10 stages: Bletterbach – Sesto Dolomites

Christjan Ladurner · Corrado Morelli

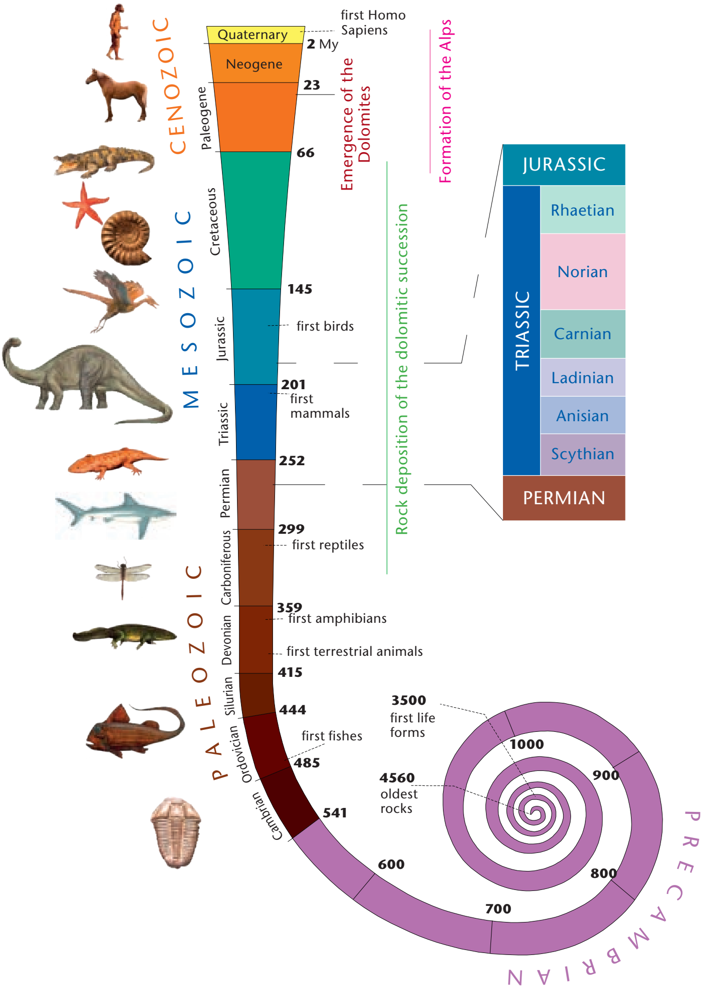
Dolomites UNESCO Geotrail

A hiking trail to discover the fossil archipelago of the World Heritage Site

TAPPEINER.

The Geological Timescale

The special feature of this spiral is its non-linear representation of time. The further back you go, the longer the period represented by the respective era. To the right of the image appears the time division of the Triassic period used in the description of the Geostops.



Introduction to this walking guide

Long-distance trails are by no means a new invention in the Dolomites. Some of the paths, such as the Dolomites Alta Via no. 1, have existed for decades, but until now none of the routes has addressed the geology of the "Pale Mountains". The Geotrail is thus a combination of long-distance footpath and educational trail. Each stage includes Geostops that are described in detail in the guide and accompanied with illustrative images. Hikers are encouraged to take a break and learn about the fascinating history of the Dolomites. The Geotrail crosses Dolomites of South Tyrol in ten days, traversing some of the most beautiful and geologically interesting mountain ranges in the region. There are breathtaking views to be had along a route that features plenty of opposites, while the walking itself is a pleasure along the well-marked, well-maintained paths.

The Dolomites are certainly some the most beautiful mountains on Earth: mountain lovers may consequently not always find the peace and solitude they seek. Those walking the Geotrail in autumn with stable weather conditions, however, will not only be able to enjoy brightly-coloured landscapes, but also quiet and even lonely spaces. The individual stages of this trail are also possible as day tours; you can almost always use public transport to get back to your starting point or to return from the day's destination. The main challenge is nevertheless to attempt the Geotrail in ten days, taking the time to explore a unique world full of secrets and for a while escaping the hustle and bustle of our (over-)organised everyday world.

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Important information

- The Geotrail follows good-quality mountain trails or narrow paths and poses no particular technical difficulties. Some exposed sections of the trail are secured with steel cables. Sure-footedness, experience of the mountains, a reasonable level of fitness and stamina are all prerequisites for attempting the trail.
- Even during the warmer months, warm and weatherproof clothing as well as waterproofs should always be carried. Even short thunderstorms in the Dolomites can be very heavy and cause an extreme drop in temperature.
- Trekking boots with a good tread are the best choice for the trail.
- As the daily stages are quite long, you should make sure your rucksack is as light as possible, for example in terms of the changes of clothing or food and drink that you take. Food and drinks for the day can be purchased at the accommodation at the end of each stage, while there are often places to stop for a break en route.
- Trekking poles are a definite advantage.
- In addition to any personal medication, a small first-aid kit containing the most important items, e.g. a few plasters in the event of blisters or an elastic bandage for aching knees will be sufficient. Each stage of the trail offers several descent options, a cable car or a bus as an escape route. For major injuries contact the mountain rescue service.
  The emergency number is 112 in South Tyrol for assistance in the event of an accident in the mountains.
- It is better to start early than to be caught by a thunderstorm in the afternoon or by darkness in the autumn. Make sure to check the weather forecast the night before. This means you can start earlier the next morning and arrive at the next hut before any afternoon thunderstorm.
- The times in this guide are for general guidance only and very much depend upon personal fitness. They are average times that do not include breaks for a rest. Ask your hosts about the path conditions for the next stage!

- → As there is often limited accommodation along the way, booking by phone is strongly recommended.
- → All information in this guide is subject to change and should in all cases be checked against the appropriate maps.

WEATHER

The weather forecast for South Tyrol is available at www.provinz.bz.it/weather or by phone on +39 0471 270555 or +39 0471 271177. There are a number of well-positioned weather cameras in South Tyrol: www.ras.bz.it/en/webcams.

