

## World Heritage Sites

### Protected Areas and World Heritage



## MONTE SAN GIORGIO SWITZERLAND & ITALY

*The pyramid-shaped, wooded mountain of Monte San Giorgio beside Lake Lugano is regarded as the best fossil record of marine life from the Triassic Period (245 - 230 million years ago). The sequence records life in a tropical lagoon environment, sheltered and partially separated from the open sea by an offshore reef. Diverse marine life flourished within this lagoon, including reptiles, fish, bivalves, ammonites, echinoderms and crustaceans. Because the lagoon was near to land, the fossil remains also include some land-based fossils including reptiles, insects and plants. The result is a fossil resource of great richness.*

### COUNTRY

Switzerland and Italy

### NAME

Monte San Giorgio

### NATURAL WORLD HERITAGE TRANSBOUNDARY SITE

2003: Inscribed on the World Heritage List under natural criterion (viii).

2010: Extended to include land across the Italian border under natural criterion (viii).

### STATEMENT OF OUTSTANDING UNIVERSAL VALUE

The UNESCO World Heritage Committee issued the following Statement of Outstanding Universal Value at the time of inscription:

#### Brief Synthesis

The pyramid-shaped, wooded mountain of Monte San Giorgio beside Lake Lugano is regarded as the best fossil record of marine life from the Triassic Period (245 - 230 million years ago). The sequence records life in a tropical lagoon environment, sheltered and partially separated from the open sea by an offshore reef. Diverse marine life flourished within this lagoon, including reptiles, fish, bivalves, ammonites, echinoderms and crustaceans. Because the lagoon was near to land, the fossil remains also include some land-based fossils including reptiles, insects and plants. The result is a fossil resource of great richness.

**Criterion (viii):** Monte San Giorgio is the single best known record of marine life in the Triassic period, and records important remains of life on land as well. The property has produced diverse and numerous fossils, many of which show exceptional completeness and detailed preservation. The long history of study of the property and the disciplined management of the resource have created a well documented and catalogued body of specimens of exceptional quality, and are the basis for a rich associated geological literature. As a result, Monte San Giorgio provides the principal point of reference, relevant to future discoveries of marine Triassic remains throughout the world.

#### Integrity

The property encompasses the complete Middle Triassic outcrop of Monte San Giorgio including all of the main fossil bearing areas. The Italian portion of the property included is an extension in 2010 of the originally inscribed area in Switzerland, which was added to the World Heritage List in 2003. The resulting extended property fully meets the integrity requirements for a fossil site. The main attributes of the Outstanding Universal Value of the property are the accessible fossiliferous rock exposures, with intact strata which occur in many parts of the property.

### **Protection and Management Requirements**

The property benefits from legal protection in both Italy and Switzerland that provides an effective basis for the protection of its geological resources. Site protection also focuses on landscape protection and has resulted in appropriate legislative controls and existing management procedures that are effectively enforced at the local level and which are underwritten by National, Regional and Provincial government support.

Strong transboundary collaboration between the States Parties of Italy and Switzerland is in place, including mechanisms that are agreed by all of the local municipalities in both countries, through common signed accords and declarations. A joint management plan is also in place for the property, and the States Parties and local authorities are committed to providing adequate ongoing staffing and management resources to the property. Maintenance of the effectiveness of the transboundary cooperation and the related management plan is a key ongoing requirement for the protection of the property. Staff with a specific responsibility for site management are in place in both countries, and collaborate effectively to ensure a fully coordinated management of the property, including in relation to its presentation.

The main management requirement in relation to the values of Monte San Giorgio is the in situ protection of fossil bearing areas. Although these areas are generally difficult to access, it is important to ensure their accessibility for managed legal scientific excavation. Continued scientific excavation is a key requirement to maintaining the values of this property as a world reference area for paleontological research.

