Provincia di Belluno

Provincia Autonoma di Bolzano-Alto Adige
Autonome Provinz Bozen-Südtirol

Provincia di Pordenone

Provincia Autonoma di Trento

Provincia di Udine

Regione Autonoma Friuli Venezia Giulia

Nomination of the Dolomites for inscription
on the World Natural Heritage List UNESCO

Cover: Sasso della Croce / Kreuzkofel / Sas dla Crusc

NOMINATION OF
THE DOLOMITES
FOR INSCRIPTION ON
THE WORLD
NATURAL HERITAGE LIST UNESCO
ANNEXES 2-8

Provincia di Belluno

Provincia Autonoma di Bolzano-Alto Adige Autonome Provinz Bozen-Südtirol

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NOMINATION OF

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ANNEXES 2-8

PROVINCIA DI BELLUNO
PROVINCIA AUTONOMA DI BOLZANO – BOZEN
PROVINCIA DI PORDENONE
PROVINCIA AUTONOMA DI TRENTO
PROVINCIA DI UDINE

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A2.2 FLORA AND FAUNA
A2.3 VIDEO “THE DOLOMITES”, 2007

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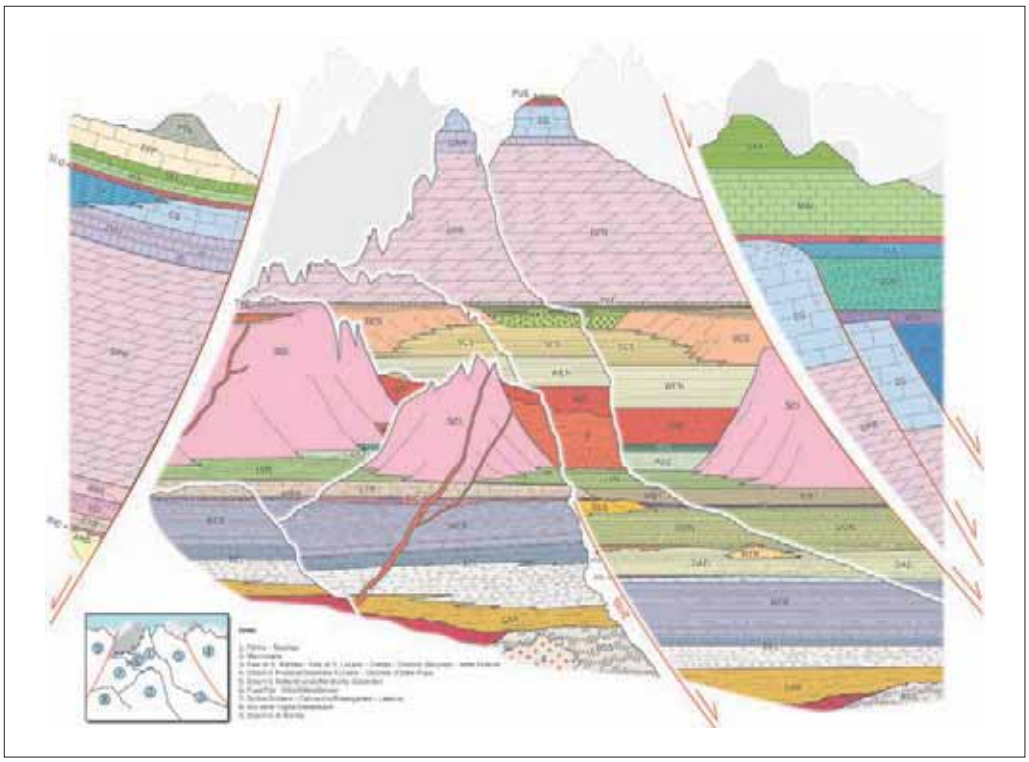
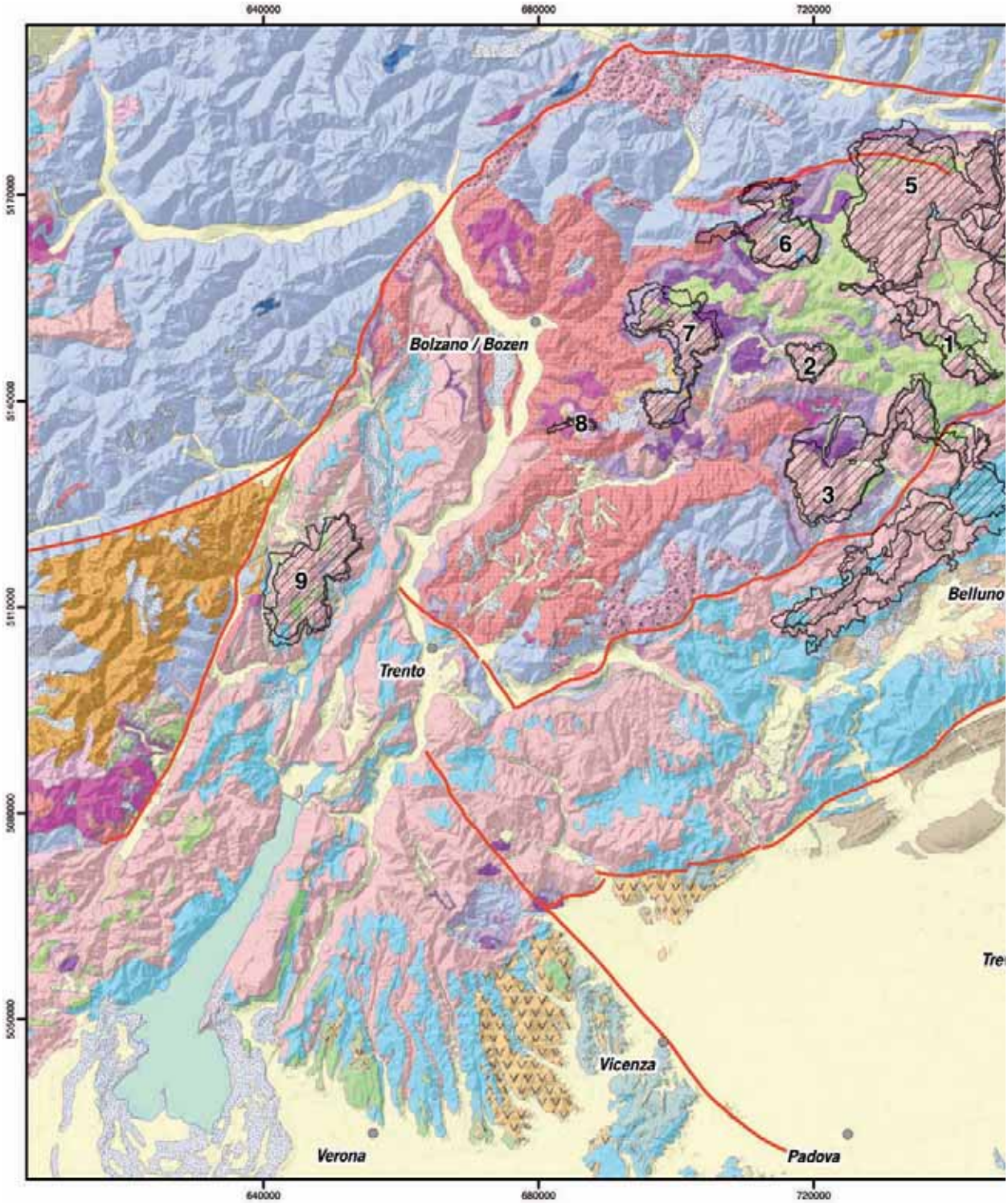
A2.1 GEOLOGY OF THE DOLOMITES

In 1860, the young German petrographer and geologist Ferdinand Freiherr von Richthofen (1833-1905) published a remarkable book on the geology of a part of South Tyrol. The interpretation that the spectacular pale mountains were in fact ancient Triassic coral reefs surprised the scientific community, and since then the Dolomites have been worldwide famous. The Dolomite Mountains, as defined in the classic mountain literature which dates back to the 19 century (Gilbert and Churchill 1864), are a group of carbonate edifices relatively well confined from the physiographic point of view. They are located in the eastern part of the so-called Southern Alps, a south-vergent fold-thrust belt, which constitutes a major structural unit of the Alpine chain. The Dolomites themselves can be seen as a large synclinorium of Neogene age, limited to the north by the dextral transpressive Insubric Lineament and to the south by the Neogene south-vergent Valsugana Overthrust. The Dolomites constitute a relatively coherent slab of upper crust carried southwards for at least 8-10 km. The sedimentary cover, preserved within this 60 km wide synclinorium, include Permian to Cretaceous rocks and is only mildly deformed by tectonics. The main part of the sedimentary succession is represented by Triassic rocks, including the famous reefs and platforms.
The spectacular and unique scenery of the Dolomite Mountains is due to particular geological characteristics, e.g. the closeness of two different kinds of rocks, namely dolomitic and volcanic. In fact, this peculiar and rare association of dark an relatively soft volcaniclastic rocks and pale, resistant dolomitic rocks is the main reason of the fantastic and spectacular Dolomite landscape, where green meadows, passes and plateaus are adjacent to white peaks and crags. Dolomite mountains are present in many other regions of the world (Canadian Rocky Mountains, Austria, Croatia, Greece, just to cite a few), but none of these areas has the unique geologic characteristics described above.

Alfonso Bosellini

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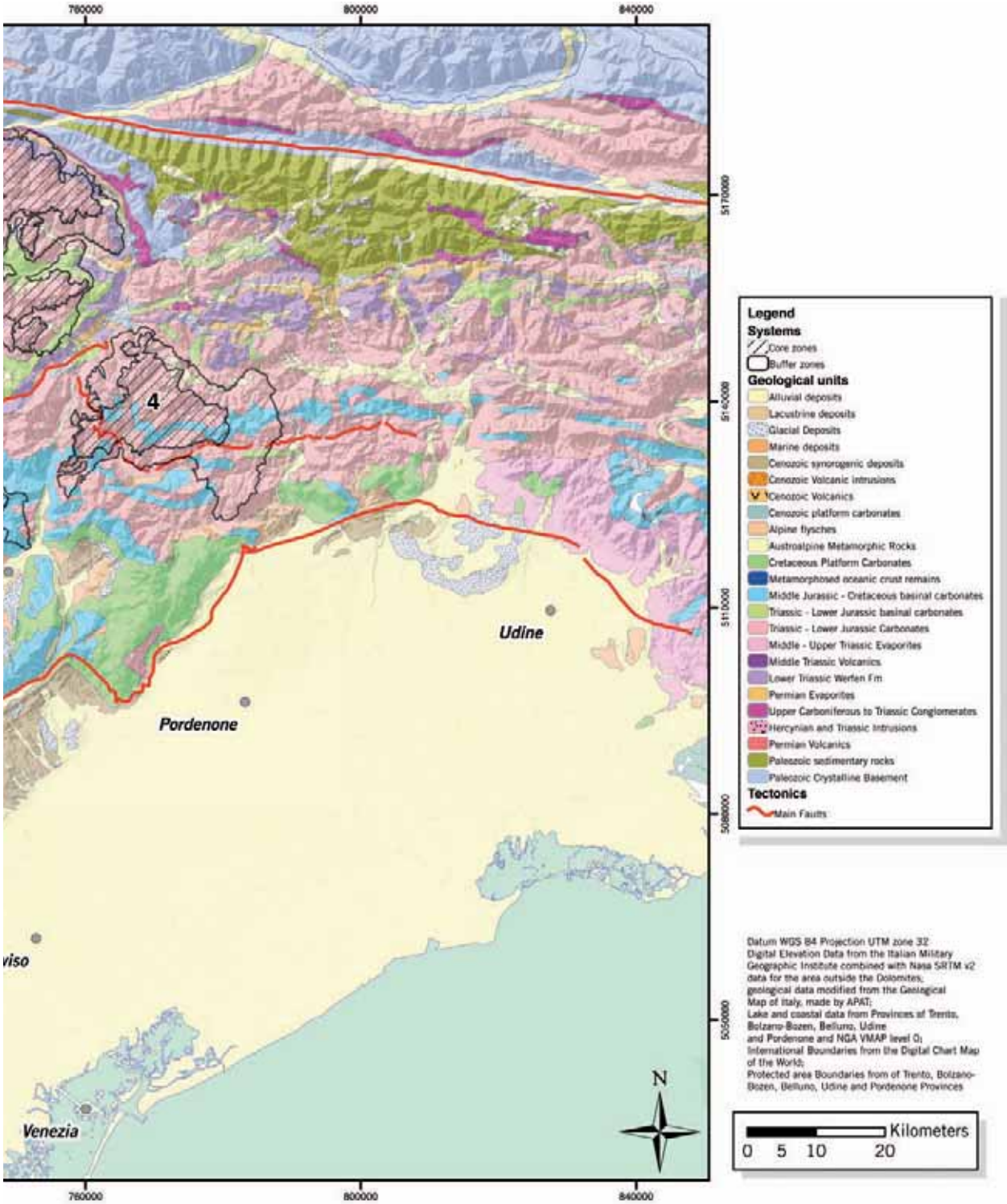
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Udine
Pordenone
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Legend
Systems
Core zones
Buffer zones
Geological units
Alluvial deposits
Lacustrine deposits
Glacial Deposits
Marine deposits
Cenozoic synorogenic deposits
Cenozoic Volcanic intrusions
Cenozoic Volcanics
Cenozoic platform carbonates
Alpine flysches
Austroalpine Metamorphic Rocks
Cretaceous Platform Carbonates
Metamorphosed oceanic crust remains
Middle Jurassic - Cretaceous basinal carbonates
Triassic - Lower Jurassic basinal carbonates
Triassic - Lower Jurassic Carbonates
Middle - Upper Triassic Evaporites
Middle Triassic Volcanics
Lower Triassic Werfen Fm
Permian Evaporites
Upper Carboniferous to Triassic Conglomerates
Hercynian and Triassic Intrusions
Permian Volcanics
Paleozoic sedimentary rocks
Paleozoic Crystalline Basement
Tectonics
Main Faults
Datum WGS 84 Projection UTM zone 32
Digital Elevation Data from the Italian Military Geographic Institute combined with Nasa SRTM v2 data for the area outside the Dolomites;
geological data modified from the Geological Map of Italy, made by APAT;
Lake and coastal data from Provinces of Trento, Bolzano-Bozen, Belluno, Udine and Pordenone and NGA VMAP level 0;
International Boundaries from the Digital Chart Map of the World;
Protected area Boundaries from of Trento, Bolzano-Bozen, Belluno, Udine and Pordenone Provinces
Kilometers
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The role of the dolomites in the development of the geological concepts during the XVIII and XIX centuries

The scientific prehistory

Before the late XIX Century, the Dolomites Mountain region was of difficult accessibility, being far from major urban areas deprived of many actual roads. Commercial and military road nevertheless crossed the region and considerable attention was focused on the mineral deposits scattered in the area. Particularly attractive were the small iron oxide concentrations within Middle Triassic carbonates, which were mined even at remote and poorly accessible spots (e.g. Latemàr cliffs). The mining activity certainly attracted a considerable pre-scientific interest on the region mountains, an attraction present also in the XIX Century literature, but no detailed studies on the technical aspects of this historical activity is presently available.

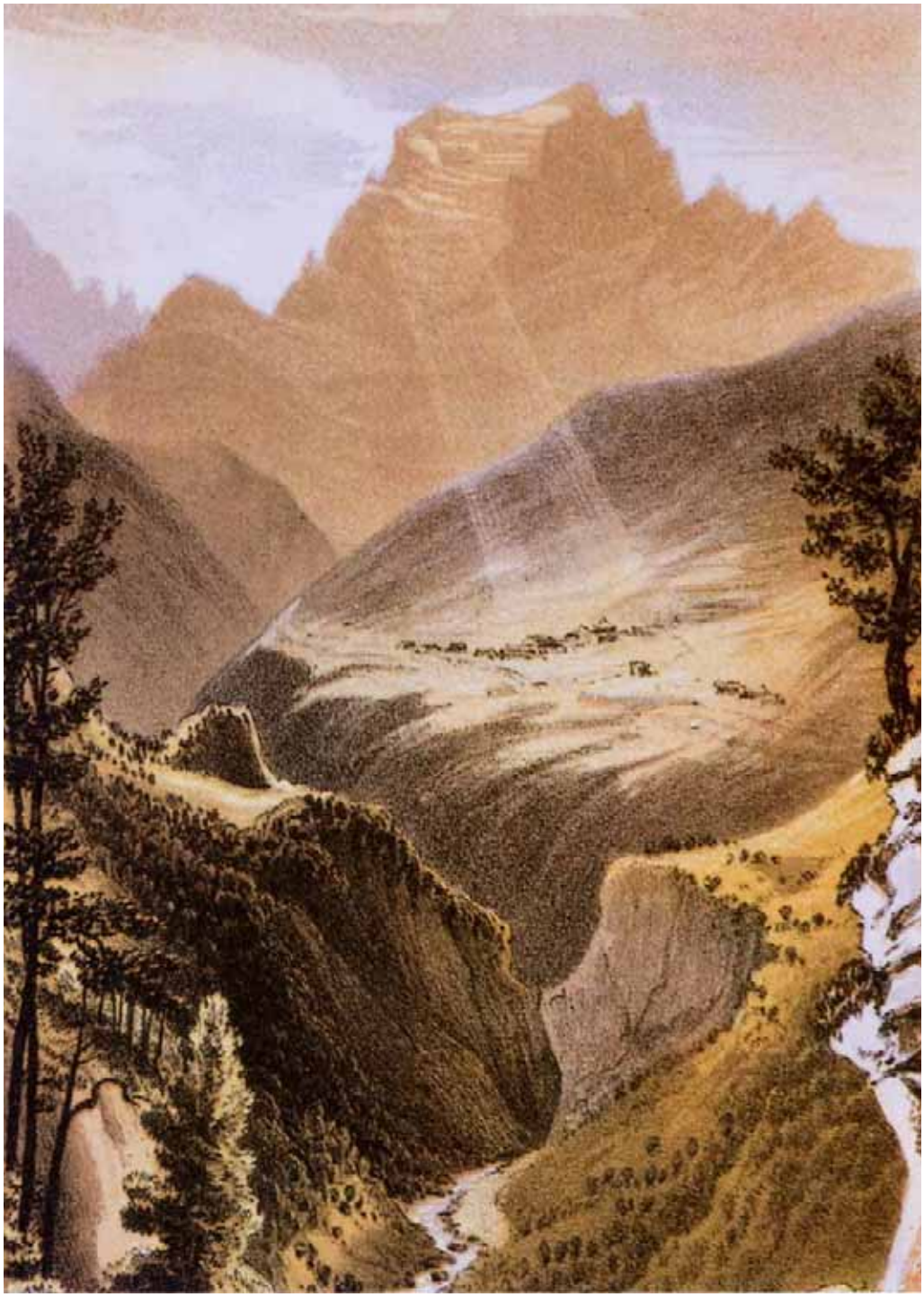
Some interest for the region then arose also in academic environments. The first reference to fossils from the Dolomites was probably made by the catholic Franz Ferdinand Giuliani (1741), in the text of the conference "*Dissertatio de Fossilibus Universalis Diluvii*", given at the Innsbruck *Accademia Taxiana*, in which marine fossils collected from the northern Dolomites slopes facing the Puster Tall/ Val Pusteria were referred to the Noah's Flood, described in the Bible.

The first development of stratigraphic subdivisions in the XVIII Century

Surprisingly modern and accurate stratigraphic subdivisions arose during the second half of the XVIII, more out the pragmatic interest for the mining activity than from any theoretical work. Giovanni Arduino (1714-1795) exposed a four-fold subdivision of the Venetian Alps, based on geometric relationships and lithology. The four orders were named: (*i*) *Ordine Primario*, corresponding to the metamorphic basement and its intrusive bodies, (*ii*) *Ordine Secondario*, encompassing the thick Mesozoic carbonate successions, (*iii*) *Ordine Terziario*, largely corresponding to the Tertiary terrigenous, carbonate and volcanic successions, (*iv*) A further unit consisted of recent loose sediments, then named *Quaternaire* by the French stratigrapher Desnoyers (1829). Arduino's terms are obviously still widely used in the modern literature, particularly Tertiary and Quaternary. Arduino also made some geological map and profile sketches, well in advance of the famous Smith's ones on England. However, Arduino's work was deeply rooted within the field and Venetian mining experience, far from the academic environment, and was therefore unable to exercise a major influence on the international geological thought development.

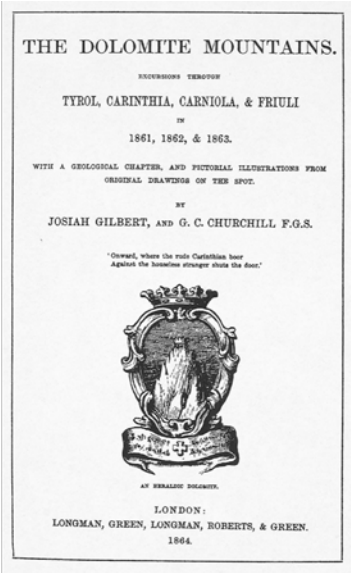
The discover of the Dolomite mineral and the entering of the Dolomite into the scientific debate

While Europe was involved in the effects of the French Revolution, a French nobleman was influential in raising the scientific interested for the then remote Dolomites area. Dieudonné Sylvain Guy Trancrede Grater de Dolomieu (1750-1801), known as Déodat, a French Savoy scientist and distinguished teacher at the Paris *Ècole des Mines*, during a trip from Tyrol to Italy, in the Adige Valley near Salurn/Salorno, in 1788, sampled a carbonate rock showing a poor reaction with a low pH solution. Intrigued by the observation, he sent several samples to the Swiss mineralogist Nicolas Theodore de Saussure who analysed the samples, describing them as Ca and Mg carbonate. The new mineral was named "Dolomite" by the Swiss mineralogist; from this term the Dolomites take their actual name. Dolomieu made also another contribution to the geological debate over the Dolomites: in 1789, he published the revolutionary and prophetic ideas that granitoids are not the ancient-most rocks of Earth and that basalts are generated by the fusion of rocks well below the granitic crust, a fusion un-



An artistic representation of the Pelmo Massif, from Gilbert and Churchill (1864).

related to any coal or hydrogen combustion. These ideas faced great scepticism, but stimulated the geological debate and were eventually vindicated by the examination of Dolomites outcrops.



THE DOLOMITE MOUNTAINS.

EXCURSIONS THROUGH

TYROL, CARINTHIA, CARNIOLA, & FRIULI

IN

1861, 1862, & 1863.

WITH A GEOLOGICAL CHAPTER, AND PICTORIAL ILLUSTRATIONS FROM ORIGINAL DRAWINGS ON THE SPOT.

BY

JOSIAH GILBERT, AND G. C. CHURCHILL F.G.S.

'Onward, where the rude Carinthian boor
Against the homeless stranger shuts the door.'

AN HERALDIC DOLOMITE.

LONDON:
LONGMAN, GREEN, LONGMAN, ROBERTS, & GREEN.
1864.

Frontispiece of the famous book by Gilbert and Churchill. With its widespread diffusion across the whole Europe during the second half of the XIX century, this book contributed to increase the international interest on the Dolomites area.

Academic interest on the stratigraphic subdivisions and the great debate on the intrusive rock origin

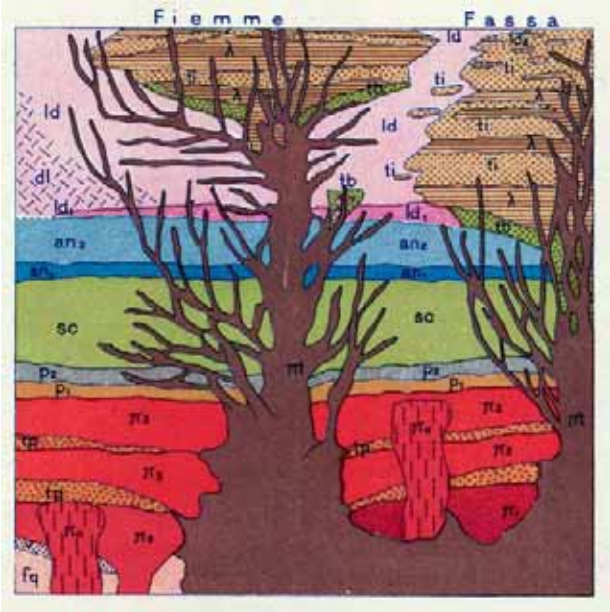
Between 1790 and 1830, the Dolomites played a major role in the geological debate, as a key area in the great neptunian versus plutonian controversy. The German geology development was largely stimulated by the enthusiastic teaching by Abraham Gottlob Werner (1749-1817). His schemes were based on a field experience essentially limited to the Erzgebirge and Bohemia, but pretend to achieve the status of universal subdivisions, at least according to the 1787 abstract of his teaching. The whole of the Earth rocks was considered as sedimented from sea-waters of changing composition, the granites from a primitive silicatic global ocean, the fossil-bearing sediment for a sea similar to the modern ones. Intrusive rocks were therefore always the oldest (Protogenic Granite = *Protogenum*). The scheme was well suited to describe an area of ancient deformation like the "*Mesoeuropa*", but Werner's pupils tried to apply the subdivision to the entire world, including the Alps and the Dolomites, meeting growing difficulties. From Great Britain, Hutton's plutonist ideas about the magmatic origin of granites, the enormous length of the geological time, and the importance of discordances in the stratigraphic interpretation were in the meanwhile spreading doubts in the geological community. The western Dolomites were soon to become a key area for this ignited debate on the igneous rocks origin.

The famous geologist and geographer Alexander Friedrich von Humboldt (1769-1859 joined the younger colleagues Christian Leopold von Buch (1774-1853) and Louis Joseph Gay-Lussac (1778-1850), in a trip aimed at examining the modern volcanoes of Southern Italy. In the way back, the two Germans made a detour from the Brenner Pass Road, to visit the Predazzo magma centre, to check the troubling relationship between the granites and the adjacent fossiliferous carbonates. We now interpreted the relationship as the intrusive contact between thermo-metamorphosed Anisian carbonate platforms and the middle Ladinian alkaline granites and basic intrusive lithologies. The granite also intrudes basaltic lava successions, cut by calderic faults. The intrusive rocks are clearly visible side by side, and even above, the contact marbles. The *Urgebirge* (primitive rocks, according to

Werner nomenclature) looked as resting on the fossiliferous *Floetzgebirge* (bedded rocks), a geometric relationship hard to explain following the Werner's genetic model. Von Humboldt wrote the first geological synthesis of the Dolomites geology and accurately studied the Predazzo intrusion, suggesting what would today call a Mesozoic age for the volcanites and dikes, but maintaining the primary origin of the granite. Christian Leopold von Buch remained very impressed by the Predazzo observations and, corroborated by other discoveries he made in Norway, he synthesised the *Erhebungs Theorie*, suggesting that volcanic and intrusive bodies were uplifted and inplaced at the semi-solid state under the lifting force of high pressure underground forces.

Geological map of the western Dolomites, after Von Buch (1822)

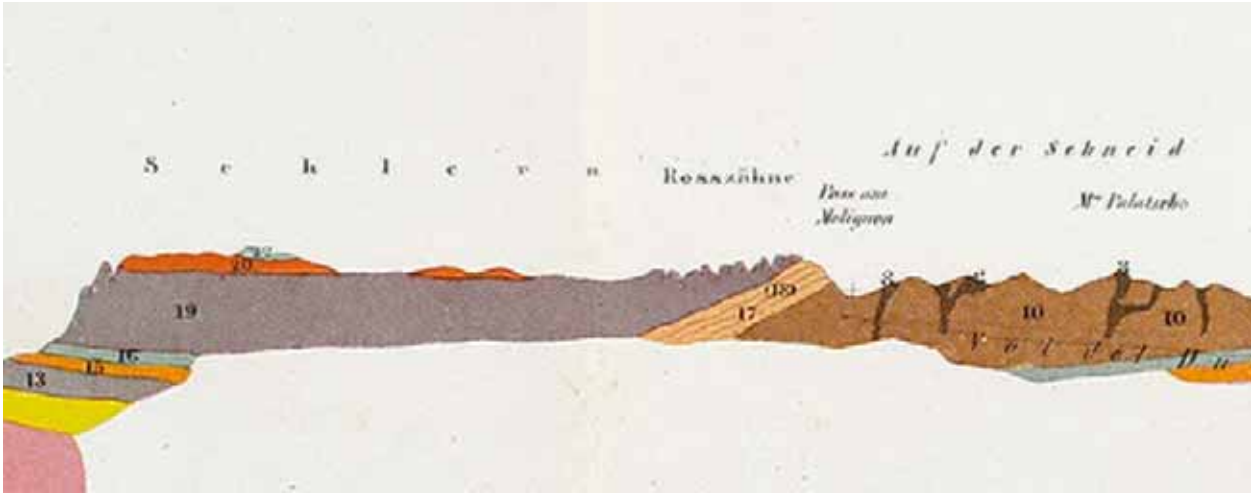
The controversy about the Predazzo magmatic centre attracted crowds of researcher to the area, making the small local inn, the *Nave d'Oro* (Golden Ship), a central place for the development of the European geological though, as recorded in its guest book geological drawings. It was to the restive Venetian naturalist Giuseppe Marzari Pencati (1779-1836) to place the most severe round against the neptunist interpretation, by referring (1819) the recrystallised band in the Anisian algae-rich limestone, outcropping at the west of Predazzo (Canzoccoli Quarry), to the thermo-metamorphic action of magmas.



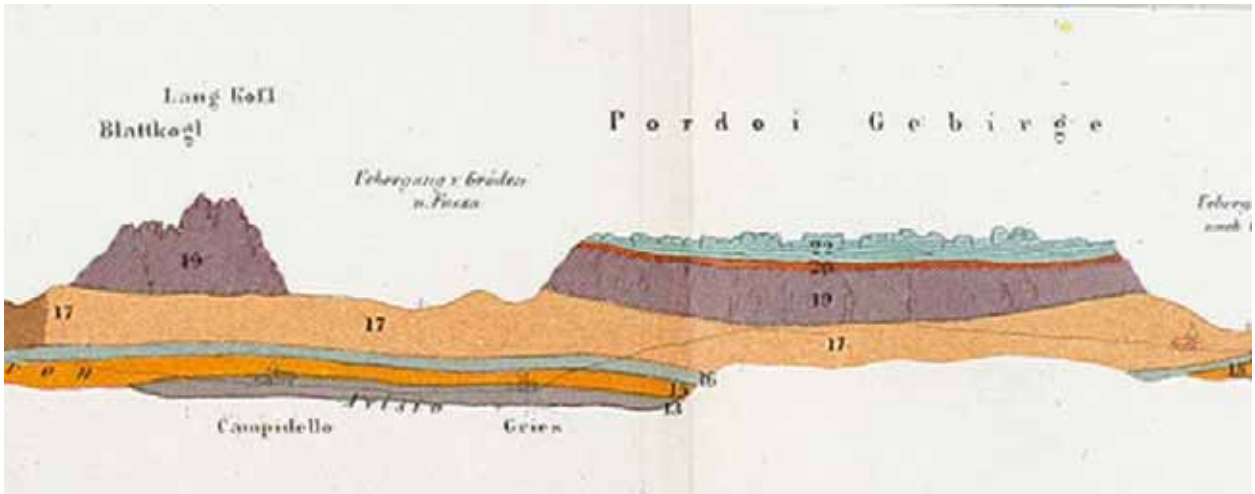
Historical scheme of the stratigraphical relationships taken from the Geologic Map of the eruptive terrains of the Predazzo and Monzoni, in Dolomites of Fiemme and Fassa. (Vardabasso S., 1930).

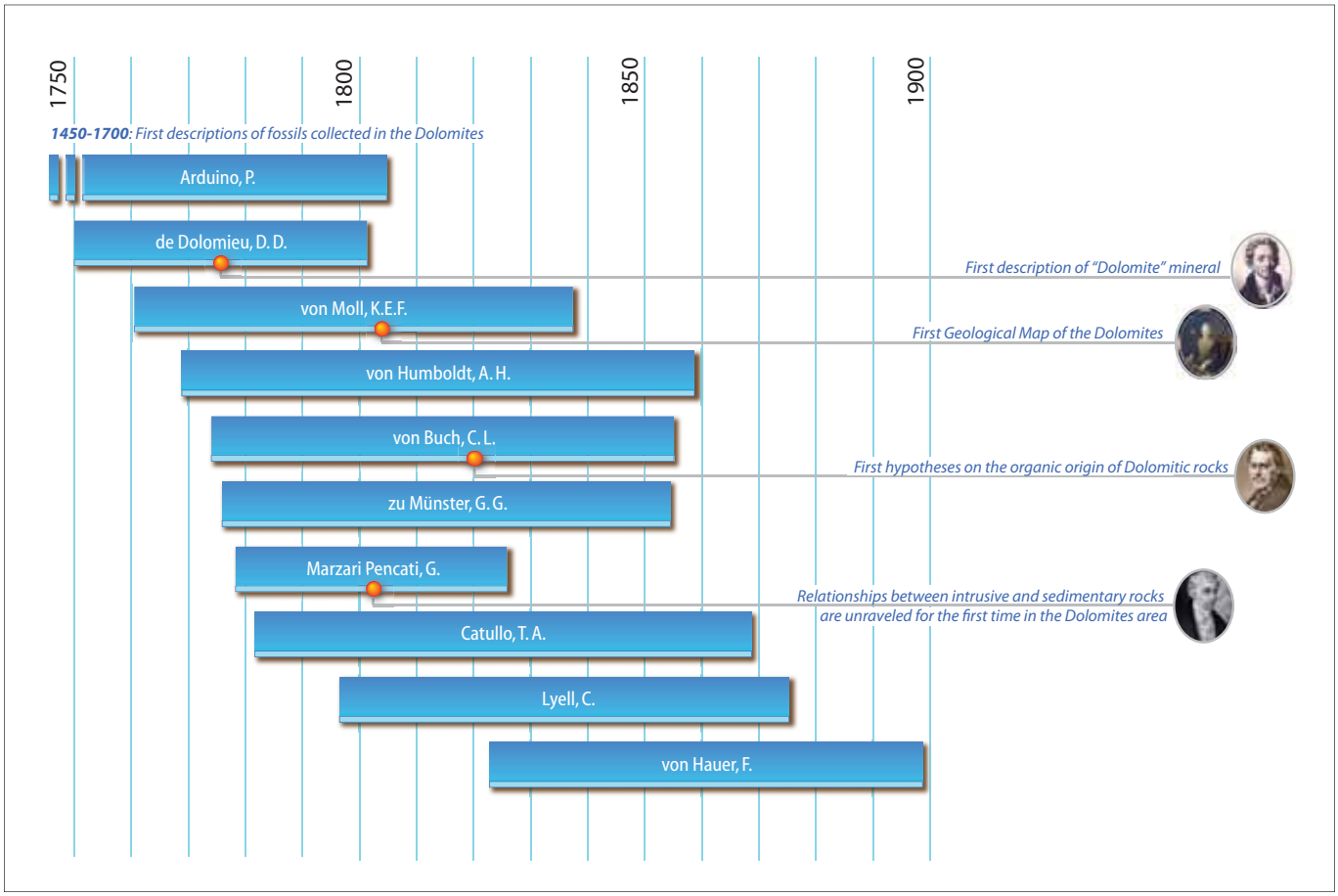
The development of the palaeontological and stratigraphic study and the eventual break through in the carbonate platform understanding

The first half of the XIX Century saw a gradual increase in the geographic, palaeontologic and stratigraphic knowledge on the region, through a large number of partial contribution, while the tectonic understanding remained very poor. The entire area was now part of the Austrian administration, supporting the ore exploration and the early topographic and geological mapping. The Italian Tommaso Antonio Catullo (1782-1869) subdivided the stratigraphic succession according to their fossil content, gave a first palaeontological synthesis of the Dolomites and Venetian Alps (*Saggio di Zoologia Fossile*, 1827) and studied the ore accumulation of the region, in the framework of the Austrian Empire mining activity. Francesco Facchini (1788-1852), the first naturalist native of the region



(Moena), suggested the Triassic age of the basaltic volcanites and suggested that the faults and folds spectacularly visible in the area were the result of tangential compressive forces more than the product of the vertical displacement suggested by the von Buch's *Erhebungs* theory. Wilhelm Fuchs, Agordo Mine geologist, published (1814) a synthesis of the northern Dolomites (Badia Valley) geology and a first accurate geological map of the area. Graf Georg zu Münster (1776-1844) described the faunae of the argillaceous limestones from the San Cassiano Formation (1834, 1841), revealing the apparently bottomless richness of this late Ladinian-early Carnian basinal formation.
Palaeontology works put the base of the modern ammonoid and pelagic pelecypods based biostratigraphy of the Tethyan Triassic.
At the publication time of these contributions, major developments in the genetic understanding of the carbonate platforms were developing. The German geologist Ferdinand von Richthofen (1833-1905) at the age of 26, interpreted the Dolomites platforms as organic coral reefs from ancient tropical seas (1860), drew accurate geological profiles of the western Dolomites platform and inferred the role of the subsidence in the accumulation of thick piles of shallow water carbonates. An further milestone in the Earth Science development was the publication, by Johan August Edmund von Mojsisovics (1839-1907) of "*Die Dolomitriffe von Südtirol und Venetien*" (1879), a book illustrated by some of the first spectacular photographs of the region and by an accurate geological map at the 1:75 000 scale. The nobleman confirmed the accuracy of von Richthofen interpretation and synthesised an accurate interpretation of the depositional geometry and stratigraphic architectures of the platforms, largely accepted even today. He interpreted the horizontally bedded nuclei of platforms as aggrading lagoon, shallow-water, algal-rich sediments, flanked by massive reefs bodies and by large volumes of slope brecciae. Despite lacking any knowledge of the modern tropical slopes, he brilliantly interpreted the steep clinostratifications as *Ueberguss-Schichten* (primarily inclined beds), associated to the slope growth. Against the accepted wisdom, he clearly stated that coeval, adjacent platform and basinal deposits can have very different facies (*Facies Heteropie*). He subdivided the large carbonate platform bodies according to the interfingering ammonoid-bearing basinal units. What we now consider as Anisian-Ladinian pre-volcanic platforms were named Buchensteiner Riff, from the coeval Buchenstein Formation (Livinallongo Fm). The syn-early post volcanic platform were named Wengener Riff, the younger Cassianer, according to their interfingering with the San Cassiano basinal formation. From a structural point of view, he considered the Southern Alps as a stair like systems of brittle basement blocks, separated by high angle faults, lowering the southerner portion. High angle faults is often what you can actually see in the field, even if now we recognize a number of important




1750
1800
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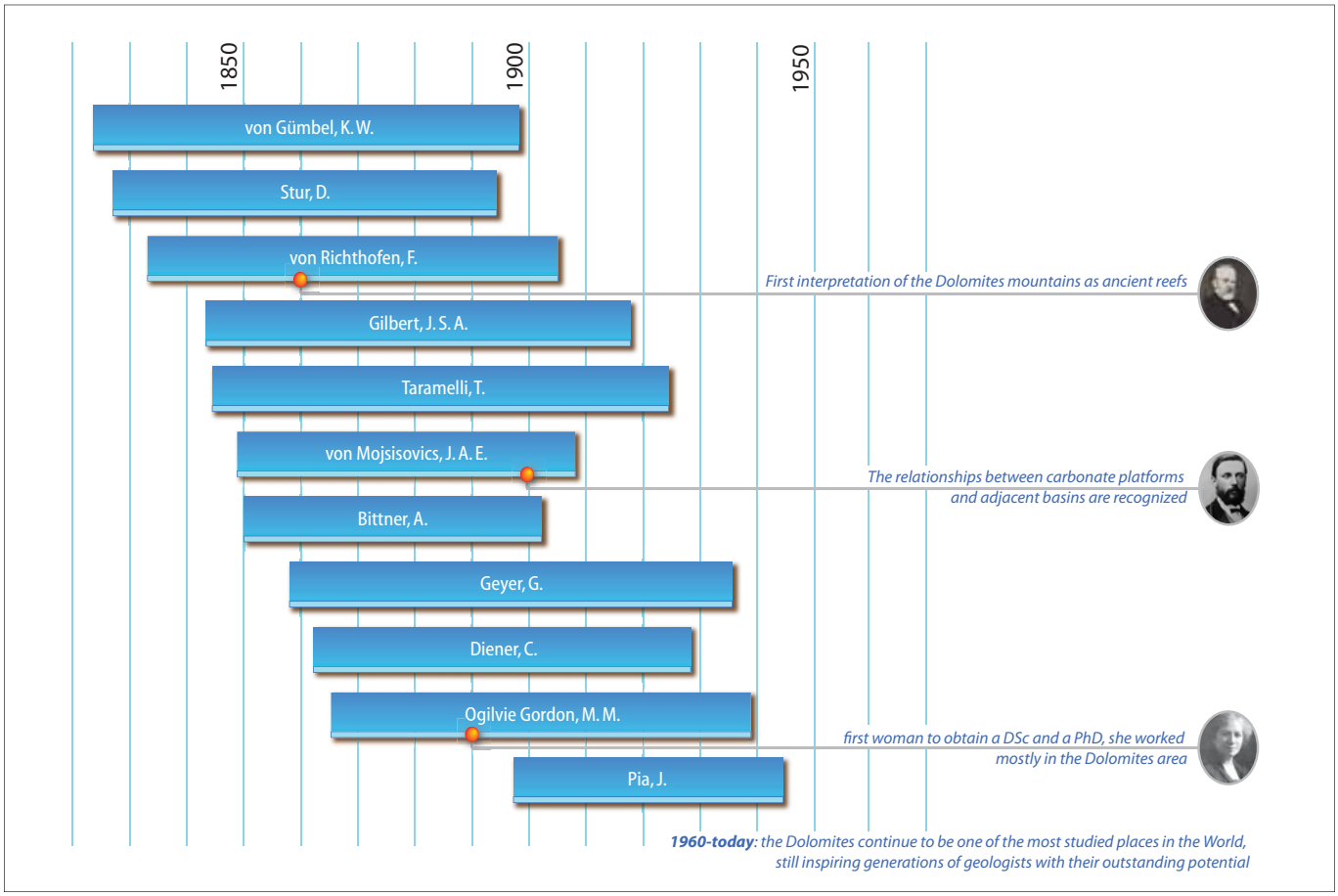
1900
1450-1700: First descriptions of fossils collected in the Dolomites
Arduino, P.
de Dolomieu, D. D.
First description of "Dolomite" mineral
von Moll, K.E.F.
First Geological Map of the Dolomites
von Humboldt, A. H.
von Buch, C. L.
First hypotheses on the organic origin of Dolomitic rocks
zu Münster, G. G.
Marzari Pencati, G.
Relationships between intrusive and sedimentary rocks are unraveled for the first time in the Dolomites area
Catullo, T. A.
Lyell, C.
von Hauer, F.

