of site visits undertaken. It was not based on a pre-established geological framework within which to assess and select sites. It was instead based on the main scientific interest of a geosite, such as geomorphology, palaeontology, stratigraphy, and mineralogy. The list was completed in a relatively short time, about two years, with about 3000 possible geosites submissions, which were then collected in an Access database.

A map representing these geological sites in Italy was presented at the International Congress of Geology, in Florence in 2004 (Brancucci et al. 2004).

From 2004 and 2009, the project remained inactive (Giovagnoli 2012). Something happened which had a strong impact on the general interest in Italian geoheritage: the Italian Code of Cultural and Landscape Assets was published in 2004. It dealt both with cultural and environmental assets, and geosites are listed in this law as "assets" to be protected. Consequently, over the next few years, local institutions began being compelled to make lists of geosites and add them to their territorial planning. Additionally, some Italian regions started local geosites inventories, in collaboration with the universities in their territories, and they started their collaboration with the Geological Survey of Italy about the National Geosites Project.

Currently, the Italian Code of Cultural and Landscape Assets represents the only national legislative constraints which protect geological heritage in Italy. This law has had the merit of not only activating projects of study and census of geosites by most of the Italian regions, but is also responsible for the publication of some regional laws. This is because, in Italy, regions have jurisdiction to legislate. They represent important instruments of protection of geosites at a local level. These laws deal specifically with geological heritage and geosites inventory, conservation, and development. In two cases, these laws provide for the financing of local projects to enhance the regional geoheritage. The results are interesting and well-done local projects, mainly focused on geotourism.

The New Italian Geosites Project

When the project started again in 2010, it was evident that the inventory needed a thorough revision. The expertise and knowledge developed at the local level in the meanwhile, also with the collaboration of academics, had made regional geologists the perfect interlocutors and partners in the important work of revising the content of the National Inventory.

Geologists of the Geological Survey of Italy and of Regional Geological Survey, with their experience gained during the fieldwork for the Italian Geological Map at the scale 1:50,000, completed the group of experts who had been working on the review of the database content so far. This work is still ongoing and will still take a long time to be completed. In the last ten years, the review of the geosites selected has been undertaken with field verifications and new assessments aided by geological experts as well as on the basis of new guidelines. Since 2018, in ISPRA, a connecting structure is at work between the Geological Survey of Italy and all regional technical institutions dealing with geological themes. The working group (WKG) concerned with geological heritage compares the experiences of all the technical regional structures, except for Sicily, in the field of the knowledge and protection of regional geological heritage.

Currently, the advancement of different regions is distinctly disparate. This is evident especially in the inventory of geosites. Hence, the working group designated a smaller group to redact guidelines, both technical and practical, based on the experience of each region in safeguarding geosites.

Guidelines

These guidelines are to be used in national and regional inventory, and to safeguard and promote regional geosites. The small group of regional experts was made up by C. Ferliga (Lombardia), M.L. Perissinotto, (Veneto), C. Piano and S. Bensi (Friuli-Venezia Giulia), G. Daniele (Emilia-Romagna), and D. Mancinella (Lazio) with E. Brustia, R. Pompili and M.C. Giovagnoli (ISPRA). The debate inside the WKG considered geosites as geological assets to be safeguarded, as they are representative of "geodiversity rather than cultural heritage", a misunderstanding sometimes generated in Italy by the insertion of geosites in the Code of Cultural and Landscape Assets. These guidelines derive directly from European ones, and specifically from Wimbledon et al. (1995). However, starting from a pre-existing original that was based on different guidelines, it was not possible to apply the same geological frameworks as in the English method, to the Italian Inventory.

The document of the WKG I am relating here contains a definition of geosite which, despite its simplicity, has been the subject of many revisions and has been preceded by a large collection of definitions used in Italy, both in scientific publications, public documents, and regional laws. The definition adopted by the Project sees a “geosite” as a “place (epigeal, hypogeal, or subaqueous), spatially limited and clearly distinguishable from the surrounding areas, with geological characteristics of intrinsic scientific interest that aids the understanding of the history or geological evolution of a territory; for a site such as this, a geological interest in conservation can be identified”.