Maintenance of the relationships between the property and leading research institutes is also essential to both its scientific value and its presentation. Because the in situ fossil resources both require excavation and preparation to be of scientific value, and are not publicly accessible or visible, the completeness, presentation and safety of the fossil collections held in a limited number of universities and museums is key to the protection of the values of the property. These collections are maintained through strict adherence to appropriate legislative controls on excavation within the property. The housing of resultant fossil finds, and the standards of curation, specimen preparation and research, and museum display are of the highest quality in the main research collections related to the property. This presentation of the fossil finds from the property in major international museums also needs to be complemented by the appropriate provision of visitor centres and services within or near to the property, and a programme to establish and maintain these services is in place. An active ongoing programme of communication and interpretation for visitors to the property is required to ensure the fullest appreciation of the Outstanding Universal Value of Monte San Giorgio.

### **IUCN MANAGEMENT CATEGORY**

V Protected Landscape

### **BIOGEOGRAPHICAL PROVINCE**

Central European Highlands (2.32.12)

### **GEOGRAPHICAL LOCATION**

Located in southernmost Switzerland and northern Italy between the southern arms of Lake Lugano in the canton of Ticino and the province of Varese. It is centred on 45° 53' 31"N by 08° 55' 27"E.

### **DATES AND HISTORY OF ESTABLISHMENT**

The site has been subject to a number of local and regional protective measures:

- 1974: The Cantonal legislature decreed authorisation for and supervision of the search and collection of rocks, minerals and fossils on the mountain; Decree amended 1975 & 1995;
- 1975: Cantonal regulation for the Protection of Flora and Fauna designated the whole mountain a Natural Protection zone;
- 1977: The entire site was listed on the Swiss Federal Inventories of Landscapes, Sites and Natural Monuments and of Heritage Sites of National Importance, based on Federal law on the Protection of Nature and Preservation of Natural Heritage;
- 1982: The Arzo Development Plan designated the Poncione forest part of a Nature Reserve;
- 1985: The Riva San Vitale Development Plan designated the mountain part of a Nature Reserve;

- 1990: The commune of Meride Development Plan designated areas on the south side of the mountain summit (the dry meadows) an area of special natural interest, and the landscape around Meride part of a Nature Reserve;
- 2001: The Cantonal law on nature protection passed;
- 2002: The Cantonal Office for the Protection of Nature designated the whole mountain a Landscape Protection Zone under the Protected Areas Scheme.
- 2003: Site inscribed on the World Heritage List (849 ha, buffer area 1,389.05 ha);
- 2010: The site extended to cover an extension of the fossiliferous formation in Italy (240.34 ha, buffer 1,818.05 ha) within a pre-existing Landscape Protection Zone. Transboundary protection and management arrangements were agreed.

## LAND TENURE

The Swiss site lies in the Canton of Ticino. The core zone and part of the buffer zone fall in the communes of Meride, Riva San Vitale and Brusino-Arzo. Some 85 ha of farmland and houses in the core zone in Meride and Riva San Vitale are privately owned. The buffer zone where there is also much privately owned land, is also within in the communes of Arzo, Tremona, Bizasio, Rancate, Ligornetto and Stabio. In Italy the extended site lies in the Lombard province of Varese, under the jurisdiction of the associated mayoralties of Monte San Giorgio: Besano, Porto Ceserio, and Viggiù (core zone) and Clivio and Saltrio (buffer zone). 43.4% of the extension is in public ownership and 56.6% is owned by private landowners.

## AREA

The total property area is now 1,089.3 ha. A buffer zone of 3,207.5 ha surrounds the property.

## ALTITUDE

From 275m at lake level to 1096.7m (M. San Giorgio) and 1,015m (Monte Pravello, Italy).

## PHYSICAL FEATURES

This largely forested low mountain is a vast pyramidal south- to southwest-dipping monocline which rises 826 meters directly above Lake Lugano and the valleys on either side, with steeper north slopes to the lake and a gentle fall at the angle of its geological formations towards the south. These are fossiliferous Triassic carbonate formations, mostly within the protected area, which outcrop between both older volcanic and more recent sedimentary formations of the Southern Alpine Series in the buffer zone. Permian andesites and rhyolites of volcanic origin are exposed on the north face. Jurassic limestone formations occur on the lower southern slopes which dip at the mountain foot under the sediments of the Po valley. The Middle Triassic sequence occurs in beds of limestone more than 1,000m thick. It comprises a continuous 15-million year record of submarine tectonic activity and of marine sedimentation under the varying conditions and differing environments of successive transgressions and recessions on the edge of the Triassic Tethys Ocean. The beds include conglomerate and sandstone (Bellano formation), reef limestone, dolomites and bituminous shales (Besano formation - the main fossil-bearing horizons), marls, limestones and gypsum (Pizzella marls), marine dolomites (Dolomiti Principale) and dolomitised oolitic limestone (Tremona beds). Within the karst there are some thirty caves. The oldest of the overlying Jurassic sediments at the southern base of the mountain yields an ornamental breccia.