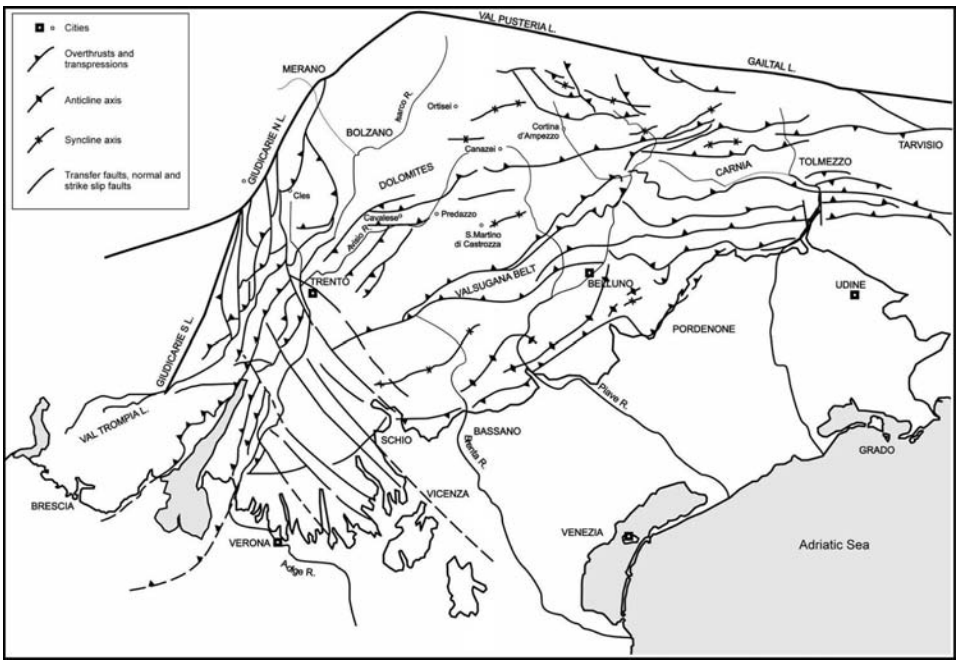


A comparative diagram showing the lifespan of some famous geologists that, among many others, actively and continously worked in the Dolomites. Several remarkable events took place in the candidate area: major breakthroughts in the Earth Sciences and memorable events are indicated by small circles.

overthrust plains. The Austrian geologist also made a synthesis on the seismic activity of the region. Following this major contribution, the XIX terminated with a co-ordinated geological mapping effort by the Austro-Hungarian Administrations and by a series of in depth palaeontological contributions (i.e. Guido Stache, Franz Hauer, Ernst Kittl studies, among others), defining the general biostratigraphic framework of the Triassic biostratigraphy and the mutual relationships between the Triassic stages, all named after ancient peoples of the Dolomites and adjacent Alpine regions (Scythian, Anisian, Ladinian, Carnian, Norian and Rhaetian). It is worthy to finish this overview on the geological study development in the Dolomites giving a tribute to the British Maria Ogilvie Gordon (1864-1939). Her strong personality made her the first geologist woman to obtain both a DSc and a Ph.D title. She studied the relationships between carbonate platforms, basinal and volcanic bodies in the Dolomites (1893, 1894), the Monzoni and Buffaure magmatites (1903), and still worked on the Sasso Lungo-Sasso Piatto Massif during the Thirties, climbing the massif at the age of 70. But we are now entering the complex evolution of the geological investigation on the unfathomed complexity of the Dolomites area during the last century, a topic beyond the scope of this synthetic introduction.

Regional tectonic setting

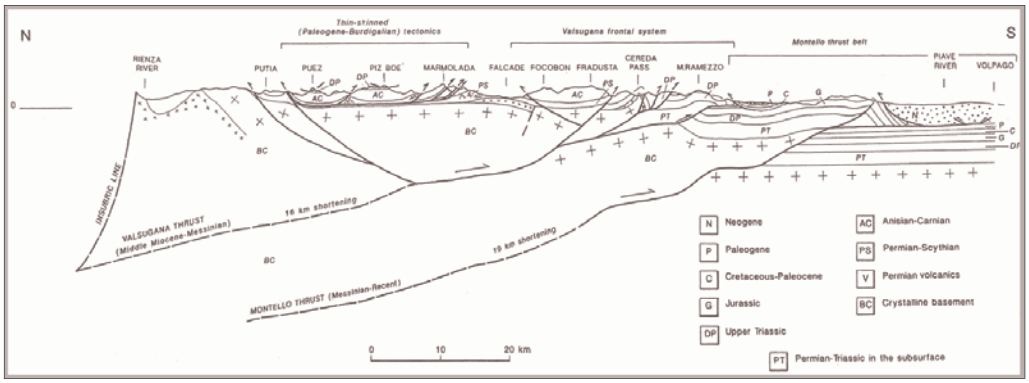
The north-central portion of the Southern Alps is comprised of a distinct geologic complex called the Dolomities (Doglioni, 1987; Castellarin *et alii*, 1998; Castellarin & Cantelli, 2000), which preserves a unique record of several important Earth history events. Over the course of millions of years, the Permian landmass Gondwana drifted northward and collided with Laurasia. This collision assembled most of the world's continental landmass into one supercontinent Pangaea, which extended from pole to pole. At the time Pangea was flanked on its eastern coast by a wide tropical sea, Tethys. Over the subsequent eras the Tethys sea closed, the only remnants of which today are the Mediterranean, the Black and the Caspian Seas.



Tectonic scheme of Dolomites Reagion (Castellarin et al. 1998)

The Dolomites formed through the deformation of the passive margin of the (Mesozoic) Tethys Ocean into a non metamorphic south-vergent thrust of the Alpine Belt. The stratigraphy of the Dolomites records a variety of events and indicates a dramatic and complex history of tectonic and magmatic events including:

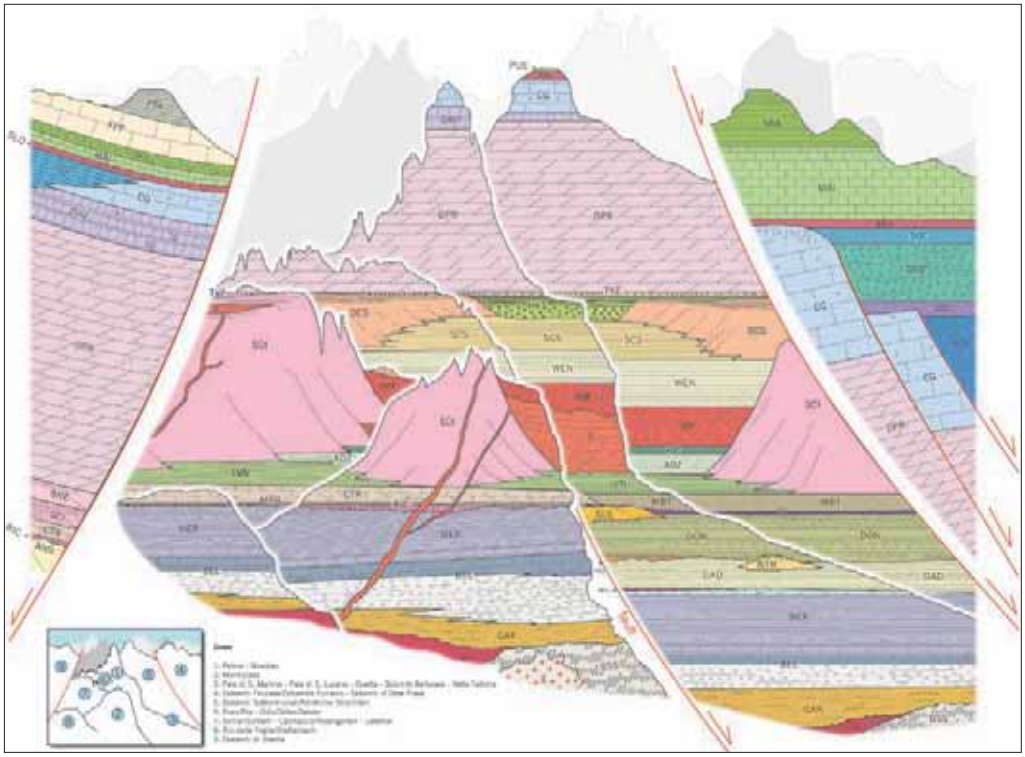
a) Permian rifting, marked by a massive magmatism that leads to a lithospheric anisotropy significantly influencing the Mesozoic and Cenozoic evolution of the area (Cassinis *et alii*, 1998; Cassinis & Neri, 1999; Massari *et alii*, 1994).
b) Middle Triassic transtensional tectonics (Doglioni, 1982; 1984; Doglioni & Neri, 1989; Blendinger, 1983; 1985; Brandner, 1984; Gianolla *et alii*, 1998a), associated with differential subsidence and uplifting, ended during the Late Ladinian with the emplacement of epicrustal intrusions (Monzoni, Predazzo, Cima Pape) and shoshonitic volcanism (Sloman, 1989). These Middle Triassic events deeply reshaped the morphology of the area and in particular the post-volcanic carbonate platforms.
c) Continental margin rifting, started in the Late Triassic and climaxing into the western Tethys opening, during Jurassic times (Bosellini, 1973; Bosellini & Winterer, 1981; Doglioni, 1987).
d) Polyphasic compressional deformation, mainly brittle in nature, affecting the region during Tertiary times that generated large overthrusting and strike slip deformation (Castellarin, 1979; Doglioni & Castellarin, 1985; Doglioni & Bosellini, 1987; Castellarin *et alii*, 1992; Caputo, 1996; 1997; Schönborn, 1999).



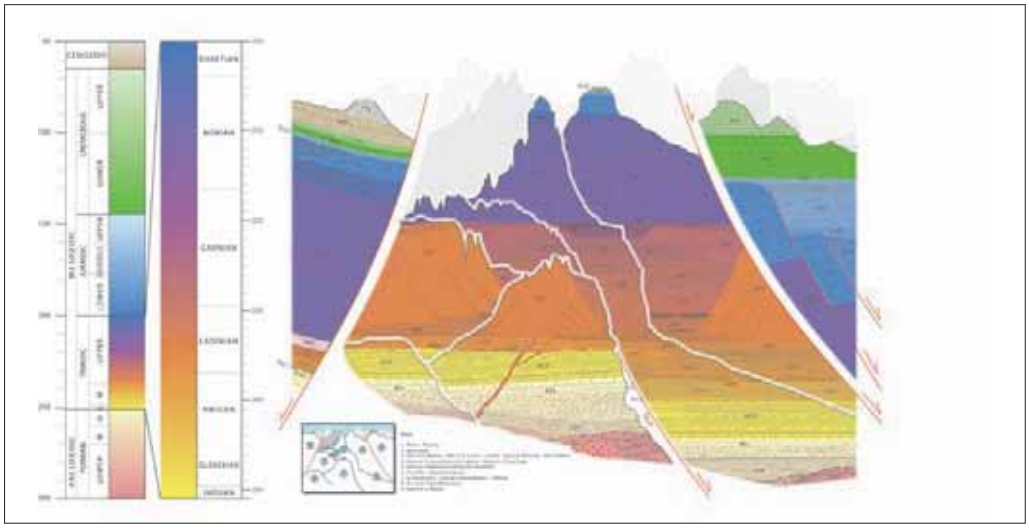
Section of Dolomites Region (Castellarin et al. 1998)

Regional Stratigraphy

The stratigraphic framework of the Dolomites is extensive and spans the Upper Paleozoic to Cretaceous. Remarkably, the end of the Permian Period (the Permo-Triassic boundary, ca. 250 million years ago) is a particularly well studied interval worldwide, as it marks the most dramatic episode of mass extinction the Earth has ever seen, wiping out over 90% of all marine life. The Dolomites contain some of the world's best Permo-Triassic sections, which preserve with astonishing detail the extinction and recovery of marine life through historic sections of Tesero, as well as those in Seceda. The successive Triassic units are especially well represented, including excellent biostratigraphic records that lend the Dolomites as a classic area for stratigraphic study of these geological periods.



Lithological sketch representing the geometric relationships between geological units in the Dolomites area. Abbreviations used in the drawing, in alphabetic order: ***ADZ:*** *Zoppè Sds;* ***ANG:*** *Angolo Lms;* ***ARV:*** *Ammonitico Rosso Veronese;* ***BEL:*** *Bellerophon Fm;* ***BIV:*** *Mt. Bivera Fm;* ***BRE:*** *Breno Fm;* ***BSS:*** *Metamorphic basement;* ***CG:*** *Calcari Grigi;* ***CTR:*** *Contrin Lms;* ***DAH:*** *Dachenstein Lms;* ***DAD:*** *Gracilis Fm;* ***DCS:*** *Cassian Dm;* ***DON:*** *Dont Fm;* ***DPR:*** *Dolomia Principale;* ***FPP:*** *Ponte Pià Fm; g: granites;* ***GAR:*** *Val Gardena Sds;* ***HKS:*** *Heiligkreutz Fm;* ***LVN:*** *Livinallongo/Buchenstein Fm;* ***IGN:*** *Igne Fm;* ***IMF:*** *Mt. Fernazza Ignimbrites;* ***MAI:*** *Maiolica;* ***MRB:*** *Morbiac Fm;* ***NTR:*** *Mt. Rite Fm;* ***OOV:*** *Vajont Lms;* ***PTA:*** *Ponte Arche clays;* ***PUE:*** *Puez marls;* ***RIC:*** *Richthofen Cgm;* ***SAA:*** *Scaglia Rossa Fm;* ***SCI:*** *Sciliar Dm;* ***SCS:*** *San Cassiano Fm;* ***SOC:*** *Soccher Lms;* ***SLO:*** *Selcifero Lombardo;* ***SOV:*** *Soverzene Fm;* ***TOF:*** *Tofino Fm;* ***TVZ:*** *Travenanzes Fm;* ***V:*** *Ladinian volcanics;* ***Vp:*** *Permian porphyries;* ***WEN:*** *Wengen Fm;* ***WER:*** *Werfen Fm;* ***ZUU:*** *Zu Limestones;*



Age of geological units comprised in the Dolomites area. Timescale according to Gradstein et al. (2004)

Pre-Carboniferous Crystalline Basement

The oldest rock units of the Dolomites belong to the Paleozoic "Metamorphic Basement", which has good surface exposure in the Valsugana valley up through Agordo town, and into the Pusteria/Pustertal valley. Paleozoic geologic units in the Dolomites are commonly complex metamorphic rocks, made of albitic schists, porphyroids, and phyllites. These rocks were metamorphically altered from greywackes (clay-rich sandstones), shales, siltstones, and rhyolites (volcanic rocks) respectively. Paleozoic rock units in the Dolomites also extend from Carnia as part of the low-grade metamorphic rocks of the Paleo-carnian belt, to the Lombardy. Deposition of metamorphosed sediments from the Paleo-carnian belt occurred along the northern margin of Gondwana. These rocks have been identified as Upper Ordovician and Devonian in age. Subsequently the Hercynian mountain chain was built through a series of successive orogens during the Carboniferous and Permian Periods more than 280 million years ago. The extensive tectonic forces in this orogenesis (mountain building) compressed and altered the sediments into metamorphic rocks. The final phase of the Hercynian orogenesis involved widespread magmatic intrusion, which deformed the weak metamorphic strata before cooling. Typical examples of these intrusive igneous rock bodies can be found in the western section of the Dolomites where granites of Bressanone/Brixen extend from Val Pusteria/Pustertal nearly to Vipiteno/Sterzing. But other well exposed examples exist in Lana, near Merano/Meran and farther south where plutons (subsurface magma bodies) of Cima d'Asta and Doss del Sabion (Bosellini, 1996) can also be traced to the Hercynian orogenesis.

The Permian Period: dismantlement of the Hercynian mountains

The dismantling of the Hercynian mountains began with the weathering and erosion of gained elevations in subsequent periods. Eroded sediments were transported away by streams that etched river valleys while filling others with sediment, altering the Hercynian landscape to one of hills, valleys and fans of accumulated sediment (alluvial plains). Sand, gravel and detritus accumulated in the deeper depressions forming what is now called the Ponte Gardena Conglomerate. The Ponte Gradena Conglomerate preserves part of the Hercynian dismantling, through its unsorted, poorly stratified sediments that indicate it was a high energy alluvial environment. Rocks from this section are made

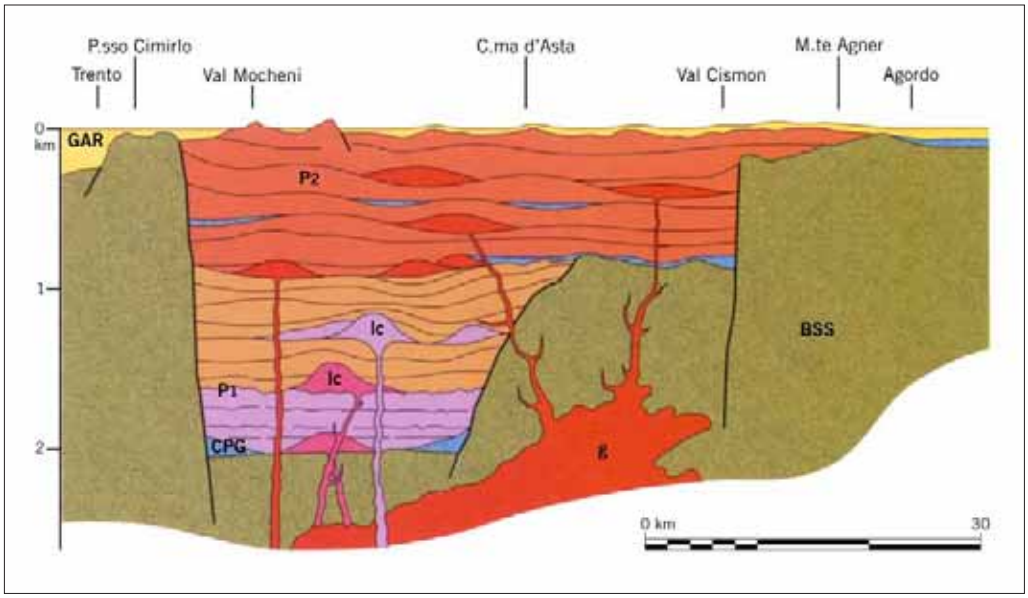
mainly of metamorphic pebbles and quartz, varying in color from gray to red, and are well exposed in the northern areas of the Valle dell'Adige/Etschtal, in the western Dolomites, and to the east in sections of the Sesto/Sexten Dolomites and in Comelico.

Magmatism and continental post-Hercynian sedimentation

The Southern Alps volcanic system developed as the result of various late Paleozoic events that now appear in the area between the eastern Dolomites and Lago Maggiore. From 285 to 260 million years ago, intense magmatic activity produced a variety of plutonic rock bodies that now cover a thick succession of red to violet vulcanites, mostly located in the area around Bolzano/Bozen, in eastern Trentino, but also west of the Valle dell'Adige/Etschtal across an area more than two thousand square kilometers from the Periadriatic Line to the northwest to the Valsugana Line in the southeast.

The order of the volcanic sequence here depended on several contemporaneous tectonic events. Volcanic rocks deposited in subsequent to Hercynian orogeny were ejected along large fissures forming pyroclastic flow deposits with subordinate dome-formed extrusions and lava flows, which today reach a thickness greater than three thousand meters.

Several of the better exposed sections allow for detailed reconstructions of the depositional geometries to be made. These features resulted from the accumulated products that were extruded from the vents and are still easily recognizable. The forces necessary to produce these features were generated by extensive tectonic activity in the Earth's crust that forced magma to cut through rock structures to reach the surface. Current evidence indicates that magmatic activity originated during a tensional (pulling) tectonic state that caused fissure eruptions throughout the basin of right-lateral strike-slip faults.

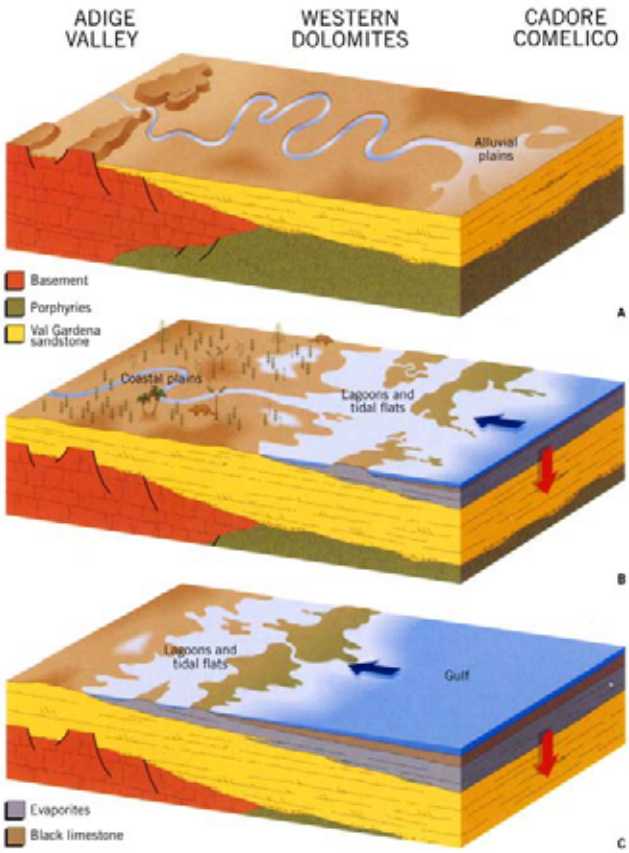


Cross-section of the volcano-tectonic caldera of Bolzano. It can be observed the complexity and variability of the volcanic products which are evidenced in various colours, in the lower part. The upper part instead is more homogeneous and constituted almost completely by ignimbrites. The Cima d'Asta intrusion is also represented. The whole volcanic succession and the lateral pilasters of the metamorphic basement have been subsequently covered by a thin blanket of fluvial sands, now called Val Gardena Sandstone (GAR). P2 – superior ignimbritres; P1 – lower ignimbrites; Ic – laccoliths; g – granite; CPG – Ponte Gardena Conglomerate; BSS – basement. (Modified from Bosellini, 1996).

Volcanism during the post-Hercynian changed as indicated by the geochemical evolution of magmas from rhyodacite lavas in basal units, to rhyolite lavas at the top. The change however, is not gradual and the presence of andesite lavas, in both the initial phases of the magmatic activity in the rhyodacites and the summit of the rhyolites indicates that both basic magmas and evolved magmas erupted during this volcanic episode.
Geochemical differences in volcanics are used by researchers to divide the vulcanites of the southern Alps volcanic system into two main groups that differ by composition and morphology. The volcanic sequence of the lower sections is comprised of andesite, dacite and rhyolite lavas that are gray-green or purple, as well as the upper section of rhyolitic ignimbrites.
The upper rhyolitic ignimbrites are the result of successive pyroclastic flows that expanded during eruptions, for many kilometers in length and for hundreds of meters in thickness, in tectonic depressions within the Metamorphic Basement. Both lavas and ignimbrites accumulated in subaerial conditions. Layers of tuff, sandstones and conglomerates are common between the flows and reveal the erosive action of the small streams that furrowed this arid volcanic region. In some cases these sediments are hundreds of meters thick and have been distinguished as distinctive geological formations (the Collio Formation and the Tregiovo Formation), where fossil have even been found such as the small proterosaurus reptile, *Tridentinosaurus antiquus*.

The transgression of the Upper Permian
255 to 260 million years ago (Upper Permian) a sea-level transgression submerged progressively from east to west a large part of the actual Alpine area. Mountainous reliefs were present to the west of the Southern Alps, and sloped down towards a piedmont belt of alluvial fans (central-west Lombardy). This terrain was replaced in Trentino, in Alto Adige/Südtirol/South Tyrol and in Carnia by a vast arid plane furrowed with sinuous rivers and dotted with isolated, small, ephemerals lakes (Massari *et alii*, 1998). Following the termination of extensive volcanic activity in the Alpine area, temperature variations and strong winds reshaped this arid plateau, eroding its surface.
Sands and gravels accumulated in depressions and lithified to form sedimentary complexes such as Verrucano Lombardo in the Giudicarie – Dolomiti di Brent area, and the Val Gardena Sandstone (AVG) ("Grödner Sandstein" by Richthofen, 1860) of the central-eastern Dolomites. Today the thickness of these rock formations varies greatly, ranging from a few meters in the far west, to more than 500 meters in the easternmost sections of Comelico. The thickness of these accumulated sands and gravels can vary greatly even over small areas, indicating that they were deposited in uneven topography over a bed of vulcanites and metamorphic basement rock. The AVG are made up of conglomerates, coarse to fine sandstones, red with occasional gray siltstone and pelites that collectively form decimeter to meters thick stratosets both massive and stratified. Its sandstones are often cross-bedded, either with festoons or planar. At most, the coarsest lithotypes (clast-supported conglomerates; paraconglomerates in arenaceous or, rarely, pelite matrix; microconglomerates) characterize the lower parts of the formation, whereas upper units are dominated by finer lithotypes (siltites and pelites alternating with smaller sandstones, with intrusions of gray dolomite with limited microfauna that are a prelude to the Bellerophon Formation above). In general, the Val Gardena Sandstone form a large, fining-upward sequence, within an overall transgressive trend.
At the top, the AVG unit grades into the Bellerophon Formation, with which it has a complex transition of lateral interfingerings. The conventional boundary between the two formations can be identified by the last (uppermost) red siltites and pelites, although characteristic Bellerophon lithotypes, such as gray dolomites and marls may appear several meters below this limit. The Upper Permian (Tatarian) designation, of the AVG is based on its tetrapod ichnofauna (dominated by *Rhyncosauroides* e *Pachypes*) and on the palynoflora.
A large part of the analytical data were acquired in the historical section of Bletterbach-Butterloch/Rio delle Foglie near Redagno/Radein (Bolzano/Bozen), known for the footprints of tetrapods

through the work of Kittl (1901) and studied from the palaeobotanical-palynological point of view through the works of Leonardi (1948) and Klaus (1963). Since the late 1970's several studies have examined globally important ichnofauna (see Conti *et alii*, 1977) and palynoflora (see Massari *et alii*, 1999) that constitute this Upper Permian section. The tetrapod footprints and palynoflora are indicative of upper Permian stages, at least post-Kazanian. This data is consistent with paleontological evidence from macroinvertibrates, algae and foraminifers contained in the shallow-water carbonates of the Bellerophon Formation, lateral in part to the continental successions.



Geologic and geographic evolution of the Dolomitic Region during the Middle-Upper Permian. In an arid alluvial plain, ploughed by meander-shaped rivers, the Val Gardena Sandstone accumulated. To the east they rest directly on the metamorphic basement, to the west they partly cover the volcanic relieves and the ignimbrite flows (quartziferous porphyries). The slow lowering (subsidence) of the whole region favoured the ingression of the sea, which is preceded by a wide belt of lagoons and arid coastal ponds. Westward, around the ponds and the little bushy areas, reptiles and amphibians left numerous traces of their activity. The further sea transgression, still caused by the subsidence, transformed the Dolomitic Region into a wide marine gulf, similar for proportions and depth to the actual northern Adriatic sea. (Modified from Bosellini, 1996).

By the climax of the marine transgression, the landscape was transformed from flood peneplain to an extensive tropical gulf with warm, shallow water, which formed the basin for rivers, lakes and coastal swamps. These areas were also subject to a strong evaporation, leading to sulphate deposition and chloride evaporites contributing to successions of dolomites, limestones and evaporites including gypsum deposits that today constitute the Bellerophon Formation. In the Dolomite area, the Bellerophon Formation is characterized by a succession with a moderately lateral variation and is structured as follows (Massari *et alii*, 1994):

a) cyclic alternation of gray more or less marly dolomites, marlstones and black argillites as well as laminated gypsum or anhydrite; the individual cycles are only a few meters thick;
b) dolomites and dark limestones, often fossiliferous, alternated with minor marlstones; the upper part of the unit is prevalently made up of dark micrites and packstones with predominant mi-

crofossils, such as calcareous algae (*Mizzia, Gymnocodium, Atractyliopsis, Vermiporella*, etc.), foraminifers (*Colaniella, Geinitzina, Pachyphloia, Globivalvulina, Paraglobivalvulina, Nankinella*, etc.), ostracodes and Prolematica (ref. Broglio Loriga *et alii*, 1988). The macrofossils are represented by bivalves (*Aviculopecten, Towapteria, Permophorus*, etc.), gastropods (including *Bellerophon* ssp. that gives its name to the formation), and nautiloids (Stache, 1877, 1878; Caneva, 1906; Merla, 1930; Broglio, Loriga *et al*, 1988; Posenato, 1999; Posenato, Prinoth, 2004).

Beautiful outcrop of the transition between the folded Bellerophon Fm (in the lower part) and the Werfen Fm

The lithofacies documented in the Bellerophon Formation (and also the fossil associations) are indicative of a shallow-water coastal and sea environments. A large fraction of these indicate an Upper Permian age, but does not allow a more detailed correlation. This unit, although loosely bracketed likely indicates continuity across the Permo-Triassic boundary.
Recent reports of Paratyrolites (markers of the second to last chronozone of the Changxingian) under the Comelicania strata, evidence of conodont fauna at the base of the Werfen Formation, and especially the identification of *Hindeodus parvus* in the lowest part of the Tesero Horizon strongly suggest that any possible hiatus at the Permian-Triassic boundary would be small if at all present.
Most of the evaporitic sequence of the lower unit consists of laminar sulphate evaporites, perhaps deposited across a wide lagoon and dammed in the east-northeast by structural highs controlled by the synsedimentary tectonics (Massari *et alii*, 1994; Massari & Neri, 1997). However, in other areas the carbonates in the upper unit document a transition to a ramp depositional model, with subsidence gradients and an average seafloor depths that progressively increased from west to east.

The ravine of Bletterbach: spectacular view of the heteropic transition between the Val Gardena Sandstone (reddish) and the Bellerophon Fm. (gray).

Airview of the ravine of Bletterbach

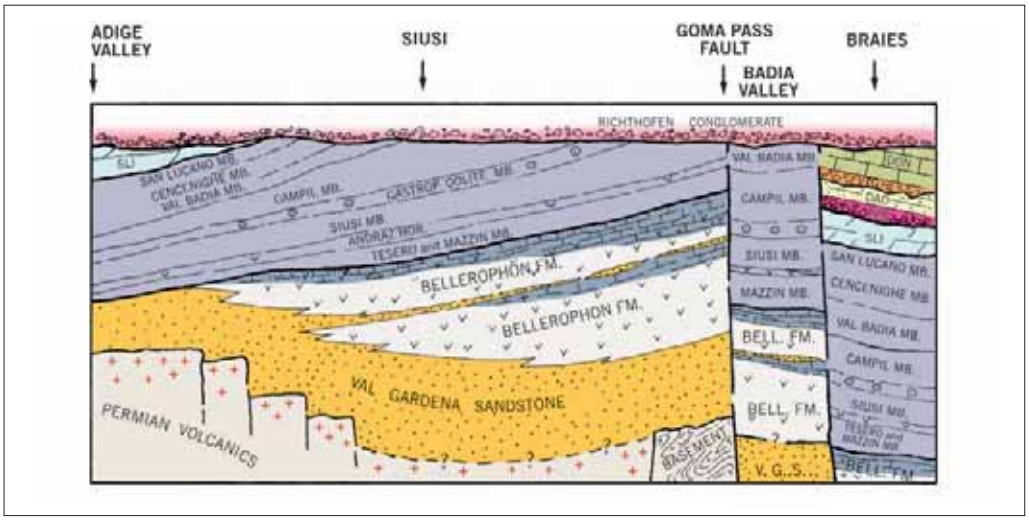
The Permian-Triassic boundary and the Werfen Formation

The Bellerophon Formation is succeeded (overlain) by the Werfen Formation. This complexity of this historic unit is the result of a terrigenous-carbonate ramp environment (*Roter und bunter Schiefer von Werfen*, Lill von Lillienbach, 1830; *Werfener Schichten*, Bronn, 1832; *Seiser Schichten* and *Campiler Schichten*, Richthofen, 1860), composed of a variety of lithologic types from carbonate to terrigenous (oolithic and bioclastic calcarenites, more or less marly micrites, marlstones, siltites, arenaceous limestones, silty and arenaceous dolomites, etc.), normally finely bedded.

The Werfen Formation has been subdivided into nine subunits (members and horizons) based on the macroscopic lithostratigraphic characteristics (prevalent lithologies, color, strongly evident fossiliferous levels) (Bosellini, 1968; Rossi, 1969; Farabegoli *et alii*, 1977; Pisa *et alii*, 1979; Broglio Loriga *et alii*, 1983; 1990; Neri & Posenato, 1988).

At the base of the Formation a level of oolitic limestones (Tesero Member) can be found which represents the passage of the underlying Permian Bellerophon Formation to the Triassic. Going up through the stratigraphic series, after the Mazzin and Andraz Members, one can find the Siusi Member, made up of gray marly limestones rich in *Claraia clarai*, an important lamellibranch guide fossil; or farther up, after the Gastropod Oolite, the Campil Member, documented by red sandstones characterized by the abundant starfish (Ophiuroids) and the sedimentary structures such as ripple marks. The Val Badia Member (Bosellini, 1968; Rossi, 1969) is 50 to 70 meters thick and consists

prevalently of gray marly, silty and arenaceous limestones, with decimeter-thick layers of bioclastic calcarenites with bivalves, microgastropods and remnants of echinoderms. The finest lithotypes are often bioturbated, with limivorous animal burrows with centimeter-wide diameters. These mixed terrigenous-carbonate deposits document shelf facies primarily characterized by storm-driven wave control and only with slight evidence of tidal control.



Stratigraphical setting of the Werfen Formation of the Dolomites: vertical scale greatly amplified. (Modified from Broglio Loriga et al., 1990).

The Val Badia Member in some areas grades and others shows an uncomformity with the Cencenighe Member and to the San Lucano Member (Farabegoli *et alii*, 1977; Pisa *et alii* 1979). These two members are characterized by distinct lithologies (mainly carbonates in Cencenighe and prevalently terrigenous in San Lucano) of fairly uniform thickness between 140-150 m, of which the first 80-90 m belong to the Cencenighe Member. The first is characterized by dolomites and oolitic-bioclastic, sometimes arenaceous limestones, yellow or red in color, that form a thick metric and plurimetric sets with bi-directional cross-bedding and subordinate hummocky cross-bedding. These bodies are interpreted as shoals with prevalent tidal control. They alternate with gray bioturbated siltites and marlstones, sometimes fossiliferous, subtidal, and with dolomitic siltites and pelitic red flaser and lenticular bedding siltites, with inter and upper tidal mud-cracks. The San Lucano Member comprises red sandstones in decimeter- thick erosive-based lenticular strata, with horizontal and cross lamination, wave and current ripples, frequently amalgamated in metric sets; silty and marly siltites, pelites and dolomites, in various colors (yellow, gray, red, purple) with ripples, mud-cracks, and small teepees. In the upper-middle part of the member the terrigenous component is reduced and the light gray, bioturbated dolomites become dominant, containing more or less terrigenous sediments, sometimes fossiliferous, alternating with minor, multi-color teepee dolomitic siltites.
In the Giudicarie area and in the Dolomiti di Brenta the Werfen Formation is replaced by the Servino Formation, in the end very similar and also made of dolomites, fine sandstones and multicolor siltites, dolomitic and oolithic limestones, proving the presence of a shallow water carbonate platform discontinuously affected by continental run-off.
The Werfen Formation crops out widely in the entire eastern Southern Alps, with thickness that vary from approx. 250 m (or less, in highly structured areas) in Val d'Adige/Etschtal up to 500-600 m in

the Eastern Dolomites (Broglio Loriga *et alii*, 1983). The fossils in the Werfen Formation are dominated by mollusks (lamellibranchs and gastropods: the ammonoids only appear in the upper portion of the formation), ostracods, inarticulate brachiopods (lingulids). The remains of echinoderms (ophiuroids, echinids and crinoids) become significant only from the upper portion of the Campil Member upward. However, entire groups of marine organisms are absent, such as calcareous algae, corals, and articulate brachiopods across the Permian-Triassic extinction boundary. Opportunistic taxa such as the Eotriassic fauna are composed of an extremely limited number of short-lived, weakly-specialized taxa that did not need to maintain competitive advantages and were able to live in varying environmental conditions, thereby having a special, large, diffusion.
The control on the Lower Triassic biostratigraphic succession is accurate. A few types of benthic mollusks, such as *Claraia*, *Eumorphotis*, *Costatoria*, *Natiria*, *Turbo* were chronostratigraphically short-lived but geographically widespread (Tethys and Arctic). In the upper portion of the Werfen Formation (Val Badia and Cencenighe Members) the ammonoids of the genus Theodolites and Dina rites are also fairly frequent, permitting good correlation with the Spathian terrains, both in Tethys and in South America.

Eumorphotys and Unionites (Werfen Fm)

Claraia Clarai (Werfen Fm)

The first carbonate platforms (Lower Serla Dolomite – Carniola di Bovegno)

Between the end of the Scythian and the beginning of the Anisian, the coastal environments that had favored deposition of the Werfen Formation were replaced by shallow water environments far from the continental run off and from the evaporitic types of lagoons with limited water circulation. These settings are represented by the dolomitic limestones of the Lower Serla Dolomite, which is rich in Dasycladaceae algae and porous ("in cells") dolomites-- the result of a complex process of fragmentation and dissolution, alternated with clay layers, called Carniola di Bovegno. The dominant lithologies consist of aphanitic dolomites (of micrite origin) and minor dolomitic packstone- wackestones with peloids and oncoids, and rarely with bioclasts. Stromatolitic layers are frequent, occasionally overprinted by mudracks, and fenestrae with geopetal fills and vadose cement: carbonate paleosol and teepee paleosol layers are rarer. The sequence can thus be subdivided into peritidal shallowing-up cycles of metric-multimetric thickness, with subtidal portions formed by fine dolomites and a loferitic inter/supratidal. The thickness is highly variable, related to the depth of the erosion sustained during the Anisian, and ranges from a few meters to a maximum of approximately 200 m.

Fossils are fairly rare in this unit, and in any case do not include any good chronological markers; from the macroinvertebrates, particularly present in the lower section of the formation, notable are the *Natiria costata*, indistinguishable *Pectinidae* and *Bakevellida*e (among which *Bakevellia costata*). The microbiofacies is dominated by foraminifers of the genus Glomospirella and Meandropira (M. gigantea, M. dinarica). The Lower Serla Dolomite is a lithostratigraphic unit typical of the eastern Dolomites and passes laterally to the Carniola di Bovegno to the west of the Valle di Non and in the area of the Giudicarie. The reasons for this variation is linked to an important tectonic phase that, as will be shown later, in the Middle Triassic (Anisian) subdivided the Dolomites area in an articulated series of basins, muddy plains and rocky islands.

Old Rocky Islands (Anisian clastic and carbonate formations)

The fundamental character of the Anisian geology of the Dolomites is the break in the relative paleogeographic uniformity that had characterized the Lower Triassic (Werfen Formation) and the lowest part of the Anisian, at the time of the deposition of the Lower Serla Dolomite. Whereas Werfen and Lower Serla extend with only minor lateral variations in facies and thickness from Lombardy to Karawanken, the Anisian successions document an articulate paleogeographic picture in which the synsedimentary tectonics creates (even in small areas) carbonate platforms, deep basins and dry lands. Various generations (at least three ones) of continental or coastal conglomerates, that evolve toward the top into shelf deposits and therefore into true carbonate platforms (or into their equivalent basins), have been documented in the Dolomiti di Braies by Pia (1937) and Bechstadt & Brandner (1970). Fundamental contributions relative to western Friuli, Agordino and Zoldano were provided during the 1970s by Pisa (1972), Assereto *et alii* (1977), Farabegoli *et alii* (1977), Pisa *et alii* (1979).

Southern cliff of Mt. Cernera: abrupt contact between the Richtofen Cgm.(reddish) and the Upper Serla Fm

During the Anisian, 240-235 million years ago, large areas of the Dolomites emerged from the sea. Short rivers with small deltas flowed into the sea (Piz da Peres Conglomerate, Val Leogra Breccias). The clastic facies are characterized by prevalent squared to rounded pebble conglomerates, made up of dolomites and pale dolomitic limestones (Lower Serla Dolomite) and, to a lesser extent, by pebbles originating from the Werfen Formation (micritic limestones, calcarenites and oolithic-bioclastic doloarenites, siltites, sandstones). The conglomerates can be in pockets, lenses or sub-metric banks;

sometimes they are organized into FU cycles with alternating reddish conglomerates-pelites. Bodies of breccias, reddish sandstones and argillaceous siltites are sometimes present. Predominant towards the top are the arenaceous dolomites and dolomitic siltites with ripple-crossed lamination that document the passage from a braided river system to marginal coastal and marine environments. The lagoons, sites of intense evaporation, usually alternated with tidal planes of carbonate sedimentation, influenced sometimes by continental terrigenous sediments in which proliferated extensive prairies of crinoids and algae (Gracilis Formation). However, in the more subsident areas, deep lagoons were formed (Coll'Alto Dark Limestone and the lower part of the Dont Formation) with some bioconstructed carbonate platforms (Monte Rite Formation). The Coll'Alto Dark Limestone is mostly made up of dark, almost black, slightly fetid limestones, of gray dolomitic limestones and of bioclastic calcarenites with algae and the remnants of echinoderms. The strata are of variable thickness ranging from centimeters to decimeters, with plane-parallel to slightly wavy boundaries. Towards the top the stratification gradually increases in thickness and passes over to light or crystalline gray dolomites from poorly stratified to massive, that gradually transition to the Monte Rite Formation. The fossiliferous associations are characterized by algae, foraminifers, ostracods, bivalves, gastropods, brachiopods and fragments of echinoderms.

The carbonate bank of the Contrin Formation and the Sciliar/Schlern carbonate platform.