“The concepts of rarity, representativeness and exemplification are an integral part of this definition, as are the criteria to define the category of interest of the geosite”.

To clarify, the term “rare” is linked to the geographical area considered: what is rare for a region can be abundant in other regions. “Representative” means that the element, the shape, the layer, etc. is the ‘best’ in a certain territory. “Exemplificative” means that the site can be used to describe a form or process.

The guidelines for identifying geosites are as follows:

International Geosites

- GSSP: currently 11 Italian sites. These are considered of international interest by definition.
- Sites of international importance such as the places where important discoveries of general value took place (Es: outcrop of the Moho Val Sesia, Vogogna).
- Sites that for their geological characteristics represent “textbook” examples (example: Karst Plateau).
- Sites showing unique or rare conditions of conservation or accumulation of materials of considerable abundance, for example, fossils or minerals or limestone caves (examples: Pesciara di Bolca and Grotte di Frasassi).
- Sites of key importance in the study of the evolution of man, animal, or vegetable forms (example: site of the

discovery of *Elephas falconeri* in Sicily (insular dwarfism) and Grotta Guattari (*Homo neanderthalensis*)).

- Morphologies and geological phenomena internationally recognized (Vesuvius, Karst, Quaternary volcanism, etc.) (Fig. 1).
- A stratotype in use as standard or potential standard, regionally or globally; or that has given its name to a chronostratigraphic unit.
- Sections, type localities, or historical areas where rocks or units of time were first described or are characteristic.
- Locations where geological phenomena were first recognized and described, or where a principle was conceived, demonstrated, or refuted regionally.
- Areas where lithostratigraphic or chronostratigraphic units have been described for the first time or where they have been conceived, demonstrated for the first time, or rejected or demonstrated regionally.

It is impossible to conduct an inventory of all fossil species and type localities and their international relevance. However, many fossil type localities could be included (some of regional or national importance and others of international importance).

National Geosites

- Sites suitable to represent the geology of Italy in one or more of its peculiar aspects or its evolutionary moments (e.g. highlights of the structuring of the Apennine or Alpine chain, stratotypes, sites representative of paleogeography at a certain time, of the forms or processes active at present or in the past).
- Sites where there are fossiliferous deposits (flora or fauna), mineralogical, morainic deposits, or otherwise linked to glacialism, as well as morphologies or tectonic structures that are unique or remarkable or that represent key sites in the interpretation of Italian geology

Fig. 1 Campi Flegrei, geosite of international interest, or “Phlegraean Fields”. A 13-km wide nested volcanic caldera complex, located west of Naples, near Vesuvius, which is represented by 6 geosites in the Italian Inventory. In 2022, it has also been included in The First 100’s UNESCO Geological Heritage Sites as a unique, great geosite (Photo: Roberto Isaia)





Fig. 2 Hyaloclastites a Chiaia di Luna (Isola di Ponza), geosite of national interest. The island of Ponza presents outcrops known worldwide for the hyaloclastic units. Ponza, with Palmarola and Zannone islands, represent a rare and very interesting example of submarine acid volcanism, studied by geologists from all over the world (Photo: Paolo Orlandi)

A site can show a multiplicity of interests, all special in their uniqueness.

- Groups of sites of common scientific interest
- Groups of sites where rocks (mainly sedimentary) formed during particular periods emerge, which make it possible to reconstruct the major sedimentary, biotic, metamorphic events, tectonic, or erosive during the geological evolution of the Italian peninsula and salient variations in time and space of climate, geography, environment, relief forms, fauna, and flora
- Groups of sites showing the evolution and/or stratigraphic range of important fossils (fauna and flora) in the Phanerozoic (e.g. the individual Permian Ichnosites of the Alps and Cretaceous Ichnosites of central-southern Italy)
- Sites showing particular phases of igneous activity (Fig. 2), orogenetic phases, and mining genesis through time
- Important sites in the study of current processes and their variations (landslides, coastal erosion) (Es: Mount Vector surface faulting)

Regional Geosites

Consider the criteria listed above but reported at the regional scale.

- Sites suitable to represent the geology of the Region in one or more of its peculiar aspects (Fig. 3) (e.g. stratigraphic, structural, paleontological, mineralogical, oro-

genic phase, paleogeography, morphology, or related processes)

Local Geosites

In this category can also be included sites of geotouristic, cultural and educational interest.