Within the Besano formation, there is a valuable sequence of six distinct regularly superimposed fossil beds where intercalated layers of ash provide a built-in time scale. They contain exceptionally rich, rare and well preserved fossils formed in an undisturbed Middle Triassic tropical environment 245-230 million years ago. The beds are named, from older to younger: *Grenzbitumenzone*, Cava Inferiore, Cava Superiore (both quarried), Cassina beds, Crocifisso bed and *Kalkscheiferzone* beds of Meride limestone. The *Grenzbitumenzone* has yielded the most diverse and spectacular finds; the *Kalkscheiferzone* has preserved exceptionally detailed delicate material, such as stomach contents,

reptile embryos and insects. The beds have yielded more than 21,000 fossilised remains including large complete skeletons both marine and terrestrial of a wide range of organisms. The present site is invaluable both as a record of life on the margin of the Triassic Tethys Ocean, and as a global reference point for comparative evolutionary studies. Its marine specimens are superior in quality to the comparable terrestrial Triassic site of Ischigualasto-Talampaya and to the more complete Triassic succession of the Dorset and East Devon coast. Recent widespread excavations in Guizhou province in south China, are proving similarly rich in both early and later Middle Triassic sites.

## CLIMATE

The climate is sub-Mediterranean with hot but rainy summers, and mild winters with few frosts. There is some air pollution in the Lugano valley.

## VEGETATION

The site lies within a WWF Global 200 Eco-region. Its flora is of southern Alpine type with acid-loving plants on the volcanic rhyolitic north slope soils and lime-loving plants on the dolomitic and limestone dominated southern slopes. The acidic soils support sweet chestnut *Castanea sativa*, sessile oak *Quercus petraea*, and ash *Fraxinus excelsior*. The damp lime-rich soils support mixed broadleaf woodland of *Carpinus betulifolia* and the sub-Mediterranean species hop-hornbeam *Ostrya carpinifolia*, with, on dry shallow soils, pubescent oak *Q. pubescens* and manna ash *F. ornus*; with *Tilia* species on dry to damp soils. Twenty-five hectares of dry meadows of high botanic diversity occur on the limestone of the mountain top, dominated by dwarf sedge *Carex humilis* and tall moorgrass *Mollinia arundinacea*. Of over 100 species of plants on the mountain, 38 are rare, endemic or protected, including *Adenophora lilifolia* and *Gladiolus imbricatus*, species endemic to Switzerland. The mountain supports the main Swiss population of *Iris gramina* and important populations of *Dorycnium herbaceum* and *Danthonia alpina*.

Monte San Giorgio is also known as a mycological sanctuary. 554 species of fungi have been found there, 130 of which are endemic to this part of Ticino, five growing only in one locale, Meride. They include *Boletus xanthocyaneus*, *Lepiota foruignoni*, *Cortinarius boudieri* var. *pseudoarcuratus*, *Cortinarius pelargoniobtusus* and *Lycoperdon velatum*. More than a third of European *Boletus* species are found here. Two species are protected by Swiss Law (Federal Ordinance on the Protection of Nature and Preservation of Natural Heritage) and 19 are listed in the provincial Red List of Swiss micromycota. The most recently discovered species, *Tricholoma basirubens* was found in 1979.

## FAUNA

Ancient: The site contains a unique Middle Triassic fossil fauna laid down in still and undisturbed tropical lagoons during a period when there were major radiations of both reptiles and actinopterygian fish. There are more than 10,000 fossil reptile specimens, including large complete articulated skeletons of ichthyosaurs, nothosaurs and placodonts, notably the long-necked saurian *Tanystropheus longobardicus*. Also preserved are 30 marine and terrestrial reptile species, 80 fish species, some 100 macro-invertebrates, bivalves, ammonites, echinoderms, crustaceans and marine microorganisms. There are also some terrestrial reptiles, insects and 3 terrestrial plants, spores and pollen. The land-based fauna also includes a complete skeleton of the archosaur *Ticinosuchus ferox*, the first complete skeleton from this group discovered in the northern hemisphere.