Southern cliff of Mt. Rite. Wonderful outcrop of the Anisian succession

The Monte Rite Formation is important from the paleoecological point of view, documenting the recovery of the bioconstructors after the biological crisis at the Permian-Triassic boundary for the first time in this stage of the Triassic Tethys, thus shifting the first occurrence of rigid-frameworks builders earlier in time by several ammonoid subzones. The Monte Rite carbonate platform is made up of alternating bioclastic calcarenites and calcirudites with algae, bivalves and brachiopods, and light gray massive dolomites and dolomitic limestones in decimeter- to meter-thick banks, eventually amalgamated. The strata bedding varies from planar to slightly wavy. In the top portion of the unit there are meters-thick banks of dolomitic boundstones with encrusting organisms, Tubiphytes and Dasycladaceae algae (*Physoporella pauciforata, Macroporella alpina, Diplopora* sp., *Aciculella* sp.), with abundant vadose cements and marine phreatic ones. Very spectacular and enormous quantities of breccias and olistoliths, sometimes packed into the Dont Formation, consist of a geometric relationship with the carbonate platform containing both superimposition and lateral substitution. These breccias can be interpreted as detrital talus bodies coeval to the platform growth and are tied to the breakdown of the platform due to submarine collapse (slides) caused by intense synsedimentary tectonics. Sedimentary dikes filled with intraclastic breccias, pelagic sediments, and considerably thick lateral variations are documented remnants of the tectonics (Farabegoli & Guasti, 1980).
The depositional environment of this unit can be referred to an open carbonate platform with sandy margins documented by cemented grainstone facies; microbialite mounds are locally recognizable that are decameters thick (Dolomiti di Braies/Pragser Dolomiten). In this time interval (between the Bythinian and the Pelsonian substages) the paleogeographic array of the Dolomites are articulated in the most complex manner with different subsidence rates producing deep basins consisting of carbonate platforms. In the carbonate platform there are relatively small variations of sea level

caused by different reactions based on the type of paleoenvironment. A significant drop in sea level caused intense erosion. The flood plains formed by tangled streams and carried eroded detritus from the highest elevations of the islands into the sea. In the sands of these ancient beaches, between rain drops and traces of insects, the animal tracks from the dinosaurs' predecessors remained impressed: a few are among the best ever to be found. These detritus accumulated in many areas of the Dolomites in the form of thick, red sandy mounds and whitish piles (Voltago Conglomerate). This unit is prevalently formed by rounded polygenic clasts with alternating sandstones, reddish arenaceous dolomites, gray laminate calcisiltstones and pelites; towards the top there are fine arenites, polychromatic micaceous quartzitic silts and gray arenaceous-silty limestones (often bioturbated) that form the transition to the overlying Recoaro and Dont Formations. The lower boundary of the Voltago Conglomerate is sharp and erosive, it is possible to observe an angular unconformity that causes the unit to rest on older formations (from the Monte Rite to the Werfen Formations).
In the area of Monte Pore (the Pelmo Nuvolau system) deep incisions tens of meters deep can be seen (Blendinger, 1983) and interpreted as incised valleys. The depositional environment, Voltago Conglomerate, can be interpreted as a continental deposit that was transported by braided-rivers (Pisa *et alii*, 1979). The coastal plain facies consists of marine incursions, and then by marginal marine facies, as documented by ripples, *flaser*- and wavy-bedding facies – a testimony to a tidal influx, and by the presence of marine fossils a unusual associations of trace fossils.
Following this erosional phase the entire Dolomites experienced a new submersion phase and marine conditions were established in the whole region. In many areas, however, some smaller basins were already formed, such as in the eastern and southern Dolomites. These basinal conditions have been documented by the sediments of the Dont Formation (*Dontkalk* in Mojsisovics, 1882).
The Dont Formation is very important from a biostratigraphic point of view because it documents precise detail of the biological associations of the Anisian and is known for its fossil fauna, with collections found in many museums in the Alpine area. From a lithological perspective, it can be subdivided into two informal units. The lower one is prevalently formed of gray sandstones (yellow due to alteration) with a grain size that ranges from very fine to medium, becoming coarser moving towards the top. Grains are represented by mica, quartz and carbonates, with sporadic intercalations of silty marlstones and calcisiltites. The strata are nodular or pseudonodular, 5-30 cm thick, with ellipsoidal or spherical nodules that are even 8-10 cm large. At the base of the beds, it is possible to observe a crossed lamination (due to waves) which is not very clear because of bioturbation. On the other hand, current structures can be seen on the top beds (plane- parallel lamination, asymmetric ripples). The upper unit is characterized by a progressive decrease in arenaceous levels, with thinly stratified (5-15 cm) alternating gray and gray-greenish pelagic limestones, rich in radiolarian, pelagic lamellibranchs, and spicule of siliceous sponge, and rather brown coarse-grained graded calcarenites and biocalcarenites, rich in crinoids, lamellibranchs, and brachiopods (Pisa *et alii*, 1979; Farabegoli & Guasti, 1980). In the eastern Dolomites and the area of Monte Bivera, in the lower section of the unit, there are huge accumulations of calcareous olistoliths rich in algae and encrusting organisms produced by collapses from the Monte Rite carbonate platform. The fossiliferous content, as already stated, is characterized by an abundant fauna, particularly of ammonoids (*Beyrichites, Balatonites, Semyornites, Bulogites e Judicarites, Megaceratites, Paraceratites, Lanceoptychites*) (Assereto, 1971; Pisa *et alii*, 1979; Mietto and Manfrin, 1995a; Balini, 1993, Balini and Nicora, 1998), conodonts (*Paragondolella bulgarica, P. bifurcata, P. hanbulogi, P. praeszabói, Gladigondolella tethydis, Nicoraella sp.*) and brachiopods (*Mentzelia mentzeli e "Rhynchonella" tommasi*), that permit the unit to be attributed to early Pelsonian to Illyrian times. Towards the west, in less subsident areas than the Giudicarie, and near Tione, a large, shallow, low-energy gulf extended, characterized periodically by bottom anoxic conditions as documented by the Angolo Limestone. These bottom conditions prevented the development of communities of detritivorous endobiont organisms. Nevertheless, crinoids can often be found along with ammonites and brachiopods when the sediments become more marly. Similar sit-

uations also characterize the southern (Piccole Dolomiti) and western sectors, where the dark limestone (Recoaro Limestone) contained remains of placodont and nothosaurus reptiles which recently been found. This latter formation is typical of the areas overlooking the growing carbonate platforms and documents a series of depositional environments that evolved from a mixed carbonate-terrigenous sedimentation shelf, progressively deepening, into an open carbonate ramp setting.
The fundamental lithotypes that make up the formation are decimeters thick and represented by marly limestones, light gray dolomitic limestones in regular beds, and with wavy boundaries that are characterized by siltitic interstratifications. Towards the top of the Recoaro Limestone, transitions into bioclastic calcarenities rich in articles of crinoids, brachiopods and bivalves. The terrigenous component seems to decrease progressively even though there may be thin layers of paraconglomerates and sandstones. Near the boundary of the overlying Upper Serla Formation, small microbialitic mounds meters thick are sometimes present (Gaetani *et alii*, 1981; Blendinger, 1983). The Recoaro Limestone, in the Dolomites, is particularly fossiliferous. The following fauna is present: brachiopods (*Coenothyris vulgaris, Mentzelia mentzeli, Tetractinella trigonella, Decurtella decurtata*), crinoids (*Encrinus carnali, E. liliformis*), bivalves (*Plagiostoma taramelli, P. lineatum*), gastropods, poriferas, chetitidis, corals and sometimes pelsonic ammonoides *(Achrocordas spp., Balatonites spp., Gymmnites sp., Bulogites zoldianus)*.

Voltzia- Dont Fm

The Recoaro Limestone transitionally passes through lateral heteropy to the Upper Serla Formation, which represents the second unit of the rimmed carbonate platform of the Anisian. This is formed of dolomites, light colored dolomitic limestones in meter-thick banks that appear sometimes amalgamated. There may be banks of light, crystalline dolomites with concentrated areas of Diploporeae and other bioclasts. Locally cavities appear with cements, sometimes with geopetal structures. Encrusting organism boundstones are often found along with calcareous chaetetid sponges bioconstructions and rare corals. A detailed analysis of the bioconstructors and of the microfacies of this carbonate platform is provided by Bechstadt & Brandner (1970) and Senowbari-Daryan *et alii* (1993), as well as by Blendinger (1983) and Fois & Gaetani (1984). The depositional environment can be referred to as a low-relief (biostrome) carbonate platform, characterized by a prevalently calcarenitic margin, locally stabilized by encrusting organisms (cyanobacteria, foraminifers, sponges) and with infrequent microbialite mounds and skeletal metazoan patch-reefs. In more internal and less articulate areas, or less controlled by differential subsidence, this interval is documented by thick succession of dolomitic limestones and dolomites organized into subtidal and/or peritidal cycles (Valsugana Dolostone, or Dosso dei Morti Limestone in Giudicarie).

The landscape changed to either a peritidal or biostrome carbonate platform, which also had deep lagoons and basins. This change was the result of sea level trangression where synsedimentary tectonic events in some areas led to a new, important erosive phase preserved by the "Badioto-Gardenese Ridge" by Bosellini (1968).

Erosion affected the rocks of both the Werfen Formation and the underlying Bellerophon Formation. Fragments of the latter flowed down small streams and were distributed as reddish pebbles along small and thin beaches now forming the Richthofen Conglomerate (Tretto Conglomerate in the Piccole Dolomiti or Val Perse Conglomerate in the Dolomiti di Brenta). These terrigenous units are mostly represented by (i) polygenic conglomerates, with clasts that derive from the underlying units, mainly from the Werfen Formation and the Lower Serla Dolomite; (ii) microconglomerates and lithic sandstones, with high carbonate contents, from coarse to medium-fine, in general brick red; (iii) red and gray siltites; and at the top; (iv) gray, highly arenaceous-siltitic marlstones and limestones.

The conglomerates form lenticular bodies with a maximum thickness of a few dozen meters that extend laterally for a few hundred meters and can be interpreted as fills of incised valleys (the most famous are the ones below the Catinaccio/Rosengarten or the Odle/Geisler). More often, the conglomerates form prisms only a few meters thick, which extend laterally from a few hundred meters to a few kilometers, with mildly erosive planar bases. Towards the top the conglomerates turn into sandstones and red and gray siltites, that transition gradually into limestones more or less rich in terrigenous components from the Morbiac Limestone.

With regard to the depositional environment, based on the depositional geometries and structures, and the morphometric studies of the clasts (Dal Cin, 1967), these units, of which the Richthofen Conglomerate is the most important, are interpreted as continental deposits, settled by moderately long rivers with torrential characteristics, in a semi-arid climate context. The continental character is highlighted by the presence of important trace fossils tied to the passage of terrestrial reptiles such as *Rhynchosauroides tirolicus, Chirotherium* sp. and *Brachychirotherium* sp. that are sometimes superbly preserved.

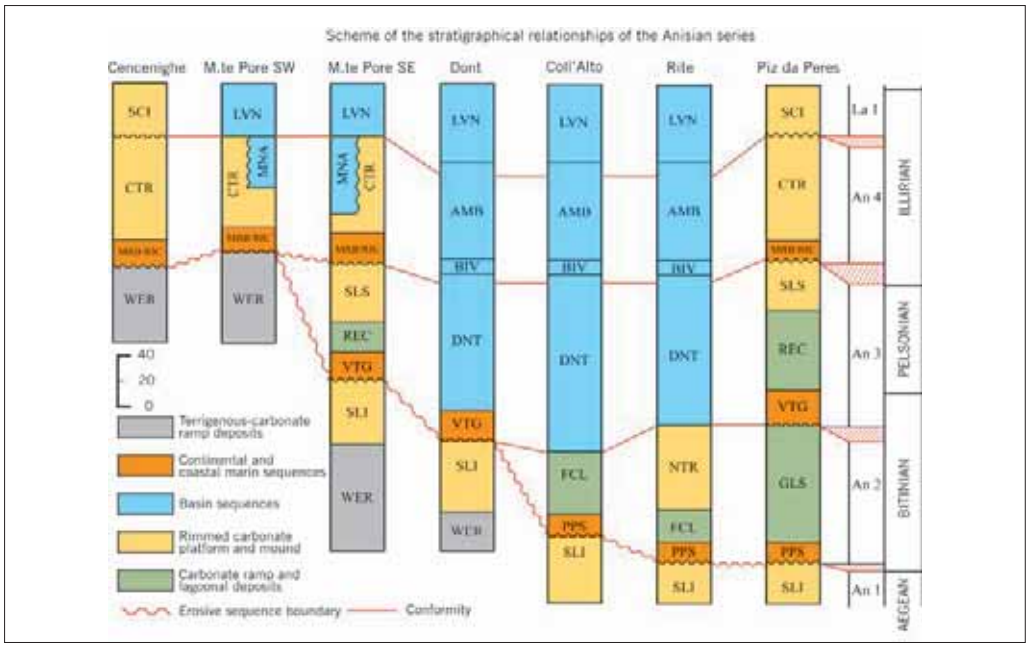
Towards the top, the sea-marginal influence is documented (sets of fine sandstones and flaser- and wavy-bedded siltites, which evidence a tidal influence; wave ripples; marine ichnofossils). The fining-up evolution of these formations reflects the general transgressive trend of the late-Anisian succession, that continues in the superjacent Morbiac Limestone.

In the basin areas, this erosive event is documented by an increase in the terrigenous component (siliciclastic turbidities) at the summit of the Dont Formation. Evidence of the new transgressive phase is the deposition of the Bivera Formation. The most diffused lithofacies in this unit is repre-

sented by nodular limestones that are more or less marly, which alternate red, green and gray siltitic-argillaceous marlstones, in strata 1-10 cm thick. These nodular limestones are made of bioturbated mudstones and mudstone/wackestones with peloids, fossiliferous sediments with radiolarians, thin-shelled bivalves (pelagic), foraminifers, ostracoids, and articles of crinoids. Fine strata of gray-green tufites (cinerites and crystal-tuffs) are spread all over the unit. The thick sediments (1-5 cm) reveal the initial acidic and explosive phases of volcanism which characterize the succession of the Anisian-Ladinian. In the upper part coarsening-upward/fining-upward sequences of dark gray packstones a few meters thick may be present. There are locations of sediment which consist condensed and hard-ground surfaces that are a few centimeters thick and are very rich in ammonites. The Monte Bivera Formation can be present at the top of the Upper Serla Formation and is an indicator of the drowning platform. The depositional environment sustained a pelagic lifestyle at variable depths. The deposition in the starved or current-swept deeper basins is documented by the most condensed sections or by sections reduced to hard ground. Based on the content in ammonoids (*Paraceratites trinodosus, P. elegans, Flexoptychites* spp., *Bulogites* sp., *Proarcestes* sp., *Ptychites* sp.) and conodonts (*Gladigondolella tethydis, Gondolella cornuta,G. constricta*), it is possible to attribute the unit to the Lower Illyrian.

Latter most Anisian platforms and basins

As mentioned previously, the partial uplifting of the seafloor that generated the islands was followed by a new deepening involving various portions of the seafloor due as a result of differential subsidence rates. In a few areas in fact, subsidence was not so extreme which allowed shallow seas to remain (Morbiac and Contrin Limestone). In other areas subsidence was greater, creating deep-sea basins (Ambata Formation). Some areas were initially within the shallow photic zone, which is indicated by their shallow-water carbonate sediments, but were later subject to intense synsedimentary tectonics that increased the water depth, creating an anoxic basin filled by chaotic deposits and breccias (Moena Formation).



Cronostratigraphic and sequential scheme of the Anisian units of the Central-eastern Dolomites, compared to the succession of Braies/Prags Dolomites (Piz da Peres)

The Morbiac Limestone (Upper Anisian: Illyrian p.p.) is mostly formed of gray, silty and marly nodular limestones, generally highly bioturbated. At the base of the formation, terrigenous lithotypes are dominant, such as coarse to medium-fine sandstone, in thickness ranging from a few centimeters to decimeters, with parallel lamination or hummocky lamination, and wave ripples that are indicative of a shoreface that may mark the beginning of the marine sedimentation. These terrigenous lithotypes were replaced toward the top by prevalent carbonate lithotypes such as packstones and wackestones with bioclasts and peloids, marly-siltitic, sometimes moderately arenaceous, alternating with marly mudstones and subordinate marlites, mostly present as interstrata. The color ranges from gray to blackish, strata that are 5 to 20 cm thick and are intensely bioturbated, giving the rock a nodular appearance. The strata are dominated by *Thalassinoides* and *Planolites* trace fossils, with frequent occurrence of *Rhizocorallium*. Plant remnants are abundant and marine fauna of lamellibranches are locally present (*Neoschizodus laevigatus, Hoernesia sp.*), as well as gastropods: *Polygyrina gracilior*, Foraminifers: *Glomospirella* sp., *Endothyra* sp., and worms: *Spirorbis*, and ostracods). Towards the top, the formation transitionally passes to the Contrin Formation (a carbonate platform) or, alternatively, to the basinal deposits of the Moena Formation.
The Contrin Formation represents the tabular carbonate body that typically forms the basement over which the large Ladinian reefs arise in the western Dolomites area. The lithology of the lower part of the formation is generally fine dolomites, with a moderate clay content that quickly disappears upward in the formation. Subsequent, what could be considered the most characteristic lithofacies of the Contrin formation are large banks of light crystalline dolomite, with decimeter-thick, lenticular or tabular concentrations of Diploporae algae, with stipes oriented parallel to the stratum surface. Cavities locally appear with cements, sometimes with geopetal structures. In case of recrystallization, only ghosts of Diploporeae are observed, and are barely recognizable. In the opposite case, in the rare, well-preserved, limestone successions the texture is characterized by peloid and intraclast packstones and wackestones with peloids and intraclasts, which are frequently stabilized by microbialite laminites, associated with encrusting foraminifers (*Tolypammina*) and subordinate *Tubiphytes*. The Dasycladaceae algae (dominated by *Diplopora annulatissima*) form concentrations that are centimeters to decimeters thick in micritic matrices that are in turn stabilized by encrusting organisms. The intraclastic levels formed by fragments of microbialite and *Tolypammina* boundstones and Diploporeae grainstones indicate periodic re-working of the sediment by storm events.
Sediments of this shallow, oxygenated facies were deposited on marine floors, probably within a wide carbonate bank below the wave base, but occasionally reworked by large storms. On a regional scale, the Contrin Formation has an average thickness of a hundred meters (Catinaccio/ Rosengarten, Odle/Geisler, Cernera), that ranges from a minimum of approximately 30 m in areas with little subsidence (the western Dolomites) to a maximum of 150-200 m in others (Val Contrin). An exceptional 500m thick section of the Contrin Formation occurs under the southern sector of Monte Alto di Pelsa (Civetta).
The net upper limit is represented by the *Plattenkalke* Member of the Buchenstein Formation or by the bodies of breccia of the Moena Formation. The speed with which this change took place suggests a traumatic drowning of the platform linked to the activation of a violent synsedimentary tectonic. The presence or the absence of the Moena Formation as well as the variable thickness with which this unit overlaps the platform, suggests a diachrony of the drowning events in the various areas.
At the nuclei of the Ladinian platforms, the Contrin Formation grades into the Sciliar/Schlern Formation with a boundary that is often difficult to identify, and rarely marked by clear disconformities due to paleokarst deposits (Torri del Vaiolet, Western Dolomites).
Carbonate breccias, megabreccias and siliceous rhythmites fill the intraplatform basins following the tectonically induced dismantlement of the Contrin carbonate bank are testified by the Moena Formation (Masetti and Trombetta, 1998). From a lithologic point of view these are carbonate megabreccias with heterometric clasts of dolomites and platform limestones (Contrin Formation), dark

fetid dolomites consisting of alternating levels of dark siliceous laminites which are sometimes bituminous. The laminites are often affected by slump processes and load deformations phenomena (e.g. in the Catinaccio/Rosengarten area). The non-oxidized organic component is very important and causes hydrocarbon impregnation that is sometimes significant. Metric intervals of bioclastic calcarenites interspersed with platform grains are also present (calcareous algae, benthic foraminifers, benthic macrofossils, crinoids, etc.) and document in part a contemporary depositional stage with phases of normal exportation from active carbonate platforms. The intervals made up of prevalent carbonate breccias are often strongly dolomitized and therefore the original clastic texture is obliterated, making its recognition difficult. The upper part of the formation is characterized by a decrease of granulometry, a larger mechanical elaboration of the clasts and by the presence of bioclastic calcarenites and encrinites forming wedge-shaped bodies with limited extension. This topmost interval tends to saturate the previous topography and most likely documents attenuation in the extensional tectonic phenomena that appear to control the placement of the breccias. The deposition environment is that of anoxic intraplatform basins those are rapidly deepening and are limited by active escarpments tied to synsedimentary faults.
The contemporary open basin sediments are, on the other hand, represented by lithotypes of the Ambata Formation, a terrigenous-carbonate unit when the sea was relatively deep, with outcropps in the northern and eastern Dolomites and the Comelico area. The Ambata Formation can be subdivided into two overlapping lithofacies. The first is made up of well-stratified dark biomicrites with alternating gray silty marls that are associated with subordinate silty limestones containing rare pelagic lamellibranchs and radiolarians. In the second lithofacies consists of millimeter- or centimeter thick beds, mostly marly siltites and slightly bituminous calc-siltites, with plane-parallel boundaries and rare levels of nodular limestones. The depositional environment deepens towards the top. The first lithofacies is characterized by thin turbiditic supply coming both from the coeval carbonate platforms (Contrin Formation) and from a terrigenous shoreline. The second, marked by an increase in the terrigenous component and by a drastic reduction in the carbonate components, indicates a more restricted environment with little oxygen, characterized by the deposition of distal turbidities, testifying the crisis and the drowning of the Contrin carbonate platform. This formation is important from the fossiliferous point of view due to the presence of light Daonella imprints (*D. fascicostata, D. pseudomoussoni*), in addition to ammonoids of the genera Flexoptychites (*F. flexuosus, F. indistinctus, F. angustiumbelicatus, F. acutus*), Ptychites, Aplococeras (*A. avisianum*), Hungarites, Proarcestes, Parakellnerites and Norites (Reitzi and Avisianum Subzones).

Ladinian platforms and basins (Sciliar Dolomite, Esino and Buchenstein Formations)
The subsidence of the seafloor continued inexorably and intensified, causing the tectonic collapse and tilting of large blocks. In some cases the tilting component favored the emersion of small parts of these blocks, while the rest remained as a pelagic plateau. These higher areas permitted the colonization by flourishing colonies of marine organisms, in some ways similar to those that form coral reefs in today's tropical oceans. They were calcareous algae, sponges and corals that possessed the peculiarity to extract the calcium from the seawater fixing it into calcium carbonate.
Even the plateaus portions that were initially uplifted, however, later suffered the effects of the rapid subsidence, equivalent to around a thousand meters in the arc of a few million years, and started inexorably to move away from the light, warm and oxygenated water surface. However, the speed with which the reefs produced calcium carbonate was enough to compensate for the subsidence of the platform, inducing a constant upwards growth of the reef (reef aggradation) that reached one thousand meters in some millions of years. Moreover, the production of calcium carbonate was so high allowing lateral growth of the reef (reef progradation) that grew therefore not only in height but also in diameter. The organisms that colonized the reef localized themselves only in the apical area and situated a short distance from the sea surface, while the remaining largest portion, the enormous con-

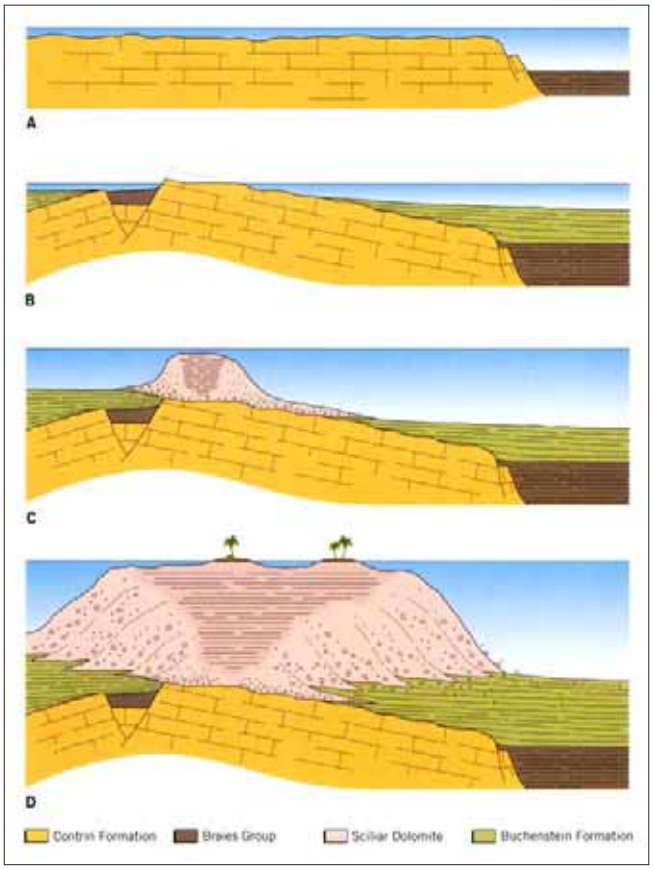
struction is made of carbonate structures deriving from organisms that were already dead. These very ancient reefs were destined to become the present-day '*Dolomia dello Sciliar* or Sciliar Dolomite' that today forms some of the most beautiful and famous Dolomite Mountains. In some cases, however, the limestone that formed the reefs remained as such and didn't transform into dolomite (lithofacies of Marmolada Limestone and Latemar Limestone).

Mt. Latemar. Cyclical lagoon facies of the inner platform

As the shelves grew, in the deep basins that separated the platforms, a pack of thin beds was deposited, sometimes cherty and often intercalated with thick levels of tuffs and volcanic ashes intensely green in color ('*Pietra Verde*'). These extremely fine pyroclastic products, coming from clouds erupted from volcanic centres, when reaching the ocean surface, by fall decanted down to the seafloor. The geographical distribution of these deep-sea formations (Buchenstein Formation) 'draws' the map of the bottoms of the ancient basins.

More specifically, the Dolomia dello Sciliar is characterized by a series of platform carbonate build-ups (representing isolated atolls) interfingered with the deep marine Buchenstein Formation. These bodies, retain a thickness of many hundreds of meters (up to almost one thousand meters) and a considerable lateral extension and are in a large way affected by pervasive late diagenetic dolomitization, hence their name *Schlerndolomit* ('Dolomia dello Sciliar' in Italian) attributed to Richthofen (1860). In the meaning used here, 'Dolomia dello Sciliar' also includes the non-dolomitized bodies belonging to the same generation of platforms, in the past distinguished as separated stratigraphic units: the Marmolada Limestone (*Marmolatakalk*, Salomon 1895), representative of the relatively massive margin and escarpment facies, often with a breccia/megabreccia texture, and the Latemar Limestone

(*Kalke des Latemar*, Richthofen 1860), representative of the internal platform deposits (well-stratified micrites and calcarenites).
The prevalent lithologies on a regional scale are mainly white or light gray granular dolomites that are re-crystallized, and to a much lesser extent limestones and white or light gray dolomitic limestone (from the textural point of view: microbialitic boundstone associated with bio-intraclastic calcirudites and calcarenites).



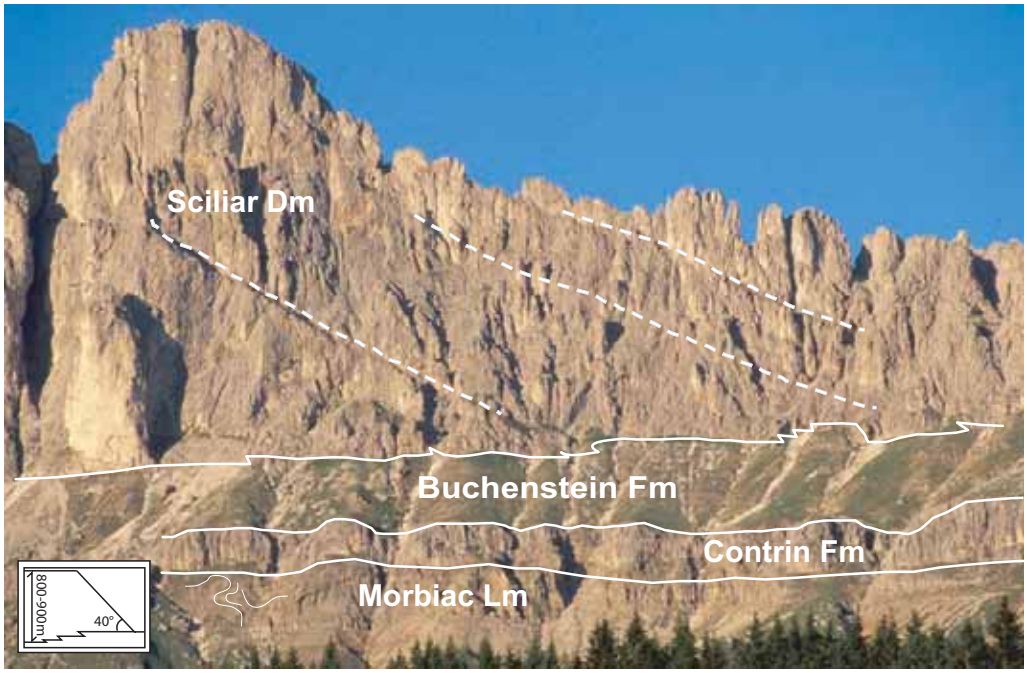
Start up and evolution of the pre-volcanic Ladinian platforms and surrounding basins and deep sea straits. The Anisian platform of the Contrin Formation broke down in blocks (A); some of those blocks, slightly tilted, emerged from the water and the lifted part suffered karst erosion (B). While the all region is affected by a strong subsidence, on the emerged or less deep areas, took root organic communities of corals, sponges and algae (C), whose carbonate production it's so abundant to keep pace with the strong subsidence; afterwards, when the subsidence rate slowed down, the carbonate production induced a lateral expansion (progradation) on the surrounding basinal sediments of the Buchenstein Formation (D). (Modified from Bosellini, 1996).

Pervasive dolomitization processes that affected 'Dolomia dello Sciliar' make it difficult to recognize the original sedimentary structures and textures. Where this doesn't occur, and the original calcareous lithology is preserved, one can still distinguish the different facies of the platform (e.g. M. Coldai, Monte Cernera, Sass da Putia/Peitlerkofel, Gruppo del Latemar, Marmolada). It appears that this area was a productive margin essentially dominated by microbialitic deposition, both in the form of stromatolitic laminites and of trombolites, with an extreme abundance of early, fibrous cements; in association, skeletal cyanobacteria, dasycladales, problematica (*Tubiphytes sp.*), skeletal metazoans (prevalent sphinctozoan; rare colonial corals).
However, even where the original limestone lithology is not preserved, within the platform buildups, three main areas based on depositional geometry can be distinguished (Bosellini, 1984): internal lagoon, margin, and slope, developed diversely in the different carbonate buildups.
The inner lagoon facies are characterized by plane-parallel stratification; the sediments, where it is

possible to distinguish them when not obliterated by dolomitization, are formed of pelmicrites, biomicrites with Dasycladaceae algae, foraminifers and ostracods, algal biolithites with fenestral cavities and widespread Stromatactis.
The margin, sometimes difficult to recognize, comprises massive dolomites with boundstones with rare corals in living position. It can be differentiated based on the exposure to the prevailing winds (Blendinger *et alii*, 1984; Blendinger, 1983b; Blendinger & Blendinger, 1989), with rigid structures (boundstones of algae and corals) in the windward margins, and sand waves comprising bioclastic/oolithic grainstone in those leeward.
The slope deposits are those that often occupy the greater volume of the carbonate buildup and are characterized by sediments originating from the erosion of the bioconstructed margins of the platform. These sediments are formed of fine grainstone in the upper part, near the margin, and gradually pass to rudites and, at the toe of the slope, to megabreccias deposited by debris flow mechanisms. The grainstones comprise mainly organic detritus with crinoids, gastropods, bivalves and algae bioclasts: the coated grains and boundstone lithoclasts from the margin are present. The coarser facies are mainly lithoclastic. The stratification is due to the clinoforms that connect the bio-constructed margin to the basin facies. They show varied inclination, normally from 30° to 45° (Bosellini & Rossi, 1974; Bosellini, 1984; 1988; Maurer, 2002). The clinostratifications, according to the observations of Bosellini (1984), represent the phase of progradation of the platform towards the basin and can form during a fall in sea level linked to 4th order cyclicity.

The Pale di San Lucano's cliffs show spectacularly the transition between the horizontal strata of the inner lagoon and the clinoformed ones of the slope.

Direct dating of the Sciliar platforms is related to sporadic findings of ammonites on the slopes or in tempestite within sediment traps in the inner lagoon (Gaetani *et alii*, 1981; Brack & Rieber, 1993; Preto *et alii*, 2001; Zühlke *et alii*, 2003). Indirectly it is possible to define the age of the platforms with precision by dating the heteropic basin facies or the drowning facies accompanying them. The 'Dolomia dello Sciliar' includes between the Upper Anisian and the Ladinian.
As has already been pointed out, the heteropic basin deposits with the carbonate platforms are known as Buchenstein Formation or Livinallongo Formation. The unit corresponds to *Buchensteiner Schichten* of Richthofen (1860) named after a locality (Buchenstein Schloss now Castello di Andraz) in a lateral valley of the Torrente Cordevole near Pieve di Livinallongo. Subsequently, Mojsisovics (1879) enlarged and generalized the stratigraphic interval, subdividing the formation, from bottom to top, into three units separated by nodular limestones with volcaniclastic intercalations ("*Pietra Verde*"): the lower *Bänderkalke*, the *Plattenkalke* and the upper *Bänderkalke*. The lower level was then successively renamed *Plattenkalke* (Ogilvie-Gordon, 1929). The Buchenstein Formation comprises an alternation of nodular and cherty micritic limestones, of bituminous limestone laminites, of volcano-detritic turbidities and of pyroclastics deposited in relatively deep basins and characterized by certain homogeneity of depositional style as well as by a large distribution area (Brack & Muttoni, 2000).



Depositional geometries amazingly preserved at the Catinaccio/Rosengarten platform.

As has been stated, the Buchenstein Formation is traditionally subdivided into three units that are, from the bottom: *Plattenkalke*, *Knollenkalke* and *Bänderkalke*:

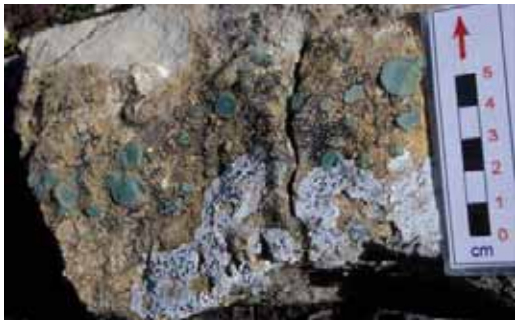
a) *Plattenkalke* – comprises bituminous rhythmites, finely laminated black calcilutites rich in pelagic bivalves, dark micritic limestone, sometimes massive, but normally with parallel lamination. There are also bituminous dolomitic limestones, with plane-parallel bedding, and bituminous dolosiltites. The *Plattenkalke* are mainly characterized by siliciclastic and carbonate microturbiditic laminas (Maurer *et alii*, 2003). The bioturbation is normally absent in the lower part

but can be sporadically present in the upper part of the member. Intercalations of both pyroclastic and epiclastic '*Pietra Verde*' are frequent. Thicknesses are always reduced and easily exceed ten meters. Available data indicates that the depositional environment was characterized by low oxygenation and by a reduced carbonate and siliciclastic sedimentary input, both carbonate and siliciclastic (starvation); the depositional geometries of the contemporary carbonate platforms (dominated by prevalent aggradation and sometimes by back stepping) give evidence to a rapid rise in the relative sea level and very strong subsidence rates.

View of the northern side of the Seceda with the Livinallongo Formation on top of the Contrin platform.

b) *Knollenkalke* are the most widespread facies of the Buchenstein Formation. They mainly comprise nodular or pseudo-nodular limestones, gray, red or green in color, gray micritic limestones, calcarenites, biocalcarenites and carbonate rudites. Black or green chert is often present in nodules or in lists. The *Knollenkalke* are characterized by early diagenesis with consequential obliteration of depositional textures and structures; where possible, peloids, coated graines, bioclasts, radiolarians and pelagic bivalves can be recognized in thin sections. The volcanic component, often present, is important and characterized by the presence of feldspar microlites, glassy shards, biotite and quartz. The most common microfacies are mudstones and wackestones with pelagic bivalves, ostracods, sponge spicules and radiolarians, as well as by wackestones and packstone that, apart from the microfossils already mentioned, can contain encrusting foraminifers, fragments of algae and crinoids. The nodular limestones are often made of carbonate turbidites of neritic origin (peloids, ooliths, bioclasts) or of pelagic turbidites (Bosellini & Ferri, 1980; Maurer & Schlager, 2003). The presence of pyroclastics, volcanic arenites and volcanic turbidites are

very widespread and in certain areas prevalent. They are linked both to volcanism coeval to sedimentation, and to the erosion of volcanic areas. These deposits are known as "*Pietra Verde*". The composition and the texture of the *Knollenkalke* depend very much on their position in respect to the contemporary carbonate platforms. The closer the depositional setting is to the growing platforms, the higher will be the percentage of materials involved in their progradation: biocalcarenites, carbonate turbidites, rudites and carbonate megabreccias at the clinoform downlap surface. During the times of growth stasis, micrite deposits will instead be prevalent. In the distal basins, with respect to the platforms, and above all in the Cadore valley basins, the mud-supported facies are prevalent; also present are carbonate and cherty microturbidites, thick layers of '*Pietra Verde*' also comprising turbiditic sandstones, microconglomerates and conglomerates with rounded volcanitic clasts.



Accretional lapilli from the Buchenstain Fm

Accretional lapilli from the Buchenstain Fm

c) The *Bänderkalke* principally comprise alternating calcisiltites and siliceous lutites, graded siliciclastic and carbonate microturbidites and green siliceous tufites. The carbonate turbidites seem to come from neritic environments due to the presence of ooliths, coated graines and bioclasts, while the siliciclastic ones mainly comprise acidic to intermediate volcanic clasts that, at least in part, are presumed to be of southern origin and linked to the erosion of emerged volcanic areas. The pyroclastic deposits are widespread with fall-out levels, tufites and volcanic turbidites mainly in the southeastern sectors. A general coarsening upward trend and an increase towards the upper parts of pure turbiditic facies characterize the *Bänderkalke*. This signifies that they were deposited during a regressive phase, a phase of shoreline progradation. Therefore the *Bänderkalke* represent a deep basin deposit linked to an increase of extra-basin sedimentary input, that is to say, to both an increase of exported sediment from the contemporary progradating platforms ('Dolomia dello Sciliar') and to an increase in the siliciclastic input caused by the progradation of the southern terrigenous shoreline. While deposits attributable to thin and distal turbiditic facies formed in the Cadore basin areas, the more protected areas were characterized by the sedimentation of hemipelagites intercalated with carbonate turbidites originating from nearby platforms.

During the Upper Ladinian a drop in sea level caused the emergence of a large part of the carbonate platforms and brought about an important erosive phase of the terrigenous shoreline that was probably situated to the south of the Dolomites. This event resulted in the deposition of siliciclastic sediments of the Zoppè Sandstone, mainly constituted of gray arkosic turbiditic sandstones, alternated with subordinated calcilutites, pelites and mainly dark marls. The arenaceous layers have a clear stratification, with plane-parallel bedding in the fine-grained facies, which are frequently erosive in the coarser facies. Channelized levels are recognizable in several places throughout the stratigraphic column. Flute casts are present together with load casts, clay chips and abundant vegetal frustules. From the composition point of view, the Zoppè Sandstone is characterized mainly by acidic and intermediate volcanic clasts and by a high content in basement lithoclasts (mainly phyllites and quartzites), and in muscovite and metamorphic quartz. This shows the existence of source areas where the dominant sedimentary covering was volcanic but also where the metamorphic basement was exposed to erosion.

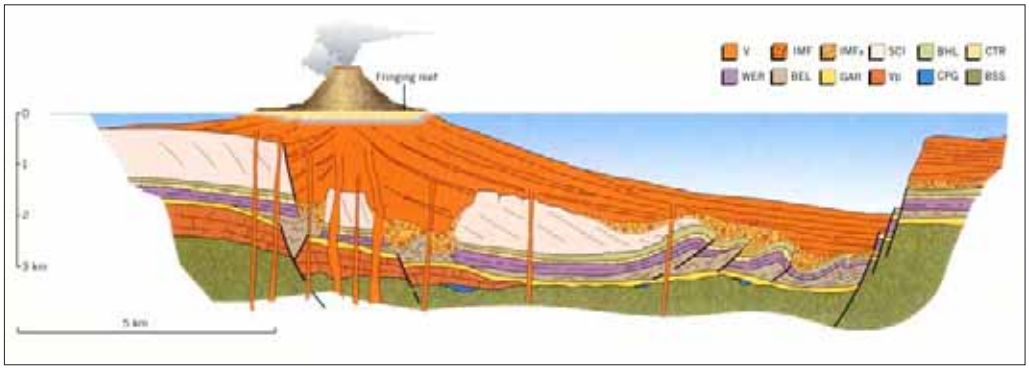
Gastropods from Marmolada Limestone

In the type-area, the lower part of the formation comprises massive sandstones in amalgamated stratas, paraconglomerates, and deposits linked to submarine debris-flows. In this interval one can also recognize phenomena of slumping (pebble mud-sandstone) that involve both part of the underlying Buchenstein Formation and of the lower part of the same Zoppè Sandstone. A complex that is characterized by fine turbidites with intercalations of graded sandstones and, towards the upper part, canalized facies follow this basal facies. Successively, and this is usually the thickest part with the widest distributional range, a coarsening upward-thickening upward complex of turbidites is found, sometimes coarse and canalized in the upper part (e.g. Mt. Corvo Alto). The Zoppè Sandstone was produced by progradation of a terriginous turbiditic lobe. Its facies are diverse in terms of both the distance from the source area of the material and of the position with respect to the progradation direction of the lobe, which gives the sandstone remarkable lateral variations of facies can be observed which are not always easy to interpret. For example, there are rapid changes between facies with negative coarsening-up/thickening-up (CU/TU) or canalized facies with hemipelagites or thin turbidites. These variations resulted from rapid sealevel changes in the progradation direction of the lobe, which causes hemipelagic and/or thin turbiditic facies of overbank to overlap canalized facies.

In some instances the vertical association of the sample area is not always maintained: the amalgamated massive sandstones in fact are typical of the areas near the depocenter and they are replaced by a complex of fine distal turbidites and of hemipelagites. The dominant input directions, defined on the basis of the study of paleocurrents (Viel, 1979), are mainly southern (SSE). The thicknesses in the basin depocenter measure around 500 meters with rapid decrease towards N and NE. In the Ansiei valley around 100 meters of distal turbidites and hemipelagites can be attributed to Zoppè Sandstone (Casati *et alii*, 1982). In the Val Fiorentina and in the Valle del Cordevole rock thickness diminishes rapidly, which seems to indicate the a tectonic threshold set to the east (assumed course: present-day Civetta – eastern border of the M. Cernera group Line), and that the carbonate platforms of the M. Civetta - Pale di S. Martino alignment formed a barrier for the southern terrigenous inputs. An important but scarce fauna characterizes this unit. Macrofossils recovered are mainly bivalves (*Posidonia wengensis* and *Daonella lommeli*). The limited findings of ammonoids such as the *Protrachiceras spp.* and *Meginoceras* sp. in the upper part, and the stratigraphic ratio allow the assignation of the depositional interval of the Zoppè Sandstone to the Gredleri-Longobardicum p.p. Subzones. The Zoppe Sandstones are followed with a clear demarcation by the Acquatona Formation. The lower part is characterized mainly by fine grained carbonate facies: siliceous calcisiltites, lutites, sometimes by cherty nodular limestones. Stratification is normally plane-parallel and laminar facies are frequent. Further facies present are in lower quantities and are light-colored sandstones, volcaniclastic levels, and channelized hyaloclastitic tufites. The latter are widespread, above all in the western zones, and are linked to the beginnings of basic volcanism (presence of clinopyroxene, calcium plagioclase and femic lithoclasts). The upper facies, on the contrary, is distinguished by a new increment in the siliciclastic component. Arkosic, turbiditic, and even coarse sandstones, dark gray arenaceous tufites, marls, pelites and subordinated dark gray siliceous calcisiltites intercalations are present. Paraconglomerates and coarse sandstones, also channelized, intercalated in layered hemipelagitic deposits can be seen in the area of Corvo Alto-Val Fiorentina. Locally (Valle dell'Ansiei) there are widespread carbonate turbidites of neritic origin, biocalcarenites and rudites may be linked to the resumption of exportation from carbonate platforms.