- Less important sites from a scientific point of view but that can, often for aesthetic reasons, be particularly suitable to be enhanced in geotourism projects (Fig. 4). These sites are comparable with the geodiversity sites of Brilha (2016)

The actual Italian Inventory of Geosites

The current inventory is a geodatabase, published on ISPRA website, and freely accessible.

In the National Inventory of Geosites, geosites are currently considered of international, national, regional, and local interest. This classification is based on scientific criteria, and it is then combined with the distinction based on the prevalent geological characteristics of each site. This distinction determines that a geosite can be categorised as geomorphological, paleontological, etc. This framework determines that the sole term “geosite” should be used, defined by its prevalent scientific characteristic (i.e. geomorphological geosite and palaeontological geosite). Other terms present in literature, such as “geomorphosites” or “geological emergencies,” have been abandoned. The term archaeo-geosite is still under discussion. We define this as a site where the connection between geology and archaeology is evident and sites where there is a relationship of cause and effect between the geological history of a territory and an



Fig. 3 Blockfields of Pian del Fretto (Savona, Liguria), geosite of regional interest. Blockfields are block deposits in slightly inclined areas consisting of boulders whose diameter is almost always greater than 60 cm, without fine material (gravel, sand, or clay) in the interstices. They are periglacial cryoclastic deposits providing particularly important information for the reconstruction of climatic limits during the last glacial period (Photo: M. Cristina Giovagnoli)



Fig. 4 “Dancing puppets”, Enna, Rocca Cerere Geopark, geosite of local interest. Shapes that formed due to the mechanical weather erosion, in particular wind, on Pliocene sands and quartz arenites (Photo: M. Cristina Giovagnoli)

archaeological site, as in Pompei where the geological phenomenon is at the origin of the archaeological site.

The dimension of the geosite is not pre-established in any way but there is a general attention to delimitate the geosite according to the area where its geological aspects are better visible, and to contain only to that area. A few man-made sites are included as well as mass movement of sediments: quarries and landslides. Quarries are sometimes perfect windows on the geological elements of an area, otherwise invisible.

In the inventory, we consider landslides that have had particularly significant effects on the geomorphology of an area, or that have affected life in human settlements where they have occurred (Fig. 5).

Currently the inventory includes only a few, but important, genuine marine geosites (Fig. 6) and some geosites which consist partly of coast, and partly of seabed.

Today, inside the inventory, each geosite is described in a dedicated datasheet where it is generally characterised by:

- name of the geosite: it must be composed of the main geological characteristic (primary scientific interest) followed by the name of the toponym (closer or more important), in order to place it geographically and to avoid replications, i.e. the Pleistocene wood of Dunarobba
- location: geographical and administrative identification; shape (area, line or point) and position (emerged or submerged, etc.)
- accessibility: type and quality of the access route, condition of access to the site in terms of difficulty, safety, related to the visiting condition; most appropriate time of year for visiting it
- legal protection: information about any kind of direct or, as occurs in most cases, indirect protection the geosite has or does not have; if the geosite is in a conservation



Fig. 5 Vajont Landslide, Erto e Casso, Pordenone, geosite of international interest. The landslide detached from Mt Toc in October 1963, it collapsed and crashed into a reservoir created by a 262 m high dam, causing the dam to overflow. A giant wave formed which killed almost 2000 people in the villages at the foot of the dam. The Vajont is one of the best studied landslides in the world. In 2022, it was included in The First 100’s UNESCO Geological Heritage Sites (Photo: M. Cristina Giovagnoli)

- area, one must enter the name of the area and/or the name of the legal constraints
- vulnerability: identification of natural and human processes that might affect the geosite, and a quantitative assessment of the risks of degradation that can affect a geosite

The geological characterisation of each geosite in the inventory describes:

- scientific interest and its assessment: palaeontology, mineralogy, geomorphology, etc., and any associated related interest: cultural, naturalistic, geotouristic, etc.
- scientific relevance: national and international, regional and local, according to the criteria adopted by ISPRA (see further in the text)
- synthetic geological description: the main lithologies and their geochronology
- illustrations: photographic coverage, if possible from different perspectives, excerpts of geological maps, geological sections, etc., with their references