MOUNTAIN RESCUE

The free phone number 112 provides assistance in South Tyrol in the event of an accident in the mountains. It is important to give your location, the type of accident, if possible the nature of the injury or at least the symptoms as well as the number of casualties, the weather conditions and a mobile phone number for contacting the persons seeking help.

A lot to remember? It is very simple: just hold the line and the dispatcher on the emergency call number 112 will give you further guidance.

Hikers should also be aware that the provision of assistance in the mountains can be very expensive. Although, unlike in other Alpine countries, the mountain rescue service in South Tyrol still consists of volunteers, the injured person must pay for the costs of helicopter use. In many cases the mountain rescue team will be flown to the scene in one of the three helicopters stationed in South Tyrol: the costs may amount to several thousand euros. Walkers should therefore take out rescue insurance before their arrival in the mountains.

The Dolomites UNESCO World Heritage Site

On 26 June 2009, the Dolomites were added to the list of World Heritage Sites by UNESCO (the United Nations Educational, Scientific and Cultural Organization), thus achieving recognition as one of the world's most striking mountain landscapes. Two characteristic features played a critical role in this decision: the extraordinary scenic beauty and the geological and geomorphological significance of these mountains. Inclusion in the list of World Heritage Sites is the highest possible accolade a natural site can achieve.

To attain World Heritage status, a Site must be a unique asset of outstanding universal value. Conserving this irreplaceable heritage of humankind for future generations is the task of the country in which it is located, but also a duty for the entire community, population and visitors.

The award is not granted on a permanent basis: it depends on the management of the site. Should one of the properties that led to its inclusion in the list of World Heritage Sites be endangered, the site may risk withdrawal of the award.

THE LONG ROAD TO WORLD HERITAGE STATUS

A first attempt was made by the relevant ministry in Rome in 1997 to have the Dolomites included in the UNESCO World Heritage List. But different opinions regarding the limits of the future world heritage area ultimately put a stop to the idea. In January 2004, therefore, the Italian Culture and Environment Ministries set out clear conditions for a renewed application. The first formal request with 27 component sites, some very small, was submitted in September 2005 and subjected to an expert review on behalf of UNESCO in 2006. It was then recommended to revise the application and to put the emphasis on the aesthetic, geological and geomorphological qualities of the Dolomites, as well as to select certain areas in particular.

Seceda, with the Fermeda peaks of the Odle/Geisler massif behind

In 2008 a new application was made with just nine component sites of greater size, which was also reviewed by UNESCO experts. These issued a positive response in May 2009, rating the Dolomites as unique in the world in terms of their exceptional natural beauty and their geological and geomorphological features. The experts however also noted that the use of the Dolomites for tourist purposes had already reached acceptable limits in some areas. At the same time they stressed the need for intensive co-operation between the provincial and regional administrations affected by the World Heritage area, recommending the creation of an appropriate Foundation. In order to ensure the integrity and uniqueness of the areas and to guarantee their sustainable tourist use, it was specified that a common strategy for their management and for the sustainable development of tourism should be developed.

Subject to these conditions, Italy's request for inclusion of the Dolomites in the World Heritage List was unanimously approved by UNESCO's World Heritage Committee in June 2009. The Dolomites demonstrated their Outstanding Universal Value with regard to two of the four UNESCO criteria for Natural Properties: on the one hand their natural beauty, on the other their geomorphological and geological importance.

EXCEPTIONALLY BEAUTIFUL, GEOLOGICALLY OUTSTANDING

The exceptional charm of the Dolomites is due to their impressive diversity: peaks, pillars and towers, uplands with rocky outcrops, spires and plateaus that rise steeply from vast scree slopes, as well as rolling hills, all with an unusual variety of colours. The deep impression that they leave is strengthened by a natural phenomenon, the Enrosadira or Alpenglow. Some of the first visitors to this landscape were geologists, whose notes, paintings and photographs underline the immense appeal of the Dolomites.

The second characteristic recognised was their geomorphological and geological importance in representing the main stages of the Earth's history. The Dolomites are particularly valuable in this respect, because their low tectonic deformation, large geological outcrops, the thickness of the sedimentary rocks and their spatial continuity mean that their history can be gleaned right up until today, both as regards time (vertically) and space (horizontally).

AN OVERVIEW OF THE DOLOMITES UNESCO WORLD HERITAGE SITE

Nine areas of the Dolomites appear on the list of UNESCO World Heritage Sites:

1. Pelmo, Croda da Lago
2. Marmolada
3. Pale di San Martino, San Lucano, Dolomiti Bellunesi, Vette Feltrine
4. Dolomiti Friulane d'Oltre Piave