The Upper Ladinian Magmatic Event

Around 230 million years ago a wide area that currently forms a part of the Mediterranean basin was subjected to significant tectonic movements, the origins of which are not yet clear, caused the opening of cracks and fissures that were intruded by magma. Through these volcanic dikes a great quantity of magma was able to rise to the surface where it remained as volcanic basalt rocks. In some cases the lava emission took place through cracks of limited dimensions while in other cases it took on the form of true volcanic edifices that grew until they emerged above the water.

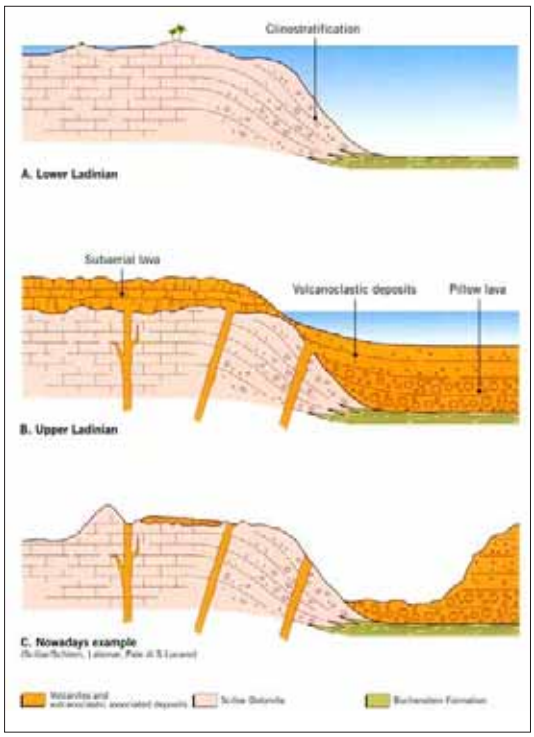


Hypothetical geologic cross-section of the Western Dolomites during Upper Ladinian. A volcanic edifice, comparable in size with actual Vesuvio, was emerging from the water in the Marmolada/Monzoni area and it was rimmed by a series of small reefs, the so called fringing reefs. On the bottom of the sea, covered by a large amount of lavas, hialoclastites and other submarine volcanic products, was laying, within the caldera collapsed, the pre-volcanic sedimentary succession, dismembered and contorted. BSS – metamorphic basement; CPG – Ponte Gardena Conglomerate; Vp – quartziferous porphyries; GAR – Val Gardena Sandstone; BEL – Bellerophon Fm.; WER – Werfen Fm.; CTR – Contrin Fm.; BHL – Buchenstein Fm.; SCI – Sciliar Dolomite; IMFa – M. Fernazza Fm, chaotic megabreccias and polygenic breccias; IMF – M. Fernazza Fm, hialoclastites; V – vulcanites in general. (Modified from Bosellini, 1996).

In present-day western Dolomites an ancient volcano was situated in the area of Predazzo (Mt. Mulat) and in Val S. Nicolò, a lateral valley to the left of Val di Fassa. These volcanic buildups are no longer visible today because they collapsed under their own weight (Predazzo) or they were broken down by erosion (Val S. Nicolò).

The unstable Mediterranean basin was caused due to telluric movements and covered by layers of lava or volcaniclastic sediments, as in Val Duron, Molignon, and Cernera, the carbonate platforms were affected by submarine landslides of enormous proportions, in the area of which these volcanic products mixed with the platform carbonates and went on to form gigantic accumulations of heterogeneous and heterometric materials (Brandner *et alii*, 1991; Yose, 1991).

In the meantime the massive loads of lava escaped from underground, rising through dikes that drew the magma from buried chambers (magmatic chambers). Alpine orogenesis and consequential erosion have brought these rocks to the light and allowed them to be observed. These rocks solidified slowly, at depth and because of this they are intrusive or plutonic. For this reason one can identify rocks that are granite in type (monzonite, syenite, tourmaliniferous granite, monzo-gabbro, gabbro) embedded in the sedimentary succession. The rocks in contact with the plutonic mass during the slow cooling were metamorphosed and formed a sort of 'aureole' that surrounds the two important volcanic constructions rich in peculiar minerals that make famous the Val di Fassa. This complex succession of events and of paleoenvironments is documented in the rocks of the Dolomites, particularly in the Fernazza Formation (synvolcanic phase) and in the powerful volcanic successions of the western Dolomites.



Geologic and morphologic evolution of the dolomitic groups of the Fassa Valley and surrounding valleys. A. The "reefs" laterally spread out on the nearby marine basins. B. Suddenly a volcanic event buried the "reef" with abundant lavas and volcanic products which fossilised the original morphologic profile of the reefs and their slopes. C. The recent quaternary erosion exhumed those old forms, today spectacularly visible in many parts of the region. (Modified from Bosellini, 1996).

Volcanic Dikes intruding the Sciliar Dolomite

In detail, the Fernazza Formation comprises mainly volcaniclastic sandstones (hyaloclastites *sensu strictu*, tufites) dark gray or black in color, generally massive; thinly stratified black pelitic intervals are present locally, in particular at the base of the formation. There are intercalations in the formation of one or more levels of 'chaotic accumulation' that correspond with the so-called 'Agglomerates Auct.', which were interpreted in the past as diatreme products (see Leonardi and Colleagues, 1967). There are bodies of extremely variable thicknesses, comprising, at the base, chaotic megabreccias with elements originating from the preceding sedimentary successions, sometimes represented by olistoliths of great size (more than 100 meters). Although most of the olistoliths seem to belong to the Buchenstein Formation, the Sciliar/Schlern or the Contrin, some blocks originate from an older stratigraphic unit such as the Werfen Formation. The matrix comprises volcaniclasts ranging from sandstone to microconglomerate size.

Pillow lavas at the Mahlknecht (Alpe di Siusi/Seiser Alm.

In the very thick bodies, the chaotic megabreccia/breccia, laid down by mass resedimentation mechanisms, without the intervention of selective processes, pass to more organized deposits comprising breccia/microconglomerates with direct gradation and signs of plane-parallel lamination. While it is not possible to distinguish more depositional episodes in the chaotic basal body, the upper part of the Chaotic seems to comprise a certain number of strong high density turbidites at high density, amalgamated with a volcaniclastic matrix and with clasts of variable dimensions, from pebbles to grains, of extremely heterogeneous composition. As already stated, the thickness of the chaotic accumulations is extremely variable on a regional scale, from many hundreds of meters in the Penia zone north of the Marmolada group, to the several dozens of meters that are found on average in the more eastern areas. The precise mechanism for sedimentation of these deposits is not yet well understood. Castel-

larin *et alii* (1977) advanced the hypothesis, then more or less followed in various successive works, according to which the chaotic megabreccias resulted from collapses along fault escarpments at the beginning of basic volcanism. The hypothesis is that the faults, distensive or transtensive in their natures determined the rapid subsidence of the area in which the volcanic products and the Chaotic's megabreccias had accumulated while providing a route upwards for the magma. The volcaniclastites are, moreover, frequently polluted with extra-basin terrigenous material, probably originating from higher zones situated to the south of the present-day Valsugana Line. In the Valle dell'Ansiei, in the area of the Sciliar/Schlern and the Sass da Putia/Peitlerkofel at the top of the formation, calcarenitic and oolithic-bioclastic intercalations with oolithic-bioclastic sediments can be observed, indicating the recovery of the carbonatic exportation from the productive carbonate platforms.

The end of the paroxystic volcanic phase and the breaking down of the volcanic constructions

As volcanism attenuated the volcanic reliefs began breaking down. Coarse deposits accumulated in the areas closest to the eruptive centres such as the Fiemme and Fassa valleys located on limited river plains, beaches and basin slopes (Marmolada Conglomerate), which were also replaced but by farther-traveling finer materials such as sandstones and clays (Wengen Formation). The paleogeography following the volcanic event was profoundly changed. Many of the basins that separated the numerous atolls are now completely full of volcanic and volcaniclastic material. Large quantities of dark rocks buried the slopes and platforms tops, and were fossilizing and preserving them. Subsidence differed from one area to the next, opening up new basins for for colonization by the bioconstructors. This complex and variegated scenario was excellently preserved allowing for precise reconstructions of the environment. During the Ladinian to Carnian transition (230 million years ago) sea level fell by tens of meters exposing reefs and large volcanic features. The carbonate buildups of the Latemar, Civetta and Pale di S. Martino Group, registered this period of emergence with paleokarstic surface. This was a regional phenomenon, and is also found also in Val d'Adige/Etschtal and in Dolomiti di Brenta where reddish breccias bodies cut the Val d'Adige/ Etschtal Dolomite and the Esino Formation. Here the sealevel fall and exposure of the erosion surface is indicated by the presence of large blocks of rock collapsed along the platforms' slopes.

The Upper Ladinian-Carnian basinal succession. Notice the gradual transition between the volcanoclastic Wengen Fm

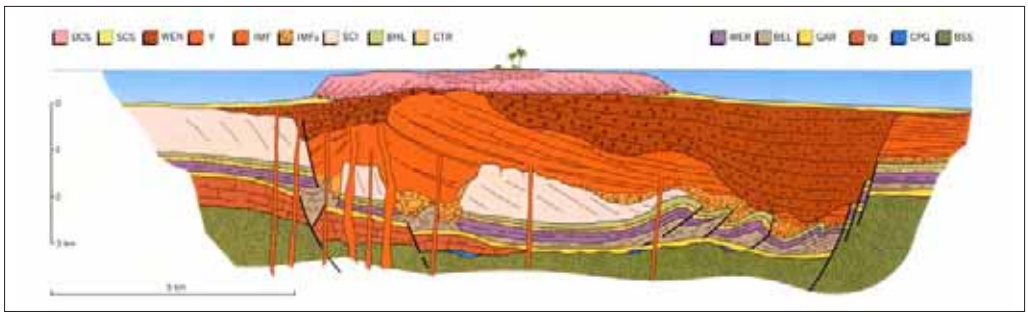
(below,darker) and the more carbonatic S. Cassiano Fm. In the background the cliffs of Cassian Dolomite platform

Volcanites and volcanoclastic deposits overlapping the Anisian slope of Mt. Cernera carbonate platform.

Volcanites and volcanoclastic deposits overlapping the northern flank of the Mt. Sciliar/Sclhern carbonate platform.

As previously mentioned, it appears obvious that the Wengen Formation presents a strong heterogeneity of lithofacies, both in terms of lateral variation and of vertical evolution. The typical lithofacies associations of the Wengen lithofacies are dominated by alternating black pelites and fine to coarse sandstones that is also dark due its richness of grains of basic volcanic origin (lithic of basaltic composition, femic minerals). The sandstones form strata from centimeters to many centimeters thick, with a tabular to lenticular geometry, frequently with erosive bases and depositional structures such as direct gradation, plane-parallel lamination and current-ripples. Pelitic intraclasts can be present in the lower-middle part of the strata. The whole of these elements indicates a deposition by gravity in a basin context, through turbiditic re-sedimentation. Deposits deformed by slumps and debrites with a breccia texture are also visible. A pattern characterized by a cyclic organization of coarsening-up/thickening–up facies, some meters thick, is also often present, which reflects the progradation of turbiditic cones. Locally, the lower part of the Formation comprises conglomerates and/or paraconglomerates of quite rounded volcanic clasts of variable diameter from 1 cm to 20-30 cm (exceptionally they can reach greater dimensions): these are the already mentioned Marmolada Conglomerate sometimes thicker than 600 meters. Towards the top there is a general decrease in average grain size, however the passage to the overlying San Cassiano Formation, usually is not transitional, and is evidenced by a progressive reduction of terrigenous input and by an increase of the carbonate one. More frequently, the upper levels of the Formation show an increase in rubble, both volcanic-detritic and extra-basin terrigenous rubbles. Therefore the top of the unit can be marked by one or more bodies several meters thick comprising mainly coarse sandstones/microconglomerates, which in their turn are covered by gray marls and pelites with minor calcareous intercalations, micritic in type, referable to the base of the S. Cassiano Formation. With regard to fossiliferous content the Wengen Formation is famous for its invertebrate fauna and plant fossils and has returned abundant ammonoid fauna from the Regoledanus Subzone *(Protrachyceras archelaus, P. neumayri, Frankites regoledanus, Celtites epolensis)*.

The recovery of carbonate sedimentation: The Cassian Dolomite and the S. Cassiano Formation
Once the volcanic activity ended in the Dolomites area the calm stretch of tropical sea resumed, and organisms proliferated in a new generation of reefs and carbonate platforms, depositing upper Ladinian/Carnian age sediments (Cassian Dolomite). Unlike reefs formation in preceding ages Cassian reefs tended to develop horizontally (= progradation) rather than vertically (= aggradation), the result of decreased seafloor subsidence rates, although in northern areas the subsidence forces may have been equal to aggradation of the Anisian – Ladinian time (Picco di Vallandro/Dürrenstein).



Geologic cross-section at the Ladinian-Carnian boundary. After the dismantling of the Marmolada/Monzoni volcanic edifice and the partial levelling down of the submarine morphology done by the Marmolada Conglomerate and by the Wengen Fm, on the highest points coral communities started up again. New carbonate platforms developed (Cassian Dolomite), this time prograding on shallower basins. WEN – Wengen Fm and Marmolada Conglomerate; SCS – S. Cassian Fm; DCS – Cassian Dolomite. (Modified from Bosellini, 1996).

Sedimentation continued bed after bed in the basins that separated these reefs, originating from the erosion of vulcanites and from the precipitation of carbonates exported from the platforms (S. Cassiano Formation). This formation, world famous for its fossiliferous content, was originally named *Cassianer Schichten* by Münster (1834), from which the name San Cassiano Beds derives, used in Italian geologic literature and geologic cartography. The San Cassiano Formation is very well represented within core and buffer areas; some areas, such as Prati di Stuores, the area of Sett Sass, the surroundings of Cortina d'Ampezzo, the area of Picco di Vallandro/Dürrenstein, the Forcella Giau (to quote just a few), are famous for the noteworthy fauna fossils, known by the scientific community thanks to numerous paleontologic writings produced from the second half of the 1900s mainly by German speaking researchers, as well as the patient work of R. Zardini in more recent times.

Panoramic view of Giau Pass. Notice the contrast between the green fields grown on basinal and fine sediments (WEN-SCS) and the high and rocky cliffs of La Gusella (Cassian Dolomite).

The San Cassiano Formation comprises a complex of alternating pelites, marls, pure to marly micrites, oolithic calcarenites, bioclastic and oncolithic calcarenites and calcirudites. Carbonate lithotypes are mixed in various proportions with sandstones of volcano-detritic origin and produced by the erosion of the crystalline basement, probably exposed in the emerged areas situated to the south of the current Valsugana Line. Hybrid arenites are extremely frequent, with a mixed carbonate-terrigenous composition, which would imply a mixing of the two components in shallow water before resedimentation in the basin. The dominant are light gray and yellowish in color. The arenite strata present thicknesses between centimeters and decimeters, while the fine parts are present both in sets from dozens of centimeters to meters and as thin interbedding between the arenite layers. The depositional structures exhibited by the arenites (erosional base, direct gradation, plane-parallel lamination, current ripples, flute-casts, absence of evident wave structures) are indicative of turbiditic transport with episodes of debris-flow and slumping. The San Cassiano Formation is, at least in the mid to upper parts, dominated by the carbonate component originating from the prograding platforms, even when the siliciclastic import does not decrease. Near the platform areas, the Formation is clearly organized in cycles of coarsening-up/thickening-up (CU/TU) facies of various thicknesses from a few meters to a little over 10 meters (Masetti *et alii*, 1991), that is lost in the more central basin areas. The more proximal CU/TU cycles end with carbonate olistolith swarms deriving from the external margin of the platforms ('Cipit Limestone' Auct.). In the eastern sector (far from the contemporary carbonate platforms) and in the southern sector (closer to the siliciclastic coastline), the terrigenous fraction can dominate the carbonatic one. The S. Cassiano Formation is indicated to be Upper Longobardian, and to most lower Carnian Stages (Julian according to Krystyn, 1978) on the

basis of a rich ammonoid fauna (Urlichs, 1974, 1994; Bizzarini *et alii*, 1986; 1989; Bizzarini & Braga, 1987; De Zanche & Gianolla, 1995; Mietto & Manfrin, 1995a,b). The unit, as has been stated, contains also a great quantity of benthic fossils (bivalves, gastropods, echinoderms), for the greater part rearranged from nearby Cassian platforms together with a great variety of metazoan builders remains (corals, stromatoporids, sphinctozoans) and, to a lesser extent, representative of the autochthonous basin communities.

Settsass and Piccolo SettSass (Richtofen Reef)

View of a spectacularly well preserved relationship between the slope downlapping on the correlated basin sediments at LaVarella-Cunturines.

This complex basin unit compares with a series of bioconstructed reef bodies that document the final phases of the filling of the Dolomitic basins and the flattening of the submarine topography.
These bodies are known by the term 'Cassian Dolomite' (*Cassianer Dolomit*, Mojsisovics, 1879) that identifies the carbonate platforms occurred after the basic volcanism and heteropic with the S. Cassiano Formation. In the Dolomite area these carbonate bodies display two distinct phases of growth (Cassian Dolomite 1 and 2), separated by an important phase of non-production, erosion from immersion at the top, and basin sediment onlap on the slopes.

Cipit boulders aligned into the basinal sediments of the S.Cassiano Fm. Picco di Vallandro-Dürrenstain

Although the Cassian platforms were subjected to intense dolomitization that almost completely wiped out the original sedimentary textures and structures, it is nevertheless possible to recognize some depositional geometry and some main sub-environments. Furthermore, analysis of the oolithic-bioclastic turbidites that comprise a quantitatively significant component of the basin deposits of the San Cassiano Formation, as well as the platform olistoliths embedded in the basin pelitic deposits provide important data on the nature of the platform margins.
In the Dolomite area one can differentiate two principal facies associations, respectively corresponding to the slope environment, and the inner platform environment.
The slope facies comprise clinostratified, grain-supported deposits, with grains varying from those of megabreccia to those of arenite. The angle formed by the clinoforms and the basin deposits coincides with the angle of rest of the materials that form the detritic talus (Kenter, 1990) and can reach 30-35°. At the base of the slope there is usually a reduction of gradient and a sort of tangential link between the clinoforms and the basin deposits. The blocks that comprise the slope breccias/megabreccias are composed principally of microbialitic boundstones, rather rich in early marine cements, coming from the platform margins and/or from the upper slopes. The sedimentation of these deposits is linked to mass gravitational movements (Bosellini, 1984; Masetti *et alii*, 1991).
The platform margin is limited in lateral extension. The intense dolomitization has usually ob literated depositional textures and structures and it is only occasionally recognizable (Keim & Schlager,

1999; 2001). On the basis of materials carried into the basin, which include, besides 'Cipit', oolithic-bioclastic turbidites, one can hypothesize that the platform margin comprised a complex mesh of bioconstructed areas, substantially dominated by microbialitic automicrites affected by early cementation, and areas in which calcarenite shoals developed.

Detail of a Cipit boulder

Corals and Sponges from Cipit Boulders

The inner platform facies are mainly characterized by plane-parallel stratification, and it is possible to distinguish an association of essentially subtidal facies comprising fine grain carbonates (dolomites), of a fossiliferous nature (with large gastropods, internal patterns of bivalves, heads of colonial corals both in living position and knocked down), that alternate with facies of subaerial exposure, dominated by teepees on a metric scale, associated with pisolites and stromatolites layers. With regard to the fossil content it is important to remember that often the peritidal deposits of the inner lagoons of the Cassian Dolomite in the southern sectors, where the platforms were probably joined to a continental dry land, are rich in footprints of tetrapods and small dinosaurs (Avanzini *et alii*, 2000) so documenting the vicinity to a continental dry land.

The distinction between Cassian Dolomite 1 and 2 is possible with certainty only where the two platform tongues are separated by wedges of basin deposits (San Cassiano Formation), as in the case of the eastern side of the Lagazuoi platform, of the Picco di Vallandro/Dürrenstein, of Cadini di Misurina and, in a spectacular way, in the area of the Settsass, where the geometrical relationships between the Cassian reefs and the basin sediments were splendidly illustrated by von Richthofen (1860). With regard to age, the dating of Cassian Dolomite 1 and 2 is indirect and is achieved through the calibration of basin deposits on which the platforms prograded or by with which the platforms are covered.

The Carnian crisis of the rimmed carbonate platforms

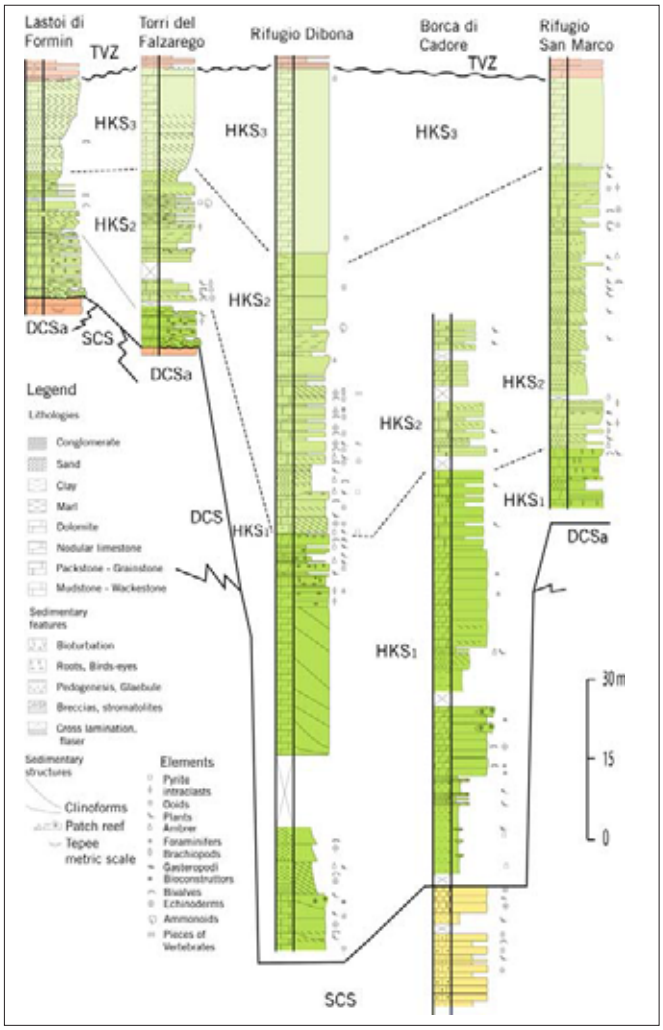
Near the end of the Julian the South Alpine area a generalized filling phase of the remaining Carnian basins occurred. This regressive phase is characterized by a climbing progradation of the Cassian platforms and by a significant diminution of the clinoform angle. This was counterbalanced by a decrease in the subsidence, which in the southern sectors led to a strong advancement of the terrigenous and carbonate coastline (Picotti & Prosser, 1987; Gianolla *et alii*, 1998a). The complete closure, the flattening of the paleotopography and the movement of the shoreline dozens and dozens of kilometers more to the NE occurred with the Heiligkreuz Formation.

The name Heiligkreuz Formation derives from the German *Heiligkreuz Schichten* that was introduced by Wissman in Wissman & Munster (1841), but better characterized by Koken (1911) who described in detail the stratigraphic position and the fauna finds. This term, after being abandoned and not used for some time, was taken up again by Bosellini *et alii* (1965) and renamed Santa Croce Beds. The Heiligkreuz Formation, was named to the definition of Keim *et alii* (2001), which corresponds to the Dürrenstein p.p. Formation by Pisa *et alii* (1980), includes the Dibona Arenites *sensu* Bosellini *et alii* (1982; 1996a) and Neri & Stefani (1998) and corresponds to the Dürrenstein Formation *sensu* De Zanche *et alii* (1993) and successive works (Gianolla *et alii* 1998a,b; Preto & Hinnov, 2001). The formation is further subdivided into members that document the different filling

phases of the remaining Cassian basins, and records an important crisis in the exportation of carbonates by the rimmed reefs. The so-called Borca member documents the first phase of filling of the basins. It comprises dolomitic limestones, arenaceous dolomites and well-stratified hybrid arenites with frequent pelitic breaks.

Ambers from Heiligkreuz Fm

Sometimes one can recognize a large-scale crossed stratification and, at the base, dark, sometimes coarse sandstones with frequent plant remains intercalated with calcarenites and sometimes boundstones with sponges, stromatoporids and colonial corals. At the top there is an interval of several meters of light-gray or whitish dolomites, well-stratified, with gray or green marly breaks of some centimeters in the upper part, organized in peritidal cycles with stromatolitic horizons on which tetrapod footprints can be seen. The thicker lower part is distinguished by subtidal, bioturbated and fossiliferous facies (bivalves including *Trigonodus* and *Physocardia*, nautiloids, gastropods, colonial corals) sometimes of high energy (structures: parallel lamines and crossed stratification). It overlies both on the S. Cassiano Formation and on the Cassian platforms (in the second case the member is generally represented by a small thickness of peritidal deposits). This member is followed by the Dibona Sandstones, characterized by polygenic conglomerates, dark, crossed-laminated sandstones, hazel, gray or blackish pelites, with frequent limestone intercalations (from micritic to ruditic), progressively more frequent towards the north and east. The vegetable remains are significant, sometimes represented by centimeter-thick levels of carbon or structured plant remains. Sea-marginal benthic fauna (*Lopha montcaprilis, Physocardia ogilviae, Cornucardia hoernigi, Costatoria vestita, etc*) abounds. One must not forget that some of the oldest amber in the world has been found in this stratigraphic interval, both in paleosoils and in arenites, (Gianolla *et alii*, 1998c). This member is characterized by a strong deepening upward tendency, marked by the upwards diminution of terrigenous sediment and by the presence of hemipelagic deposits, sometimes rich in ammonoids (*Shastites sp.*). Finally, this formation was closed by the rapid progradation of oolithic shoals or by the shuffling of sandy, terrigenous-carbonatic bodies that went on to completely suture every depression and, as has already been stated, caused the paleotopography of the area to be homogenized.



Stratigraphical correlations among some Heiligkreuz Fm sections, showing the important lateral variation of this formation. HKS-Heiligkreuz Fm; DCS-Cassian Dolomite; SCS-San Cassiano Fm; TVZ-Travenanzes Fm. (Mod. from Preto & Hinnov, 2003 and Stefani et alii, 2004).

Upper Triassic carbonate platform: a regional peritidal succession

The deposits of the Upper Carnian and of the Norian are indicative of a significant reorganization of the paleogeography of the future Alpine area (Bosellini, 1973). While the Anisian-Carnian break is characterized, in the area of the Dolomites, by an extreme environmental variability, even at short range, probably controlled by synsedimentary tectonic activity, with the Upper Carnian/ Norian a paleogeographic pattern characterized by slow and gradual lateral variations is established. At the time of the deposition of the Dolomia Principale, the entire South Alpine realm was incorporated into a peritidal depositional system, with wide lagoons and tidal plains that extended for hundreds of kilometers both in a north-south and in an east-west direction. The dry lands were localized to the south and to the southwest (e.g. the German Trias of Sardinia). The platform margin and the passage to the open sea are documented in the Tarvisio area (Gianolla *et alii*, 2002) and in Dachstein Kalk of the upper Austro-Alpine slabs. However, notwithstanding this contest characterized by a large-scale homogeneity of the environments, one can recognize and distinguish more lithostratigraphic units. With the definitive filling of the ancient marine basins, the region again became a vast coastal plain. On this plain took place the slow deposition of carbonate sediments mixed with deposits of conti-

nental origin that gave origin to the so-called Travenanzes Formation (Raibl Formation Auctorum). This characteristic unit comprises alternating beds of dolomites, limestones, marls and vary colors clays and its more easy affected by weathering processes in contrasts with the compactness that is instead typical of the dolomites/carbonate rocks among which it is normally embedded. It is from these sediments, for example, that the ledge at the base of the Tofane, of the Tre Cime di Lavaredo/ Drei Zinnen and those that open up in many Dolomites walls, are constructed. The Travenanzes Formation comprises mainly pelites and marls of various colors (green, red, violet, gray) alternating with aphanitic pale dolomites. The subordinated lithotypes are formed of thin levels of green and gray sandstones and of reddish conglomerates, with clasts deriving mainly from a crystalline basement (metamorphic quartz, etc.), generally concentrated in the lower part of the formation.

Travenanzes Valley:the multicoloured clayey deposits of Travenanzes Fm

There are evaporative breaks present locally with laminated gypsum alternating with dolomites and pelites. Generally speaking, however, coarse terrigenous lithotypes (conglomerates and sandstones) characterize the lower part of the formation and are quantitatively more important in the southern sector of the Dolomites, where they can present clear clues to deposition in a continental context. In the area of Passo Duran - Cime di San Sebastiano there are clearly recognizable sequences of meander bars, while in the neighborhood of Perarolo and in the Marmarole one can see arenaceous conglomerate bodies, clinostratified, interpretable as shallow-water deltas. This lower break is followed by the classic succession with variegated pelites and/or marls, prevalently red or green, alternating with aphanitic sterile dolomites in strata of centimeters or decimeters, with plane-parallel to wavy joints, and minor intercalations of gray and green sandstones in beds of centimeters/decimeters. Towards the upper part, decimetric bioturbated layers, sometimes fossiliferous (with *Megalodon* ssp. and other bivalves) alternate in the carbonates (dolomites) with stromatolithic layers, according to a depositional style that is a prelude of the peritidal cyclicity of the overlying Dolomia Principale. As has been stated, moreover, in the mid-high part of the formation, there can be intercalated levels of nodular and/or laminated sulfated evaporites, alternating with dolomites and pelites. These lithofacies, indicative of an arid climate, are representative of coastal sabkha and restricted lagoon environments. The above-described vertical succession is purely indicative, because the Travenanzes Formation is

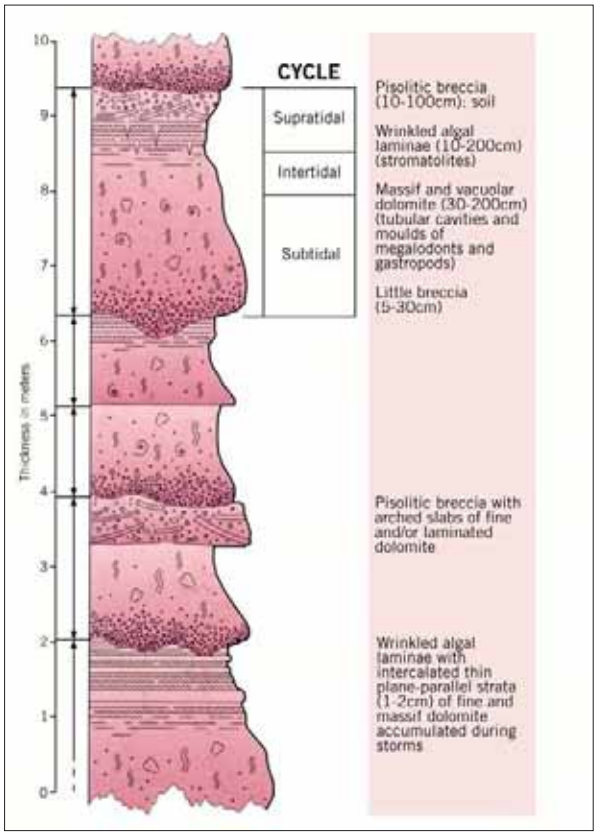
characterized by frequent lateral facies variations, probably attributable to a distensive synsedimentary tectonics, for which evidence exists in the outcrops in the form of small grabens or normal faults sutured by deposits belonging to the same formation. Furthermore, towards the east, the unit seems to be heterotopic to the Monticello Formation, that comprises alternating aphanitic dolomites and varicolored pelites. Towards the top, the Travenanzes Formation transitionally passes to the facies of the Dolomia Principale. The so-called 'Dolomia Principale' (*Dachsteinkalk und Dolomit* by Hauer, 1853; *Hauptdolomit* by Gümbel, 1857) comprises an extensive and thick platform, which is present in the greater part of the Southern Alps (and further: e.g. northern Dinaric Alps), characterized by a great lateral homogeneity of facies (mainly peritidal). In the Dolomites area s.s., the Dolomia Principale is one of the more characteristic rock formations outcropping extensively in the whole region and constituting the backbone of many of the more important mountain groups.

Sfornoi, M.del Sole group:Dolomia Principale

Notwithstanding the homogeneity of the environments, the large-scale variability is ascribable to the significant thickness variations, with maximum values to the north and east (e.g. from 800-1,000 meters in the Tofane and Altopiani Ampezzani to the 2,000 meters and so of the future Belluno basin), that reduce to a few hundred meters to the southwest (around 400 meters at Monte Pelmo or even just over 200 meters in the Gruppo di Sella/Sellagruppe) and west of Val d'Adige/Etschtal. These differences suggest a rather articulated subsidence pattern.

The formation prevalently comprises well-stratified light-colored dolomites, from gray to whitish; stratification layers of tens of meters alternate cyclically. These are bioturbated, sometimes fossilized, with bivalves (*Neomegalodon* ssp.) and gastropods (*Worthenia* sp.) and stromatolitic levels, generally in thinner layers, that can provide evidence of more or less prolonged subaerial exposure in the form of mud cracks and small *teepees*. Bosellini's classic interpretation (1967), which refers to the then very recent definition of loferitic cyclothems by Fischer (1964), is that these are peritidal cycles in which

bioturbated and fossiliferous layers represent subtidal lagoon deposits, while the stromatolitic levels represent the real tidal flat deposits, and in particular, of the tidal flat ranging from the intertidal to supratidal. The fossil associations of the Dolomia Principale are mainly represented by bivalves (Megalodontides) and gastropods of little stratigraphic value. Age calibration is thus necessarily approximate. Based on vertical distribution of the benthic fauna (and in particular, of the Megalodontides), the formation has traditionally been attributed to the Norian, with possible 'intrusion' into the Rhaetian. The base of the Dolomia Principale could be ascribed to the Upper Carnian.



The Dolomia Principale is made by a cyclic succession of subtidal (massif strata with megalodonths) and inter-supratidal dolomites (stromatolitic and pisoliths rich strata with various associated structures). Stratigraphic log with detail description of a piece of Dolomia Principale outcropping in the Canale d'Agordo. (Modified from Bosellini, 1996).

It is important to evidence that the continental tetrapods fauna have been discovered in some of the nominated properties (Pelmetto, Tre Cime di Lavaredo/Drei Zinnen, Mt. Caserine, Val Cimoliana etc.) of footprints, often organized in paths, of ornithischian, saurischian and theropod dinosaurs impressed in the supratidal horizons of the Dolomia Principale (Mietto, 1984; Avanzini *et alii*, 2001 Dalla Vecchia & Mietto, 1998).

This immense tidal flat characterized the Dolomites landscape for a remarkable interval of time between the Upper Carnian and the Rhaetian, but already in the Norian an important tectonic phase linked to the incipient opening of the Atlantic Ocean started to make its effects felt with the formation of greatly subsiding areas bordered by faults. These faults, that are responsible for the variability of thicknesses (from 100 to 2,000 meters), brought about the development of small, deeper basins. A very well-preserved example of these intraplatform basins, sometimes anoxic (Forni Dolomite) is present in the area of Mount Pramaggiore (Cozzi, 1999), where the different lithofacies of the carbonate platform can be reconstructed in great detail. Beyond these close intraplatform basins

controlled by extensional faults, sometimes perfectly preserved, in the final stage of the Triassic two rapidly sinking areas formed, to the east and west of present-day western Dolomites. In these areas (western Trentino to the west and Schiara/Talvena - Dolomiti d'oltre Piave-Dolomiti Friulane towards the east) they successively went on to form the Lombardy Basin and the Belluno Basin respectively (Winterer & Bosellini, 1981). At the end of the Norian, the extensional tectonics underwent an acceleration that led, during the Rhaetian, to a significant regression of the carbonate platform and to a deepening of the basins. Towards the west (Dolomiti di Brenta) the greater subsidence during the Rhaetian stage led to the deposition of strong calcareous shale sediments (Riva di Solto Shale, Zorzino Limestone), followed by marly calcareous successions (Zu Limestone). The climate here was generally more humid and fine terrigenous deposits can be observed. In the western Dolomites, the sediments from the Rhaetian period (through the presence of *Triasina hankteni* and *Aulotortus* sp.) continued instead to be typical of a shallow-water plain (Dachstein Limestone), characterized by a mainly subtidal platform sedimentation. Characteristic of this stratigraphic interval are the calcareous (from wackestone to packstone) banks with bivalves, among which are large Megalodontids and *Dicerocardium* with dimensions even greater than 15 centimeters, and the small coral patch-reefs (*Thecosmilia* sp.) (Casati *et alii*, 1981), characterize this period.

Megalodon and Stromatolites of the Dolomia Principale

The Calcari Grigi and the definition of an early-drowning carbonate platform

Towards the end of the Triassic, the paleogeographic scenario of the Dolomite area and of the entire southern Alpine region changed in a radical way. The phase of differential subsidence and the establishment of a distensive regime ascribable to the formation of the passive margin are characterized by paleogeographic and paleostructural elements that are elongated in a north-south direction, and are known in literature as Lumbardy Basin, Trentino Platfomr, Belluno Basin and Friuli Platform (Bosellini, 1973).

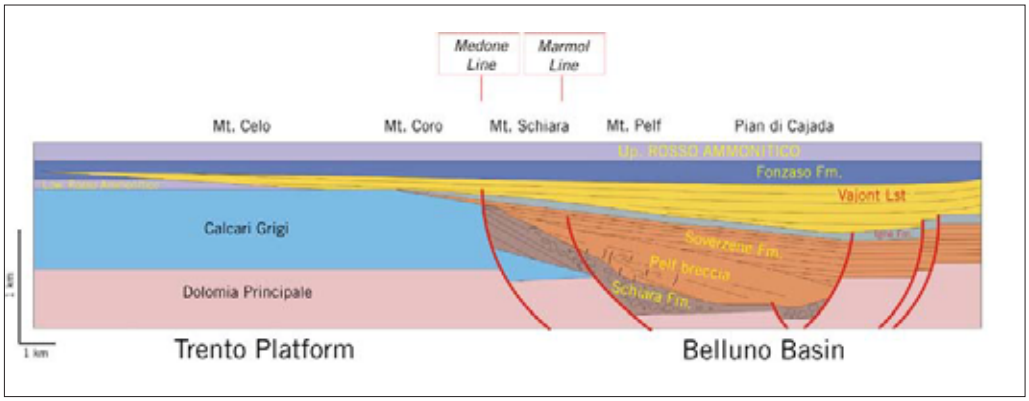
Croda del Becco. Well stratified limestones (Calcari Grigi group)

The sediments that characterize this great carbonate platform comprise the Calcari Grigi Group, within which it is possible to identify more units (Mt Zugna Formation, Loppio Oolitic Limestone, Rotzo Formation and Massone Oolitic Limestone).

In the Dolomite area the Calcari Grigi Group comprises a strong succession of dark gray to light gray or hazel micritic limestones with abundant *fenestrae*, oolith pockets, mollusks and echinoderms bioclasts, and rare benthic foraminifers. The layers, sometimes amalgamated, present parallel joints sometimes slightly wavy, and have a thickness of 30-50 centimeters. Intercalated to these are sometimes strata of 15-25 centimeters of marly carbonate laminites, whitish in color, that flake in millimeter sheets and which can give origin to teepee structures. Fragments of these laminites can be found at the base of the strata within the intraformational small breccias. There are also intercalations of centimetric horizons of gray-greenish pelites.

Towards the top the succession is less monotonous due to the greater alternation of lithotypes. The strata, 20-40 centimeters, present flat and parallel joints and sometimes are amalgamated in blocks of metric thickness. These are micritic, bioclastic and pellettiferous-oolithic limestones, with a color ranging from gray to hazel and even white. In thin sections one can recognize: dark gray mudstones, containing rare grains among which small peloids, sponge spicules and indeterminable agglutinate foraminifers can be identified. There are also dissolution cavities full of spathic calcite and geopetal cavities. The micritic matrix is locally recrystallized. Also present are fossiliferous and pellettiferous

packstone-wackestones in which the identifiable grains correspond to pellets, oolites, coated grains, micritic intraclasts, minute quartz grains, fragments of bivalves, gastropods and echinoderms, porcellanaceous and agglutinate foraminifers, Dasycladaceae algae and sponge spicules, as well as oolithic-pisolitic grainstones, where the total absence of a matrix leads to the assumption that these are well-swashed deposits. The ooliths have concentric radial structure and the nucleus comprises small foraminifers, gastropod protoconchs, *Globochaete* and even bivalve fragments in the pisolites. Intercalated with the described lithotypes are horizons with lumachella and red-greenish pelites horizons. At the level of the outcrop in the oolithic-pisolitic grainstones one can identify low-angle crossed laminations.



Scheme of the stratigraphical relationships between the units characterizing the Trento Platform and the relative successions of the Belluno Basin.

This large carbonate platform displays a very complex evolution that is controlled in a large part by the synsedimentary tectonics and generally records progressive phases of drowning. For example, while in the area to the south of the Valsugana Line and towards the Dolomiti di Brenta the platform was still productive and Rotzo Formation or the Massone Oolithic Limestone deposited, in the western Dolomites deposits were characterized by encrinites. These sediments take the name of Encrinite di Fanes Piccola and their deposits are interpreted as encrinitic sandwaves migration caused by the action of sea currents in a sinking open plateau (Masetti & Bottoni, 1978).

The Trento Platform and the Calcari Grigi thus started to diversify and to record steadily deeper environments, more and more proximate to the open sea. While towards the west (Dolomiti di Brenta) whitish or hazel carbonate muds accumulated (Corna Formation and Tofino Formation), towards the inner platform, the tidal flats transformed into vast marshes and lagoons in which enormous bivalves (Lithiotis) proliferated.

