

Hiking in the Triassic

When visiting the Dolomites of northern Italy, you can combine hiking, biking and climbing with scenery dominated by towering pinnacles and plateaus. This spectacular Late Cenozoic mountain range, home to many well known ski resorts, consists of carbonate rocks deposited in the vast Tethys Sea in the Triassic, more than 200 million years ago.

Queen of the Dolomites

The Marmolada massif (3,343m), with its pale peaks of dolomite towering above the green slopes of the mountains and valleys below, hosts the only glacier in this section of the Alpine mountain range. A careful inspection of this photo will reveal that the glacier has retreated in recent years: Where the ice ends the mountain slope is barren, indicating that the ice has washed the surface clean. An end moraine can also be seen at this point. The photo is taken from the summit of *Piz Boe* (3,152m) in the Sella Massif where – most surprisingly – there is a small refuge where you can sit down at a table and enjoy a meal, while at the same time take in this panoramic view of sculptured dolomitic rocks.



Dolomite

Dolomite is a sedimentary rock containing more than 50% by weight of the mineral dolomite [$\text{CaMg}(\text{CO}_3)_2$]. Dolomites usually form through replacement of pre-existing limestones. The rock is often stratified with layers of calcite [CaCO_3].

Sella Massif

The tabular Sella Massif consists of *Dolomia Principale Formation* of the Late Triassic (Norian). This photo is taken from the slopes of the Sella massif, some 300m above *Passo Pardoj* (2,239m), a half-hour drive from Val Gardena. The viewpoint is 400m below *Sas de Pardoj* (2,950m) which boasts a 360° view of the Dolomites. From the pass it is a two-hour leisurely steep walk to the top of the plateau, but a modern, albeit boring, cable car, takes you in a rapid ascent to the summit in only four minutes. During summer months, this pass – *Passo Pardoj* – is the ideal point of departure for hikers, climbers, mountain bikers or those who just enjoy being in direct contact with rocks and flowers without going through the exhaustion of climbing mountains.



Geographically, the Dolomites form a 60-80 km long east-west trending strip. Geologically, however, the dolomitic rocks extend way south towards the Adriatic Sea. The Dolomites are easy to access, as they are situated only a couple of hours drive from München in the north and Venice in the south, and a visit to these mountains can easily be combined with other ventures in northern Italy.



Halfdan Carstens

Last summer I spent a week in the sunny Dolomites, and – following many years of hiking in the Norwegian mountains, the western Alps and the Pyrenees – I am in no doubt: This must be hikers' paradise.

There are well-marked trails and tracks almost everywhere. They will take you from the bottom of the largely north-south oriented valleys to the highest peaks, sev-



Just do it: Climb the steep dolomite mountains using whatever is at your hands.

eral reaching heights of more than 3,000m, or from the countless number of passes with shops and restaurants, to an endless number of refuges where you can buy a glass of beer and a decent meal. On a lazy day, the cable car can bring you high up in the mountains, and you can take an easy stroll down, just enjoying the unsurpassed scenery of white ice, pale peaks, brownish plateaus, green forests, and grassy slopes.

The mountains and valleys of this fold-thrust belt, which is only mildly deformed, are criss-crossed by a vast network of well-marked trails. Close to the car parks, cable cars and refuges these paths may be crowded in the high season, but as soon as you get a little way from them, you can enjoy yourself without the hassle of meeting and passing other tourists all the time.

More than hiking

If you want a change, this mountain range is also excellent for biking, with paved roads through many passes. Imagine Tour de France, with professionals climbing steep hills in the baking sun, or speeding downhill through breathtaking turns (no wonder they are heavy on dope). Well, here you can do the same yourself, but unlike young sportsmen in a hurry, you can enjoy refreshments at the pass. But stay away from the beer; it gets back to you during your next



The Tethys Sea – where The Dolomites were born

In 1893, using fossil records from the Alps and Africa, the European (born in England, raised in Austria) geologist Eduard Suess (1831-1914), proposed the theory that a shallow inland sea had once existed between Laurasia (North America, Europe, former Soviet Union, China) and Gondwana (South America, Africa, India, Australia). He named it the "Tethys Sea" after the Greek sea goddess Tethys. Suess was an expert on the Alps and was the first to realise that the Alps were once at the bottom of an ocean.

In Permian times, the continents were assembled into one, enormous landmass, known as Pangea. This landmass was crescentic in shape and a large wedge-shaped area of ocean separated the southern continental masses of Gondwana from the northern continental masses of Laurasia. It is this ancient oceanic region that is termed Tethys.

In the Triassic, some 250 million years ago, a wide ocean started to open between Europe and Africa. This is known as the Tethys Ocean, where deposition of huge amounts of continental and marine sediments took place in a tropical climate.