The Sesto Dolomites, Three Peaks and Cortina Dolomites

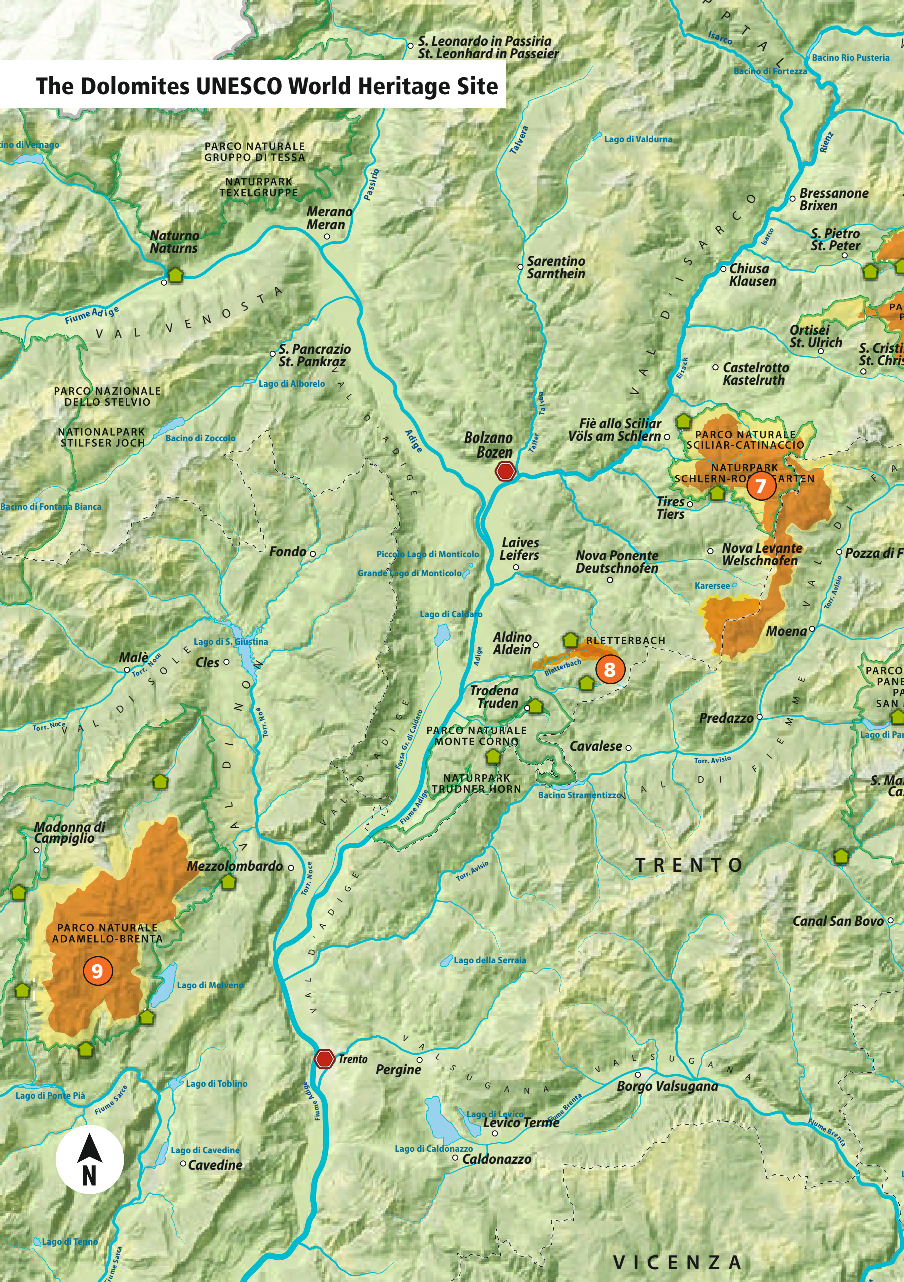
5 Northern Dolomites
6 Puez-Odle/Geisler
7 Sciliar/Schlern-Catinaccio/Rosengarten, Latemar
8 Bletterbach
9 Dolomiti di Brenta

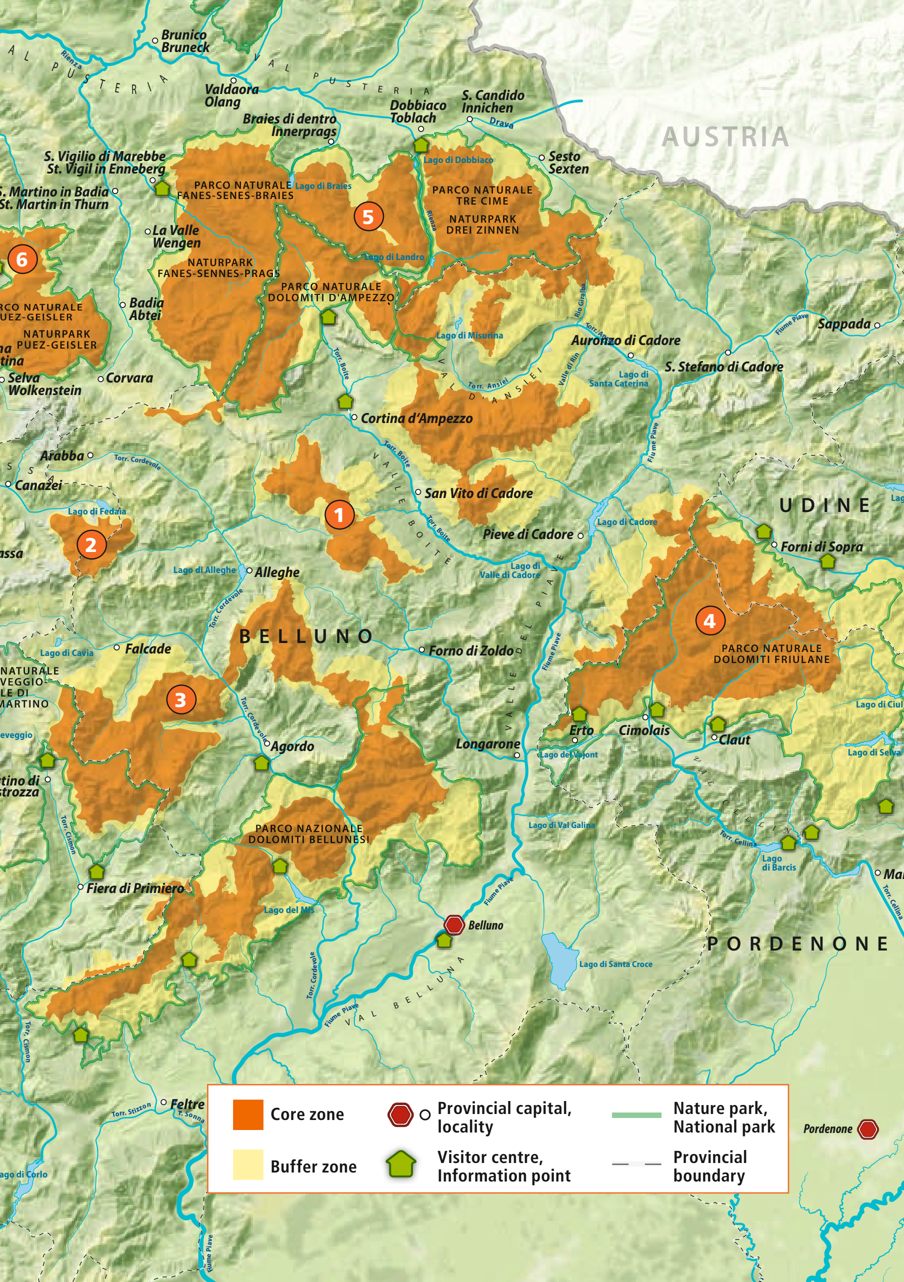
The core area of the World Heritage Site covers approximately 142,000 hectares and extends into the provinces of South Tyrol, Trento, Belluno (Veneto region), Pordenone and Udine (Friuli-Venezia-Giulia region). The outer regions bordering the World Heritage Site, with an area of around 89,000 hectares, are deemed a buffer zone and have an additional protective function. Overall, some 95% of the total area consists of protected areas such as nature parks, national parks or Natura 2000 sites.