As the lacerating movements of the Pangea intensified, the most internal Trento Platform also started to sink. In the most external zones, near to the Lumbardy Basin, yellowish muds accumulated (Tenno Formation) while further towards the interior the Calcari Grigi unit was covered by great masses of ooliths (small spherules of calcium carbonate caused to roll by the force of the waves) and by crinoid fragments that gave origin to the San Vigilio Oolite formation (western border of the ancient Trento Platform).

In the Belluno Basin, on the contrary, a thick succession of sediments accumulated that records, in great detail, the regression phase of the platform. The Soverzene Formation (Hettangian – Pliensbachian sup.) is, in fact, characterized by dolomites and locally by gray, bituminous micrites, sometimes chert-containing, organized in thin beds, and that frequently pass (Schiara Dolostone)

to chaotic accumulation of breccias with sharp-edged chert clasts wrapped in a dolomites matrix. These breccias represent chaotic bodies of slope and marginal materials that have collapsed into the basin following an intense extensional tectonics. The area of the Schiara/Talvena system documents in an exceptional way this part of the Trento Platform margin towards the Belluno Basin and enables the step-by-step analysis of the evolution of this part of Southern Alps during the paroxystic rifting phases. The successive drowning phases with the final collapse of the eastern margin of the Trento Platform, that sank rapidly, evolving into a high pelagic bottom, are documented by the Igne Formation, which buried the paleoslopes and covered the lowered platform blocks.

Southern cliff of MtSchiara with the famous Gusela del Vescovà in the centre. The higher part of the mountain is made of breccias dipping eastward, overlaying the horizontal strata of the Calcari Grigi Group.

Rosso Ammonitico and the drowning of the platform

Little by little the sea took over, also thanks to a spectacular sinking that in the course of a few dozens of millions of years took the seabed to more than 1,000 meters from the water surface. The Trento Platform was completely submerged and transformed into a high pelagic plateau. A very fine sediment was deposited at the bottom of this abyss at a quite reduced rate: less than one millimeter every one thousand years. These sediments are known as Rosso Ammonitico. This formation lays on the Calcari Grigi Gp. or on the Fanes Piccola Encrinite, through the interposition of a hard ground, and can be usually subdivided into two members: The Lower Rosso Ammonitico and the Upper Rosso Ammonitico, are divided by an hardground surface (Clari *et alii*, 1983). The basal hard ground, around 25-30 cm thick, comprises bright red limestones with ferrous-manganesiferous nodules and fossil concentrations (ammonite fragments, usually corroded, belemnite rostrums and crinoid articles). Inside can be seen stromatolitic domes impregnated with oxides, cut by erosive surfaces and microperforated, and identifiable as deep microbialites (Winterer & Bosellini, 1981). The Lower Rosso Ammonitico comprises pink to red nodular limestones rich in pelagic lamellibranchs ('*Posidonia alpina*' Auct.) and protoglobigenirids, in thin strata with marly interbeddings at the base, in meter sized packs amalgamated toward the top. Those are packstone-grainstones in which the pelagic bivalves are associated with peloids, intraclasts, echinoderm fragments and large bivalves, foraminifers, rare radiolarian and *Globochaete alpina*. In many cases an intense bi oturbation is evident, but occasionally a primary iso-orientation of the elongated grains can be recognized. Ammonites and belemnites characterize the macrofauna.

Ammonitico Rosso

The Upper Rosso Ammonitico is separated from the underlying unit by a hard ground, less evident and thinner than the basal one (5-10 cm), distinguished by the presence of small ferrous- manganesiferous nodules. Alternatively, on a local level, in the more southern areas, the separation between the two members is ascribable to an interval of a few decimeters to several meters of thickly stratified red marls (Fonzaso Formation). The Upper Rosso Ammonitico comprises at its base pink micritic limestones with radiolarians and ammonites, intercalated with dark red encrinitic limestones. These are wackestones and subordinated packstones with *Saccocoma sp.* and fragments of other echinoderms, *Globochaete alpina*, peloids, radiolarians, aptichs, sections of small ammonites, foraminifers, pelagic bivalves and rare lithoclasts, often limonitized. There are also stromatolitic domes and one can observe weak, oblique, low-angle laminations evidenced by the alternating packstones and wackestones. The stratigraphically higher lithotypes comprise tintinnid wackestones or wackestone-packstones (among which, *Calpionella alpina*, indicative of Titonian), with associated radiolarians, foraminifers, echinoderm remains, aptichs, rare mica blades indicate the passage to the facies typical of Biancone or Maiolica. The drowning of the Trento Platform caused the whole Dolomites area from the Jurassic to the whole Neogene to become a deep hemipelagic basin. Only the

Ammonitico Rosso

eastern areas of the Friuli Platform still continued to remain in a photic zone and thus maintain the status of a productive carbonate platform throughout the Cretaceous. Resedimented deposits from this platform such as the Vajont Limestone are present in the Belluno Basin and cover large parts of the drowned platform.

The emipelagic deposits of Biancone and Scaglia Rossa

With the end of the Jurassic and the beginning of the Cretaceous, around 150 million years ago, the entire Dolomites area was affected by the deposition of calcareous mud of planktonic origin, typically whitish in color (Biancone Formation). During the Cretaceous, while the western Dolomite areas were still in deep seas, further north, the collision between Africa and Europe caused rocky islands to emerge in the area corresponding to the present-day Switzerland and Austria. From this emerged land, subjected to the erosive action of weathering processes, great quantities of argillaceous sediments invaded the "dolomitic" water and were deposited on the seafloor.

At those times, in the area of Giudicarie Valley a real tectonic threshold was active (the Giudicarie Paleoline), that prevented propagation of these sediments southwards. With the passing of time the effects of the Alpine compression felt more violent. Along the Giudicarie belt a series of folds rose up with a NE-SW orientation, separated by crests of varying depths. This paleogeographic situation prevented the ocean currents from oxygenating the entire seafloor and sediments very rich in organic substances accumulated in restricted areas. This is the Scaglia Variegata, a typical succession of gray, greenish and whitish micritic limestones, usually bioturbated (*Chondrites*), with radiolarians and foraminifers, well-stratified (5-15 cm) and sometimes chert-containing (nodules and beds of black chert), alternating with grey-greenish, black and reddish marls, sometimes bituminous and very thinly layered.

Tipical landscape with Puez Marls (Col da la Sonè).

In the Adige Valley, south of the Valsugana Line and in the Dolomites Friulane, the sediments of this time were widespread, north of the Valsugana and in the rest of the Dolomites are those preserved only in the area of the Puez and in the Gardenaccia (Puez Marls). This unit is sporadically found in the area of the Altopiani Ampezzani, where it is frequently involved in the so-called 'peak overthrusts', and comprises a rather monotonous alternation of siltous marly limestones, gray-green (very occasionally reddish) marls and rare green and blue argillites. The Puez Marls contains abundant macrofauna with echinoderms, bivalves and, above all, ammonites (the hetermorphic ammo-

nite fauna is famous, and has been studied since the 1800s, Haug, 1889; Uhlig, 1887).
The hemipelagic stratigraphic succession continues with the Scaglia Rossa (Santonian – Maastrichtian), a powerful unit of well-stratified reddish micritic limestones with *Globotruncana* (5-25 cm) for the most part plate-shaped and sometimes chert-containing. The very powerful and complex Mesozoic succession ends with this basin unit. Paleogene and even Neogene sediments are documented in marginal areas of the Dolomites system.
In the heart of the Dolomites a very important outcrop of Oligo-Miocene clastic sediments is documented in the Col Bechei – Croda del Becco/Seekofel/Sas dla Porta crest, in the area of Fanes. These are absolutely the youngest rocks to be found in the Dolomites. They comprise rounded pebbles of various nature and size, intermixed with sand and shell remains, algae and shark teeth and are called Monte Parei Conglomerate. Monte Parei Conglomerate represents coastal sediments deposited at the base of cliffs or on an articulated and jagged rocky coast dating back to about 25 million years ago. They are lying uncomformably on Jurassic faulted and folded sediments, therefore documenting and dating the mesoalpine phase in the Dolomites orogenesis. The Monte Parei conglomerate is then truncated by a south-vergent overthrust belonging to the neoalpine phase of the orogenesis, being thus a good constraint to two principal phases of formation of the Southern Alps.

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A2.2 ECOLOGICAL ASPECTS OF THE DOLOMITES: THE FLORA AND THE FAUNA

Introduction

The Dolomites are universally known for the breathtaking beauty of their rock walls. Even when the huge rock towers loom vertically above narrow valleys they still give visitors a sensation of delicate charm evoked by their immense soaring spires and thousands of high pinnacles.
This zone is the birthplace of Alpinism sport. The Dolomites' multitude of vertiginous sheer precipices and rock walls are a challenge for anyone who is keen on climbing, in fact these mountains offer infinitive possibilities for those who want to dare that which seems impossible to climb.
"These are not the only principle diversities of the Dolomites' landscape in respect to the harsh Alps. In fact, the variety of Dolomite rock forms, hues and shades contrast intensely with the bare rocks and the slopes underlying them, which are lush green pastures and woodlands during the summer. Furthermore, spread out below the Dolomites one can admire distinctive groups of gigantic rocky masses and huge blocks of rock"
"In a sense these high Dolomite Mountains seem to be divided into two distinct parts, thus generating an aerial width to the landscape and creating a vivid boldness to its rock forms. The huge blocks of rock stand out in contrast from the slopes and pebble cones they dominate and their backdrop is even more evident when the wide valleys are covered in lush green pastures and thickets." Aldo Sestini, the renowned geographic academic, wrote this prologue about the Dolomite landscape in 1963.
Little can be said today, except to comment that over the last fifty years the weight of mankind in forging his way between rocks and living nature, and the limitations between pastures and woods and those between agricultural systems and urban systems, has increased excessively. If in the past nature and its scenery dominated the landscape, nowadays mankind's manipulation is far too evident. However in many areas, even in spite of the growing rate of tourist exploitation, many rural activities are suffering from rapid regression. Therefore large areas are almost naturally surrendered and are thus used for the spontaneous recovery of biocenosis.
This phenomenon does not occur only in the highest areas, where animal grazing no longer takes place and the forests have increased, covering slopes and overgrowing borders imposed by the secular grazing of cows and sheep. Even around the villages down in the valleys, the fields and the kitchen-gardens are also invaded by arboreal neo-formations, sometimes in a very short time and with the involvement of species which used to be quite rare in these zones.
The living landscape has therefore changed, and the transformations nowadays are more forceful due to clime warming and rainfall variations. Thus creating an interesting new motivation for naturalistic observation, this, within the Dolomites has many great historical examples of absolute scientific interest.
It is crucial to contribute to the majestic Dolomites landscape by taking into consideration its main elements of flora, vegetation and wildlife.

FLORA AND VEGETATION

The vegetal landscape and its development

The plant landscape and its development in every place on the planet which has not been radically shaped by man, the plant cover, namely, the apparent form of the landscape designed by growing plant life, is the result of the synergetic combination of a variety of climatic and soil factors, as well as human interventions. In the case of the Dolomite area, the pattern of plant life is also the dynamic and ever changing result of the complex historic and geological events that have caused the formation of the Alpine mountain chain. Faults, dislocation, oversteps, folds and other tectonic phenomena make it possible to reconstruct, fairly precisely, what the area might have looked like in the past. The morphology that characterizes the present-day landscape of the Dolomites largely derives from quaternary glacial formation that overturned the previous situation by making a drastic natural selection, resulting in the disappearance of many species and the arrival on the Alps of other species of Artic and boreal origin.

Although not particularly abundant during individual snowfalls, total snow accumulation over the long Dolomite winter can reach extremely considerable depths.

Since the withdrawal of the last Wurmian glaciers (10,000 to 12,000 years ago), diverse climatic periods have alternated, bringing a succession of dry and cold phases and more temperate and humid phases. Certified evidence of this historic succession of climates is obtained from pollen analyses con-

ducted in lake or swampy areas. The results of these studies provide information, including on a local scale, of the periods in which the most important species have been able to spread and multiply thanks to the appearance of favourable ecological conditions. It is now certain that several marginal areas have managed to avoid the disaster caused by glacier formation. These are refuge massifs which still preserve precious relics of Tertiary era flora. Other areas in the Dolomites, such as around several peaks and on steep slopes, survived the devastating glacial invasion, making it possible for several species to continue to exist, even in extreme conditions. These islands of land left free of glaciers are known by their Eskimo name 'nunatakker'. The geographic isolation that has been created in the recent two million years explains many phenomena, such as the development of endemic alterne species and the exceptional variability of some genuses or groups of species. However, it would be inaccurate to attribute the current distribution of plant life only to natural factors. The centuries-long work of man, primarily farmers and livestock raisers, has also resulted in profound changes due to the great fragmentation of habitats and to the creation of new ecological niches. Without this work the level of biodiversity would certainly be inferior, save for the more recent, high-impact events related especially to burgeoning mass tourism and the construction of great infrastructure that have impoverished and trivialized the flora.

Spruce woods and larch woods on the peaks of Monte Pelmo (Belluno).

Today, it is not infrequent to find authentic plant treasures in the most undamaged valleys less influenced by tourist activity, namely archeophytes related to cereal cultivation. These rare species are contrasted against the banal species of the irrigation consortia, more and more widespread on the valley floor where the land surface is not directly occupied by artisanal and industrial set lements. These unploughed areas and the clearings, especially in proximity of the larger rivers, give a home to an increasing number of exotic species from other continents, and especially from North America. The number of non-indigenous species might be considered a valid ecological indicator and in any case, an important parameter to defining the degree of alteration or degradation of a territory. Many rare species have become endangered. This is especially true of the species that grow in humid biotopes, which are subject to land reclamation, drainage, channelling and, unfortunately, general eutrophication (an increase in nitrogen and nutrients) whose effects involve the entire planet. Special mention should be made of the innermost valleys where the climate is continental (endoalpine) or the stations where topographical factors increase summer dryness. This is the only area where several steppe relics survive which in the Dolomite region represent an exceptional rarity (the needle grass or *Stipa capillata, Dracocephalum, Ephedra helvetica*, ect.).

Sub-Alpine prairies (Sesleria) under the Tre Cime di Lavaredo/Drei Zinnen

The recent trend to abandon farming and agriculture, especially in the mountains, is showing clear effects, perceptible even by non-experts whose remembrance of the places reaches back some twenty or thirty years. Among these: – the rise of the wood edge, due to the increased average temperatures caused by global warming; – the increase in woody coverage generated by a decrease in ploughing and/or retraction of the pasture; – the spread of dominant and physiognomic species which have been able to take advantage of the crop abandonment (especially graminaceous plants: *Molinia,*

Brachypodium, the tufted hair grass or *Deschampsia caespitosa*, several species of *Festuca*, etc.) while others seem to be in evident decline.

Botanical exploration

The Dolomite region includes well-defined geographic, historic, and cultural areas and thus, it is impossible to summarize the fundamental steps that led the pioneers of botany to discover such a high number of species in relation to its surface area. Every valley or locality has its own history and there is a rich bibliography in addition to herbariums and substantial collections of dried plants stored at several major museums (Trento, Rovereto, Bassano del Grappa, Udine, Padova). As far back as 1500, P.A. Mattioli provided the world with vital information on plants he discovered, but only later in the centuries, starting in 1700, did G.A. Scopoli and his contemporaries make strides in methodical exploration campaigns and the great Linneo developed the first wellorganized classification system (*i.e.* the binomial nomenclature that has survived today), making comparison possible. The 19th century was characterized by intensive exploration and the rise to prominence of several scholars, many of whom corresponded with each other on their discoveries. An important role was played by German authors (remember that a large part of the Tyrol included a large part of the Dolomites). We've listed only a few here from a long list, who were fortunate enough to leave a mark or were distinguished by the importance of their works: Ambrosi, Kerner, Hofmann, Huter, Koch, Sendtner, Reichenbach, Moretti, Hausmann, Leybold, Sardagna and, above all, Facchini, who more than others explored a substantial portion of this territory. These scholars were frequently doctors, pharmacists, priests and mountain climbers. For most of the territory considered here, the main reference is represented by the 9 books of the extraordinary work of Dalla Torre and Sarnthein, published between 1900 and 1913. It is an unsurpassed work which also gathers together all the previously published information in a single volume. For the areas located farther east, outside the region investigated in this work, we have to settle for less complete contributions. This includes the Gortani (1905-1906) pioneers of Friuli - Venezia Giulia. There is for this region a catalogue with a distribution atlas (Poldini, 1991) which is still the only one of its kind in Italy, at least regionally. Locally, on the other hand, there is no lack of recent and quite extensive contributions which involve essentially the protected areas. A very detailed catalogue (Festi & Prosser, 2000) explores the flora of the Parco naturale di Paneveggio - Pale di San Martino. Argenti & Lasen (2001) have published a checklist of the vascular flora of the Parco Nazionale Dolomiti Bellunesi which later, in 2004, was extended to the entire Provincia di Belluno. We cannot ignore the herborizations of Pampanini in Cadore (with a beautiful book published posthumously, in 1958, and which includes the information of Rinaldo Zardini for the Ampezzo basin) or the exceptional guidebook (well-known to many students) on the Trentino flora, published by Dalla Fior, an important figure also for palynological studies. Additional information on the distribution of plants in the Dolomites can also be found in the various national flora, but usually, the geographic indications are not sufficiently defined. More recent publications include the comprehensive work by Erika and Sandro Pignatti, authors of many articles who intend to produce a general monograph of the flora and plant life in the Dolomites. Exemplary, and still in the process of preparation and updating, is the work of floral cartography which, in the Provincia Autonoma di Trento, revolves around the Civic Museum of Rovereto. In the Provincia Autonoma di Bolzano, the initiative of a detailed flora census is led by Austrian scholars, in conjunction with Thomas Wilhalm of the local City Museum. For the district of Belluno, there are various contributions for the lower part of the province and around the national park (work mainly by Argenti and Lasen), while still scarce is information for the Agordino area and for the Dolomites of the left bank of the Piave river. The same two authors have published the aforementioned provincial checklist (2004) with a primary objective of identifying the red-listed species. It is also worth mentioning how the research into the flora, even in a territory which for centuries has been known and frequented by visitors, has produced very interesting results also in recent times, such as discoveries of new species. This is true,

in the Piccolo Dolomiti in the pre-Alpine area, of the *Primula recubariensis* (1998). Some doubts remain as regards the actual taxonomic consistency of *Nigritella buschmanniae* (1996), discovered in the Dolomiti di Brenta and Gymnadenia (actually, this is a *Nigritella* of the same group of the *buschmanniae*) *dolomitensis* (Dolomite- vanilla orchid), described in 1998 and identified in the area of Col Becchei, Passo di Limo / Limojoch and Colli Alti / Hochalm near Braies / Prags. Also mentionable are the cases, not remote, of *Draba dolomitica* (1969) and *Festuca austrodolomitica* (1995). In the Carnia Prealps, an area equally well-known and valued for its flora, with a fairly large number of endemic or disconnected taxa, *Pinguicula poldinii* was described in 2001, found on humid cliffs, a species presumably widespread farther west on the pre-Alpine and external Dolomite slopes. The flora legacy and endemic Dolomite species including the valley floor, which is abundant in Sinanthropic species, and well-naturalized exotic varieties, the Dolomite vascular flora can count some 2,400 types of plant life. Among these, the endemic plants, namely the plants whose range of distribution is limited to a well-defined and more or less narrow area, are the ones that characterise and sum up the biocenosis and sinecological significance better than others. Due to the effects of glacier movement, the Dolomites can in no way be considered a territory abundant in endemic plants, despite the fact that its flora holds exceptional biogeographic importance for the total number of species and the presence of rare varieties, disconnected or strongly localized entities, or varieties located at the edge of the distributional area. If we exclude the critical groups still imperfectly known (e.g. *Festuca*, or the recently discovered *Nigritella*) and the apomictic species of several genuses (*Alchemilla, Rubus, Hieracium, Taraxacum*), we can consider endemic Dolomite species (often with a distribution range at the boundary areas) in the classical sense the following seven species:

– *Campanula morettiana* Rchb.
– *Primula tyrolensis* All.
– *Sempervivum dolomiticum Facch*. (Dolomitic houseleek)
– *Rhizobotrya alpina* Tausch
– *Saxifraga facchinii* Koch
– *Saxifraga depressa* (Ampere) Sternb.
– *Draba dolomitica* Buttler

We should also note the existence of endemic subspecies or varieties which are still frequently identified by adjectives *dolomitica, dolomiticum or dolomitensis*. The sphere of the nominated property also encompasses sectors that, on a geographic level, are not necessarily in the Dolomites but can be included in it due to the landscape and to bio-geographical reasons. Among these, in particular, are the Carnia Prealps (Dolomiti Friulane - Dolomitis Furlanis), which are doubtless among the most important sectors of the Alpine arc in terms of the flora. Among the most representative types are the following:

– *Arenaria huteri*
– *Gentiana froehlichi subsp. zenariae*

Campanula morettiana.

While these nearly always refer only to vascular plants, the so-called 'inferior' plants still warrant more than a passing remark. The briophytes (mosses and liverworts) were the first plants to take root on dry land, while remaining dependent on water in the reproduction phases. Furthermore, lichens represent a unique amalgamation of an alga and a fungus and characteristically thrive in high altitude environments and windy peaks (in addition to bark and tree branches). Briophytes include some 500 species, which are not always easy to recognize. Frequently scientists need a microscope to identify different varieties (this is also true of several types of lichens). Their importance is relevant in several environments such as natural springs, snowy valleys, and peat bogs, especially in deep bogs and in acidic ones with sphagnum traits. The briophytes also form communities that are investigated with the same principles of phytosociology. An interesting fact about these plants is that several types of moss are used as markers due to their ability to detect the accumulation of heavy metals. Lichens have been used for years as markers of atmospheric pollution and have long been used to date historic landslides. Numerous works have focused on these groups but most only involve very limited territories or specific habitats. Even less comprehensive is our knowledge of algae, some of which (cyanophytes) are very primitive organisms but essentially important in several eco-systems. The wide bands of dark colour seen near calcareous walls, sometimes covered by running or dripping water, are in fact colonies of these organisms.

Zones of detritus and rocky walls in Val Sasso Vecchio/Altensteintal (Gruppo di Cima Una/Einser – Dolomiti di Sesto/Sexner Dolomiten –Alto Adige/Südtirol).

The vegetation

Approximately 2,400 species represent the flora in the Dolomite area. In the absence of an organic body of synthesis, we can consider that the plant life in the Dolomite area is represented by some 150 plant associations, which can be grouped into an increasingly smaller number of alliances (e.g. Tilio-Acerion), orders (e.g. Vaccinio-Piceetalia) and classes (e.g. Salicetea herbaceae). In the description of the plant landscape of a territory, the altitude belt differentiation approach is still quite commonly used. Adige/Südtirol).

Altitude belts

According to the outline proposed by Pignatti, there are 4 belts (not counting the Mediterranean belt). The *Middle European* belt includes the valley floor and the warm submontane areas which are usually characterized by horn-beam woods and oaks. The *Sub-Atlantic belt* includes the wooded areas of the cooler slopes of the submontane horizon and nearly all the slopes on the montane horizon and, in the outermost Dolomite area, also the altimontane area. These comprise exclusively beech woods or mixed beech and silver fir woods, as the spruce population is rather marginal. Also several ravine woods, plentiful in noble broadleaf trees (maple, linden, witch elm and ash) and yew trees are typical of this belt where the rainfall is usually high and well distributed. The *Boreal belt*, which corresponds to the altimontane and sub-Alpine zones, includes the evergreen woods and the sub-Alpine shrubs: red fir woods, mainly, and firs that thrive in acidic soil, larch woods, and mixed larch and Swiss stone pine (Swiss stone pine are rare and limited to the more continental areas, i.e. Bolzano/Bozen). The

shrubs, fairly characteristic in the Dolomite landscape to the point where dwarf mountain pine represents one of the most peculiar and most important species in terms of quantity, include not only mugo pines, but also rhododendrons, green alder woods and various types of pioneer willow woods. The *Alpine belt* is located higher in elevation, above the tree and shrub line where the primary prairies begin. This belt refers to all the types of discontinuous plant life in the higher elevations (cliffs, detritus, and snowy valleys). Above the elevation where there is perennial snow cover, the presence of plant life is sporadic and is often represented only by cryptogams (mosses and lichens). We might also mention here types of so-called *azonal* plants, since they are particularly related to ecological conditions, regardless of altitude. This is true of the riparian woods in the vicinity of streams and a large part of the Scots pine and/or Austrian pine woods. In the Dolomite area, there are no significant examples of out-of-area plant life, namely the expression of ecological climates and conditions of past eras or other geographic territories. This category might include several arid-steppe realms, located on the steep slopes in the innermost continental valleys.

Woods and shrub forests

In the residual flood areas of the valley floor, potentially very hospitable to mixed forests of oak and horn-beam (widespread in Central Europe), human settlement and agricultural areas have very nearly replaced forest regions. Possible relict species (English oak and common alder) therefore hold exceptional bio-geographical value and are protected as biotopes, especially in the Alto Adige (Provincia Autonoma di Bolzano). The presence of black locust, a North American species well naturalized in these regions, is a good indicator of the decay of these flatlands and hill habitats. Woods are well conserved on the steep slopes that characterize the valleys of the outermost Dolomite area. Mixed manna ash and horn-beam woods, with prevalent hop-hornbeam and several thermophilic shrubs and shrubs from the sub-Mediterranean zones occupy large surfaces. In the more suitable habitats, these can grow even up to 1,000 to 1,200 meters. In the more continental realms (with a distinct gradient from south east to north west) of these coppices – whose trees are still used for firewood – there is a significant increase in pubescent oak. Oak is more commonly localized on dry and acidic soil and forms communities, generally mixed, in several Trentino valleys on soils whose origin is the breakdown of silica rocks, sometimes even in the montane belt. In the easternmost Dolomite mountains, oceanic influences lead to an important presence of Austrian pine, which thrives and has pushed all the way to the Cordevole and Mis valleys. The distribution of Scots pine is also noteworthy, especially in the innermost continental realms or on the Dolomite substrates as communities and colonies on gravely soil. In the montane belt more fertile woods develop and hold more interest for the forestry industry. The general makeup of the communities is heavily influenced by the climate. Outside, toward the Prealps and in the zones of higher rainfall (meso-Alpine region), pure and mixed beech woods dominate, while conifers increase farther inward, thriving in the more continental climate until the beech trees disappear. In a wide stretch of the Dolomite territory, very widespread (and very beautiful, and sometimes very valuable from a naturalistic viewpoint) are the mixed woods with a predominance of silver fir. Primiero, Val di Fiemme and Lagorai, Caiada and Val del Grisol (Longarone area), Auronzo, left-bank Piave Dolomites, Comelico and Carnia are very beautiful forest districts. The Norway spruce, one of the most distinctive features of the Dolomite landscape, was heavily planted by man, but actually finds better conditions in either the altimontane or the sup- Alpine belts, above the fir coppices, or in the innermost valleys in which red fir woods dominate unchallenged over other types of trees. Spruce has been replaced only on the steeper and drier slopes, on the primitive gravely soils, by Scots pine coppices. Considering the complex orographical features and the numerous microclimates of the Dolomite region, it would be presumptuous to name the diverse situations that can be created (a characteristic of the Dolomite plant landscape is in fact its variegated and sometimes quite unpredictable nature).

Pinus cembra at the treeline (Pale di San Martino – Trento).

Larch is surely one of the colonizing plants that best characterize the higher elevations, especially near to the grasslands. Pure larch woods are rare formations and often only found pursuant to interventions by man. In the continental climate valleys, the most characteristic forest plant in the sub-Alpine belt is Swiss stone pine, which is particularly abundant in the Ladin valleys. In the fall, larch and Swiss stone pine woods lend beautiful colour effects that make the landscape suggestive and attractive with majestic vistas on the backdrop of the mountain peaks. Even the few sub-Alpine woods of Norway spruce, larch and Swiss stone pine (between 1,500 and 2,200 m), we can appreciate the characteristic underbrush of whortleberry, rhododendron and dwarf juniper. Above the edge of the forest live isolated trees, often bent and mutilated by lightning, sometimes with the characteristic candelabra shape. Dwarf shrubs form the most characteristic plant life (*climax*) on the Dolomites as in the rest of the Alpine arc. The strong presence of Alpenroses, instead of hairy Alpenroses or dwarf Alpenroses, indicates that these are lands rich in silica or formed by the breakdown of carbonate rocks, but on deep and acidic soils. A widespread presence of heather and red whortleberry distinguishes the more continental slopes that are relatively warmer in summer. Bog bilberry (*Vaccinium gaultherioides*) indicates drier and acidic realms. The most typical hallmark of the Dolomite landscape, especially on rocks and calcareous detritus, are the dwarf pine woods which are rarely found on the crumbly slopes, even at the lower elevations. Any hiker will tell you how demanding it is to hike through dense dwarf pine coppices, but he is also aware of the safety that they lend to the mountain climber and the very important job they play in keeping loose soil compact. Damp lands (caused by the accumulation of looselypacked soil, often carried along by landslides) is often covered by coppices of green alder (in some areas these woods can be very large; for example, in the volcanic group of Cima Pape, such coppices stretch out from 1,000 to 1,900 meters) which host thriving flora of high grass which take advantage of the high humidity and the nitrogen supplied by the bac-

teria that live in symbiosis in the root systems of the green alder. Generally, in the cooler and snowy realms, often rejuvenated by new accumulations of detritus, there are groups of willows (at least a score of the willow woods described) frequently pure or accompanied by rhododendrons, alder and other shrubs. Only in the drier and more arid realms (windy summits) do we find colonies of juniper and red bearberry. Even less common is the poisonous savin juniper which grows in silica-rich soil in well localized montane and sub-Alpine belts of several valleys (e.g. Livinallongo).

Prairies

The beauty of the Dolomite landscape would not be so charming if the alternation of woods and grasslands was not the result of a centuries-long balance between nature and the intervention of man. All the clearings and pastures located under the limit of the shrub vegetation are the result of mowing and meadows. Pursuant to the gradual abandonment of agricultural and livestock raising activities, their survival is currently endangered; significantly, several prairie species are included on the red lists among the endangered or vulnerable species. Dolomite prairies are a very highly developed and complex realm. It includes fertile prairie areas (triseptate), quickly replaced by the forest when their usability ended, drier prairies (bromelia and seslerio-bromelia) which are capable of holding out longer against the advancement of shrubs, already shown - at least in the more oceanic climates -, by the expansion of rayed broom (*Genista radiata*). The most characteristic and peculiar prairies are the ones primarily situated above the forest line. On its alkaline soil surfaces, the landscape is dominated by *Sesleria caerulea*, frequently associated with *Carex sempervirens* (evergreen sedge). In the cooler areas, Carex ferruginea (Northern rusty sedge) is found in abundance while the lower elevations and the more primitive realms (mainly steeper cliff areas) are dominated by *Carex firma* (sedge) which creates the distinctive pioneer plate vegetation. On the more acidic soils, the most characteristic type of prairie is *Carex curvula* frequently associated with *Festuca halleri* (Haller fescue). As early in midsummer, the leafy tops show curves and a deeper yellow colour due to the premature drying, while in springtime (which is in early July at these elevations) a bursting with dazzling blooms of primroses and gentian occurs. On the steeper and drier slopes, the robust *Festuca varia* (variable fescue) dominates other vegetation and pushes up to the vertical walls with the characteristic embankments. In similar habitats but on limestone and at lower elevations, the comparable species, *Festuca alpestris* (Alpine fescue) dominates, at least in the more external Dolomite areas often accompanied by an even more shrub-like and hearty graminaceous plant, *Helictotrichon parlatorei*. Going back to the silica-based lands, worthy of mention are the aspects of the windy peaks with *Juncus trifidus* (three-leaved rush) and, especially, the dry slopes at the crests with the soft blanket of Alpine azalea (*Loiseleuria procumbens*). In proximity to mountain saddles, on slightly mildly acidic soil, growing also in the limey soils is Bellar's Kobresia (from Elyna (*Kobresia*) *myosuroides*), often enriched by interesting milk-vetches and other species that tolerate extreme temperature fluctuations and the relative dryness. The areas more highly subject to use as grazing lands – silica and lime rich (in this case, the soil becomes very acidic, which is not surprising especially in the Dolomites) – are occupied by nardus colonies, communities relatively poor in species but still valued for their beautiful blooms, in which the pungent graminaceous variety, Nardus stricta (mat-grass), clearly dominates and signals to livestock the presence of excessive treading, sending an invitation to look elsewhere for more appetizing grasses. There are several aspects characterized by seasonal sequences and surprisingly beautiful blooms, but these are frequently located in several sectors and would be impossible to list comprehensively on these pages. We remind of the prairies (former grazing lands) of Festuca paniculata, on developed soils or the fertile fields of the flatlands and the basins, with Poa alpina (Alpine bluegrass) and Crepis aurea (golden haw's-beard), as well various types of fescue grasses. A significant presence of Deschampsia caespitosa (tufted hair-grass) a tall and hearty graminaceous plant and with sharp blade leaves, marks the damp and asphytic soils

Pastures with blooms of Ragged Robin (Lychnis flos-cuculi).
In the backdrop, the Sasso della Croce/ Kreuzkofel/Sass dla Crusc (Armentara – Alto Adige/Südtirol).

Pastures of Nardus stricta with blooms of Swiss dandelion
(Leontodon helveticus) (Vette Feltrine – Trento).

This species is undergoing substantial expansion phases and the quite accentuated changes taking place in the past few decades demonstrate to the observer a myriad of aspects of transition that make the ecological interpretation complicated if the previous use of the soil is not fully understood. We should also mention the flowering period of the great umbrelliferous plants (eg. *Heracleum sphondylium*, hogwood) which are found in the meadows of the valley floor of the Dolomite area, especially after the first cutting. Other showy umbrelliferous plants (*Laserpitium latifolium*, *Laserpitium siler, Chaerophyllum villarsii, Chaerophyllum aureum, Angelica sylvestris*, etc.) signal particular ecological conditions in the outermost Dolomite areas.

Wetland environments

In the Dolomite landscape, wetland biotopes can readily be found, more in terms of surface extension than for a particular quality importance, caused by land drainage and reclamation campaigns which have deeply altered the original equilibrium. These areas are quite significant from a natural perspective, frequently submitted for protection as sites of Community importance, sites of national importance or sites of regional importance (SIC, SIN, or SIR respectively) but which at the current time do not enjoy appropriate forms of protection. In the autonomous administrative areas, regional and provincial laws have promoted early identification and the Veneto is the only region where there remains to be a specific regulation, despite the fact that proposals have been submitted on numerous occasions.

Glaciokarstic basin of Foses. Small lakes, peat bogs and sub-Alpine pastures (Dolomiti d'Ampezzo – Belluno).

Particularly important and delicate areas are the peat bogs, extraordinary localities that attract botanists in a special way due to the presence of glacial relict species and/or artic-Alpine species (*Andromeda polifolia*, *Oxycoccus*, several types of rare sedge grasses) or curious carnivorous plants of the Drosera genus. Special mention should be made of the delicate and sensitive micro-environments that distinguish the flood areas of the glacial streams. *Juncus arcticus, Tofieldia pusilla*, *Carex maritima, Carex bicolor, Carex microglochin*, with the less rare *Kobresia simpliciuscula* and *Juncus triglumis* hold enormous bio-geographical importance. Regrettably, these habitats have virtually disappeared and today only a few traces of them remain (Alpe di Siusi/Seiseralm, Val Venegia, Val Duron, Laghi di Foses). There are high peat bogs with the characteristic accumulation of sphagnum alternated with depressions (*Carex limosa, Rhynchospora*) and low peat bogs, with basiphilous plant species (where *Carex davalliana* predominates with cotton grass, *Primula farinosa*, and another carnivorous plant, *Pinguicula*) or other acidophilous plants (*Carex nigra* with other sedge grasses and *Viola palustris*). We can still see vast systems of wetlands that, while fragmented by human infrastructure, have been able to conserve largely untouched segments (for example, in Comelico, on the Falzarego, in Val Sarentina/Sarntal, at the foot of Pelmo, on the Lagorai, etc.). Remember that all the highly natural peat bogs and wetlands environments are considered priority habitats by the European Union. There are several different types of wetlands habitats. First of all are the rivers, of primary importance not only for landscape concerns. The various types converge in the single plant classifi- cation, *Montio-Cardaminetea*. Quite a widespread species, associated with the typical mossy pillows, includes Saxifraga stellaris and Arabis soyeri. Surrounding the lakes are many types of easily recognizable plants. Associations of floating plants in the ponds and lakes are followed by helophyte consortia with plants that take root in the mud on the banks (e.g. the *Phragmites canes*) and groups of high sedge grasses (various associations already described). Subject to drainage in the past because they were deemed useless or sometimes toxic were the residue of wet meadows (moors, from the name of the genus of dominant graminaceous plant *Molinia cerulea*, purple moor-grass), which are conserved only where they are still regularly cut, the groups of marsh marigolds, bulrush, the edges of streams or Alpine ponds, the drip areas and, only on the valley floor, underground springs, channels, and offshoots of major rivers.

Wetlands habitats (peat bogs) in Comelico (Belluno).

Crags in Muntanaia, Dolomiti Friulane.

Crags and detritus

While the beauty of flowering blooms in the meadows touches our sentimental side, it is in the more primitive habitats, rocks and screes, that we can fully appreciate their most characteristic aspects. Certainly at one time or another, every hiker has stopped for a moment to admire the vertical rock faces dotted with extraordinarily beautiful, but, all told, fairly easily recognizable, flowers: primroses, violets, bluebells, golden rampions, sandworts, rock jasmine, and saxifrages. Exclusive to the Dolomite region is the *Campanula morettiana*, which grows on relatively isolated walls that are concurrently swept by upward currents of warm and damp air. Also in this area of the Alpine arc, the *Potentilla nitida*, dominant in the detritus at the higher elevations, finds the optimum growing conditions. Somewhat less common is the association with *Androsace helvetica*, located mainly in the higher windy realms and especially in the inner zones. In similar habitats grows *Carex rupestris* which prefers less vertical niches. Several other associations characterize the fissured and layered crags, especially in the external ridges; these are, for example, saxifrage colonies of the fissures (leading species is the *Saxifraga burserana*), the saxifrage that grow near running water (with *Saxifraga mutata*), the spiraea potentilla growths (with Spiraea hacquetii, endemic of the Friuli and the area near Belluno). In the shadier realms, frequently abundant in moss and some ferns (especially *Cystopteris fragilis, Asplenium viride*), the guide species is *Valeriana elongata*, sometimes found in tandem with *Paederota lutea*, another endemic plant of the Eastern and Dinaric Alps. In the easternmost Dolomites, the *Arenaria huteri* and *Primula wulfeniana* thrive in narrow, twisting recesses. Completely different are the plant colonies that populate the volcanic rock regions with species that thrive in acidic soils: *Saxifraga bryoides, Androsace vandellii, Asplenium septentrionale, Saxifraga depressa, Saponaria pumila, Viola thomasiana*, and *Androsace alpina* are species that eschew lime. The detritus cones, like the mugo pine woods, represent one of the most characteristic expressions of the Dolomite landscape. There are several associations described for the diverse substrates, according to elevation, the dimen-

sion of the clasts, the abundance or shortage of nutrients, and geographic location. All these colonies fall under the single class of *Thlaspietea rotundifolii*, named after the guide species, *Thlaspi rotundifolium*. At the higher elevations, in realms that are snow covered for most of the year, the best known and most visible bloom is probably that of the Alpine poppy (part of the *Papaveretum rhaetici*), often accompanied by *Saxifraga sedoides* and *Achillea oxyloba*, as well as *Linaria alpina* and other species indifferent to substrate. At very high elevations, on the terrigenous substrates that cause events of solifluxion, the dominant species is *Leontodon montanus*. On fine detritus, in the sub- Alpine belt, *Athamanta cretensis* and *Trisetum argenteum* have formed an association (which replaces, in the greater part of the Dolomites, *T. distichophyllum*, found abundantly in the central chains and in the internal and continental Dolomite region). On soil that is coarser (gravel and pebbles) but damp, and therefore more vulnerable to events of summer aridity, the spring flowering Alpine Butterbur (*Petasites paradoxus*) flourishes as does the *Adenostyles glabra*, whose blooms emerge in the summer. Limited to some external areas but of important bio-geographical interest are the Brassicaceae colonies (guide species *Alyssum ovirense*, present on the Vette di Feltre, on Monte Serva, and M. Pramaggiore), the primroses (*Cortusa matthioli*: Alpi Feltrine, Tesino and lower Agordino area) and colonies of fescues, such as *Festuca nitida* (Dolomiti Bellunesi and Friulane). Somewhat more widespread are blue fescue (*Festuca pulchella*). At lower elevations, the quarries are colonized by succulent plants of the *Sedum* genus, *Moehringio- Gymnocarpietum robertiani*, by colonies of *Achnatherum calamagrostis* and *Epilobium dodonaei*. Not lacking are spectacular examples, albeit localized of coarse stone screes undergoing consolidation by the work of the hearty and showy clumps of *Festuca spectabilis*. In the Prealpi Carniche we can also find *Festuca laxa*. On silica-rich detritus at higher elevations, dominant species include *Oxyria digyna*, *Geum reptans, Poa laxa*, and *Ranunculus glacialis*. In grassier areas which are subject to lengthy snow coverage, a prevalent species is the *Luzula alpino-pilosa*. Somewhat less common, on the coarse silica stone screes, is the association of *Cryptogramma crispa* (parts of the Lagorai). Also interesting are the communities that colonize the flood areas and pebbly river banks. As regards species thriving in lime-rich soil, we also remember the aspects of *Leontodon berinii* and *Chondrilla chondrilloides* or *Calamagrostis pseudophragmites* while on silica, we only name the extreme eastern penetrations of *Epilobium fleischeri*. Less widespread with respect to the Central and Western Alps, but no less important in terms of quality, is the typical plant life of the snowy valleys. Guide species include the dwarf willows: *Salix herbacea* (it prefers silica), *Salix retusa* (indifferent) and *Salix reticulata* (it prefers lime). The areas localized near the snowfields are characterized by meagre but rather specialized plant life and often have interesting detritus contributions. *Soldanella pusilla, Veronica alpina, Potentilla brauneana, Sibbaldia procumbens, Arabis caerulea, Gnaphalium supinum*, and *Gnaphalium hoppeanum* are a small number of vascular plants that, in the more extreme habitats, leave space to cryptograms when the snow cover begins to exceed 9-10 months per year.

Rocky walls and detritus strata on the Tofane (Dolomiti d'Ampezzo – Belluno).

Other realms

This perfunctory and unavoidably superficial panorama on the various aspects of the Dolomite landscape should not omit at least one reference to other areas that play host to unusual plant colonies.