A particular importance in the evaluation of the geosite is the information about:

- its integrity, related to the present conservation status of the site, taking into account both natural processes and human actions
- its representativeness, if the site is the “best” in a certain territory
- if the site can be used to describe a form or process

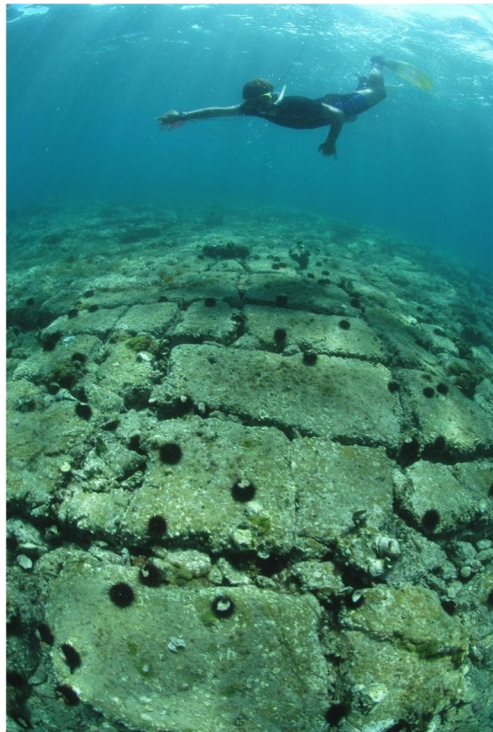


Fig. 6 Punta Sottile Coastal Platform, Friuli-Venezia Giulia, marine geosite. The inventory includes some marine geosites and only a few of them are genuinely marine, as is the geosite in the photo. The morphology of the shore platform of Punta Sottile is linked to the retreat of a cliff that once reached the sea. It represents a unique underwater morphological landscape in the Adriatic Sea (Friuli Venezia Giulia) (Photo: Fabrizio Antonioli)

- and its rarity, meaning the number of sites in Italy presenting similar geological features

The datasheet is completed by a pdf file containing the extended geological description of the geosite including bibliography. The description is divided into two parts: the first should be written in simple language, understandable even to non-geologists, and the second has more technical language and a bibliography related to the geosite.

The inventory is published on the ISPRA website and it is freely available. Anyone can consult all the information contained in the Inventory. There is only one exception, and it is what we call “the confidential geosite”. Some fragile geosites have been catalogued but data is not visible on the website. In most cases, these are paleontological or mineralogical sites, particularly rich in fossils or minerals and therefore very attractive to collectors who may endanger the integrity or even the existence of the geosite. So, their data is only available through documented, official requests.

A GIS map is also available so that an area on a map of Italy can be selected and geosites in that area identified. Information can also be read about a single geosite by

clicking on a square symbol (red, yellow, or blue), opening the pop up linked to that geosite and containing the data sheet information.

A website dedicated to the Italian GSSP, which contains additional data, is linked to the inventory. The GSSP website contains a more detailed geological description of each of the (at the moment) eleven Italian sites, pdfs of authorised documents, full bibliography, and a rich photographic gallery. The website is part of a project that also includes the installation of an official plaque at the site and activities that see the involvement of the inhabitants of the territory.

“Future”

In the inventory, we currently have just over 2100 geosites out of 3000 in the 2004 version. This is because the content review process now is mostly focused on eliminating the inconsistent geosite reports from the first phase of the work. This activity proceeds in parallel with the insertion of new geosites.

New geosites reports can be sent directly to ISPRA by filling an online form on the inventory website, attaching photos and any kind of useful document to describe the geosite. The shapefile of the site can be drawn directly on the form and sent with a click. The documentation arrives at the geologist of the Geological Survey of Italy who begin an established process of evaluation which has been created to manage and verify the reported geosite. It establishes a scientific evaluation by Geological Survey experts, both national and regional, or by an academic who has special knowledge in the geology of the area of the geosite reported.

We are now planning a new Geosite Inventory website as a place for the exchange of information on geosites, any kind of initiative, dissemination, and divulgation activities.