In South Tyrol the nature parks of the Three Peaks, Fanes-Senes-Braies (Northern Dolomites), Puez-Odle/Geisler and Sciliar/Schlern-Catinaccio/Rosengarten, the Latemar massif and the Bletterbach all form part of the Dolomites UNESCO World Heritage Site.

One of the main tasks of the competent authorities, such as the UNESCO Dolomites Foundation, is to raise awareness of the World Heritage Site among locals and visitors alike, and to convince them of the global value of this unique landscape. A new, long-overdue sense of responsibility must be established, not only for the world heritage site, but for the entire Dolomites landscape, with the protection and preservation of this unique mountain world assuming the status of an international obligation.

The Dolomites UNESCO World Heritage Site




AUSTRIA
BELLUNO
UDINE
PORDENONE
VAL PUSTERIA
Brunico
Bruneck
Valdaora
Olang
Braies di dentro
Innerprags
Dobbiaco
Toblach
S. Candido
Innichen
Drava
Sesto
Sexten
Rienza
S. Vigilio di Marebbe
St. Vigil in Enneberg
S. Martino in Badia
St. Martin in Thurn
La Valle
Wengen
Badia
Abtei
Corvara
Selva
Wolkenstein
Arabba
Canazei
Torr. Cordevole
Lago di Fedaia
Lago di Dobbiaco
Lago di Braies
Lago di Landro
Lago di Misurina
PARCO NATURALE
FANES-SENES-BRAIES
NATURPARK
FANES-SENNES-PRAGS
PARCO NATURALE
TRE CIME
NATURPARK
DREI ZINNEN
PARCO NATURALE
DOLOMITI D'AMPEZZO
PARCO NATURALE
PUEZ-GEISLER
NATURPARK
PUEZ-GEISLER
Rio Giralba
Torr. Ansiei
VAL D'ANSIEI
Auronzo di Cadore
Valle di Rin
Lago di
Santa Caterina
S. Stefano di Cadore
Fiume Piave
Sappada
Torr. Boite
Cortina d'Ampezzo
VALLE BOITE
San Vito di Cadore
Pieve di Cadore
Lago di Cadore
Lago di
Valle di Cadore
Forni di Sopra
Lago di Alleghe
Alleghe
Lago di Cavia
Falcade
Forno di Zoldo
VALLE DEL PIAVE
PARCO NATURALE
DOLOMITI FRIULANE
PARCO NATURALE
PANEVEGGIO
PALE DI
SAN MARTINO
Erto
Cimolais
Claut
Lago del Vajont
Longarone
Agordo
Lago di Ciul
Lago di Selva
VAL CELLINA
Torr. Cellina
Lago
di Barcis
Lago di Val Galina
PARCO NAZIONALE
DOLOMITI BELLUNESI
Torr. Cismon
Fiera di Primiero
Lago del Mis
Belluno
Lago di Santa Croce
VAL BELLUNA
Fiume Piave
Feltre
Torr. Stizzon
T. Sonna
Lago di Corlo
Pordenone
1
2
3
4
5
6
Core zone
Buffer zone
Provincial capital,
locality
Visitor centre,
Information point
Nature park,
National park
Provincial
boundary

Why a Geotrail through the Dolomites?

The Dolomites were selected in 2009 as a UNESCO World Heritage Site mainly on account of their unique geological history. From this arose the idea of designing a trekking route through the Dolomites that would present this spectacular history to walkers.

The ten stages of the Dolomites UNESCO Geotrail are assembled like the beads on a necklace and follow an overall guiding principle. The theme of each stage is set out in its title and clearly explained in the geological introduction. Two points along each stage were selected that would show one aspect of the geological history of the Dolomites in a particularly interesting or memorable way. Each Geostop is shown on the map together with accompanying text, photos and sketches.

As we are aware that geology is considered by many to be a difficult science, only open to the experts, we have deliberately chosen simple and easy-to-understand language. Readers are gradually introduced at the respective Geostops to the technical terms that are indispensable to understanding the geological phenomena.

For those with no basic knowledge of geology, one of the greatest difficulties undoubtedly lies in understanding the spatial relationship between the rock layers that build up into the different mountains. Perhaps it is helpful to imagine the Dolomites as a huge old building, where each floor represents a certain time period: the Palaeolithic, Neolithic, the Roman era, the Middle Ages, the Renaissance and so on.

If we go up a floor in this building, we reach a more recent age, while going down means going back into the past. Moving on the same level, however, reveals different rooms and areas of the same time period. As we hike through the mountains, we do exactly the same, with the rock layers corresponding to the storeys of the Dolomites "building". To make the comparison even clearer, we must imagine that over time the original appearance of the building has been greatly altered: many areas are missing altogether, others have been relocated or even buried beneath the Earth.

What was once one large building is now divided into many parts that exist more or less separately from one another, and at first glance appear to have nothing to do with each other. In reality they are all remnants of a single jigsaw puzzle, and it is up to us to reconstruct the overall picture. Before we begin with the reconstruction, however, it is important to know that the entire Dolomite structure is inclined to the East, making the Geotrail also a journey through time: in the West, around the Bletterbach, the deepest and thus the oldest storeys are on the surface, while in the East, around the Three Peaks, the highest and thus most recent storeys form the summit silhouettes.