The Italian section has also produced a rich palaeontological record. This includes some 35 species of reptile, over 100 fossilised fish species, larger and of better quality than the Swiss specimens, plus about 100 species of cephalopods, bivalves, gastropods, echinoderms, crustaceans, exceptionally well-preserved insects and arthropods and numerous plants. Where the dip of the strata obliged the Swiss to excavate parallel to bedding planes, which exposes more complete specimens, the Italian exposures are normal to the bedding planes making the removal of complete specimens harder but allowing more detailed interpretation of the stratigraphic sequence. The largest complete swimming reptile so far found, an articulated 6m skeleton of *Besanosaurus*, was found in the Italian section.

Modern: Including adjacent lakeside sites, 109 species of vertebrate animals have been recorded on Monte San Giorgio comprising 27 mammals, 66 birds, 9 reptiles and 7 amphibians. Of these 109

species 37 are included in the Swiss Red List of Endangered Species, and 21 are protected by the Berne Convention. The site is unique, supporting Switzerland's only population of Savi's pine vole *Microtus savii*. The Monte San Giorgio area is particularly important for the reproduction of amphibians and reptiles, it includes six sites identified as areas of national importance. There are also 58 species of mollusc (18 on the National Red List), 63 species of butterflies Hesperidae and moths Rhopaloceri (a third of all Swiss species), 85 species of wild bees (apoid Hymenoptera), 11 species of ground beetle (carabid Coleoptera), 47 cricket and grasshopper (Orthoptera) species, two of which are endemic to Ticino, and a high number of spider species that are found in the dry meadow area. In the Gaggiolo stream there are large numbers of crayfish *Astacus pallipes*, and in the karst caves of the southern slopes many cave-dwelling crustacea and millipedes.

### **CONSERVATION VALUE**

The Triassic formations of Monte San Giorgio comprise a long studied very legible series illustrating geological processes and the development of life in the past. The mountain is one of the five or six most important fossil-bearing sites in the world, because of:

- a) its wide diversity of well preserved palaeontological specimens of fish, reptiles, invertebrates and plants;
- b) the rarity and uniqueness of these species;
- c) the continuous sedimentary succession over 15 million years, dateable by intercalated ash, in five levels of deposition enabling evolutionary studies of marine biota;
- d) its setting in the South Alpine series of rocks dated from some 350 million years ago to the present;
- e) their excavation for over 100 years only by university and museum personnel which has resulted in one of the world's most complete, best studied and well catalogued such sites and an invaluable reference point for Middle Triassic marine fauna comparable to sites being uncovered in southern China; and
- f) continuous planning and regulation for their protection and a local population which shares fully in the aims of preservation.

### **CULTURAL HERITAGE**

The Ticino has been settled since Neolithic times. Roman and Lombardic tombs, inscriptions and artifacts have been found at Riva San Vitale where there is a famous 5th century baptistry. Ornamental breccia from Arzo and building stone from the Viggiù quarries have been quarried for centuries: many fossils being originally discovered this way. In the late 18th century, there were excavations for fuel oil from the bituminous shales near Besano which continued intermittently for a century. Ichthyol and Sauroil used for treating skin conditions were obtained from these shales from 1907 to the early 1950s at Cava Tre Fontane, just beneath the mountain summit. This mining also uncovered many fossils. The processing plant at Spinirolo near Meride is now a cultural and holiday centre. Gypsum peat and lime have also been quarried in the past. The architecture of the local villages typifies the Sottocenero Lombardic style of the Ticino.