Since the method of identification of geological frameworks within which to categorise geosites was not implemented from the beginning, today the inventory includes many geosites with very similar geological characteristics. To rectify this, an attempt was made to overlaid the map of geosites to the geological map of Italy in scale 1:1,000,000. However, the position of the geosites does not perfectly align with units identified as possible frameworks on the geological map: some units aligned with multiple geosites and others with none.

To identify areas where geological heritage has not yet been studied, a future revision of the inventory’s content on the base of these results cannot be ruled out. However, its value notwithstanding, this method proves hard to perform a posteriori.

It must be said that, today, the goal of the inventory has changed, with respect to the original one of knowledge of the Italian geoheritage. Today, it is also a tool for local administrators and technicians, both for land-use planning and to identify geosites suitable for geotourism projects.

The inventory is also consulted during the planning stages of road, rail, and other infrastructure construction (Bentivenga et al. 2010).

Since ISPRA is the scientific advisory institute of the Ministry of the Environment, the inventory is also a tool of knowledge of the territory to identify new protected areas. In recent years, it has also been a tool in the case of major issues such as the identification of locations for activities involving environmental risk. The latter is a significant change in considering the importance of geoheritage in issues of national interest.

A Geological Heritage Protection Act would certainly reinforce this importance, and a European law could be the right way to gain this important instrument for preservation.

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Declarations

Conflict of Interest The author declares no competing interests.

References

- Bentivenga M, Cavalcante F, Mastronuzzi G, Palladino G, Prosser G (2019) Geoheritage: the foundation for sustainable geotourism. *Geoheritage J.* <https://doi.org/10.1007/s12371-019-00422-w>
- Bentivenga M, Giovagnoli MC, Palladino G, Ruscito V, Sciacca P (2010) *Interazione fra infrastrutture e patrimonio geologico. Manuali e Linee Guida a cura di ISPRA e CATAP, Ambiente, Paesaggio e Infrastrutture, I, 65.1, ISBN 978-88-448-0471-8*
- Brancucci G, Cresta S, D'Andrea M, Lisi A (2004) Geosites and geodiversity: framework for an early geological sites cartography in Italy. Abstract 32nd IGC Firenze, Sess. 48-1
- Brilha (2016) Inventory and quantitative assessment of geosites and geodiversity sites: a review. *Geoheritage* 8:119-134. <https://doi.org/10.1007/s12371-014-0139-3>
- Brilha (2018) *Geoheritage: inventories and evaluation*. In: Emmanuel Reynard and José Brilha, editors, *Geoheritage*. Chennai: Elsevier, 2018, pp. 67-86. ISBN: 978-0-12-809531-7
- Giovagnoli MC (2012) Geosites in Italy – a 2012 status. In: Wimbledon W.A.P. & Smith-Meyers S. Editors, *Geoheritage in Europe and its conservation*. ProGEO, 2012, pp. 197-199
- Giovagnoli MC (2013) *Geoheritage in Italy*. In: *Landscapes and landforms of Italy*. Springer-Verlag https://doi.org/10.1007/978-3-319-26194-2_42
- Gray M (2013) *Geodiversity: valuing and conserving abiotic nature*. Second edition Wiley Blackwell Chichester.
- Hilario A, Asrat A, van Wyk de Vries B, Mogk D, Lozano G, Zhang J, Brilha J, Vegas J, Lemon K, Carcavilla L, Finney Stanley (Eds). *The first 100 IUGS geological heritage sites*. Edited & Published by IUGS (International Union of Geological Sciences)
- Pescatore E, Bentivenga M, Giano SI, Siervo V (2019) Geomorphosites: versatile tools in geoheritage cultural dissemination. *Geoheritage J.* <https://doi.org/10.1007/s12371-019-00378-x>
- Wimbledon WAP, Smith-Meyer S (eds) (2012) *Geoheritage in Europe and its conservation*. ProGEO, Oslo
- Wimbledon WA, Benton MJ, Bevins RE, Black GP, Bridgland DR, Cleal CJ, Cooper RG, May VJ (1995) The development of a methodology for the selection of British Geological sites for geoconservation: part 1. *Mod Geol* 20:159-202

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