GEOLOGICAL AGES

Geology allows time to be read from the layers of rock. The lower layers of a rock sequence are older than those that lie above. Some layers are so characteristic in their colour, appearance, material composition, fossil presence, etc., that it is always possible to identify them – even in areas that are a considerable distance apart. It is therefore possible to reconstruct a perfect and complete sequence of rock layers for each area of the Earth – for example the Dolomites – that reflects its geological evolution. Preserved fossils also allow packages of layers to be correlated in time over distances of thousands of kilometres. This is because certain plants and animals lived in a such a (relatively) short period of time that they have tremendous value as fossils. When such fossils are found in rocks, even in the remotest places on Earth, this confirms that the rock packages formed at the same time.

Geologists have collected all this information and created a timescale for the evolution of the Earth, from its birth to the present day. The geological time scale – from the appearance of the first higher developed beings until today – is divided into three main eras: the Palaeozoic, Mesozoic and Cenozoic. The entire previous era is referred to as the pre-Cambrian. According to this division, the dinosaurs lived in the Jurassic period, the first horses emerged in the Neogene and man only appeared in the Quaternary.

Radiometric age dating, based on the physical decay of radioactive atoms in certain minerals occurring in rocks, also enables the absolute age of the Earth's various time periods to be determined.

THE AGE OF THE MOUNTAINS

When we look at a mountain, we seldom ask ourselves when the mountain was formed. There is a reason for this: compared to a human life, a mountain is an eternal, never-changing work. It is hard for us to imagine that the mountain was never there.

If we refer to geological periods, however, the above query makes sense. The answer to this simple question is nevertheless neither trivial nor easy to answer. We must first define what we mean by the age of a mountain: the age of its formation, i.e. its elevation and uncovering, or the age of rocks that make up the mountain?

The formation of a mountain is a very long process that can be divided into three phases:

- the formation of the rock layers *(lithogenesis)*
- the deformation and subsequent uplifting *(orogenesis)*
- the shaping of its relief through erosion *(morphogenesis)*

In the case of the Dolomites, the first and oldest phase occurred almost entirely in the Mesozoic era. The rocks were formed layer by layer in various areas at the bottom of a sea that we will learn about along the Geotrail.

The second phase caused the deformation and uplifting of the rock layers, which are today tilted, broken, shifted and folded. This process goes back to the large convective forces in the Earth's interior that are responsible for the movements of the Earth's crust and shift the tectonic plates. This process began in the Cenozoic era in the Dolomites and continues to this day.

The third phase in the formation of the Dolomites began about 30 years million ago, when the first land masses of the Dolomites rose out of the sea. Since then erosion has continuously eaten into the layers of rock, with material from the summit areas removed and deposited at the foot of the slopes and in the valleys.

This last stage is certainly the fastest in terms of action. The appearance of a landscape can be radically altered within a few tens of thousands of years. The present-day form of the Dolomites goes back more or less 20,000 years, with this development continuing, even if we are only aware of it when "catastrophic" events occur, such as floods, landslides and major rockfalls.

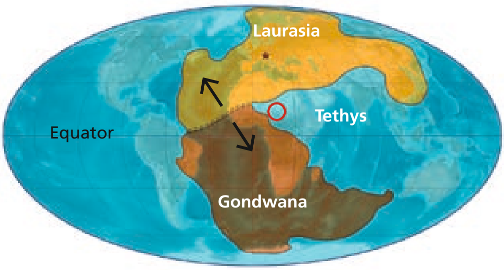
A typical Dolomites landscape; traces of recent erosion such as the alluvial fan at the foot of the steep Dolomite walls, more or less covered by trees, are clearly visible. The white "stripes" record the most recent deposits caused by debris flows. The landscape also shows traces of older events: the U-shape of the valley in the foreground is a relic of the last Ice Age, when the central part of the valley was scored by a glacier tongue. In the foreground is the Langental/Vallunga with the town of Selva/Wolkenstein in the Val Gardena Valley in the background.

THE DOLOMITES

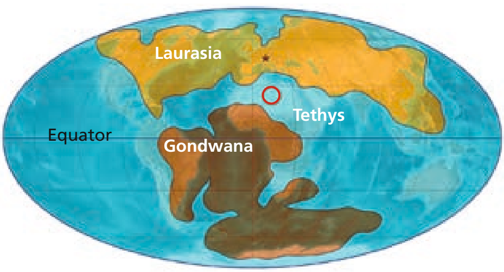
The Dolomites owe their name to the mineral that comprises a large proportion of the rocks of the "Pale Mountains". The mineral named dolomite was discovered in 1791 by the French aristocrat and geologist Déodat de Dolomieu, who was studying rocks from the Dolomites. Dolomite stone is a carbonate that, in contrast to limestone, will not react when exposed to diluted hydrochloric acid: this is because it contains magnesium in addition to calcium.

Stage for stage along the Geotrail we will learn about the unique geological history that has led to the formation of dolomite rock and all the other rock types that today form the region of the Dolomites.

The history of the Dolomites starts in the Permian period, about 280 million years ago. At that time the entire region was a vast continent in the area of the Equator, with flat desert landscapes and vast volcanic zones. The form and arrangement of the continents was substantially different from that of today: the region of the Dolomites formed part of a single continent, the supercontinent Pangaea. Two major continents were formed after the breakup of Pangaea, Laurasia in the north and Gondwana in the south, which gradually drifted apart, with the Tethys Ocean forming in between. The Dolomites, at that time on the northern margins of Gondwana, were gradually flooded by the sea and slowly evolved into a tropical archipelago. Despite some significant geological events, this landscape remained almost unchanged throughout the entire Triassic period until a drastic climate change finally marked the end of this development. However, the history of the Dolomites did not end there: the region was transformed into a vast marine coastal plain, which slowly but steadily sank at the beginning of the Jurassic period



Simplified paleogeographical reconstruction of the distribution of the continents in the Triassic period when the Dolomites region (red circle) was a tropical archipelago. The star shows the current position of the Dolomites.