– Shelters under rock formations, with nitrophilous flora, nourished by the evacuations of wild hoofed animals that pause there. The guide species are *Cynoglossum officinale, Hymenolobus pauciflorus, Lappula deflexa.*
– Nitrophilous habitats near the grazing lands and rest areas in areas of accumulation. *Rumex alpinus*, *Chenopodium bonus-henricus, Urtica dioica, Stellaria nemorum*.
– Colonies of nitrophilous high grass in the wooded clearings or among the shrubs. *Adenostyles alliariae, Cicerbita alpina, Aconitum vulparia, Peucedanum ostruthium*. Only in the Dolomiti Pesarine (Dolomitis Pesarinis and Dolomiti di Sapade) do we observe the very rare and flamboyant *Eryngium alpinum*.
– Dry areas along walls: *Sedum* in several species, *Saxifraga tridactylites, Scleranthus*.
– Open clearings in the woods with decomposing organic substances. *Epilobium angustifolium, Rubus idaeus, Atropa belladonna* (beech woods).
– Peripheral areas of woods: thermophils with *Geranium sanguineum, Aster amellus, Origanum vulgare*. Several mesophils with *Trifolium medium, Vicia sylvatica*.
– Ploughed or heavily developed areas. There are various ruderal or segetal associations, related to crop planting or other areas subject to clearing, located on roadsides or in uncultivated areas. Interesting, here and there, are several relicts, now in the process of disappearance.

The great floristic and vegetal value of the Dolomites sites includes the following point:

Biodiversity. Above all on the southern massifs, not only is the number of species very high per surface unit (floristic wealth), but there are also vegetal communities that are endemic and exclusive to these massifs, the survival of which is partly due to the glaciations that have conserved important elements of Tertiary origin. The major biological wealth of the outer chain is above all confirmed as regards the many invertebrate groups. The vascular floristic heritage of the Dolomites area includes about 2,400 species. Excluding the valley floor areas and those outside the nominated area, the number is reduced to about 1,700, which is equivalent to that of the entire British Isles. In the territory of the Parco Nazionale Dolomiti Bellunesi alone about 1,350 species have been recorded, which is a very high number indeed, equal to about 25% of the entire heritage of the nation including islands. The Alps are an important biogeographical region with high specific biodiversity and biocenosis (an ecoregion also recognized by the WWF and the site of a centre of plant diversity - see Smith G., J. Jakubowska. 2000. *A global overview of protected areas on the world heritage list of particular importance for biodiversity.* UNEP, WCMC, WH, IUCN. Cambridge, UK).

Endemism. The massifs of the southeastern sector in particular are the richest, also qualitatively, in endemic species of great interest, since they contain species that have survived from pre-glacial times. The value of this area is affected by the important influence of both the refugial Arctic-Al pine species that arrived during the Quaternary glaciations, and the species gravitating from the east (Dinaric, Illyrian, Pontic, Steppe) that arrived in the warmer and/or drier post-glacial periods.
Associations and habitats. The Dolomiti Bellunesi, for example, have no less than 55 forest type units, representing more than 50% of the whole Veneto Region including the plain. In all the sites proposed, habitats of Community interest are to be found, and some of the sites contain many habitats considered as priorities by Annex 1 to the Habitat Directive 92/43/EEC.

Ecosystem dynamics in progress. One factor worthy of note, involved in the more interesting ecosystem dynamics, is the abandon or diminished use of the high pastures, where progressive acidification of the upper layers of soil can be observed.

Cypripedium calceolus.

In addition, within the nominated properties, the following vascular species are on the "IUCN Global red list": *Eryngium alpinum* (V), *Arenaria huteri*, *Rhizobotrya alpina*, *Sempervivum dolomiticum*, *Saxifraga facchinii*, *Cytisus emeriflorus*, *Campanula morettiana*, *Physoplexis comosa*, *Artemisia nitida* (R), *Gladiolus palustris*, *Knautia persicina* (I). And in the Bern Convention there are: *Campanula morettiana, Physoplexis comosa, Cypripedium calceolus, Primula spectabilis, Eryngium alpinum*. Moreover, it should also be taken into consideration that a number of endemic species that have recently been discovered, for example *Primula recubariensis* (Piccole Dolomiti) and *Pinguicula poldinii* (Dolomiti Friulane, Vette di Feltre), have not officially been classified based on their extinction risk vulnerability.

In conclusion, the present-day flora and plant legacy is the result of a complex historical and geological succession of events and human farming activities. The recent and profound changes display intensive dynamics and a good capacity to meet the impact of weather changes as well as the intrinsic fragility of several habitats. The emergence of protected areas (national and regional parks, biotopes, SICs and oases…) should represent a valid support for organizing a network that can actively and passively protect the most significant realms. It would not be enough if there wasn't also a system of ecological corridors and planning was done with appropriate tools. As part of a plan to protect biodiversity, the Dolomite region, whose nomination as a natural world heritage - is being proposed to UNESCO, represents an especially privileged experimental territory. Abandonment of the mountains, accentuated in the past few decades, carries risks not only for the populations of the valley floor, but also in terms of conservation of peculiar eco-systems that have made the Dolomite landscape famous.

The core of Dolomiti di Brenta and the Ritorto

FAUNA

Exploring local fauna

Exploration of the local fauna of the Dolomites, especially as regards invertebrate animal life, began in the latter half of the 18th century at the hands of Austrian naturalists, among whom Laicharting and Rosenhauer. An early contribution to the understanding of vertebrates was due to the Belluno native Tomaso Antonio Catullo, professor of Natural History at the University of Padua, who published *Catalogo ragionato degli animali vertebrati permanenti o solo di passaggio nella provincia bellunese* in 1838. In the following decades, the fauna of the Dolomites began to attract the attention of other Italian scholars, such as P. de Strobel, F. Ambrosi, A. Dogliosi, and S. Bertolini, but this area continued to be toured with great interest by Austrian and German researchers, such as A. Stentz, who collected interesting zoological materials on the Alpe di Siusi and on the Sciliar, and later, J. Mann, F.F. Kohl and T. Becker, who have devoted their research respectively to lepidopters, hymenopters and dipterans. In the second half of the 19th century, the biggest contribution to zoological studies in the area in question was made by a cleric from the Alto Adige, Vincenz-Maria Gredler, whose studies spanned from the vertebrates (reptiles and amphibians) to molluscs and insects (ants, beetles and hemipteras). Subsequent investigations were centered on increasing attention on the ecological aspects of the population, as well as the increasingly more extensive reconstructions of its origin. A synthesis of the fauna of the Dolomites is therefore presented by G. Marcuzzi in 1956. Many brand-new studies have been conducted in the past ten years which are still in the process of being condensed into a new summary.

Wealth and uniqueness of the animal population

In the absence of a complete and up-to-date catalogue of the Dolomite fauna, extended to all the zoological groups, to arrive at an estimate of the richness of the animal population of the area, we have to make use of partial lists related to several groups (especially vertebrates and several orders of insects) and lists of fauna related to individual, better-explored localities and more interesting zoological groups. Generally speaking, Marcuzzi (1961) had estimated that there were at least 7,000 already known animal species in the Dolomites, a number that has risen with the explorations conducted in the last fifty years. We can argue that the actual population is closer to 10% of the entire non-marine fauna population in Europe. A recent census (www.faunaeur.org) has brought that number to just over 130,000 species. We should also note the very substantial specific legacy of animals, perhaps less obvious than the vertebrates (especially birds and mammals), which often unduly draw the most attention. Lepidopters (daytime and night-time butterflies) are found in the Dolomites and are represented by at least 1,600 species. This significant wealth of fauna in the Dolomites is not due only to the substantial diversity of the habitats and the multiplicity of the local plant life, which in turn is due to the extremely wide difference in elevation that separates the valley floor from the highest peaks and the variegated relationship that the area has had with man over the centuries, but also their location in the vicinity of the Eastern hinge of the Alpine arc and the complexity of the paleogeographic and paleoclimatic events which have involved and have led to the allocation, into more or less expansive districts of the Dolomites, of endemic or sub-endemic species of animals, characterized by a narrow distributional range which, in some cases, is entirely encircled by the Dolomites. At the moment, the species or subspecies of endemic animals of the Dolomites has not been compiled into a list, but there are certainly several dozen. In this regard, it is interesting to note that in the aforementioned data base relating to the European fauna, 26 species and subspecies have been surveyed, whose specific name includes the Dolomites (*dolomitae*, *dolomitanus*, etc.) or Cadore.

Origins of the Dolomite fauna

Following the criteria of a recent analysis of the fauna that can be recognized in the animal population of the entire Alpine chain (Chemini and Vigna Taglianti 2002), we can see six distinct groups represented of Dolomite fauna.

Species endemic to the Alps.

While the southern edge of the Alps plays host, especially in the area of cave-dwelling fauna, to several species of very specifically localized distribution whose origins can be traced back to antiquity, this component is lacking in the innermost belt of the Alpine chain due to the severity of the weather conditions that it was subjected to during the Pleistocene age. Here, we find several localized (endemic) species of a more recent origin. This category includes species exclusive to the Alpine chain or a portion of it, which subsist mainly in the medium to higher elevations and which have originated by geographic isolation with respect to similar species that remained allocated in other mountain regions of Eurasia, between the end of the Pliocene and the Pleistocene eras. Among the vertebrates, this fauna sector in the Dolomites is represented by the black salamander (*S. atra*), but the invertebrates are even more numerous. Among these, several species of ground beetles of the *Carabus* genus, such as *C.* (*Orinocarabus*) *adamellicola*, *C.* (*O.*) *alpestris dolomitanus* and *C.* (*Orinocarabus*) *bertolinii*. These belong to a group of species whose distribution areas, complex and partly overlapping, are the result of complicated paleogeographic and paleoclimatic events that involved the fauna of the high Alpine elevations. Numerous other species of beetles are found in geographic areas of the same type, for example, in the genera of *Nebria, Trechus*, *Simplocaria*, *Dichotrachelus*, *Otiorhynchus* and *Oreina*.

Glacial relicts of the *massifs de réfuge*.

Even during the coldest glacial phases of the Quaternary era, the Alpine and Prealpine regions had never been completely covered with glaciers. Here, there were areas that acted as "refuge massifs" where several animal (and plant) populations that were better able to withstand the harshness of the weather conditions managed to survive. The isolation experienced by these populations, even for short periods of time – on a geological scale - has often led to their differentiation on a sub-specific or specific level. This is proven today by the existence of species of a very narrow distribution which still live in these refugia. These species are represented mainly in the Prealps belt, but are also found in the southernmost limit of the Dolomites.

Boreoalpine species.

The characteristic present-day fragmented and even punctiform geographic distribution of the species referred to in this group of fauna is the result of the glaciers pulling back at the end of the last glacial age, which took place between 15,000 and 10,000 years ago. The previous advancement of the glaciers southward pushed the animal (and plant) life toward more southern latitudes, where other natural geographic barriers stopped the flow. For many species, the peninsula of Italy - as in the other great Mediterranean peninsulas - represented a refuge where they were able to survive during the glacial maximum periods and which became a new starting point in their subsequent colonization of Central and Northern Europe. The prevalent parallel orientation of the Alps represented a formidable obstacle to the recolonization which carried northward numerous species surviving the glacial maximum periods. Several populations remained at the higher elevations in these mountains. In some cases, migration would begin in one southern refuge area and split along the way, giving rise to population settlements in the Alps, including the Dolomites, above the upper limit of the treeline, and at the same time, to populations that continued their advancement toward Scandinavia, but without making any stable colonies in Central Europe. These were species well adapted to life in the colder climates (periglacial and similar), whose distributional range is split into two parts, separated by an enormous distance. The first is a northern area, generally circumscribed to one part

of the Scandinavian peninsula and another to the south, corresponding to a section (fairly extensive and continuous) of the Alpine arc. The distribution of these boreoalpine species is the result of the climatic changes during the last ice age and the subsequent post-glacial period. These geographic distribution areas have taken shape in fairly recent times, over the past ten thousand years. Such a short interval of time was generally not sufficient for Alpine and Scandinavian populations to accumulate a sufficient level of genetic divergence to be considered distinct species. Across the Alpine chain, there are at least 200 animal species in the boreoalpine distribution. Many of these are present in the Dolomites and include especially valuable species, among which the mountain hare (*Lepus timidus varronis*) and the rock ptarmigan (*Lagopus mutus*). One of the boreoalpine species is also the three-toed woodpecker (*Picoides tridactylus*), whose presence on the Dolomites was observed and recorded half a century ago. There are several species of boreoalpine butterflies. Some of the daytime species are the Apollo butterfly (*Parnassius Apollo)*, peak white (*Pontia callidice)*, Shepherd's fritillary (*Boloria pales)*, Thore's fritillary (*B. thore)*, small mountain ringlet (*Erebia epiphron)*, Alpine argus (*Plebeius (Albulina) orbitulus)*, and the Alpine grizzled skipper (*Pyrgus andromedae)*; among the night-time species, *Agrotis fatidica*, *Elophos vittaria*, *Pygmaena fusca*, *Grammia quenseli*, *Setema cereola*, *Sterrhopterix standfussi*, and *Gazoryctra ganna*. Other elements in the boreoalpine area that refer to zoological groups of less 'landscape' value are represented by species important on a biogeographical level. Among these is the small rove beetle *Mannerheimia arctica*, whose presence in the Italian Alps is limited to two realms, one of which is in the Dolomites. Other boreoalpine beetles are the rove beetle *Eucnecosum tenue* and the click beetle *Selatosomus confluens.* Among the dipterans we observe the tiny Sphaeroceridae *Crumomyia setitibialis*; while the hemipterans are represented by the Lygaeidae *Geocoris lapponicus*. Many other species of the Dolomite fauna can be described as glacial relicts of boreal origin, but are not included in the boreoalpine category as they are much more disseminated in Northern and Central Europe. Among these elements are three Tetraonidae, some of the most characteristic birds of the Dolomite bird population, namely the capercaillie (*Tetrao urogallus*), the black grouse (*Tetrao tetrix*) and the hazel grouse (*Bonasa bonasia*); plus, the nutcracker (*Nucifraga caryocatactes*) and the short-tailed weasel (*Mustela erminea*).

Tetrao tetrix.

The simultaneous presence of the four alpine tetraonids in the nominated area is undoubtedly one of the most significant wildlife issues in the area. These are species of recognised interest, considered to be in demographic decline throughout much of their habitat and the alpine area in particular, and their environmental requisites are very closely dependent on low impact land use, geared to maintain the natural balance of the territory. The preferred habitats of the capercaillie, hazel grouse, black grouse and rock ptarmigan are naturalistically managed woodlands, undisturbed brush, pastures and rocky terrain. While these four gallinaceous birds are extremely vulnerable species, the conditions in the nominated area are still reasonably favourable for their survival. The courting displays of some of these birds (capercaillie and black grouse) are highly spectacular and well known, have even inspired many artists and writers and are among the most unique expressions of the animal kingdom in this area.

Steppe species

These species are originally from the Asian stepps, having reached the ridges in the Alpine arc during the Quaternary era, where they left specimns, often relicts, in steppe formations which may be natural in origin (Alpine prairies, mountain pastures) or may be represented by cultivated steppes, namely in grain fields. This group of animals includes the Alpine marmot (*Marmota marmota*), whose distribution area is limited to the Alps and the Tatra, being differentiated on a specific level from its affine Asian species. This component is well represented by the insects of the high elevation prairies, especially among the orthopterans and beetles.

Alpine or Alpine related species

These are northern species, Alpine or similar species, often with a vast Asian-European, Siberian-European, or European distribution or may have a more limited distribution area, such as a Central European or Alpine area. These species, which represent a large percentage of the high elevation Alpine population, prefer the cool and damp habitats formed by the higher altitude plant life (montane, Alpine or snowy).

Southern thermophile elements

The northern penetration of thermophile species during the Quaternary era, that grew and thrived in the warm interglacial periods and, recently, by the end of the most recent glacial period, usually involves only the elevations below the montane vegetation belt. Therefore, these elements are present only in the more peripheral areas of the Dolomites.

Significant species of the Dolomite animal population

Among the mammals living in the Dolomite area, the species lending particular prestige are the chamois (*Rupicapra rupicapra*), the Alpine marmot (*Marmota marmota*), the mountain hare (*Lepus timidus*), the snow vole (*Chionomys nivalis*), and the Alpine shrew (*Sorex alpinus*). The brown bear (*Ursus arctos*) was object of a reintroduction campaign into the Trentino area of the Dolomites but it is also returning spontaneously to these lands as part of the natural event known as the "return of the great predators". We should also remember the European red deer (*Cervus elaphus*), the roe deer (*Capreolus capreolus*), the Eurasian badger (*Meles meles*), the pine marten (*Martes martes*), the least weasel (*Mustela nivalis*), the short-tailed weasel (*Mustela erminea*), the water shrew (*Neomys fodiens*), and the squirrel (*Sciurus vulgaris*). Among the birds, a substantial presence in the higher elevations of the Dolomites, in addition to the four Tetraonidae already mentioned, is the golden eagle (*Aquila chrysaetos*). The golden eagle – the largest predator in the area – is the unquestionable symbol of the mountains and, as a result, of the Dolomites. After centuries of persecution, new protective measures specifically for the species and increases in the populations of its prey (ungulates and marmots

in particular) have allowed the eagle to regain a foothold in all the niches available, and the Dolomite area now hosts a few dozen breeding pairs. Major studies and projects, including one project currently in progress (an Interreg project, with the participation of the Parco Nazionale Dolomiti Bellunesi and Parco Naturale Fanes-Senes-Braies/Fanes-Senes-Prags), have drawn up an outline of the situation and monitored a number of pairs, providing results that are also of significant importance for administrative purposes (protection of nesting areas). Another important member of the birds of prey is the goshawk (*Accipiter gentilis*), which can be seen at elevations up to 2,500 m. The griffon vulture (*Gyps fulvus*) is also frequently sighted in the southern Dolomites, due to the reintroduction efforts made of the species in Friuli-Venezia Giulia.

The golden eagle (Aquila chrysaetos) populates large expanses of the Dolomites in relatively stable populations.

Several species are moving into the high pastures and beyond, including the common swift (*Apus apus* and *A. melba*), the crag martin (*Ptyonoprogne rupestris*), the common raven (*Corvus corax*), the Alpine chough (*Pyrrhocorax graculus*), the black-capped chickadee (*Parus atricapillus*), the black redstart (*Phoenicurus ochruros*), the whinchat (*Saxicola rubetra*), the Alpine accentor (*Prunella collaris*), the brambling (*Fringilla montifringilla*), the snow bunting (*Plectrophenax nivalis*) and the white-winged snowfinch (*Montifringilla nivalis*), which has been observed at elevations up to 2,500 m. The most notable species for aspect and habits is the wallcreeper (*Tichodroma muraria*), which is the European vertebrate most adapted to life on the craggy walls of the high mountains. Of the snakes, the most frequent and widespread is the common adder (*Vipera berus*), while the nose-horned viper (*Vipera ammodytes*) is extremely localized, with populations in the Val di Fiemme, in the valley of T. Cordevole, in the center of Cadore and in the Dolomiti Friulane. As for the lizards, the most widespread and characteristic species found on the pastures above 2,000 m in elevation is the viviparous lizard (*Zootoca vivipara*), which can subsist at altitudes even above 2,500 m. Still fairly unknown, due to its similarity to other species, is the distribution of the Horvath lizard (*Iberolacerta horvathi*), which lives nearly exclusively on the rocky walls and in stony accumulations, up to 2,000 m in al-

titude. Among the amphibians, the most characteristic is the Alpine salamander (*Salamandra atra*) which has been observed up to 2,300 meters in the Dolomites. The same altitudes also give a home to the male Alpine newt (*Triturus alpestris*). Several species of invertebrates have adapted to the higher elevations in the Dolomites. Among the coleopterans, for example, the species *Cychrus caraboides*, *Carabus creutzeri kircheri*, *Notiophilus biguttatus*, *Amara erratica*, *Harpalus laevipes*, *Trichotichnus laevicollis*, *Quedius alpestris*, *Teuchestes fossor*, *Athous subfuscus*, *Otiorhyncus prolixus*, *O. montivagus*, *O. nodosus*, *O. chalceus*, *O. hadrocerus*, *O. cadoricus*, *O. subdentatus*, and *O. subquadratus* have been observed; among the dipterans, *Bibio pomonae*, *Scaeva pyrastri*, and *Platycheirus manicatus* are found up to 2,500 meters and higher. Among the daytime butterflies of the high elevation grazing land and screes, in addition to the spectacular Apollo butterfly (*Parnassius Apollo)*, which is not found at elevations beyond 1,600 m, noteworthy are its cousin, the clouded Apollo (*P. mnemosyne)*, *Pieris callidice*, the mountain clouded yellow (*Colias phicomone)*, the Alpine heath (*Coenonympha gardetta)*, the silky ring- let (*Erebia gorge)*, the eriphyle ringlet (*E. eriphyle)*, the large ringlet *(E. euryale)*, the blind ringlet (*E. pharte)*, the common brassy ringlet (*E. cassioides)*, the woodland ringlet (*E. medusa)*, the dewy ringlet *(E. pandrose)*, the sooty ringlet (*E. Pluto)*, the Shepherd's fritillary (*Boloria pales)*, the mountain fritillary (*B. napaea)*, the mazarine blue (*Cyaniris semiargus*), and the Alpine blue *(Plebeius (Albulina) orbitulus)*. At very high elevations, up to 2,500 meters, several species of butterfly with extraordinary ecological value fill the air, such as the lesser tortoiseshell and the painted lady (*Vanessa urticae* and *V. cardui)*, on the paths of the long-range migratory movements that cross the Dolomites. The blooms of the high elevation pioneer plants are visited by several spectacular hymenopters apoidea, such as *Psithyrus flavidus* and *Bombus elegans*, which subsist at elevations above 2,500 m, and *Bombus pyrenaeus*, which has been sighted at over 3,000 m. Among the dipterans, well represented in the higher belts are the Chironomidae and Sciaridae, two families that on the Dolomites include two small-winged endemic species, respectively *Bryophaenocladius thaleri* and *Lycoriella ventrosa*, both found at over 3,000 meters. Among the small-winged insects, an interesting specimen is the mecoptera *Boreus hyemalis*, which is active mainly in the winter and which has been observed in the Dolomites up to 3,200 meters. Among the arthropods, which have been sighted up to 2,500 m and beyond, on the Dolomites, several spiders such as *Alopecosa pulverulenta*, *Gnaphosa badia*, *Pardosa nigra* and *Erigone tirolensis* (the last two species have been sighted above 3,000 m), myriapods such as *Glomeris helvetica* (a circumalpine species with a fragmented distributional range), *Leptoiulus alemannicus* and *L. montivagus* and isopod crustaceans such as *Trachelipus ratzeburgii*. Endemic in the Dolomites are the spider species *Lepthyphantes merretti* and *L. brunneri*. The terrestrial mollusc community is very extensive in the most peripheral districts. A recent survey conducted in the Parco delle Dolomiti Bellunesi (Dalfreddo *et al.* 2000) has led to classification of some 134 species, 111 which are land-inhabiting and 23 live in fresh water. Of this quota, some 75 species are found in the subalpine transitional belt between 1,600 and 1,900 m and 47 species reach or exceed 1,900 m. This population is much poorer in the more internal areas, for edaphic (the molluscs are much more scarce on non-carbonate soils), climatic and historic reasons. Also noteworthy are the *Truncatellina monodon*, present at higher elevations on the Sciliar, the Catinaccio, and the Alpe di Fedaia, and the rare *Neostyriaca corynodes*. Among the Annelida phylum, two species of Lumbricus subsist at very high elevations, despite the low depth of the soil. These are *Dendrobaena rubida,* up to 2,300 meters, and *Lumbricus rubellus* up to 2,400 meters. Among the aquatic species, the small leech *Helobdella stagnalis* reaches habitats up to 2,500 meters.

The animal population of several peculiar Dolomite habitats

A small colony of insects, some of which in a boreoalpine geographic distribution, is related to the dwarf willow. Characteristic and frequent is the presence of hymenopters of the *Pontania* genus, whose females have determined the formation of characteristic galls on the leaves of the willows (or bilberry in the case of *P. vacciniella*). The Alpine prairies give a home to several species of grasshoppers, many of which are steppe relicts. In the Alpine plains there are several species of daytime and night-time butterflies, often characterized by relict and disconnected distributions. Among these, the beautiful Papilionidae or swallowtails of the *Parnassius* genus and the small but no less spectacular *Zygaena exulans*, which can be found even at the higher elevations; what's more, *Euphydrias cynthia* and various species of the *Boloria*, *Melitaea*, *Colias* and *Pontia* genera have been observed as well as the numerous Satyridae of the *Erebia* genus. In the realms used primarily as grazing land, there is no lack of coprofagia insects, several of which are closely related to the higher elevations and have a limited geographic distribution. Among these, *Neagolius montanus* is endemic of the Dolomites and the Veneto Prealps. The poor vegetation of the screes and the landslides give a home to a significant community of Orthopterans, including *Antaxius difformis*, characteristic of the central and eastern Alps, which live only in the mountain and Alpine habitats and are locally represented by large populations. *Chopardius pedestris* also lives at the lower elevations and in a vaster range of realms, but often represents a characteristic element of the local craggy mountain habitats. Among the most frequently found species on the rare grassy vegetation of the mountain screes, especially in the areas adjacent to the Sesleria grasslands, or in the vicinity of low growing juniper and rhododendron shrubs, we might remember not only the widespread *Tetrix bipunctata*, but also various podismines among which *Chorthopodisma cobellii*, endemic in north eastern Italy. Living in between the rocks, the Japanese beetles are represented by many forms in a narrow distribution area, which often have small wings and therefore, scarce movement capacity. This condition has promoted the formation of isolated colonies which tend to differentiate themselves in endemic subspecies or species in a narrow distributional range. Among the representatives of the *Carabus* genus, there are several species of the *Platycarabus* sub-genus, such as *C. creutzeri*. In the damp screes of the Alps, there are other species of Japanese beetles, less showy but holding a significant biogeographical interest, which belong to the *Ocydromus*, *Trechus* and *Oreonebria* genera. The many orophile species of the *Amara*, *Pterostichus*, *Harpalus* and *Cymindis* genera are present with a certain regularity in these areas. Of the weevils, the region gives a home to representatives of the *Dichotrachelus* genus with various endemic and subendemic species, all related to the *Saxifraga* spp., and typical of the precipitous rocks and the vertical walls of the great massifs of the medium and height elevations. Of great interest is the fauna associated with Dolomite lime-rich screes where the latter are consolidated by *Carex firma* grasslands with *Dryas octopetala* (the so-called *Dryas* stairs). In this type of environment, clods form where the soil is deep enough and this becomes a preferred habitat for many apterous and small-eyed species of the Leptusa genus of beetles such as *L. manfredi*, *L. tirolensis tirolensis* and *L. tridentina*. Also in the *Carex firma* grasslands, on the *Dryas* flowers and frequently other white flowers such as the *Cerastium* we have found several rove beetles of the *Eusphalerum* genus in punctiform distribution: *E. annaerosae* is endemic in the Dolomites. The rocky walls are inhabited by several species of birds such as the Alpine chough (*Pyrrhocorax graculus*), which builds its nests at over 1,500 m in elevation and pushes to the snowy belt in search of food. The common raven (*Corvus corax*) builds its nest in the niches that open up on the mountain crags, while on the less windy walls the crag martin (*Ptyonoprogne rupestris*), the golden eagle (*Aquila chrysaetos*) and several species of falcons also make their nests, such as the kestrel (*Falco tinnunculus*) and the peregrine falcon (*Falco peregrinus*), though these tend to be confined to the lower elevations. Among the vertebrates, the species most specialized for living, reproducing and finding food on the rocky walls is the wallcreeper (*Tichodroma muraria*). In the Dolomites, the peat bog habitats have a relict character and therefore, give a home to large populations of biogeographical value, despite being scarce in species by number. Among the vertebrates, the Alpine

salamander (*Salamandra atra*) is found in numbers and it also frequents red fir woods and mountain grazing land above 2,100 meters in elevation; in addition, we also find the male Alpine newt (*Triturus alpestris*), the common frog (*Rana temporaria*), the common adder (*Vipera berus*) and the viviparous lizard (*Zootoca vivipara*). Of the Japanese beetles, the most prestigious species is *Agonum ericeti*, though there is a certain lack of precise information on this species; among the rove beetles, worthy of mention are the *Atanygnathus terminalis*, *Tetartopeus sphagnetorum* and the boreoalpine *Eucnecosum tenue*, found at elevations higher than 2,000 m Few but specialized are the dragonflies that fulfil their development in the acidic waters of the peat bogs. Flying adults of the species represent one of the most characteristic presence of these realms. Especially significant are *Sympetrum flaveolum*, *Leucorrhinia dubia* and *Aeshna juncea*.

Aquatic fauna

Despite that the cold climate of the mountain limits their period of activity to a few months a year, rather numerous are the animal species that populate the small lakes and streams or rivers in the Dolomites. Several species of insects (dragonflies, hemipterans, dipterans, caddis-flies, coleopterans), crustaceans (amphiphods, cladocera, copepods) and even molluscs (both gasteropods and bivalves) have been observed in habitats over 2,000 m, for example in Laghetto di Valparola (2,143 m), in Lago di Boè at 2,250 m and in Lago di Fedaia at 2,028 m. This latter also gives a home to a population of common frog (*Rana temporaria*). The tiny temporary pools of water that form seasonally in the Alpine pastures are also rich in animal life - seven species of aquatic beetles have been found in a pool near Lastè di Lusia, at 2,100-2,200 m. Fewer in number but extremely specialized and therefore important from a physiological and biogeographical perspective, are the species that live in the melted water of the glaciers, where the temperature is only a couple degrees above zero and which includes insect larva (dipterans of the *Diamesa* genus, trichoptera of the *Cryptothrix nebulicola* species) and Platyhelminthes. The snowy fauna is characterized by the so-called glacier fleas, primitive, wingless insects (collembola) that can spend their entire biological cycle on the surface of glaciers, and by a genus of small wing dipterans with an appearance similar to a small spider (*Chionea*), whose adults are active on the snow during the cold season.

Species of Community importance

Among the species included in Annex 2 of the Habitat Directive, the Dolomites give a home to the brown bear, the lynx, the coleopteran *Rosalia alpina*, the lepidopterans *Erebia calcaria* and *Euphydrias aurinia*, and the mollusc *Vertigo moulinsiana*. Among the species under Annex 4, in addition to the aforementioned, *Rosalia alpina*, also present are the lepidopterans *Maculinea arion*, *Parnassius apollo* and *P. mnemosyne*. Of the species listed in Annex 1 of the Bird Directive, we observe the lammergeier (*Gypaetus barbatus*) (whose presence is due to the recent reintroduction campaign in adjacent areas), the European honey-buzzard (*Pernis apivorus*), the yellow-billed kite (*Milvus migrans*), the golden eagle (*Aquila chrysaetos*), the peregrine falcon (*Falco peregrinus*), the hazel grouse (*Bonasa bonasia*), the rock ptarmigan (*Lagopus mutus helvetica*), the black grouse (*Tetrao tetrix*), the capercaillie (*Tetrao urogallus*), the rock partridge (*Alectoris graeca*), the corn crake (*Crex crex*), the european eagle owl (*Bubo bubo*), the eurasian pygmy owl (*Glaucidium passerinum*), the boreal owl (*Aegolius funereus*), the european nightjar (*Caprimulgus europaeus*), the common kingfisher (*Alcedo atthis*), the greyfaced woodpecker (*Picus canus*), the black woodpecker (*Dryocopus martius*) the three-toed woodpecker (*Picoides tridactylus*), and the red-backed shrike (*Lanius collurio*).

Tetrao urogallus

Lanius collurio

Lagopus mutus

The importance of the fauna

The reasons for affirming the great value of the Dolomites from the point of view of the fauna are to be found in a crowded series of elements that we will sum up point by point. Before considering, albeit briefly, each of the single points, it is worth emphasizing that this large area includes a huge variety of thermophile and mountain-alpine habitats, respectively distributed in the southern and central-northern sectors of the property. It is therefore particularly difficult and complex to describe local fauna species, also because sufficiently in-depth studies have not yet been conducted in the area. However, a rather special mingling of thermophile and mountain-alpine fauna can be seen, which is particularly evident in the zones straddling the southern and southeastern borders. A remarkable number of amphibian species are represented, distributed in diverse sectors and environments, thus including the most varied ecological niches (Alpine salamander *Salamandra atra,* fire salamander *Salamandra salamandra,* male Alpine newt *Triturus alpestris,* Italian crested newt *Triturus carnifex,* Southern smooth newt *Triturus vulgaris meridionalis,* yellow-belly toad *Bombina variegata,* common

toad *Bufo bufo,* green toad *Bufo viridis,* Italian tree toad *Hyla intermedia,* green frog synklepton *Rana* (*P.*) synklepton *esculenta*, agile frog *Rana* (*R.*) *dalmatina*, Italian agile frog *Rana* (*R.*) *latastei*, common frog *Rana* (*R.*) *temporaria*). Among the reptiles, the nose—orned viper (*Vipera ammodytes*) and the Horvath's rock lizard (*Iberolacerta horvathi*) stand out for their naturalistic value, but the number of species is so great that grouping and description is far from easy (slow worm *Anguis fragilis,* western green lizard *Lacerta bilineata,* common wall lizard *Podarcis muralis,* viviparous lizard *Zootoca vivipara carniolica,* Western wip snake *Hierophis viridiflavus,* smooth snake *Coronella austriaca,* Aesculapian snake *Zamenis longissimus,* grass snake *Natrix natrix,* dice snake *Natrix tessellata, Vipera aspis francisciredi,* common adder *Vipera berus*). The vast area is of outstanding ornithological importance, both for the quality of the avian communities, and for the species present. The northern section is very interesting for the presence of the species that are typical of the Alpine biome, for example: wallcreeper (*Tichodroma muraria*), Alpine chough (*Pyrrhocorax graculus*), white-winged snowfinch (*Montifringilla nivalis*), Alpine accentor (*Prunella collaris*). But many other taxa can be mentioned, such as: European honeybuzzard (*Pernis apivorus*), black kite (*Milvus migrans*), golden eagle (*Aquila chrysaetos*), peregrine falcon (*Falco peregrinus*), hazel grouse (*Bonasa bonasia*), *Lagopus mutus helveticus,* black grouse (*Tetrao tetrix tetrix*), Eurasian pygmy owl (*Glaucidium passerinum*), boreal owl (*Aegolius funereus*), grey-faced wookpecker (*Picus canus*), black woodpecker (*Dryocopus martius*), three-toed woodpecker (*Picoides tridactylus*), red-backed shrike (*Lanius collurio*). The extension of the zone allows for the survival of entire avian populations. Apart from species of Community interest, it is important to underline the presence of many other species that are significant at a regional or provincial level, for example: goshawk (*Accipiter gentilis*), sparrowhawk (*Accipiter nisus*), kestrel (*Falco tinnunculus*), Eurasian tawny owl (*Strix aluco*), to name but a few. Many of the sweeping grassy-rocky areas of the zone are still frequented by the rock partridge (*Alectoris graeca saxatilis*), with moderate to good population densities in some cases. And even *Gyps fulvus,* the griffon vulture, is sporadically sighted on these mountains. Included in the fauna of major value in the class of mammals, the garden dormouse (*Eliomys quercinus*) must be mentioned; it is generally rare and localized elsewhere, but in this area it is common and widespread. The European wild cat (*Felis s. silvestris*) avoids both the higher altitudes and the more internal zones of these mountains, but can be found in the south-eastern sector (Parco delle Dolomiti Friulane). And the polecat (*Mustela* (*Putorius*) *putorius*) is still present in several of the valleys (Lago di Tramonti), while the beech martin (*Martes f. foina*) very often shares its territory with the pine marten (*Martes m. martes*), and Northern lynx (*Lynx lynx carpathicus*) is occasionally seen. The brown bear, *Ursus arctos,* also makes sporadic appearances in the area, although sightings are irregular and there seem to be no real populations as such. The Alpine marmot (*Marmota marmota*) populations of these mountains, which were originally introduced by man, are well established and widespread. Insectivores are represented by various species, as important as they are varied (Western hedgehog *Erinaceus europaeus italicus,* Alpine shrew *Sorex alpinus,* common shrew *Sorex araneus,* pymgy shrew *Sorex minutus,* Miller's water shrew *Neomys anomalus*, water shrew *Neomys fodiens,* bicloured white-toothed shrew *Crocidura leucodon,* lesser white-toothed shrew *Crocidura suaveolens,* mole *Talpa europaea*), while only a few species of bat have been reported as yet (brown long-eared bat *Plecotus auritus*, *Miniopterus schreibersii, etc.*). Lagomorphs are represented by the brown hare (*Lepus europaeus*) and by the splendid mountain hare (*Lepus timidus varronis*) that has survived from the Rissian glaciation. Numerous arboreal rodents inhabit the forested areas (red squirrel *Sciurus vulgaris,* fat dormouse *Glis glis,* garden dormouse *Eliomys quercinus*, dormouse *Muscardinus avellanarius*), while the bank vole (*Clethrionomys glareolus*) and the yellow-naked mouse (*Apodemus* (*Sylvaemus*) *flavicollis*) share the forest undergrowth. *Microtus* (*Terricola*) *subterraneus,* the pine vole that prefers cold environments and which is one of the typical species of the internal Alpine mountain chain, has recently been captured in the area. The common vole (*Microtus* (*T.*) *arvalis*), the Liechtenstein's pine vole *Microtus* (*T.*) *liechtensteini*, the snow vole (*Chionomys nivalis*), striped field mouse *Apodemus* (*Apodemus*) *agrarius*, the wood mouse (*Apodemus* (*S.*) *sylvaticus*),

brown rat *Rattus norvegicus,* black rat *Rattus rattus*, the red fox (*Vulpes vulpes*), the Eurasian badger *Meles meles*, the short-tailed weasel (*Mustela* (*Mustela*) *erminea*), the least weasel (*Mustela* (*M.*) *n. nivalis* and *Mustela* (*M.*) *nivalis vulgaris*), complete the basic list of very small and slightly larger fauna. In some areas the wild boar (*Sus scrofa*), which has been enjoying a phase of expansion in recent years, is fairly frequent, whereas the red deer (*Cervus elaphus*) has long been common and widespread. The roe deer (*Capreolus capreolus*) is a dominant species as regards the hoofed fauna of the forested areas at moderate altitudes. The ibex (*Capra ibex*) has been reintroduced on several massifs. The chamois (*Rupicapra rupicapra*) populations are noteworthy and in many zones have reached remarkably high densities. The European mouflon (*Ovis orientalis*), which was introduced purely for hunting, is also common in certain zones.

Picus canus

Picoides tridactylus

Dryocopus martius.

Thanks to knowledge of the entomofauna, it has been discovered that the decentralized position of these areas in respect of the more glaciated zones of the central Alps may indicate a faunistic and biogeographical situation of outstanding importance, especially as regards the Dolomiti Friulane and the Dolomiti Bellunesi. The influence of the Pleistocene glaciations is evident, particularly in consideration of the conspicuous presence, for example, of stenoendemites of the 'massifs de réfuge' and of the nunattakers, mostly constituted of endogenous, less-visible bio-elements. Stenoendemites defined by Poldini, 1974 as '*esocarnici*', i.e. limited to the western Prealpi Carniche, include for example the carabid beetles *Abax springeri* (Müller, 1925), *Cymindis carnica* (Müller, 1924) and *Amara uhligi* (Holdhaus, 1904). In the Parco Nazionale delle Dolomiti Bellunesi there are pre-glacial mollusks and, within the sphere of the vast range of insects, the carabid beetles that live in the caves and underground environments. Certain exclusive endemic species are present, such as *Orotrechus pavionis*, *O. theresiae*, *Neobathyscia dalpiazi*, *Leptusa pascuorum pavionis,* and others that are still being studied.
The information available at present, however, is more than sufficient to confirm the exceptional biogeographical value of the territory. The reasons for which this territory can be declared of outstanding value as regards fauna are summed up below point by point.

Wealth and singularity of the animal populations. It can be estimated that the fauna population is 10% of the entire non-marine fauna of Europe; the recent census (www.faunaeur.org) has recorded just over 130,000 species. Lepidoptera alone (butterflies and moths) are present on the Dolomites with a contingent of at least 1,600 species.

The presence of elements that are endemic to the Alps. The Dolomites are noteworthy for the presence of endemic or subendemic species, characterized, therefore, by distribution over a limited area that in some cases is entirely within the Dolomites area: carabid beetles of the *Carabus* genus, such as *C. (Orinocarabus) adamellicola, C. (O.) alpestris dolomitanus* and *C. (Orinocarabus) bertolinii*; beetles of the *Nebria*, *Trechus*, *Simplocaria*, *Dichotrachelus*, *Otiorhynchus* and *Oreina genii*.

The presence of glacial relicts on the 'massifs de réfuge'. Above all in the pre-Alpine bands, but also on the southern border area of the Dolomites, glacial relicts are present.

The presence of paleo-mountain and paleoxero-mountain species. The Dolomites, in as much as being part of the Alps, are the habitat of species that are distributed only in the high Palearctic mountain systems. Bird species include the dipper (*Cinclus cinclus*), the Alpine accentor (*Prunella collaris*), the wallcreeper (*Tichodroma muraria*), the Alpine chough (*Pyrrhocorax graculus*), and the white-winged snowfinch (*Montifringilla nivalis*). Other species, which have adapted to the particular conditions, found in the more arid mountain areas (always with reference to birds) are: the crag martin (*Ptyonoprogne rupestris*), the black redstart (*Phoenicurus ochruros*), and the rock thrush (*Monticola saxatilis*).

The presence of Boreo-Alpine and Arctic-Alpine species . The zoogeographic value of the Dolomites must be considered in relationship to a series of elements among which the presence of species with inadunate distribution ranges is certainly important. Examples of such species are: the mountain hare (*Lepus timidus varronis*), the rock ptarmigan (*Lagopus mutus*), the three-toed woodpecker (*Picoides tridactylus*), the redpoll (*Carduelis flammea*), the ring ouzel (*Turdus torquatus*); the boreo-Alpine diurnal butterfies: *Parnassius apollo*, *Pontia callidice*, *Boloria pales*, *B. thore*, *Erebia epiphron*, *Plebeius (Albulina) orbitulus*, *Pyrgus andromedae*; the boreo-Alpine nocturnal moths: *Agrotis fatidica*, *Elophos vittaria*, *Pygmaena fusca*, *Grammia quenseli*, *Setema cereola*, *Sterrhopterix standfussi*, *Gazoryctria ganna*; the Staphylinidae beetle *Mannerheimia arctica*, the presence of which on the Italian Alps is limited to two stations, one of which is in the Dolomites; the Staphylinidae beetle *Eucnecosum tenue;* the Elateridae *Selatosomus confluens;* the minute diptera known as the spuler (*Crumomyia setitibialis*); the wood-boring hemiptera (*Geocoris lapponicus*).