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ascent – we are talking about continuous uphill climbs of 500m - or even 1,000m

Don't forget the *via ferrata*¹. This has to do with rocks – carbonates – and you will never get closer than this to a reservoir analogue. The cliffs are steep, almost vertical, and the rocks are loose. If you have fear of heights, then stay away, but if you enjoy a slow climb, foot by foot, the scenery at the top is definitely worth the effort. The descent is easier, you say? Maybe so, but the bad news is that you have to look down all the time. Take care!

And, having already made the investment in your summer holiday, the geology of the Triassic carbonate platforms is for free. This is an excellent opportunity to have a look at the dolomitic rocks laid down more than 200 million years ago and the result of the sculpturing made by the ice and water through the Late Tertiary and Quaternary (Neogene). In addition, you get an insight into some of the consequences of global warming. Whatever the reason, the Alps - including the Dolomites – will lose some of the attraction if the ice melts away. And it is melting. There is no doubt

¹According to Wikipedia, a *via ferrata* (Italian for "iron road") is "a mountain route which is equipped with fixed cables, stemples, ladders, and bridges." The Alps have many *via ferrate*. In German it is named *klettersteig*.



Photo: Haldan Carstens

Take care, don't go too fast downwards. The turns are steep.



Photo: Haldan Carstens

There are numerous trails.

that the glaciers have retreated through many decades - just look at the photo on the previous pages. (See also the front cover of GEO ExPro No. 2, 2008.)

Part of the Alps

The Dolomites of northern Italy consist largely of Triassic dolomites that rest on Permian red beds and Precambrian metamorphic rocks.

Extensive deposits of organic sediments testify of a vast, ancient sea of corals, sponges, molluscs, fish and calcareous mud, and

in some areas a lot more than 1,000m of sediments were laid down in response to rapid subsidence. These stratified calcium magnesium carbonate rocks are considered worldwide to be excellent examples of ancient carbonate platforms and buildups. Petroleum geologists and reservoir engineers therefore use them for research in reservoir characterization (GEO ExPro, No. 2, 2006).

The Tethyan Ocean started to open between Europe and Africa in the Triassic, while continental and marine sediments

Dolomite – the Rock

Dolomite – the rock that dominates the Dolomites – consists predominantly of the mineral dolomite $[\text{CaMg}(\text{CO}_3)_2]$. The rock "dolomite" was named after the French mineralogist Dieudonné Sylvain Guy Tancrède de Gratet de Dolomieu (1750-1801). The rocks he collected when visiting the area in 1789 were later analysed by a friend of his, who confirmed that they consist of calcium-magnesium carbonate. Different from limestone, dolomite does not show any reaction when immersed into hydrochloric acid, and as such it is easy to distinguish from pure calcium carbonate. Following this discovery, the "Pale Mountains" were later renamed the Dolomites.

were laid down through tens of millions of years. The tropical climate favoured the development of huge colonies of calcareous algae that were capable of constructing carbonate shelves. In the Middle Triassic, building organisms – like those corresponding to present barrier reefs – started a fight for their own survival, trying to oppose the progressive subsidence of the sea floor. They quickly built up new reefs stretching towards the sea surface.

Also in the Middle Triassic, the region was affected by strong volcanism, resulting in the outpouring of huge amounts of lava and tephra that flowed along the

reef slopes, causing the extinction of many species.

In the Late Triassic a new phase of sea floor subsidence began. New reefs were built, and, the thick sequence of the *Dolomia Principale Formation* was laid down. This forms the present-day tabular mountain groups of Sella and Gardenaccia.

The carbonate platforms of the Dolomites are said to bear witness to a remarkable set of changes in carbonate production and to significant paleoclimatic fluctuations.

Tertiary Mountain Building

The Alps, including the Dolomites, owe their existence to the convergence of the African continent with the European one. Firstly, the closure of the Tethys Ocean took place, followed by the actual collision of the two continents. The first phase of this compression is ascribed to the Palaeogene (Eocene), followed later by Neogene overthrusting and strike slip movements. This uplift, though with lower intensity, still continues at present. Ultimately, these movements will result in the closure of the Mediterranean Sea.

Ladinian – the Epoch

Ladin is the native tongue still spoken in many valleys of the Dolomites, as well as in two other regions in Italy and Switzerland. It is a result of Roman expansion into the Alps more than 1500 years ago and is today used alongside Italian and German. It is also taught in schools as a third language. **Ladinian** is a geological epoch within the Middle Triassic period.

Photo: Halldan Carstens

The volcanic rocks of the Dolomites can be easily seen in two places in Val Gardena and above Arabba. Walking east from Passo Pordoi, you tread on the dark grey to brown volcanic rocks all the way to Viel del Pan and Porta Vescovo, a hike which only takes a few hours. At the same time, you can admire the stratified dolomites of the Sella Plateau on the northern side of the valley.