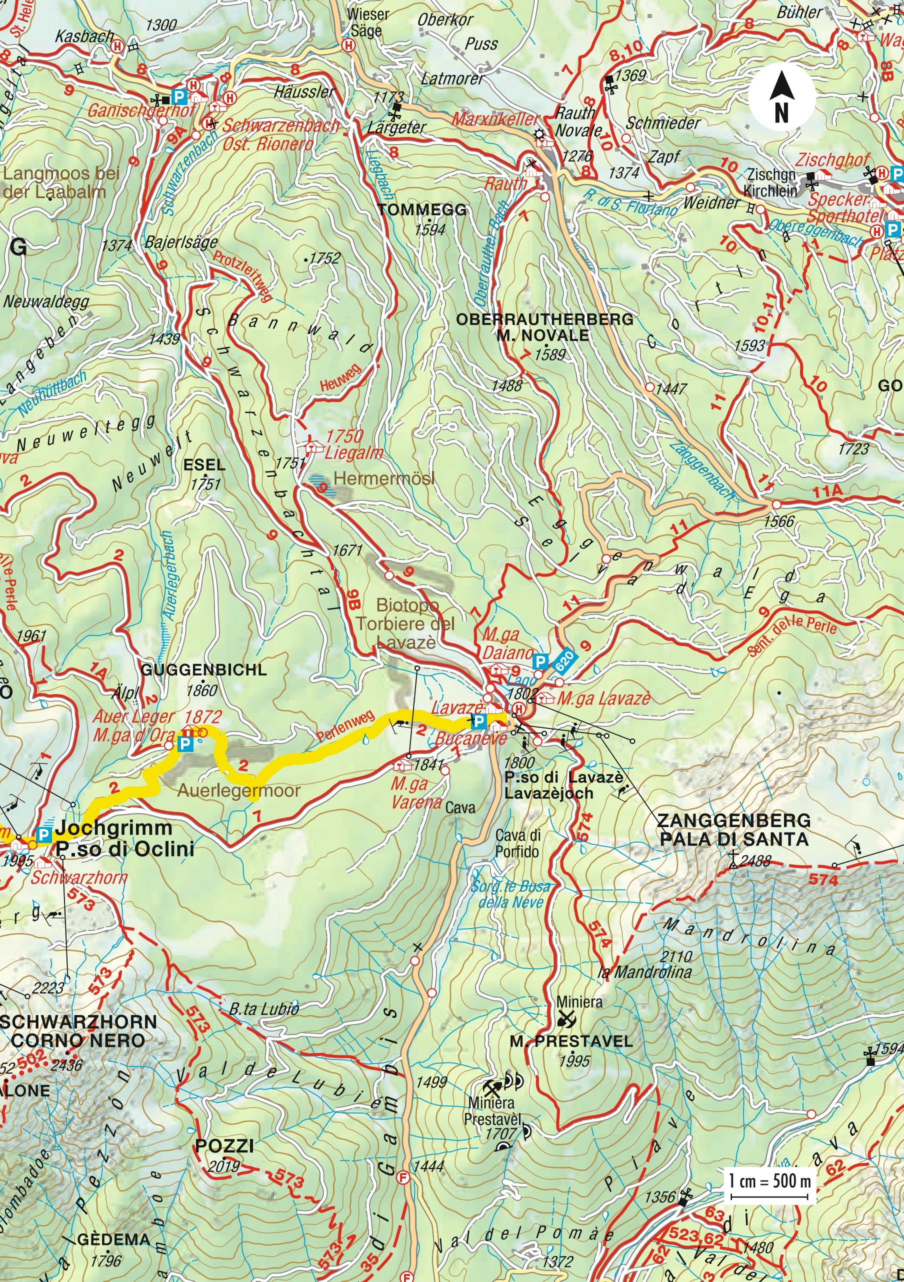
Simplified paleogeographical reconstruction of the distribution of the continents in the Cretaceous period when the Dolomites region (red circle) was a deep sea. The star shows the current position of the Dolomites.

Numerous mountains in the Dolomites have retained their original Triassic form, i.e. that of a tropical atoll (kindly provided by P. Gianolla).

until it became a deep sea plain. These deep-sea conditions endured for the entire Cretaceous period, at the end of which the Dolomites began a long "journey" northwards. After travelling 3,000 kilometres they finally reached their current location.

The peculiar aspect of the Dolomites as part of the Alps is that they have experienced all of the above processes, but have in many areas retained their original form of Triassic archipelagos. The form of recent atolls in the Dolomites can in fact be reconstructed owing to the characteristic arrangement of rock layers. The sedimentary structures and preserved fossils evidence the same deposit mechanisms and ecological and environmental conditions found in today's tropical reefs. This is the main reason that the Dolomites continue to fascinate geologists from around the world and now have "UNESCO World Heritage" status.

Stage 1: from the Bletterbach to the Lavazèjoch pass



Kasbach
Wieser Säge
Oberkor
Puss
Bühler
Latmorer
Häussler
Ganischgerhof
Schwarzenbach Ost. Rionero
Lärgeter
Marxnkeller
Rauth Novale
Schmieder
Zapf
Zischghof
Zischgn Kirchlein
Weidner
Specker
Sporthotel
Langmoos bei der Laabalm
TOMMEGG
1594
Rauth
R. di S. Floriano
Obereggenbach
Bajerlsäge
Protzleitweg
Neuwaldegg
Bannwald
OBERRAUTHERBERG M. NOVALE
1589
Schwarzenbachtal
Heuweg
Neuhüttbach
Neuweltegg
Neuwelt
1750 Liegalm
Hermermösl
ESEL
1751
Zanggenbach
1566
Eggerwald
Auerlegerbach
Biotopo Torbiere del Lavazè
M.ga Daiano
Lago
M.ga Lavazè
GUGGENBICHL
1860
Älpl
Auer Leger 1872 M.ga d'Ora
Perlenweg
Lavazè
Bucaneve
Sent. delle Perle
1841
M.ga Varena
1800
P.so di Lavazè Lavazèjoch
Auerlegermoor
Cava
Jochgrimm P.so di Oclini
1995
Schwarzhorn
Cava di Porfido
ZANGGENBERG PALA DI SANTA
2488
Sorg.te Busa della Neve
Mandrolina
2110
la Mandrolina
2223
B.ta Lubio
SCHWARZHORN CORNO NERO
2436
Miniera
M. PRESTAVEL
1995
Val de Lubiè
1499
Miniera Prestavèl
1707
POZZI
2019
1444
Piave
1 cm = 500 m
1356
GÈDEMA
1796
Val del Pomàe
1372
1480