### **LOCAL HUMAN POPULATION**

An estimated 150 people live within the core protected area of the nominated property in Switzerland. Four villages, Arzo, Meride, Tremona and Besazio are wholly within the site's buffer zone. Bordering the site at the base of the mountain, are the villages of Rancate and Ligornetto and the small towns of Riva San Vitale to the east and Brusino-Arcizio in the north-west. Including the nearby village of Stabio, there are nine communities close to the site, the total population of which is 11,500. The southwest fifth of the mountain lies on Italian soil. Mining and quarrying no longer occur in the area, except at Arzo where breccia (Arzo marble), is mined under tight regulation. Forestry and farming are the only other activities occurring within the locality. No-one lives in the Italian core section but the five villages of the buffer area had a combined population in 2009 of 15, 801. The local people are sympathetic to preservation of the palaeological heritage of the site. The 'Friends of the Mountain Park', is a local NGO which proposes the establishment of a Natural Park on the mountain.

### **VISITORS AND VISITOR FACILITIES**

Despite comparatively little tourist infrastructure, 80-100,000 people are estimated visit Monte San Giorgio each year. Public visits to the excavations are organized from time to time. In 1974, a fossil

museum was established in the village of Meride on the edge of the core zone which currently receives 11,000 visitors a year. A new more comprehensive museum at Besano and another at Induno Olona outside the area each receive about 6,000 visitors a year. There are also a new visitor centre at Clivio and information point at Viggiù. An educational trail with information displays linking the main geological and palaeontological features of the mountain was established in 1980. Nearby museums also exhibiting finds from the mountain exist in Besano and Induno to the south-west and in Lugano in Switzerland. These sponsor publications and exhibitions. A Geo-Guide to the mountain in German and Italian is available at museums in Zurich, Milan and Lugano. Local ventures are developing exhibitions of industrial archaeology. Increased tourism will necessitate improved access and trails, as well as the possible regulation of visitors.

## **SCIENTIFIC RESEARCH AND FACILITIES**

The quantity and quality of this Triassic fossil biota has enabled studies of marine life which existed during a critical period of vertebrate evolution, and of the palaeo-environments and land-forming processes of more than 200 million years ago. The presence of the six superimposed fossil layers has allowed exceptional evolutionary and comparative studies, and features within the sedimentary sequence have also allowed precise dating. This has resulted in a remarkably complete and well coordinated record of the site's rich diversity. Strict systematic scientific research has been carried out on the mountain continuously for almost 150 years in both Italy and Switzerland, almost exclusively by the Universities of Zürich and Milan. The horizon richest in large fossils, the *Grentzbitumenzone* in the Besano formation, was studied as early as 1800, and first published about in 1847. It has yielded great quantities of large, well-preserved saurian fossils new to science. Major excavations were started by Italian researchers in 1863, 1878 and in the early years of the 20th century. In 1919, the production of ichthyol for medical use, from the bituminous beds revealed valuable fossils, and since 1924, mainly under the direction of Dr B. Peyer from the University of Zurich, there have been more than 50 excavation campaigns at some 20 sites in the *Grentzbitumenzone*.

The southern slopes of the Swiss section have been studied since the 1950s, under the direction of Dr E. Kuhn-Schnyder, by the Italian Society of Natural Sciences and staff of the Milan Civic Museum; and in the 1990s by the Department of Earth Sciences at the University of Milan, the Palaeological Institute and Museum of the University of Zurich and the Lugano cantonal Museum of Natural History. Quarrying and excavations in the Cava, Cassina and *Kalkschieferzone* beds have exposed a wealth of smaller fossils. All formations are still yielding species new to science. The hundreds of fossil species have been recorded in over 800 scientific publications, some 70 since 1989. There is a museum at Besano and small fossil museums at Meride and Clivio are being improved. Exploration of the Italian site has been from the Milan Museum, Milan University and the local Museum of Induno Olona. 99.9% of the site's known specimens are confined to the exceptional displays of the Zurich, Lugano and Milano museums, with some specimens at the small museums at Meride and Besano. This has ensured the accurate and thorough recording of finds, their detailed preparation and widespread dissemination. Continued strong links between the site's management and these institutions is essential.