The presence of Steppe species. Always from the zoogeographic viewpoint, it is important to note the presence of steppe elements, including the common marmot (*Marmota marmota*), which although an introduced species, is nevertheless important.

The presence of Alpine species and like-Alpine species. These are northern, Alpine or like-Alpine elements, many of which are distributed over vast Asian-European, Siberian-European, and European type areas, although the distribution of others is of the more limited central-European or Alpine type. These species, which constitute a relevant fraction of the high-altitude animal population, prefer the cool, damp conditions of the upper slopes where, however, there is still vegetation (mountain, Alpine and snow-covered environments)

The presence of southern thermophile species. One such is the endemic Italian amphibian *Hyla meridionalis* (stripeless treefog), found in the southern areas of the Dolomites.

The presence of central-European fauna. It is highly likely that certain central-European species (e.g. the European tree frog *Hyla arborea*) may be present on the northern border areas of the Dolomites, although due to the lack of study in this area there is no relative documentation as yet

The presence of species in their own marginal areas. These are the numerous species for which the Dolomites represent the margin of their own distributional area. Particular importance seems to be represented by arrivals from the Balkans, particularly evident in the more southern and eastern sectors, such as the nose-horned viper (*Vipera ammodytes*), Horvath's rock lizard (*Archaeolacerta*

horvathi), and the forest dormouse (*Dryomis nitedula*).

The presence of numerous species listed as protected by international directives and conventions and/or entered on red lists. A particularly relevant number of species present in the area are listed as protected by international directives and agreements and/or included on red lists. The main examples are listed below.

IUCN Red List

Crex Crex	NT	ver 3.1 (2001)
Rhinolophus ferrumequinum	LR/nt	ver 2.3 (1994)
Chionomys nivalis	LR/nt	ver 2.3 (1994)
Muscardinus avellanarius	LR/nt	ver 2.3 (1994)
Sciurus vulgaris	NT	ver 3.31 (2001)
Parnassius apollo	VU A 1cde	ver 2.3 (1994)
Lycaena dispar	LR/nt	ver 2.3 (1994)
Rosalia alpina	VU A 1 ce	ver 2.3 (1994)
Vertigo angustior	LR/cd	ver 2.3 (1994)
Formica “Formica spp. of the F. rufa group”	LR/nt	ver 2.3 (1994)

CR = critically endangered species, i.e. with a very high risk of extinction in the immediate future.
EN = endangered species, i.e. with a very high risk of extinction in the near future.
VU = vulnerable species, i.e. with a high risk of extinction in the medium-term future.
LR = specie at low risk, i.e. not in the above risk categories, but the state of conservation is not risk-free.
DD = species on which there is insufficient information

HABITAT DIRECTIVE (Directive 92/43/EEC)

ANNEX II: Animal and plant species of Community interest whose conservation requires the designation of special areas of conservation
INSECTS
The *Rosalia alpina* beetle
The *Erebia calcaria* lepidopter
The *Euphydrias aurinia* lepidopter
MOLLUSKS
Vertigo moulinsiana
AMPHIBIANS
Italian crested newt *Triturus carnifex* (LAURENTI, 1768)
Yellowbelly toad *Bombina variegata variegata* (LINNÉ, 1758)
MAMMALS
Bear and lynx are also priority species
Numerous bats

Bear *Ursus arctos* LINNÉ, 1758
Lynx *Lynx lynx* (LINNÉ, 1758)
FISH
-Marbled trout *Salmo* (*trutta*) *marmoratus* (CUVIER, 1817)
-Bullhead *Cottus gobio* LINNÉ, 1758

ANNEX IV: Animal and plant species of Community interest in need of strict protection
INSECTS
The *Rosalia alpina* beetle
The *Maculinea arion* lepidopter
The *Parnassius apollo* lepidopter
The *Parnassius mnemosyne* lepidopter
AMPHIBIANS
Alpine salamander *Salamandra atra atra* LAURENTI, 1768
Italian crested newt *Triturus carnifex* (LAURENTI, 1768)
Yellow-bellied toad *Bombina variegata variegata* (LINNÉ, 1758)
Green toad *Bufo viridis viridis* LAURENTI, 1768
Agile frog *Rana dalmatina* BONAPARTE, 1840
REPTILES
Horvath's rock lizard *Lacerta* (*Archaeolacerta*) *horvathi* MEHELY, 1904
Western green lizard *Lacerta bilineata*
Wall lizard *Podarcis muralis* (LAURENTI, 1768)
Dark green snake *Coluber viridiflavus* LACEPEDE, 1789
Smooth snake *Coronella austriaca* LAURENTI, 1768
Aesculapian snake, Anda *Elaphe longissima longissima* (LAURENTI, 1768)
Dice snake *Natrix tessellata tessellata* (LAURENTI, 1768)
Nose-horned viper *Vipera ammodytes ammodytes* (LINNÉ, 1758)
MAMMALS
Bats: all species
Forest dormouse *Dryoms nitedula* (PALLAS, 1779)
Dormouse *Muscardinus avellanarius avellanarius* (LINNÉ, 1758)
Brown bear *Ursus arctos* LINNÉ, 1758
European wild cat *Felis silvestris silvestris* SCHREBER, 1777
Lynx *Lynx lynx* (LINNÉ, 1758)

ANNEX V: Animal and plant species of Community interest whose taking in the wild and exploitation may be subject to management measures
MOLLUSKS
Helix pomatia
AMPHIBIANS
Green frog sinklepton *Rana* synklepton *esculenta* LINNÉ, 1758
Common frog *Rana temporaria* LINNÉ, 1758
MAMMALS
Mountain hare *Lepus timidus* LINNÉ, 1758
Golden jackal *Canis aureus* LINNÉ, 1758
Polecat *Mustela putorius* LINNÉ, 1758
Pine marten *Martes martes* (LINNÉ, 1758)
Chamois *Rupicapra rupicapra* (LINNÉ, 1758)
Ibex *Capra ibex*

BIRD DIRECTIVE (Directive 79/409/EEC)

ANNEX I: Species for which special conservation measures are foreseen concerning their regards habitat in order to ensure their survival and reproduction in their area of distribution
European honey-buzzard *Pernis apivorus* (LINNÉ, 1758)
Black kite *Milvus migrans* (BODDAERT, 1783)
Lammergeier *Gypaetus barbatus* (LINNÉ, 1758) (presence due to recent reintroduction programs in adjacent areas)
Griffon vulture *Gyps fulvus* (HABLIZL, 1783)
Golden eagle *Aquila chrysaetos* (LINNÉ, 1758)
Peregrine falcon *Falco peregrinus* TUNSTALL, 1771
Hazel grouse *Bonasa bonasia* (LINNÉ, 1758)
Rock ptarmigan *Lagopus mutus* (MONTIN, 1776)
Black grouse *Tetrao tetrix* LINNÉ, 1758
Capercaillie *Tetrao urogallus* LINNÉ, 1758
Rock partridge *Alectoris graeca* (MEISNER, 1804)
Corn crake *Crex crex* (LINNÉ 1758)
European eagle owl *Bubo bubo* (LINNÉ 1758)
Eurasian pygmy owl *Glaucidium passerinum* (LINNÉ, 1758)
Boreal owl *Aegolius funereus* (LINNÉ, 1758)
European nightjar *Caprimulgus europaeus* LINNÉ, 1758
Common kingfisher *Alcedo atthis* LINNÉ, 1758
Grey-faced woodpecker *Picus canus* GMELIN, 1788
Black woodpecker *Dryocopus martius* (LINNÉ, 1758)
Three-toed woodpecker (*Picoides tridactylus*)
Red-backed shrike *Lanius collurio* LINNÉ, 1758

NEW RED LIST OF ITALIAN BREEDING BIRDS
Adopted and recommended by the CISO. LIPU & WWF (eds.): E. Calvario, M. Gustin, S. Sarrocco, U. Gallo Orsi, F. Bulgarini & F. Fraticelli in collaboration with A. Gariboldi, P. Brichetti, F. Petretti & B. Massa The present list represents the updating of the previous one (Frugis & Schenk 1981; Brichetti & Cambi 1982) and has been compiled according to the guidelines and criteria suggested by the IUCN (1994). Questa lista aggiorna la precedente (Frugis & Schenk 1981; Brichetti & Cambi 1982) e utilizza le categorie di minaccia e le linee guida proposte dall'IUCN (1994).

Systematic List (1988-1997)
European honey-buzzard *Pernis apivorus* Vulnerable
Black kite *Milvus migrans* Vulnerable
Lammergeier *Gypaetus barbatus* Extinct
Griffon vulture *Gyps fulvus* Endangered
Goshawk *Accipiter gentilis* Vulnerable
Golden eagle *Aquila chrysaetos* Vulnerable
Peregrine falcon *Falco peregrinus* Vulnerable
Hazel grouse *Bonasa bonasia* Lower Risk
Rock ptarmigan *Lagopus mutus* Vulnerable
Black grouse *Tetrao tetrix* Lower Risk
Capercaillie *Tetrao urogallus* Vulnerable
Rock partridge *Alectoris graeca* Vulnerable
Quail *Coturnix coturnix* Lower Risk

Corn crake *Crex crex* Endangered
Little ringed plover *Charadrius dubius* Lower Risk
Woodcock *Scolopax rusticola* Endangered
Scops owl *Otus scops* Lower Risk
European eagle owl *Bubo bubo* Vulnerable
Eurasian pygmy owl *Glaucidium passerinum* Vulnerable
Ural owl *Strix uralensis* Not evaluated: recent immigration?
Long-eared owl *Asio otus* Lower Risk
Boreal owl *Aegolius funereus* Lower Risk
European nightjar *Caprimulgus europaeus* Lower Risk
Alpine swift *Apus melba* Lower Risk
Common kingfisher *Alcedo atthis* Lower Risk
Grey-faced woodpecker *Picus canus* Vulnerable
Green woodpecker *Picus viridis* Lower Risk
Three-toed woodpecker *Picoides tridactylus* Endangered
Dipper *Cinclus cinclus* Vulnerable
Rock thrush *Monticola saxatilis* Lower Risk
Wallcreeper *Tichodroma muraria* Lower Risk
Alpine chough *Pyrrhocorax graculus* Lower Risk
Common raven *Corvus corax* Lower Risk
White-winged snowfinch *Montifringilla nivalis* Lower Risk
Siskin *Carduelis spinus* Vulnerable
Hawfinch *Coccothraustes coccothraustes* Lower Risk

TUCKER G.M. & HEATH M.F., 1994. *BIRDS IN EUROPE: THEIR CONSERVATION STATUS* - CAMBRIDGE, U.K.: BIRDLIFE INTERNATIONAL, (BIRDLIFE CONSERVATION SERIES NO.3).

SPECIES	Tucker and Heat. 1994	
	SPEC	STATUS
Pernis apivorus	4	S
Milvus migrans	3	V
Aquila chrysaetos	3	R
Falco peregrinus	3	R
Falco tinnunculus	3	D
etrao tetrix	3	V
Alectoris graeca	2	(V)
Coturnix coturnix	3	V
Crex crex	1	V
Scolopax rusticola	3^{w}	V^{w}
Columba palumbus	4	S
Otus scops	2	(D)
Bubo bubo	3	V
Athene noctua	3	D
Strix aluco	4	S

Caprimulgus europaeus	2	(D)
Alcedo atthis	3	D
Jynx torquilla	3	D
Picus canus	3	D
Picus viridis	2	D
Picoides tridactylus	3	D
Alauda arvensis	3	V
Hirundo rustica	3	D
Prunella modularis	4	S
Erithacus rubecola	4	S
Phoenicurus phoenicurus	2	V
Saxicola rubetra	4	S
Saxicola torquata	3	(D)
Monticola saxatilis	3	(D)
Turdus merula	4	S
Turdus philomelos	4	S
Turdus pilaris	4w	S
Turdus torquatus	4	S
Turdus viscivorus	4	S
Sylvia atricapilla	4	S
Phylloscopus bonelli	4	S
Regulus ignicapillus	4	S
Regulus regulus	4	S
Muscicapa striata	3	D
Parus caeruleus	4	S
Parus cristatus	4	S
Certhia brachydactyla	4	S
Lanius collurio	3	(D)
Fringilla coelebs	4	S
Serinus serinus	4	S
Carduelis chloris	4	S
Emberiza cia	3	V

– "SPEC 1" = globally endangered species; "SPEC 2" = species concentrated in Europe, with unfavourable conservation status; "SPEC 3" = species not concentrated in Europe, with unfavourable conservation status; "SPEC 4" = species concentrated in Europe, with favourable conservation status;
– V = vulnerable; R = rare; D = in decline; S = safe;

THE BONN CONVENTION (ON THE CONSERVATION OF MIGRATORY SPECIES BELONGING TO WILD FAUNA)
Source: Internet site of the Ministry for the Environment and Protection of the Territory

Appendix 2: Goshawk *Accipiter gentilis*, Sparrowhawk *Accipiter nisus*, Golden eagle *Aquila chrysa etos*, Buzzard *Buteo buteo*, Griffon vulture *Gyps fulvus*, Black kite *Milvus migrans*, European honeybuzzard *Pernis apivorus*, Mallard *Anas platyrhynchos*, Little ringed plover *Charadrius dubius*, Common sandpiper *Actitis hypoleucos*, Woodcock *Scolopax rusticola*, Peregrine falcon *Falco peregrinus*, Kestrel *Falco tinnunculus,* Quail *Coturnix coturnix*, Corn crake *Crex crex*, Spotted flycatcher *Muscicapa striata*.

THE BERNE CONVENTION (ON THE CONSERVATION OF EUROPEAN WILDLIFE AND NATURAL HABITATS)
Source: Internet site of the Ministry for the Environment and Protection of the Territory

Appendix II: Green toad *Bufo viridis*, Yellow bellied toad *Bombina variegata,* Agile frog *Rana dalmatina,* Alpine salamander *Salamandra atra,* Italian crested newt *Triturus carnifex,* Common swift *Apus apus,* Alpine swift *Apus melba,* European nightjar *Caprimulgus europaeus,* Little ringed plover *Charadrius dubius,* Common kingfisher *Alcedo atthis,* Peregrine falcon *Falco peregrinus,* Kestrel *Falco tinnunculus,* Corn crake *Crex crex,* Long-tailed tit *Aegithalos caudatus,* Short-toed Treecreeper *Certhia brachydactyla,* Common treecreeper *Certhia familiaris,* Dipper *Cinclus cinclus,* Nutcracker *Nucifraga caryocatactes,* Alpine chough *Pyrrhocorax graculus,* Rock Bunting *Emberiza cia,* Greenfinch *Carduelis chloris,* Linnet *Carduelis cannabina,* Goldfinch *Carduelis carduelis,* Redpoll *Carduelis flammea,* Siskin *Carduelis spinus,* Common crossbill *Loxia curvirostra,* European Serin (finch) *Serinus serinus,* House martin *Delichon urbica,* Swallow *Hirundo rustica,* Crag martin *Ptyonoprogne rupestris,* Red-backed shrike *Lanius collurio,* Water pipit *Anthus spinoletta,* Tree pipit *Anthus trivialis,* Pied wagtail *Motacilla alba,* Grey wagtail *Motacilla cinerea,* Spotted flycatcher *Muscicapa striata,* Coal tit *Parus ater,* Blue tit *Parus caeruleus,* Crested tit *Parus cristatus,* Great tit *Parus major,* Willow tit *Parus montanus,* Marsh tit *Parus palustris,* White-winged snowfinch *Montifringilla nivalis,* Tree sparrow *Passer montanus,* Alpine accentor *Prunella collaris,* Dunnock *Prunella modularis,* Nuthatch *Sitta europea,* Common chiffchaff *Phylloscopus collybita,* Wood warbler *Phylloscopus sibilatrix,* Firecrest *Regulus ignicapillus,* Godcrest *Regulus regulus,* Blackcap *Sylvia atricapilla*, Common whitethroat *Sylvia communis,* Lesser whitethroat *Sylvia curruca,* Wallcreeper *Tichodroma muraria,* Winter wren *Troglodytes troglodytes,* Robin *Erithacus rubecula,* Rock thrush *Monticola saxatilis,* Northern wheatear *Oenanthe oenanthe,* Black redstart *Phoenicurus ochrurus,* Redstart *Phoenicurus phoenicurus,* Whinchat *Saxicola rubetra,* Stonechat *Saxicola torquata,* Ring ouzel *Turdus torquatus,* Black woodpecker *Dryocopus martius,* Wryneck *Jynx torquilla,* Great spotted woodpecker *Picoides major,* Three-toed woodpecker *Picoides tridactylus,* Grey-faced woodpecker *Picus canus,* Green woodpecker *Picus viridis,* Boreal owl *Aegolius funereus,* Long-eared owl *Asio otus,* Little owl *Athene noctua,* European eagle owl *Bubo bubo,* Eurasian pygmy owl *Glaucidium passerinum,* Scops owl *Otus scops,* Tawny owl *Strix aluco,* European wildcat *Felis silvestris,* Brown bear *Ursus arctos arctos,* European Brown Bear *Ursus arctos marsicanus,* Dark green snake *Coluber viridiflavus,* Smooth snake *Coronella austriaca,* Aesculapian snake *Elaphe longissima,* Dice snake *Natrix tessellata,* Horvath's rock lizard *Archaeolacerta horvathi,* Horvath's lizard *Lacerta horvathi,* Common wall lizard *Podarcis muralis,* Nose-horned viper *Vipera ammodytes.*

Appendix III: Common toad Bufo bufo, Italian tree frog Hyla intermedia, Common frog Rana temporaria, Fire salamander Salamandra salamandra, Alpine newt *Triturus alpestris,* Common newt *Triturus vulgaris,* Goshawk *Accipiter gentilis,* Sparrowhawk *Accipiter nisus,* Golden eagle *Aquila chrysaetos,* Buzzard *Buteo buteo,* Bearded vulture *Gypaetus barbatus,* Griffon vulture *Gyps ful-*

vus, Black kite *Milvus migrans,* European honey-buzzard *Pernis apivorus,* Mallard *Anas platyrhynchos,* Common sandpiper *Actitis hypoleucos,* Woodcock *Scolopax rusticola,* Eurasian Collared-Dove *Streptopelia decaocto,* Cuckoo *Cuculus canorus,* Quail *Coturnix coturnix,* Hazel grouse *Bonasa bonasia* Black grouse *Tetrao tetrix,* Capercaillie *Tetrao urogallus,* Skylark *Alauda arvensis,* Common raven *Corvus corax,* Bullfinch *Pyirrhula pyirrhula,* Song thrush *Turdus philomelos,* Fieldfare *Turdus pilaris,* Mistle thrush *Turdus viscivorus,* Chamois *Rupicapra rupicapra,* Roe deer *Capreolus capreolus,* European red deer *Cervus elaphus,* Beech marten *Martes foina,* Pine marten *Martes martes,* Badger *Meles meles,* Weasel *Mustela erminea,* Least weasel *Mustela nivalis,* Polecat *Mustela putorius,* Bicloured white-toothed shrew *Crocidura leucodon,* Miller's water shrew *Neomys anomalus,* Water shrew *Neomys fodiens, A*lpino shrew *Sorex alpinus,* Common shrew *Sorex araneus,* Pygmy shrew *Sorex minutus,* Arctic hare *Lepus timidus,* Forest dormouse *Dryomis nitedula,* Garden dormouse *Eliomys quercinus,* Common dormouse *Muscardinus avellanarius,* Fat dormouse *Myoxus glis,* Marmot *Marmota marmota,* Red squirrel *Sciurus vulgaris,* Viviparous lizard *Zootoca vivipara,* Asp viper *Vipera aspis,* Common adder *Vipera berus*

RED LIST OF ITALIAN VERTEBRATES (mammals)

Spagnesi M., de Marinis A.M., 2002. *Mammiferi d'Italia*. Quaderni di conservazione della Natura N. 14, Ministry for the Environment and Protection of the Territory, Istituto Nazionale per la Fauna Selvatica.

CRITICALLY ENDANGERED SPECIES
Carnivores
Brown bear (*Ursus arctos arctos*)

VULNERABLE SPECIES
Bats
Mouse-eared bat (*Myotis blythii*)
Rodents
Red squirrel (S*ciurus vulgaris*)
Dormouse (*Muscardinus avellanarius*)
Carnivores
European wild cat *Felis silvestris silvestris*

SPECIES ON WHICH THERE IS INSUFFICIENT INFORMATION
Parti-colored bat (*Vespertilio murinus*)
Northern Serotine Bat (*Amblyotus nilssonii)*
Polecat (*Mustela putorius*)

DOLOMITES' ECOLOGICAL VALUE

From the scientific and naturalistic profile, the Dolomites region offers a very particular situation of the variability, within a small area of environmental factors that represent borderline conditions for many plant and animal species and for the phytocoenosis and zoocoenosis constructed by these species. At times, thanks to plays on exposure and altitude, conditions for the living components of a certain ecological landscape vary from optimal to absolutely hostile within the space of a few dozen meters. In other words, the Dolomites are a *microcosm* in which a great number of different environmental conditions exist, with their relative ecosystems and transitional situations (ecotones) be-

tween each. This is one of the main reasons for which some Universities and other research institutes have placed their laboratories and permanent monitoring stations in the Dolomites. Many of these study show that the high-altitude ecosystems (micro-thermal grasslands and forests), are particularly sensitive to environmental change. Climate change and the direct and indirect effects of human activity, in fact, are shown as having a strong negative impact on their structure and functioning. For that matter, the effects of environmental change seem to cause damage, to a greater or lesser extent, according to the level of the timberline. In the Tyrol, the area that has suffered the worst impact of such changes is that of the northern calcareous Alps, whereas on the south-facing mountains and particularly in the Dolomites areas, the timberline shows no marked symptoms of deterioration as yet. In some sectors, on the contrary, a progressive upward movement of the forests can be observed, which are taking over large areas of the secondary grasslands, presumably re-gaining their former altitude limit. In this sense, the Dolomites area, as a whole, is a spectacular laboratory for the study of the re-evolution of arboreal ecosystems, processes in which other collateral processes are visibly triggered off, linked to variations in temperature (perceptible also on a planetary scale) and in rainfall and soil hydration in the summer, due to the increase of intense phenomena in the summer and the reduced snowfall in the winter. The conspicuous pedologic variability (effusive or sedimentary) connected to the more superficial matrices enriches the composite framework of the re-evolving systems and adds an important and interesting element of complexity to both the interpretation of the phenomena in progress and to the changing vegetal landscape, especially at the higher altitudes. Georg Grabherr, of Vienna University, reports that at high altitudes many more plant species can now be found than in the past. He ascribes this fact to the increased altitude of the timber and vegetation lines, a process which is proceeding, according to each case, at a rate of between 2-4 and 20-30 meters every decade.

The never-ending battle of stones and grass constantly climbing up the scree, covered by new rockslides. The contrast between the whiteness of the shattered rock and the pale green of the vegetation is one of the most spectacular sights

of the location at high altitude (the northern slopes of Monte Talvena in the Parco Nazionale Dolomiti Bellunesi).

At high altitudes, therefore, the total number of species is increasing, but the cryophilic species are disappearing when they reach the level of bare rock and can find no other proper habitat. About 400 Alpine species are condemned to this fate. The valleys will thus take on a new appearance with the coming and going of the various species. Oaks and hornbeams will take the place of beech and fir, while the conifers that have stood for centuries on the higher slopes will be crowded into increasingly narrow areas and will eventually disappear. Where animal husbandry is practiced, pasturing may possibly stabilize the present timberline, which is now around 1,800 meters (in the outer areas) and 2,000-2,200 meters (in the inner, more continental areas) in the Dolomites area. Therefore, agricultural activities could still heavily shape the Dolomite landscape.

The close relationship between man and nature is emphasized by grazing at high altitudes. The high-altitude prairies keep their charm and naturalistic value (with rare and endangered species) thanks to the continuation of livestock grazing (Rascesa/Raschötz, in the background).

The system of screes, typical of the Dolomites, is equally interesting. These are the wide expanses of fragmented material surrounding the feet of the rock walls, generated by collapse of the rocks above and the continual contraction and dilation processes according to the day/night and seasonal temperature differences. Scree represents a system of violent and highly visible contrasts: totally dry on the surface, but deep below crossed by important water courses every time there is rain or snowfall or during snowmelt. They appear as deserts at first sight, but in fact they are home to amazing micro- and ecosystems of exceptionally ostentatious life forms. Freezing cold or scorching hot, according to the time of day or night and the season, these are the favoured habitat of the animals most known and well-loved by the occasional visitors to these mountains: ibex, chamois, Alpine choughs, eagles, marmots and a hundred others that populate not only the mountains but also the glossy magazines dedicated to nature and mountains. The Dolomites, in the strict sense, do not have a relevant

number of endemic vascular species (9, apart from a few examples of minor taxonomic significance). However, they are of absolute importance for the extraordinary variety of the plant communities favoured by climatic, historic and thropic and geological factors. This results in the matchless variety of the landscape that even the most distracted tourist with no scientific knowledge of biological phenomena can appreciate. If the annual blossoming can be considered as a part of the landscape, the variety of the plant communities, even when less conspicuous and noticed mainly by the expert, adds a special fascination that makes these mountains unique. The scientific value, as regards both quantity (number of species present in each quadrant - 6 x 6 km per side) and quality (rare, endemic, inadunate species, situated at the limit of the distributional range), is generally greater in the outer and marginal chains, precisely where the geological phenomena seem to be less spectacular (on the Vette di Feltre, for example, more than 1,100 species were counted in a single quadrant). The areas on the southern edges (apart from the Dolomiti Bellunesi, also the Dolomiti Friulane), therefore, give a significant contribution to the unique character of the Dolomites system, due in particular to the extraordinary floristic and biocenotic biodiversity. Not only is there a higher number of species per surface unit (floristic wealth) but there are often plant communities that are endemic and exclusive to these massifs, the survival of which is partly due to the glaciations that have conserved important elements of Tertiary origin. The greater biological wealth of the outer chains is confirmed above all with regard to the many invertebrate groups.

The Dolomites abound in endemic species. The Orotrechus pavionis beetle, for example, has adapted to the environment formed in narrow areas of these mountains (Monte Pavione, Dolomiti Bellunesi).

The great variety of the Dolomites biocenosis, more accentuated on the external massifs, is further confirmed by the speed at which the ecological-dynamic processes are taking place. The recent climate change, although without a generalized impact on all systems, combined with modifications in soil use (essentially the abandonment of the grasslands), can be clearly perceived and is already being monitored. The higher level of the timberline and of the perennial snows is being constantly reported and is creating dynamic trends that tend to exacerbate phenomena of competition, resulting in ecotone bands that are in continual evolution. The plan communities (*Salicetea herbaceae*) of the high snowy valleys are rapidly being replaced by communities that are less partial to a snowy environment, such as grasslands, however the former are moving to the new areas freed by the retreat of the glaciers and snow fields. Of no less importance, and certainly highly exceptional, is the gravitational dynamics linked to the majestic detritus fans that represent one of the more unique and remarkable features of the Dolomites area. The spatial distribution of phytocoenosis is strongly conditioned by these processes, and the temporal successions can be observed in very limited spaces. The marked variations in seasonal weather, typical of the Dolomites territory, also influence competition

and heighten the natural dynamics. The positions of wells and springs also tend to move, under the influence of sliding detritus and new accumulation that also interfere with the evolution of certain wetlands.

The Dolomites' territory is unequalled in the entire world. Based on the documents available, there exists no orographic system capable of proving the historical exploitation of resources made by mankind, in all valleys, also the most distant and isolated. The "laudi", or the rules applying to the utilization of soil established by the Communities and the Family Communions, dating back to before year 1000 (Ampezzo), or the forestry rules, and the forest management land registers established and published by the Serenissima Republic of Venice in early 1500, are documents that do not exist in any other area on earth. And just for the reason of this historical documentation, the primary activities were abandoned, in a decisive manner as from the second half of the last century; significant changes are taking place in the meadowland and forest ecosystem's structure which are largely dependent on and comparable with previous situations which can be documented by historical findings. This obviously applies to either changes resulting in negative situations and those which are becoming evidence of a natural re-colonization on a large-scale basis, having an extraordinary scientific value. This is also proved by the researches that are being carried out on a national and international level, regarding:

- The progressive advancement towards the higher lands, formerly grazing lands, by new forests,
- The systemic structure of newly-formed woods,
- The new forms of humus that are rising in newly-formed arboreal systems,
- The calibration of naturalness indicators associated with ecosystems whose composition was almost unknown.

Also, one should not neglect the fact that in Western Europe forests are being increasingly exploited – because of the productivity of woods located on the plain (e.g. Poland, Scandinavia), as well as in Eastern Europe (Hungary, Czech Republic, etc.) for reason of the new, interesting markets that have opened in these low-cost labour countries, while the alpine woods and above all those located in the Dolomites - now presented for nomination – are practically no longer utilized and therefore they are playing a leading role in an exceptional ecological process of epigeal ligneous biomass and hypogeal necromass accumulation which, above and beyond the benefits it brings from a naturalistic standpoint, is universally considered fundamental for the storage of carbon dioxide. Another just as important aspect, and unequalled in any site of the World heritage, is the recovery of biological balanced structures in a single area, the first supported by evidence, affected by ecosystem deterioration processes originating from the phenomenon known as "acid rain". In the area of the Parco Nazionale delle Dolomiti Bellunesi (National Park of Dolomites located in the Belluno area), around the proto-industrial site of the Imperina Valley (pyrite and iron mining, casting and processing), large forest strips were destroyed for this reason in the XVII and XVIII centuries and now, after approximately fifty years from the final divestment of that activity, this testifies the slow progressive evolution of the ecosystem. Recovery of nature in areas abandoned by mankind and its activities has fostered another significant and fantastic process, i.e. the return of the big predators: lynxes, bears and probably also wolves. These species are in fact increasingly returning to these mountains and this may sound incredible if one thinks that the Dolomites, already highly urbanized and crossed by huge infrastructures, are grasped within a system of highly populated territories, of which the Po valley is the most significant, with a population density amongst the highest in the world.

The return of large predators to the Dolomite region (Ursus arctos).

The restocking of the alpine brown bear on the Parco delle Dolomiti del Brenta was supported by international interventions and fundings (EU) on the basis of specific LIFE projects. It is opening interesting consolidation and expansion perspectives of the species' areale, involving several provinces and fitting in with the population dynamics observable and quantifiable on an international level (Austria, Slovenia). This is an ecological process which, similarly to the spontaneous one regarding lynxes, cannot be compared with those taking place in other areas of earth, for both the rarity of the species, which is unique and typical of this region of the world, and because of the ecosystem, environmental and social peculiarity of the Dolomites' area. This may also apply to the lammergeyer, which has been reintroduced in adjacent areas (Alti Tauri), but which has been seen many times in the Dolomites, where the quantity of ungulates is such as to qualify its habitat as meeting its needs. In general, the entire fauna is transforming, with an increase, for example, in the number of all species of birds of prey. Also a reasonable number of vegetable species included in the red list seems to be recovering significantly, however this perspective requires confirmation and respect for the most vulnerable habitats, specially the damp ones. These are phenomena of re-naturalization, in countertendency as compared to other areas of earth where, unfortunately, the dynamics are opposite.

The Dolomites are the only Alpine region where bears have maintained a sufficient, albeit minimum, population. The European project to reintroduce the species has restored vitality and a new demographic impetus to the local population.

The Dolomites, with their specific biodiversity and internal equilibrium, differ from other natural Alpine and Central Europe natural sites for a few fundamental reasons.
I.e. the area presented for nomination is inhabited by many endemic species, and this helps in characterizing this territory in an unequivocal way if compared with other districts. This is correct only in part: it is true that there are some endemic species, also and above all among the invertebrates, however their number is lower than that of other districts.
As compared with other areas in the Alpine chain, and more in general in the respective bio-geografical provinces and Europe, and with reference to the vertebrate fauna, a very important factor is represented by the coexistence, in most part of the area presented for nomination, of the four *Tetraonidae*: the mountain francolin *Bonasa bonasia* (LINNÉ, 1758), the white partridge *Lagopus mutus* (MONTIN, 1776) – *existing only in the Alps, the Pyrenees and Northern Europe*, the black grouse *Tetrao tetrix* LINNÉ, 1758, the cock of the wood *Tetrao urogallus* LINNÉ, 1758 – *inexistent in the Western Alps*, contrary to the western area of Alps and Central Europe. These are quite rare species, whose number is increasingly reducing in many areas in the areale, included in the protected red lists and protected under national and international rules and regulations;
Also, the presence of the brown bear (*Ursus arctos*) is an absolutely unique fact, which in the Dolomites' area, contrary to that which happened in the remaining Alpine area, has always preserved a specific population.
Significant and emblematic in comparison with other Palaearctic mountains is also the presence of the rock goat *Capra ibex*, limited, as well known, in the Alps and progressively and significantly increasing in the Dolomites' Alps.
Also, the Dolomites' area seems to be very important for the Alpine chiropterans, and the *Eliomys quercinus* shows no comparable densities in other locations of its areale of distribution;
A special mention should be given to the corncrake, *Crex crex,* which, although living in a very small area of the territory presented for nomination, can certainly still find in these mountains conditions suitable for its survival. This is a very vulnerable species, which cannot be found in the western Alpine chain nor in central Europe.

The core areas contain the habitats of animal species of considerable naturalistic interest, but which are relatively frequent and abundant. The chamois, has always been an ubiquitous species in all the Dolomite systems, and of the whole of the alpine chain; the recent scabies outbreak is decimating the population, with a violence proportionate to the density of the populations. However, this is a recurrent phenomenon that in recent years has taken on exceptional dimensions due to the reduction in the hunting and in the total ban on this activity inside the natural parks.

The ibex population is rapidly increasing after the reintroduction carried out in the 1980s, with animals taken from the western Alps (Parco del Gran Paradiso). The mouflon is a species that was introduced, and is well acclimatized in some systems; there are still different opinions on whether it would be opportune to take measures for its eradication. Nothing can be feasibly done about the rainbow trout, another alien species in the Dolomite mountain streams. The present balances between exotic and local species do not appear to represent a threat for the continuity of the local populations. In fact, the food systems are so abundant and available that the only danger, for that matter in the distant future, could be that represented by alterations to the composition linked to global change.
The golden eagle populations and those of the other representatives of the bird fauna at the higher altitudes are reliably stable and balanced with the natural capacities of the places. For the other elements of the animal system of the Dolomites, the assessment of balance, and therefore of the integral nature of the systems themselves, is inseparably linked to that formulated with regard to the plant components, and in particular the woods and grasslands. Almost all the woods of the buffer zones can be said to substantially adhere to the natural condition, thanks to forestry activities aimed purely at health control (dedicated to controlling plant disease and preventing fires), or to the total lack of any forestry work (total ban in the Parks, but also in other areas where interventions are not technically possible). However, for the pastures and grassland cultivation systems certain specific facts must be noted.
The grasslands are, in fact, the result of centuries of grazing and haymaking. With the end of the economic convenience of these practices, which were anyway merely for subsistence, a slow and progressive change is occurring in the composition, often with a considerably pejorative result. Many rare floral species, of importance for local biodiversity, are in danger of becoming even rarer, a situation that is triggered off by the spontaneous recovery of systems tending towards a more natural vegetal organization.
This leads to the need to decide between conservation of the naturalistic value of the places and their biodiversity, and conservation of the natural dynamics tending towards compositions of little naturalistic and scenic-landscape worth.

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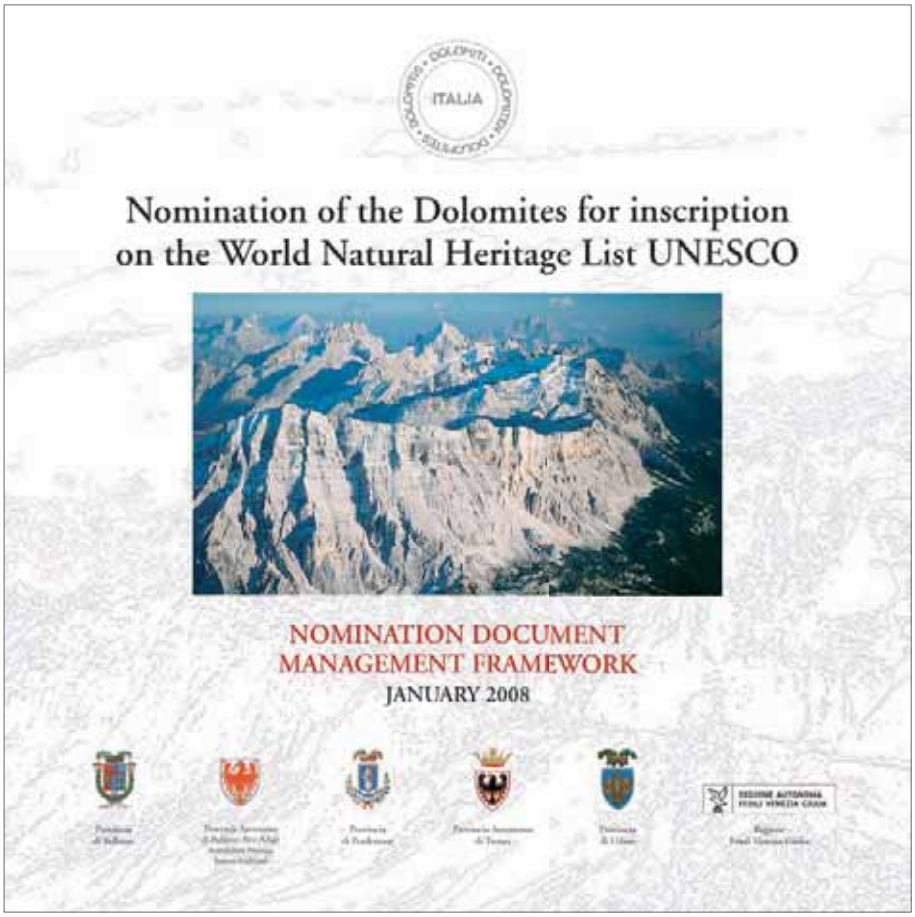
A2.3 VIDEO "THE DOLOMITES", 2007

See the linked DVD.



ANNEX 3

A3.1 LETTERS OF SUPPORT

Letter written in support to the nomination

Reinhold Messner – *Alpinist*
Creator of MMM Messner Mountain Museums
Meran, Italy

Maria Bianca Cita – *Professor Emeritus of Geology*
University of Milano, Italy
Chair, IUGS Subcommission on Stratigraphic Classification (ISSC).

Forese Carlo Wezel – *Professor of Stratigraphy*
Institute of Environmental Dynamic – University of Urbino, Italy
President of the Italian Geological Society

M. J. Orchard – *Geological Survey of Canada*
Vancouver, B.C. V6B 5J3, Canada
Chair, IUGS S Subcommission on Triassic Stratigraphy (STS)

Francesco Zarlenga – *President of ProGEO*
European Association for the Conservation of Geological Heritage.

Gian Gaspare Zuffa – *Professor of Sedimentary Geology*
University of Bologna, Italy
President of the Italian Federation of Earth Sciences.

Emmanuel Reynard – *Institute of Geography*
University of Lausanne, Lausanne, Switzerland
President of the working group on Geomorphosites of the International Association of Geomorphologists

Franco Salvatori – *Professor of Geography*
University of Torvergata, Roma, Italy
President of the Italian Geographic Society

Nickolas Zouros – *Director of the Natural History Museum of the Lesvos Petrified Forest*
Coordinator of the European Geoparks Network
Sigri, Lesvos – Greece

Wolfgang Schlager – *Professor Emeritus of Marine Geology/Sedimentology*
Vrije University, Amsterdam
The Netherlands

Edward L. Winterer – *Distinguished Professor of Geology, Emeritus*
Geosciences Research Division – Scripps Institution of Oceanography
La Jolla, CA 92092-0220, USA

Rainer Brandner – *Professor of Geology*
Head of Department of Geology and Palaeontology – Universität Innsbruck, Austria

Dr. Michael Vogel – *President alparc*

Dr. Guido Plassmann – *Direktor Task Force Schutzgebiete*
Alparc Netzwerk Alpiner Schutzgebiete – Chambèry, France

Dominik Siegrist – *President CIPRA International*
International Commission for the Protection of the Alps – Schaan, Liechtenstein

Silvia Metzeltin – *Alpinist, geologist and scientific journalist*
Pura, Switzerland

Bruno d'Argenio – Professor of Geology
University of Napoli Federico II
Italy

Riccardo Cassin – *Alpinist*
Honorary chairman of "Riccardo Cassin Fondation"
Lecco, Italy

Paolo L. Bürgi – *Landscape Architect.*
Adjunct Professor of Landscape Architecture, School of Design, University of Pennsylvania, Philadelphia USA.
Professor of Landscape Architecture, IUAV, Istituto Universitario di Archiettura di Venezia
Italy.

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Messner Mountain Museum

Dolomiten-Eintragung in die Liste des Weltnaturerbes der Unesco

Ich bin in den Dolomiten groß geworden, dann, nach 1000 und mehr Klettertouren daheim, in allen Gebirgen der Welt unterwegs gewesen. Mein Fazit: Kein Gebirge kann sich an Schönheit mit den Dolomiten messen.

Die Dolomiten sind unverwechselbar: In ihrer Formenvielfalt, Geologie und vor allem im Landschaftsbild, das von der Spannung zwischen horizontal daliegenden Almmatten und vertikal ausgebildeten Felsformationen lebt. Und wie für mich ist die Felslandschaft zwischen Brenta und Udine, zwischen Peitler und Pordenone auch für viele andere Kenner die schönste der Welt:
Seit gut 200 Jahren sind die Dolomiten Mekka für eine Vielzahl von Wissenschaftlern, Forschern, Dichtern, Malern, Bergsteigern, Kletterern und Urlaubern. Ludwig Steub sah dort „die verrücktesten Linien der Alpenwelt", Josef Kreil die „Stachelkrone Europas". Leopold von Buch bezeichnete die Dolomiten als „den Schlüssel zur Geologie", Friedrich Simony lobte sie als „Riesenstadt mit zahllosen Kastellen und Türmen". Otto Julius Bierbaum sprach von einem „Epos in Stein", Theodor Christomannos von „mythischen Riesen, den Göttern zum Trotz", Murray von Zähnen „gleich dem Rachen eines Alligators". Le Corbusier nannte sie die „eindrucksvollsten Bauwerke der Welt".

Wo heute die Dolomiten stehen, war einst tropisches Meer. Vulkanische Vorgänge, Korallenriffe mit Algen und anderen Meerestieren, die mit der Zeit höher und höher lagerten, Hebungen durch die Kollision der Kontinente, Wüstenklima, Senkungen, die Eiszeiten und die Verwitterung haben im Laufe von Jahrmillionen die Dolomiten geformt, wie wir sie heute kennen – die schönsten Berge der Welt. Sie gehören als Weltwunder unbedingt in die Liste des Weltnaturerbes der Unesco.