From land to sea

Lost in thought, I stand in the empty car park. It is early morning and, at what is perhaps the most important geological point in South Tyrol, there is absolute silence. Slowly and deliberately I walk down the broad path until I enter the incredible time machine. Within seconds I am catapulted back into the past: millions of years rush past me as I follow the stream into the depths of the canyon.

The Bletterbach gorge is a huge, constantly changing kaleidoscope. It is not only the day and seasons that change the colours of the steep rock walls; fierce summer storms and prolonged periods of rain are constantly chiselling new forms in the bottom of the gorge. My journey through the Dolomites has only just begun and I already feel as if I could simply sit down and be captivated by this spectacle. Slowly I ascend the trackless bed of the gorge, which is 8 kilometres long and up to 400 metres deep. I have climbed numerous steep walls in the Dolomites and held onto small and ancient holds, and I have occasionally also encountered small relics embedded in stone that reminded me of gifts from a bygone era: but I have never penetrated so far into the bowels of this landscape. I have effortlessly pushed open a door that has drawn me into the wonderful underworld of this unique canyon.

At the end of the canyon I will re-emerge into the present. Carefully I head for the Weisshorn/Corno Bianco and it is not long before I can once again look back deep into the geological past. The summit of the Weisshorn seems to stand guard over the gorge. On its west flank, however, the mountain offers a view into its interior where huge boulders slowly but inexorably move downwards. Eventually they will reach the entrance to the gorge below and give it a new face. From the Weisshorn I can see far out across the land; only to the east do coral reefs obstruct the view. If I close my eyes I am surrounded by the soothing

At the entrance to the Bletterbach gorge

sound of the sea, which has tirelessly piled up the bizarre landscape that today we call Latemar.

Soon I pass through a shady forest, then past an inviting-looking mountain, but I follow the tranquillity that, siren-like, attracts me: I float in thought, heedless of time, until I arrive at today's destination and come back to earth.

INTRODUCTION

The first stage of the Geotrail climbs up from the Bletterbach gorge to the summit of the Weisshorn. We pass through stunning scenery that reveals various layers of rock with the oldest at the bottom, the most recent at the very top. Like a book, these layers tell a story – a story that has lasted 40 million years, with the transformation of the Dolomites of the time from a landmass into a sea. Geologists can read this history recorded in the rocks.

It all began some 280 million years ago in the geological age known as the Permian (the last period of the Paleozoic era). The area, upon which the Dolomite mountains will later be built, was at the time a vast flat land marked by volcanic activity. The explosive eruptions of magma solidified into a layer of rock more than one kilometre thick. The rocks created by these volcanic eruptions are called ignimbrites (from the Latin for "rain of fire"): they are compact, dark-red to purple rocks that may also be seen at the base of the gorge.

Travelling further upstream you encounter red, layered rocks: sandstones. Huge amounts of sand were deposited by rivers on a hot, dry plain. The individual grains of sand are the result of the erosion of the underlying volcanic rocks. Following the extinction of the volcanic activity, a plain formed under dry and hot climate conditions, crossed by periodically water-bearing river systems. The rivers rose in the west in the area of today's Lombardy, finally emptying into the sea that lay far to the east, approximately where Croatia is today.

Slowly, over millions of years, the shoreline moved further and further west and initially transformed the former plain into a coastal lagoon with a high evaporation rate, ultimately creating a shallow sea. Only at the end of the story documented in the rock layers of the Bletterbach gorge did the sea prevail: the seawater was clear and warm (the mainland was now some distance away) and the first reefs could begin to grow.

The Bletterbach gorge from the air

ROUTE

Stage 1: from the Bletterbach to the Lavazèjoch pass

→| 12.2 km ↑ approx. 1070 m ↓ approx. 810 m 5–5½ hours

From the GEOPARC Bletterbach visitor centre take Path no. 3 (signed) down towards the Butterloch in the Bletterbach gorge (charge payable, helmet must be worn). From there you follow the path, constantly changing through erosion, through the gorge to the Butterloch (→ **GEOSTOP A**). Proceed a little further through the canyon until you reach the Gorzsteig path, upon which you ascend to the right and out of the Bletterbach gorge.


View from the Weisshorn into the Bletterbach gorge

When the Gorzsteig joins the Zirmersteig path (marked no. 12), turn left and climb until the route branches off to the right. Here you will find ➔ **GEOSTOP B**. Carry on straight ahead in the direction of the Weisshorn (marked no. 12) and, at the next junction, continue straight ahead until you reach the summit of the Weisshorn via numerous zigzags. From the highest point descend southwards to the Jochgrimm pass. Follow the road for a short distance, past the large car park, then immediately take a left onto Path no. 2 (Auer Leger). At the Auerleger Hut go straight ahead onto the Perlenweg (marked no. 2). Continue largely through forest until you reach the destination for the day, the Lavazèjoch pass.