## **MANAGEMENT**

Management of the original site is by the Swiss Agency for the Environment, Forests and Landscape, Nature Division, by the Ticino cantonal Dipartimento di Territorio, Sezione dei Beni Monumentali e Ambientali, with the nine affected communes. The almost uninhabited mountain is in a largely natural state and protected by a variety of Cantonal decrees, federal inventories, local commune plans and federal and Cantonal laws governing forests. These decree Cantonal control over the collection of rocks, minerals and fossils, the monitoring of sites, the protection of flora and fauna, especially of the summit dry meadows. An area near Meride was created a Landscape Protection Zone under the Protected Areas Scheme. Excavations are authorised and supervised by the Cantonal Museum of Natural History in Lugano. Access is allowed only to university staff in good standing and permits are held by the Palaeological Institute and Museum of the University of Zurich, the Lugano Cantonal Museum of Natural History and the Department of Earth Sciences of the University of Milan.

A draft management plan for the site in Switzerland was developed, stating the following objectives:

1. Management of the palaeontological components of the site through co-ordination between universities and local authorities of their excavation, conservation, study and exhibition;
2. The need for the construction of a new fossil museum at Meride as a comprehensive introduction to all aspects of the mountain and as a visitor reception, information and training centre;
3. Management of planning for the area: local authorities in both Switzerland and Italy, with a number of public and private sector organisations, have agreed as part of the INTERREG IIIA initiative on a joint program of integrated sustainable development to co-ordinate excavations, disseminate information and promote the environmental and landscape protection, public transport and path networks of the area;
4. Optimisation of public transport connections by adoption of the Mendrisiotto Transport Plan.
5. Promotion by publication of the geo-guide, a website and a video on the area's tourist potential.

In late 2008 Italian stakeholders in the area signed an Agreement Protocol to extend the above management objectives to any extension in Italy; and by a formal memorandum in early 2009 agreed to coordinate transboundary management. On extension, the Italian State Party undertook to establish a Foundation for its portion of the site, to appoint a World Heritage site manager and to provide sufficient funding for the site's management. Both the Convenzione Monte San Giorgio (Svizzera) and the Convenzione Monte San Giorgio (Italia) agreed that the transboundary management system be governed by a Strategic Transnational Board to ensure effective and consistent management. This should include enhanced programmes of presentation, interpretation and monitoring, maintenance of important rock exposures, and coordination of science and research. Protection in the Italian part will continue to be effectively enforced at national, regional and provincial levels. Several local museums supported by numerous volunteers ensure an almost constant monitoring of key sites making unauthorized excavation extremely difficult, though there is at present no overall process for regular monitoring of the site's state of conservation.

## **MANAGEMENT CONSTRAINTS**

There are no significant constraints on management of the site at present. The forest cover provides some protection against the effects of climate change, landslides and erosion, but fire prevention strategies are in place in preparation for an increase in tourist numbers in future.

## **STAFF**

A number of federal and cantonal officials, forestry rangers and local authority managers were responsible for the original protection area, and since 2001 a leading Swiss geologist has acted as the World Heritage site manager. He has worked closely with the Italian Coordinatore della Convenzione Monte San Giorgio who could become the World Heritage site manager for the extension, supported by adequate staff and resources. A scientific coordinator will work with the two site managers, and technical- operative committees will work under them on different aspects of the site. Milan and Insubria Universities have one part-time palaeontology researcher-technician each; Besano Museum has a part-time director, two part-time technicians and a museum guide, and Clivio Museum, a part-time director and part-time curator.

## **BUDGET**

Excavations and exhibitions are funded by university institutes and museums. The Swiss Confederation and Canton of Ticino have granted CHF 500,000 for maintenance of features of the mountain. Under the EU INTERREG III Project, CHF100,000 has funded a Management Plan. Following extension, the association of the five mayors of Monte San Giorgio will be responsible for raising the funds needed to manage the Italian section of the site.

## **LOCAL ADDRESSES**

Swiss Confederation, Swiss Agency for the Environment, Forests and Landscape - Nature Division, CH 3003 Berne, Switzerland.

Canton of Ticino, Dipartimento di Territorio, Sezione dei Beni Monumentali e Ambientali, Viale S.Francini 17, CH-6500, Bellinzona, Switzerland.

Fondazioni Monte San Giorgio, Comune di Meride, CH-6866, Ticino, Switzerland.

Municipio del Comune di Viggiù, Via Roma 10, I-21059 Viggiù, Provincia di Varese, Italy.

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## DATE

August 2002. Revised 3-2007, July 2011.