→ GEOSTOP A LON: 11 25 2,325 N | LAT: 46 21 39,112 E

The sea advances

The waterfall in the Butterloch is the location of the oldest rock layer in the Dolomites, containing the first evidence of the sea encroaching from the East, the so-called cephalopod bed. Even at a distance this layer stands out from the other layers, both above and below. The waterfall has formed at this weathering-resistant layer precisely because of its greater hardness and angular, compact formation. On closer inspection this rock stratum differs markedly from the underlying layers: it does not consist of grains of sand from river deposits, but rather of calcium carbonate formed in the sea. Numerous marine fossils can be found in the layer itself, such as gastropods, bivalves and nautiloids. The latter are related to modern cephalopods (e.g. octopus, squid and cuttlefish). In contrast to present-day species, however, they had a spiral outer shell and dominated the seas of the Jurassic and Cretaceous periods along with the more widely known ammonites.

Fig. 1 – Waterfall in the Butterloch with the distinctive cephalopod bed that indicates the first encroachment of the sea from the East

The sea did not prevail for long, however. It soon retreated and fluvial sandstones were again deposited, very similar to those of the layers below. In addition to the numerous plant fossils contained, the surface of these sandstone layers – which can be traced along the streambed above the waterfall – are marked by the tracks of various reptiles, including those made by the ancestors of the first dinosaurs.

Fig. 2 – Outer shell of a nautiloid from the cephalopod bed (photo H. Prinoth)

→ GEOSTOP B LON: 11 26 3,189 N | LAT: 46 21 17,538 E

The naming of rock layers

From this viewpoint can be seen, in all its glory, the entire rock sequence that forms the upper part of the Bletterbach gorge. The layers run through the entire amphitheatre and even the thinnest strata can be traced through the entire gorge.

On closer inspection we see that the rock layers have very different characteristics in terms of their colour spectrum, hardness, thickness and composition. These different properties mean that erosion can spectacularly model the colourful, step-like structure of the rock layers that can here be seen in all its diversity. The Bletterbach gorge is rightly known as the Grand Canyon of South Tyrol.

Layers that consist of the same material and have been deposited at the same time and under similar conditions are grouped together by geologists as "formations". Each formation has an internationally recognised designation (name) and thus represents a certain time period in the Earth's geological history, telling us the setting (coastal plain, shallow water, deep sea) and depositional environment (glacial, fluvial, lacustrine, lagoon, offshore, marine) in which the rocks were formed.

Three clearly recognisable formations can be distinguished from here. From bottom to top, these are the Bellerophon Formation, the Werfen Formation and the Contrin Formation (Fig. 3)

The Bellerophon Formation consists of an alternating sequence of grey carbonate strata, grey-yellowish clays and white gypsum layers. These deposits point to the existence of lagoon conditions close to the coast, with high evaporation rates in a hot and dry climate. The Bellerophon Formation follows the red sandstone ("Val Gardena Sandstone") that we can observe in the area below and above the waterfall and which documents the definitive advance of the sea.

The Werfen Formation on the other hand consists of yellowish-grey limestone or marl strata as well as reddish sandstones and claystones. All of the layers in this formation are rich in marine fossils, indicating that these were deposited in a shallow-water coastal area along with the sedimentary structures they contain.

Fig. 3 – Subdivision of the visible layers into formations (see explanations in text). (B) Bellerophon Formation; (W) Werfen Formation; (C) Contrin Formation. The yellow lines delimit the respective formations, with the upper boundary represented by a dotted line as its exact location is uncertain owing to its covering by recent talus material.

Alternating sequences of different rock types reveal the cyclical advance and retreat of the sea. The red sandstones indicate the presence of river systems that transported large amounts of sand material from the mainland and deposited them in the shallow sea.

The white rocks that form the summit of the Weisshorn are part of the Contrin Formation. These are dolomites, mainly formed from calcareous algae. This striking change in the rock type marks the change from a beach-like environment to conditions similar to those forming today's tropical reefs that grow in warm, clear sea water.

Unique feature:

At the base of the Werfen Formation can be found one of the most important boundaries in the Earth's history: the boundary that separates the Palaeozoic from the Mesozoic era, also called the Permian-Triassic boundary, i.e. the respective end and beginning of the two time periods. This boundary represents the largest known mass extinction of flora and fauna, an event far more catastrophic than that leading to the disappearance of the dinosaurs 65 million years ago: around 252 million years ago, approximately 90 % of all marine and 70 % of all terrestrial species vanished.

Places to eat and stay

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The summit of the Weisshorn

The guide was produced in collaboration with the Office for Nature Parks and the Office for Geology and Building Materials Testing of the Autonomous Province of Bolzano, IDM Südtirol, and the tourism organisations of the South Tyrolean Dolomites.

Verena Larcher and Daniel Costantini have been involved in preparing the geological part of this hiking guide from the outset; they also supervised the preparation of the German version. Thanks go to Chiara Siorpaes, Evelyn Kustatscher, Marcello Caggiati and Piero Gianolla for their valuable advice and critical reading of the texts.

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Christjan Ladurner,

born in 1961, works as a mountain guide, author and photographer. He has spent considerable time in and "over" the Dolomites; climbing, hiking and taking photos of the Pale Mountains from the air. His excellent local knowledge was an enormous help in the setting and adjusting of the Geotrail route. As always, the camera was his constant companion and while neither the weather nor the lighting conditions were always the finest, his images nevertheless allow the breathtaking beauty of the Dolomites to be seen in the right light.

Corrado Morelli,

born in Formia in 1963, graduated in geology and gained his PhD in Earth Sciences from the University of Rome. He has lived in the Vinschgau/Venosta Valley for over 20 years and has helped compile the new Geological Map of Italy and South Tyrol. He has co-authored over 20 scientific publications as well as ten geological maps with explanatory notes and a geological guide.

The Dolomites UNESCO Geotrail is an outstanding long-distance hiking trail through a UNESCO World Heritage Site. This guide provides a detailed description of 10 stages through the landscapes of the South Tyrolean Dolomites, along with photos, maps and sketches. 19 geological highlights, like beads on a necklace, give hikers and readers an overview of the area's unique geological history and thus explain why the Dolomites have been awarded the title of "World Heritage Site".

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