R. Messner
27.12.2007

UNIVERSITÁ DEGLI STUDI DI MILANO
FACOLTÀ DI SCIENZE MATEMATICHE FISICHE E NATURALI
DIPARTIMENTO DI SCIENZE DELLA TERRA "ARDITO DESIO"

Milano, 15 January 2008

Prof. Piero Gianolla
Dipartimento di Scienze della Terra
Polo Scientifico e Tecnologico
Via Saragat, 1 – Blocco B
44100 Ferrara, Italy

Dear Gianolla
I am privileged to nominate herewith the Dolomites region of Italy for inclusion on the UNESCO World Heritage List.

Subject: The Dolomites World Heritage Site Nomination

Dear Committee,

The Dolomites definitely have to be included in the World Heritage List of the UNESCO, not only for the magnificence of the landscape but also for the geological importance they held. In the last two centuries hundreds of scientists and researchers from all over the world came to visit and study this region. Since the beginning, the extraordinary, well exposed outcrops present in this area allowed a detailed study of the evolution of the carbonate buildups and their relationships with the terrigenous and volcanic deposits. The stratigraphic interval here represented in great detail, spans from the latest part of the Paleozoic to the whole Mesozoic, allowing to read a long chapter of the Earth's history. Due to the richness of features regarding depositional geometries, volcanic events, evolution of biota, extinction and climatic events, several formations and biozones have been defined for the first time in this region.
A large number of these features can be correlated worldwide making the Dolomites a key study area. As president of the ISSC, I would like to underline the stratigraphical importance of the Dolomites where have been defined stages as the Ladinian, and substages as the Cordevolian and Fassanian. Morever, several type-locations that give their name to formal lithostratigraphic units (formations ang groups) belong to the Dolomites.
We may say that the Dolomites have been for the understanding of carbonate systems what the Rosetta's Stone has been for the comprehension of Egyptian hieroglyphics.
The Dolomites are therefore of inestimable and unparalelled value and should be protected for their natural resources and for their geologic peculiarities that both have no equals in the world.

Sincerely yours

Maria Bianca Cita
Professor Emeritus of Geology
University of Milano, Italy
Chair, IUGS Subcommission on Stratigraphic Classification (ISSC)

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Società Geologica Italiana

Fondata nel 1881

Ente Morale R.D. 17 ottobre 1885

IL PRESIDENTE

Letter of support for the Dolomites candidature at UNESCO

The Dolomites are an open book of the Nature. They bear among the finest landscapes of the world, and are a rare compendium of outstanding geological features, from well preserved 230 Ma atolls, to spectacular tectonic, paleontological and volcanic features. Hundreds of geologists, naturalists, students from all over the world come every year to visit this unique wildness. They are a spectacular region where rocks, fauna and vegetation together create a sort of miracle of beauty.

The Dolomites are an open museum where people feel their common relation with nature.

They have been the theater of the first world war in which thousands of European soldiers from different countries have fought in tragic useless battles, and the memories of these events are now permanent witnesses of the fragile attitude of the human being to preserve itself and its environment.

These mountains are now celebrated monuments which deserve to be maintained for their fundamental scientific, cultural and historical patrimony, the best premises for a peaceful development.

On behalf of the Italian Geological Society (Società Geologica Italiana) I am proud to support the candidature of the Dolomites as a world treasure to be admired and preserved for future generations.

December 5, 2007

The President
Prof. Forese Carlo Wezel
Forese Carlo Wezel

IUGS

ICS

SUBCOMMISSION ON THE TRIASSIC STRATIGRAPHY

December 18, 2007

Dear committee

I write to you on the matter of the nomination of the Dolomites as a World Heritage Site.

I believe this status is fully justified on the grounds that the Dolomites area is famous for its sections of Mesozoic rocks that, in terms of stratigraphic completeness, are rivaled by few localities in the World, all of them already included in the World Heritage List. The paleontological and stratigraphic record of its Late Permian and Triassic rocks is unique and deserves international tutelage. I would like to stress the role that the candidate area has played in the development of the Earth Sciences since the 1700s and the birth of the geosciences. The remarkable landscapes, the exceptional exposures, the richness of unique fossil species and peculiar mineralizations are complemented by the ease of access. The area has long been a laboratory for international researchers and many classic chronostratigraphic subdivisions are based on Dolomites localities, as for example the Ladinian, the Cordevolian, and the Fassanian. The rock successions and in particular the outcrops included in the nominated areas are today, as they were in the past two centuries or more, a unique source of information to unravel the history of the Earth.

On the basis of these peculiarities, the Subcommission on Triassic Stratigraphy (STS) fully supports and strongly recommends the nomination of the Dolomites for World Heritage status.

M. J. Orchard

Dr. M. J. Orchard
Chair, STS
Geological Survey of Canada
625 Robson Street, Vancouver
B.C. V6B 5J3
Canada

ProGEO

The European Association for the Conservation of the Geological Heritage

Roma, 8/2/2008

Ministry of the Environment of Italy
Via Cristoforo Colombo, 44
00147 Roma
Italy

ProGEO, the European Association for the Conservation of Geological Heritage, is very glad to support the Italian proposal to insert Dolomites in to the UNESCO World Heritage List.

The Dolomites have in fact an outstanding universal value. They are a sort of geoheritage high-altitude field laboratory, ideal for research, education and the development of geomorphological theories and understanding. Furthermore, they are a particularly representative case of geodiversity, in every meaning, at different scales. Finally, they show their geomorphological particularities in the midst of a landscape which is among the most spectacular ones at a global level.

The suggest criteria for this nomination are extremely effective:
Criterion (vii): Superlative natural phenomena or natural beauty and aesthetic importance.
Criterion (viii): Earth's history, geological and geomorphic features and processes.

To be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.

I wish you the success of your initiative.

Best Wishes
ProGEO President
Dr. Francesco Zarlenga

FIST

FEDERAZIONE ITALIANA DI SCIENZE DELLA TERRA

FEDERAZIONE ITALIANA DI SCIENZE DELLA TERRA

il Presidente

Al Ministero dell'Ambiente e della Tutela del Territorio e del Mare
Via Cristoforo Colombo, n. 44
00147 - Roma (Italia)

Subject:
Dolomites of northern Italy in the UNESCO list "World Heritage"

I am pleased to declare that the Italian Federation of Earth Science has endorsed the initiative for having the Dolomites of northern Italy in the UNESCO list "World Heritage".
This initiative, carried over in the frame of the International Year of Planet Earth (2008) proclaimed by the United Nations on December 2005 and opened by the provinces of Bolzano, Pordenone, Trento, Belluno, and Udine, is meant to increase the value of one of the most outstanding geomorphic feature of the planet Earth.

Gian Gaspare Zuffa

(President of the Italian Federation of Earth Sciences)

Bologna 10 Gennaio 2008

Prof. Gian Gaspare Zuffa - Dipartimento di Scienze della Terra e Geologico-Ambientali - Università di Bologna,
Via Zamboni, 67 - 40127 Bo (Italy) – T.: +39 051 209 4540/20, mb 338 1255107, mail: giangaspare.zuffa@unibo.it

GEOMORPHO SITES
IAG WORKING GROUP

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Lausanne, 9 January 2008

Ministero Italiano dell'Ambiente
Roma
Italia

Support Letter for the nomination of Dolomites to the World Heritage List of UNESCO

Dear colleagues,

As president of the Working Group on Geomorphosites of the International Association of Geomorphologists (IAG), I strongly support the candidature of Dolomites as World Heritage Site of UNESCO.

Dolomites have a very high importance for geomorphologists for different reasons. They represent and unique and unitary set of morphostructural and morphoclimatic landforms resulting of the combination of complex geological structure and the influence of past and present climate conditions. The Dolomites represent therefore a **unique geoheritage high-altitude field laboratory**, where to study both the morphogenesis of the Earth and the **geodiversity**, that is the full range of geological structures and morphological landforms, at different scales. Finally, they show their geomorphological particularities in the midst of a **landscape**, which is among the most spectacular ones at a global level.

The working group on Geomorphosites of the IAG has the objective to improve the knowledge on geoheritage and geodiversity in the field of geomorphological sciences. In this sense, I believe that the most spectacular and important sites in a scientific point of view, as it is the case of the Dolomites, must be recognised as heritage site by the international community. **I therefore strongly support the Dolomites candidature.**

Best wishes.

Prof. Emmanuel REYNARD
President of the working group on Geomorphosites
of the International Association of Geomorphologists

SOCIETÀ GEOGRAFICA ITALIANA
VILLA CELIMONTANA - ROMA

Roma, 15 gennaio 2008

Prot. 55/08

Ministero dell'Ambiente della
Tutela del Territorio e del Mare
Via Cristoforo Colombo, 44
00147 ROMA

The Italian Geographic Society, an Environmental Institution under Law No 349 of 8 July 1986, has learned about the proposal of the provincial governments of Belluno, Bolzano, Pordenone, Trento and Udine and of this Ministry to include the Dolomites in UNESCO's World Heritage list.

This Society endorses the proposal, which it will support on all occasions and strongly hopes will be accepted.

Yours faithfully,

(Franco Salvatori)

NATURAL HISTORY MUSEUM OF THE LESVOS PETRIFIED FOREST

atural History Museum
of the Lesvos Petrified Forest
Sigri, Lesvos, Greece
Post Code: 811 12
Telephone / Fax: 2253054434, 2251047033
www.petrifiedforest.gr
e-mail:lesvospf@otenet.gr

Geoparks

Mytilene 15-1-2008
Prot.Num.

__:
Ministero dell'Ambiente
Roma
Italia

Subject: **Nomination of Dolomites in the UNESCO World Heritage List**

Dear Sir/Madam,

The Dolomites have an outstanding universal value from the geomorphological point of view: they make up a unitary set of representative morphostructural and morphoclimatic genesis, which results from the complex geological structure of these mountains and past and present climate conditions.

They are a sort of geoheritage high-altitude field laboratory, ideal for research, education and the development of geomorphological theory and understanding. Furthermore, they are a particularly representative case of geodiversity, in every meaning, at different scales.

Finally, they show their geomorphological particularities in the midst of a landscape which is among the most spectacular ones at a global level.

For the above mentioned reasons I fully support the Nomination of Dolomites in the UNESCO World Heritage List.

Yours Sincerely,

Nickolas Zouros

Ass. Prof. Dr. Nickolas Zouros
Director of the Natural History
Museum of the Lesvos Petrified Forest
Coordinator of the European Geoparks Network

Date Your letter dated Telefax Enclosure(s)
Jan.2 '08
Our reference Your reference Telephone E-mail
080102A (31 20) 598-7328 wolfgang.schlager@falw.vu.nl

Mailing address: De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands

Prof. Dr. P. Gianolla
Dipt. Scienze della Terra/Polo Scientifico e Tecnologico
Via Saragat, 1 - Blocco B
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vrije Universiteit amsterdam

Dear colleague,

It is a great pleasure to support the initiative to nominate the Dolomites for World Heritage Site. The striking juxtaposition of sheer cliffs and gentle pastures makes the Dolomites area of the Italian Alps a landscape of exceptional scenic beauty. To a large extent, this breath-taking scenery mimics the shape of the sea floor of 200 million years ago. This is one reason why the Dolomites are world-famous geologic territory. This ancient landscape (or better "seascape") was preserved by a delicate balance between the forces of mountain building and erosion. I know of no other place in the world where this situation is preserved on such a grand scale and with such a variety of patterns. The similarity with modern tropical oceans is further accentuated by the fact that the growth of atolls was interrupted by volcanism whose vestiges, too, are exceptionally well preserved in the Dolomites.

Another reason for the geologic fame of the Dolomites is the exquisite clarity of the patterns of folds and faults formed by alpine mountain building. Usually, mountain building is a drawn-out affair that consists of many deformation events, comparable to a series of battles in a long war. If many human battles are fought in the same area it becomes extremely difficult to reconstruct the individual events – archeologists are well aware of this fact. The same holds for mountain belts like the Alps where phases of faulting, folding, overthrusting and uplift followed each other for millions of years. The Dolomites represent the exception to this rule. Alpine deformation in the Dolomites was relatively gentle and the events were separated by extended periods of quiescence and sedimentation. Thus the deformation patterns of individual events are exceptionally well preserved and the strong uplift of the area has exposed them in stunning detail on the steep mountain slopes.

Sincerely yours

Prof. Dr. Wolfgang Schlager

UNIVERSITY OF CALIFORNIA, SAN DIEGO UCSD

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SCRIPPS INSTITUTION OF OCEANOGRAPHY
GEOSCIENCES RESEARCH DIVISION

9500 GILMAN DRIVE
LA JOLLA, CALIFORNIA 92093

Prof. Piero Gianolla
Dipartimento di Scienze della Terra
Polo Scientifico e Tecnologico
Via Saragat, 1 - Blocco B
44100 Ferrara, Italy

Dear Professor Gianolla,

I am privileged to nominate herewith the Dolomites region of Italy for inclusion on the UNESCO World Heritage List.

The Dolomites World Heritage Site Nomination

The Dolomites constitute a virtual outdoor geological museum, whose great walls of white dolomite strata formed parts of immense Triassic coral reefs that built themselves out and over flanking deep-water deposits. A first generation of reefs built to a height of a thousand meters but was then partly buried under volcanic flows and debris, only to have a second generation build upward from the ruins of the first. The combination of unparalleled access to the reefs and the mildness of later tectonic deformation has attracted geologists from the world around to work out in detail the external morphology and internal anatomies of the reefs complexes and their histories of upbuilding and subsidence. The region is now a great laboratory for the training of students and a required visit for any geologist coming to see the Alps. Yet in spite of the superb exposures, the Dolomites have not yielded up all their geologic secrets, and the region still attracts teams of scientists seeking to use the reefs and their flanking strata as analogues for reef anatomies and structure elsewhere in the world.

Finally, it would be less than honest to ignore the breathtaking physical beauty of the region, a beauty that stirs all who come, geologists and laymen alike.

Of all the natural wonders of this world--and I have visited many of them--few rank as high as the Dolomites in both scientific interest and natural beauty. The region should certainly be designated a World Heritage Site.

Very truly yours,

Edward L. Winterer
Distinguished Professor of Geology, Emeritus
Geosciences Research Division
Scripps Institution of Oceanography
La Jolla, CA 92092-0220, USA

INSTITUT FÜR GEOLOGIE UND PALÄONTOLOGIE, UNIVERSITÄT INNSBRUCK

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Letter of support to the candidature of the Dolomites to be inscribed on the World Heritage List

The Dolomites provide an outstanding record of a Mesozoic, synchronous and side by side development of reefal carbonate buildups and basinal sediments with water depths of several hundreds of meters. These over 200 million of years old facies heteropies are responsible for the present day spectacular landscape: the long lasting and still ongoing different erosion rate of soft rocks in the Triassic basinal areas and hard rocks of dolomitized reef bodies shaped the significant landforms and physiographic features since the Miocene.

Studied since over 200 years these mountains have been and will be one of the most famous open-air laboratories for geologists to study sedimentology, stratigraphy and recently the important new method of seismic stratigraphy for the very well preserved depositional geometries of carbonate platform systems. The possibility to walk along footpaths on top of a 230 million of years old sea bottom from a reef platform down over the palaeoslope to the basin (i. e. Schlernplateau to the Seiser Alm) is unique in the world. More comfortable but also unique in the world is the possibility to drive by car around a Triassic atoll reef (i. e. the Sella massif).

A very complete section of shallow marine sedimentary sequences south of Gardena valley provides a holistic picture of the end-Permian mass extinction, when marine organisms suffered the most severe reduction in the history of metazoan life. Millions of years of recovery and evolution of carbonate producing organisms which built finally several generations of carbonate platforms are documented in spectacular outcrops. But the development of carbonate platforms was not continuous. There is a strong interruption in the Carnian, called "Carnian Crises" when the carbonate platform of Cassian Dolomite drowned and was overlain by anoxic black sediments. Triggering factor has been climate change through temperature increases. Recent findings suggest that global warming is causing considerable deterioration of coral reef growth. Carbonate production stopped or was diminished for some ten thousands of years. The impacts of climate change on growth potential of carbonate platforms, well documented in the Dolomites, are impressive examples for possible developments in the near future of our "global warming" world!

Innsbruck, 17.01.2008

Prof. Dr. Rainer Brandner
head of Institute

alparc

Netzwerk Alpiner Schutzgebiete

Unesco Sekretariat
C/o Provinz Belluno
Via S. Andrea 5

I – 32100 Belluno

U. Ref.: GP/RB 2008 01 17

Chambéry/Berchtesgaden,
den 10. Januar 2008

Betrifft: Empfehlung des Netzwerkes Alpiner Schutzgebiete (ALPARC) zum UNESCO Welterbeantrag DOLOMITEN

Sehr geehrte Damen und Herren,

5 Provinzen der Dolomitenregion reichen ein Gesuch zur Anerkennung als Naturwelterbe ein. ALPARC, das Netzwerk der Alpinen Schutzgebiete unterstützt die Dynamik, die durch die Einreichung von Anträgen zum Weltnaturerbe der Alpen aufgebaut wird.

Die Dolomiten zählen zu den faszinierendsten Naturräumen der Erde. Wir glauben, dass die einzigartige Symbiose von natürlichen Elementen der geologischen Struktur und der geomorphologischen Prozesse und der daraus resultierenden Ästhetik der Landschaften der Dolomiten eine Bereicherung für das Weltnaturerbe darstellt.

Die Alpen sind gleichzeitig das am meisten besiedelte und geschützte Bergmassiv der Erde, mit etwa 1000 Schutzgebieten über 100 Hektar. Sie weisen Spuren früher Besiedelung auf ("Ötzi") und besonders die Dolomiten vereinen sowohl kulturgeschichtliche als auch im höchsten Masse geologische und geomorphologische Zeugnisse der Evolution der Alpen. Die Ernennung von repräsentativen Gebieten der Alpen zum Welterbe erscheint für ALPARC eine Dringlichkeit um dieses bedeutende Gebirgsmassiv für die zukünftigen Generationen zu bewahren. Die Dolomiten stellen hierfür eine der einzigartigsten Landschaften der Erde dar und haben daher auch für die Alpen den allerhöchsten Stellenwert.

Eine aktive Schutzpolitik wurde seit mehreren Jahrzehnten von den 5 Provinzen der Dolomiten aufgebaut und führte gerade in diesem Gebiet zu einer außerordentlich hohen Anzahl von aus Naturschutz-

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256, rue de la République

F –73000 Chambéry

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sicht sehr wirksamen Schutzgebieten. Die Vorraussetzung des Naturschutzes für das Gebiet ist somit gewährleistet.

Wir denken auch, dass neben den bereits bestehenden Naturwelterbegebieten Aletsch und Monte San Giorgo, die Dolomiten ein weiteres einzigartiges Gebiet darstellen, das eine sehr hohe Repräsentativität für die Alpen aufweist. Die Dolomiten gliedern sich somit perfekt in eine Serie von einzigartigen Gütern der Alpen ein.

Wir empfehlen somit ausdrücklich die Ernennung der Dolomiten gemäß des Antrages zum Weltnaturerbe und sind der festen Überzeugung, dass dies einen weiteren Meilenstein zum Schutz dieser außerordentlichen Landschaft darstellt.

Mit freundlichen Grüssen

Dr. Michael Vogel
Präsident ALPARC

Nationalparkdirektor Berchtesgaden

Dr. Guido Plassmann
Direktor Task Force Schutzgebiete
Ständiges Sekretariat der Alpenkonvention

Commission Internationale pour la Protection des Alpes
Internationale Alpenschutzkommission
Commissione Internazionale per la Protezione delle Alpi
Mednarodna komisija za varstvo Alp
International Commission for the Protection of the Alps

CIPRA International

Segretariato UNESCO
C/o Provincia di Belluno
Via Sant'Andrea 5
32100 Belluno

Schaan, 10 gennaio 2008

Oggetto: candidatura delle Dolomiti per l'iscrizione nella Lista del Patrimonio Mondiale UNESCO

La Commissione Internazionale per la Protezione delle Alpi – CIPRA, organizzazione della quale fanno parte oltre cento enti ed associazioni di tutto l'arco alpino, da oltre mezzo secolo impegnata a favore di uno sviluppo sostenibile del territorio alpino, è consapevole dell'unicità delle Dolomiti in virtù dei fenomeni naturali superlativi, della bellezza naturale ed estetica presente nonché dei processi geologici e geomorfologici che contraddistinguono il sistema montuoso.

Oltre agli aspetti legati al paesaggio naturale, che hanno reso famoso nel mondo il complesso dolomitico e per questo ritenuto meritevole di essere iscritto nella Lista UNESCO, questa organizzazione riconosce le valenze ambientali ed ecologiche delle Dolomiti per le quali auspica una gestione sostenibile da parte degli Enti propositori della candidatura.

La CIPRA, pur non conoscendo i dettagli del dossier di candidatura, valuta positivamente il processo che porterà al riconoscimento delle Dolomiti come Patrimonio mondiale dell'Umanità, nella convinzione che il raggiungimento di tale importante riconoscimento possa costituire una ulteriore opportunità, ad esempio mediante il piano di gestione, di preservare un paesaggio naturale unico, ricco di valenze ambientali sempre più minacciate dalla pressione antropica e da aspettative di forti ritorni economici.

In particolare la CIPRA richiama la necessità che venga sempre rispettato lo spirito della Convenzione delle Alpi e dei suoi protocolli al fine di preservare la qualità naturalistica, l'insieme del patrimonio di biodiversità, la qualità naturalistica e paesaggistica del territorio in considerazione e di arrivare a promuovere una fruizione turistica qualificata e consapevole anche mediante impegni concreti volti a migliorare le situazioni di degrado dovute ad attività antropiche capaci di generare impatti sul paesaggio.

La CIPRA auspica che l'intero procedimento della candidatura trovi nelle istituzioni la volontà di garantire alle parti interessate momenti di coinvolgimento informativo e partecipativo, in modo particolare all'attento associazionismo ambientalista e protezionista.

Dominik Siegrist
Presidente di CIPRA Internazionale

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Silvia Metzeltin
dr. sc. geol.

DOLOMITI: PATRIMONIO MONDIALE UNESCO

Come geologa, sottolineo ovviamente l'unicità naturalistica delle Dolomiti nell'ambito delle catene montuose del mondo. Ma, oltre l'eccezionalità geologica che predispone le Dolomiti al loro particolare incanto estetico, in base alla mia lunga frequentazione alpinistica pongo l'accento anche su altri aspetti che valorizzano in modo specifico la loro bellezza minerale.

Per gli alpinisti di tutto il mondo, le Dolomiti non sono solo un famoso richiamo sul piano dell'impegno sportivo, ma sono un paesaggio cognitivo che rappresenta pagine importanti per la storia di esplorazione e conquista delle configurazioni rocciose più ardite, dove la massima prestazione atletica si esprime sempre di nuovo nell'evidenza estetica dell'itinerario in rapporto alla montagna stessa. Nelle Dolomiti è stato coniato il riferimento di bellezza per gli itinerari congrui allo slancio della montagna: è "la linea della goccia cadente".

Le Dolomiti hanno una propria bellezza armoniosa, che trascende i paesaggi cognitivi di scienziati, alpinisti, artisti e poeti. Il fascino di armonia di queste montagne sta anche nell'equilibrio tra abitati e luoghi selvaggi, tra la dinamica delle attività umane e quella della natura. La cornice di bellezza si è sviluppata e mantenuta grazie anche a saggi interventi secolari delle comunità degli abitanti. Questi interventi, che perdurano fino ad oggi, hanno portato all'integrazione tra la storia del paesaggio e i valori culturali, conferendo alle Dolomiti anche il segno estetico manifesto della possibile armonia tra l'uomo e la natura.

Proprio perché la bellezza delle Dolomiti va oltre quella delle loro eccezionali conformazioni rocciose, esse non sono un santuario da recintare, bensì una testimonianza viva della dinamica di interazione, un modello di sviluppo e non un museo. In questo quadro, ritengo che iscrivere le Dolomiti nel Patrimonio Mondiale dell'UNESCO possa essere determinante per evitare che le attuali strategie di mercato le trasformino in uno dei molti "non-luoghi" della montagna.

Silvia Metzeltin, 17.01.08

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
POLO DELLE SCIENZE E DELLE TECNOLOGIE
DIPARTIMENTO DI SCIENZE DELLA TERRA

To whom it may concern:

The candidature of the Dolomites to the UNESCO Word Heritage List is a significant issue for several and well documentable reasons, clearly fitting into the criteria that the UNESCO as well as IUCN suggest for acceptance into the list.

To begin with, the Dolomites are a unique spectacle of towers and peaks reminiscent of gothic cathedrals and castles. Its fossil cliffs, with atolls and other carbonate platforms of over 200My, are perfectly preserved in their entire structure. A geological phenomenon of breath-taking beauty that documents in continuous and remarkable manner a large part of the Mesozoic. High sedimentation rates, the enormous variety of depositional environments and the abundant fossiliferous documentation make the Dolomites an important reference area for the biostratigraphy of the Triassic Tethys. The site not only offers a classic "vertical reading", i.e. of both biological and environmental evolution over time, but also represents one of the best examples of preservation of depositional geometries for the Mesozoic carbonate platform-basin systems showing several generations of different types of carbonate environment superposition.

In the history of Earth Sciences, the Dolomites area has represented an open-air laboratory for innumerable researchers who have studied and worked here, from the XVIII century to the present (we may remember the classic authors such as Giovanni Arduino, Déodat de Dolomieu, Alexander von Humboldt and Edmund von Mojsisovics, to mention but a few).

Today the Dolomites continue to be a training and research ground for the many scientists who come from all over the world for in-depth study and to compare notes on geological matters of great interest. These zones are unquestionably a teaching laboratory par excellence which allows the great number of students and young researchers who visit these mountains every year, to see, to touch and to understand those geological phenomena that are documented here with extraordinary clarity.

In addition to its aesthetic qualities, which make it one of Europe's most distinctive mountain landscapes, the Dolomites, outstandingly illustrate the interaction between carbonate and terrigenous sedimentation and volcanism, documenting the recovery and evolution of the biosphere following the Permo-Triassic extinction crises.

For all the above reasons, I believe that the Dolomites deserve to be inscribed in the World Hertiage List.

Bruno D'Argenio
Professor of Geology

Naples, January 25 2008

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FONDAZIONE
RICCARDO CASSIN

Spett. Provincia di Belluno
Via S. Andrea, 5
32100 Belluno

Lecco, 16 febbraio 2008

Oggetto: Candidatura delle Dolomiti per UNESCO

Egregio Presidente Reolon,

a titolo personale e in qualità di presidente onorario della "Fondazione Riccardo Cassin" mi unisco allo Stato italiano e all'Amministrazione provinciale di Belluno per sostenere la candidatura delle Dolomiti per la loro iscrizione nella Lista del patrimonio Mondiale dell'UNESCO.

Memore delle splendide ascensioni fatte sulle cime delle Dolomiti, mi auguro che la richiesta di cui Vi fate promotori venga accolta con il favore che merita.

Con viva cordialità

Riccardo Cassin
Presidente onorario
Fondazione Riccardo Cassin

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Codice Fiscale 92042420130

P A O L O L B Ü R G I
p r o f . a r c h . p a e s a g g i s t a

Camorino, 24 Gennaio 2008

DOLOMITI UNESCO WORLD HERITAGE LIST NOMINATION

Vorrei supportare con la presente lettera la candidatura delle Dolomiti alla World Heritage List dell'UNESCO da parte dello Stato Italiano.

A sostegno di questa proposta vi sono considerevoli motivazioni che riguardano diverse caratteristiche delle Dolomiti: le loro specificità geologiche e geomorfologiche, il fatto che esse siano state importante scenario della storia anche recente dell'umanità e che rimangano da sempre fonte inestinguibile di ispirazione per artisti, architetti, letterati, uomini in genere che le hanno potute conoscere ed ammirare.

Il mio sguardo di architetto del paesaggio si sofferma specialmente sul loro alto valore estetico, inteso nel senso più ampio, come qualità che tocca non unicamente il singolo gruppo montuoso con le sue pareti rocciose, le magnifiche guglie, le torri, i pinnacoli…, ma che pure si estende e coinvolge tutto il paesaggio e il vasto territorio circostante. Rendere le Dolomiti un sito protetto dall'UNESCO sarebbe dunque un passo importante per il *rispetto e la tutela dell'ambiente*, oltre che della specifica regione montuosa.

Penso ad esempio ai panorami e alle visuali che si aprono dalle cime delle Dolomiti sul territorio sottostante e -viceversa- all'orizzonte ricco di forme imprevedibili e maestose che caratterizza le vallate di questa regione. Trovo sia giusto prestare un'attenzione più profonda e consapevole verso questo paesaggio: si tratta di un'incredibile quinta scenica naturale verso la quale vanno tutelati ed incentivati i punti di vista più importanti, allo stesso modo in cui in alcune città storiche la presenza dei castelli era resa percepibile attraverso scorci e aperture tra le abitazioni ed i palazzi , instaurando una forte relazione reciproca che ne arricchiva il significato.

Cito ad esempio anche la città di Potsdam, in Germania, dove il sovrano in persona -re Federico il Grande- visionava le proposte di intervento e, nel caso in cui non vi fossero stati i mezzi economici sufficienti da parte dei cittadini oppure i progetti non fossero stati di qualità, egli stesso finanziava la facciata del singolo edificio, nell'intento di rendere la città comunque più bella. Al di là del contesto

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storico e culturale si palesa in questo caso il legame esistente, che va tuttora perseguito, tra edificio e città, così come si deve perseguire e *difendere il dialogo tra la montagna e il suo territorio*.

L'inclusione delle Dolomiti nella lista dei siti patrimonio dell'umanità rivestirebbe così un *notevole significato nell'orientare gli interventi futuri sul loro contesto*, interventi che dovrebbero tenere conto, basandosi su uno sguardo naturalmente più attento, curioso ed approfondito, della presenza importante, espressiva ed altamente suggestiva delle montagne, rendendole un *punto di riferimento e di ispirazione nel paesaggio*.

Paolo L. Bürgi

Landscape Architect.

Adjunct Professor of Landscape Architecture, School of Design, University of Pennsylvania, Philadelphia USA.

Professor of Landscape Architecture, IUAV, Istituto Universitario di Archiettura di Venezia, Italy.

[illegible]

ANNEX 4

A4.1 FACILITIES (supplementary data and statistics on shelters, mountain cabins, and footpath network)

Systems:

1. Pelmo - Nuvolau
2. Marmolada
3. Pale di San Martino - San Lucano - Dolomiti Bellunesi - Vette Feltrine
4. Dolomiti Friulane (Dolomits Furlanis) e d'Oltre Piave
5. Dolomiti Settentrionali/Nördliche Dolomiten
6. Puez - Odle/Puez - Geisler/Pöz - Odles
7. Sciliar - Catinaccio/Schlern - Rosengarten - Latemar
8. Rio delle Foglie/Bletterbach
9. Dolomiti di Brenta

Dolomiti

CORE ZONE

	n° (evaluation)		density (p/km)	period
visitors **	/			

** record in progress

	length		density (km/km²)	
footpath*	648			

* data incomplete

facilities inventory	n°	dormitory	sleeping spaces	opening period
shelters	67	545	2286	VI-IX
mountain cabins	33	291		always
others (malghe, alberghi, ristoranti,etc)				
	100	836	2286	

OWNERSHIP

systems	mountain cabins	shelters	Alpine clubs	private
1	0	4	4	0
2	1	2	1	1
3	14	9	7	2
4	7	3	3	0
5	11	24	13	11
6	0	4	2	2
7	0	11	6	5
8	0	0	0	0
9	0	8	4	4
	33	**65**	**40**	**25**
		100%	62%	39%

BUFFER ZONE

	n° (evaluation)		density (p/km)	period
visitors **	**			

** record in progress

	length		density (km/km²)	
footpath*				

* data incomplete

facilities inventory	n°	dormitory	sleeping spaces	opening period
shelters	40	30	1464	V-X
mountain cabins	8	57		always
others (malghe, alberghi, ristoranti,etc)	3			
	51	87	1464	

MOUNTAIN CABINS		SHELTERS		
systems	**dormitory**	**dormitory**	**sleeping spaces**	
1	0	0	149	
2	9	6	16	
3	121	0	389	
4	58	0	125	
5	103	283	676	
6	0	0	216	
7	0	179	336	
8	0	0	0	
9	0	77	379	TOTAL
	291	**545**	**2286**	**3122**
	9%	18%	73%	

1. Pelmo - Nuvolau

CORE ZONE

				n° (evaluation)		density (p/km)	period
visitors							

				length		density (km/km²)	
footpath				50,82		1,11	

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Città di Fiume	(costr XVII sec– rist.1924) 1964	1917m	CAI		25	10.06-30.09 / 26.12-06.01
	Venezia	1892 (ric.1954)	1947m	CAI		55	15.06-24.09
	Croda da Lago	1901	2046m	CAI		45	15.06-30.09 / 26.12-06.01
	Nuvolau	1883	2574m	CAI		24	20.06-20.09
	4					149	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

BUFFER ZONE

				n° (evaluation)		density (p/km)	period
visitors							

				length		density (km/km²)	
footpath				51,36		1,27	

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Passo Giau			Private			
	Scoiattoli	1969	2255m	Private		24	29.06-20.09 / 01.12-30.03
	Averau	1938 (ristr 1974)	2416m	Private		19	15.06-30.09 / 20.12-20.04
	Cinque Torri	1904	2137m	Private		16	13.06-26.09
	4					59	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

2. Marmolada

CORE ZONE

	n° (evaluation)		density (p/km)	period
visitors				

	length		density (km/km²)	
footpath	6,96		0,62	

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Falier	1911	2080m	CAI		16	20.06-20.09
	Punta Rocca (fino al 2003)	1933 (funivia 1969)	3280m	-		-	-
	Serauta (fino al 2003)	1970	2950m	-		-	-
	Capanna Punta Penia		3340m	Private	6		VI-IX
	4				6	16	
mountain cabins	Dal Bianco	1968	2727m	CAI	9		always
	1				9		
others (malghe, alberghi, ristoranti,etc)							
	0						

BUFFER ZONE

				n° (evaluation)		density (p/km)	period
visitors							

				length		density (km/km²)	
footpath				0,49		0,2	

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Ghiacciao Marmolada	1978	2700m	Private		5	VI-IX
	Pian Fiacconi		2625m	Private		21	IV-XII
	2					28	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

3. Pale di San Martino - San Lucano - Dolomiti Bellunesi - Vette Feltrine

CORE ZONE

				n° (evaluation)		density (p/km)	period
visitors							
				length		density (km/km_)	
footpath				237,52		0,96	
facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Mulaz (Volpi di Misurata)	1907	2571m	CAI		39	26.06-20.09
	Dal Piaz	1962	1993m	CAI		22	20.06-20.09
	Pian de Fontana	1993	1632m	CAI		26	20.06-20.09
	Bianchet	1972	1250m	CAI		40	20.06-20.09
	Torrani	1935 (restr.1973)	2984m	CAI		18	01.07-15.09
	"Giovanni Pedrotti"	1952	2578m	SAT		77	VI-IX
	Pradidali		2278m	Private		64	VI-IX
	Treviso		1631m	Private		39	VI-IX
	Velo della Madonna	1980	2359m	SAT		64	VI-IX
	9					389	
mountain cabins	Grisetti	1965	2050m	CAI	9		always
	Tomè	1969	2860m	CAI	6		"
	Ghedini	1976	2575m	CAI	4		"
	Biasin	1965	2650m	CAI	9		"
	Cozzolino	1972	1398m	CAI	9		"
	Bedin	1977	2210m	CAI	9		"
	Brunner	1966	2665m	CAI	9		"
	Carnielli	1970	2010m	CAI	9		"
	Sperti	1963	2000m	CAI	6		"

Continua >>

BUFFER ZONE

				n° (evaluation)		density (p/km)	period
visitors							
				length		density (km/km_)	
footpath				216,56		0,88	
facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Bottari	1970	1573m	CAI		24	25.06-10.09
	7° Alpini	1950-51	1502m	CAI		58	16.06-23.09
	Boz	1967	1718m	CAI		36	20.06-20.09
	Sommariva al Pramperet	1923 (1950)	1857m	CAI		20	20.06-20.09
	Casel sora'l Sass	1971 (1990)	1588m	CAI		22	20.06-20.09
	Vazzoler	1927/28	1714m	CAI		52	15.06-20.09
	Carestiato	1948/49	1834m	CAI		34	
	Tissi	1961	2250m	CAI		49	10.06-20.09
	Coldai	1905 (ricostr. 1946)	2132m	CAI		83	20.06-20.09
	Tomè	1948/49	1601m	Private		22	21.06-21.09
	San Sebastiano	1979	1595m	Private		18	always
	11					418	
mountain cabins	Capanna Medassa	1972	1342m	CAI	4		always
	Lussato	1969	1502m	CAI	6		"
	Angelini	1980	1680m	CAI	6		"
	Palia	1968	1577m	CAI	3		"

Continua >>

	Dalla Bernardina	1959	2320m	CAI	6		“
	Bocco al Marmol	1968	2265m	CAI	9		“
	Feltre e Bodo	1958-1972	1930m	CAI	19		“
	Valdo	1971	1540m	CAI	9		“
	Campo-torondo	2003	1763m	-	8		“
	14				121		
others (malghe, alberghi, ristoranti,etc)							
	0						

	4				19		
others (malghe, alberghi, ristoranti,etc)	Ricovero Malga Stia						
	Ricovero Baita Malgonera						
	2						

4. Dolomiti Friulane (Dolomits Furlanis) e d'Oltre Piave

CORE ZONE

	n° (evaluation)		density (p/km)	period
visitors	70000,00		3283,30	annual
	length		density (km/km²)	
footpath	21,32		1,07	
footpath	94		0,39	

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Pordenone	1930 (1972)	1249	CAI		65	VI-IX
	Pussa	1971 (1982)	940	CAI		28	VI-IX
	Maniago	1963 (1998)	1730	CAI		32	VI-IX
	3					125	
mountain cabins	shelter "Anita Goitan"	-	1810	CAI Trieste	9		Always
	bivacco Greselin	-	1988	CAI	9		Always
	bivacco Perugini	-	2080	CAI	9		Always
	Montanel	1978	2048m	CAI	4		always
	Vaccari	1978	2050m	CAI	9		"
	Gervasutti	1970	1940m	CAI	9		"
	Baroni	1976	1732m	CAI	9		"
	7				58		
others (malghe, alberghi, ristoranti,etc)							
	0						

BUFFER ZONE

				n° (evaluation)		density (p/km)	period
visitors				180000		3.082,19	annual
				length		density (km/km²)	
footpath				58,4		1,21	
footpath				136		0,49	
					dormitory		
facilities	inventory	construction year	altitude	ownership		sleeping spaces	opening period
shelters	Pacherini	1956 (2006)	1587	CAI		19	VI-IX
	Giaf	1938 (1968)	1400	Comunale		50	VI-X
	Padova	1910 (ricostr. 1931)	1287m	CAI		24	15.04-31.10 / 25.12-06.01
	3					93	
mountain cabins	bivacco Marchi Granzotto	-	2162	CAI	12		Always
	Casera Laghet de Sora	Ristr 1988	1871m	CAI	8		always
	2				20		
others (malghe, alberghi, ristoranti,etc)	"casera Chiampis"	-	1236	CAI Tramonti di Sopra	16		Always
	1						

5. Dolomiti Settentrionali/Nördliche Dolomiten

CORE ZONE

	n° (evaluation)		density (p/km)	period
visitors				

	length		density (km/km²)	
footpath	236,94		1,07	

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Rifugio Fanes	1928	2060	Private	30	44	VI-X e XII-III
	Rifugio Lavarella	1912	2042	Private	26	25	XI-X e XII-IV
	Rifugio Fodara Vedla	1936	1966	Private	14	32	Vi-X e III-IV
	Albergo Pederü	1980	1548	Private	10	24	Vi-X e XII-IV
	Rifugio Munt de Senes		2176	Private		15	VII-IX
	Rifugio Senes	1939	2116	Private	30	31	VI-X e XII-IV
	Rifugio Scotoni	1967	1985	Private		20	VII-IX e XII-III
	Albergo Ponticello	1905	1491	Private		24	always
	Rifugio Tre Scarperi	1972	1626	Alpenverein Süd.	28	24	V-X e XII-III
	Rifugio Zsigmondy Comici	1886	2240	CAI	45	41	Vi-X
	Rifugio Pian di Cengia	1964	2528	Private		11	Vi-X
	Rifugio Locatelli	1882	2405	CAI	100	50	VI-IX
	Rifugio Fondo Valle	1953	1548	Private		18	V-X e XII-III
	Città di Carpi	1970	2110m	CAI		22	20.06-20.09
	Fonda Savio	1962	2367m	CAI		16	20.06-10.10

Continua >>

BUFFER ZONE

				n° (evaluation)		density (p/km)	period
visitors							

				length		density (km/km²)	
footpath				217,83		1,11	
facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Rifugio Vallandro	1969	2028	Private		24	always
	Albergo Pratopiazza	1983	1991	Private	30	12	always
	Albergo Hohe Gaisl	1890	1993	Private		60	always
	Auronzo	1912 – 1955	2333m	CAI		104	26.05-07.10
	Lunelli	1949	1568m	Private		12	10.06-30.09
	Son Forca	1955	2235m	Private		40	25.06-20.09 / 01.12-31.03
	Malga Ra Stua	1876 – 1974	1668m	Private		17	01.06-30.10 / 26.12-20.04
	Faloria	1939	2123m	Private		35	19.06-20.09 / 27.11-30.04
	San Marco	1895	1823m	CAI		37	20.06-20.09
	Scotter	1979	1580m	Private		18	01.07-20.09 / 20.12-15.03
	Galassi	1905	2018	CAI		99	20.06-20.09
	Antelao	1947	1796m	CAI		24	15.04-31.10
	Capanna degli Alpini	1957	1395	Private		9	20.06-20.09
	Chiggiato	1926	1911m	CAI		24	20.06-20.09
	Ciareido	(1890) 1973	1969m	CAI		21	01.06-30.09

Continua >>

	Lavaredo	1954	2344m	Private		17	25.05-31.10
	Carducci	1908	2297m	CAI		25	20.06-20.09
	Berti	1962	1950m	CAI		48	20.06-30.09
	Bosi	1931	2205m	Private		20	20.06-30.09 / 26.12-06.01
	Giussani	1972	2580m	CAI		55	18.06-20.09
	Biella	1907 (1926)	2327m	CAI		46	20.06-30.09
	Lorenzi	1959	2932m	Private		25	20.06-30.09
	Cima Tofana	1973 (fino al 2003)	3244m	-		-	-
	Vandelli	1891 (ricostr. 1924)	1928m	CAI		43	20.06-20.09
	24				283	676	
mountain cabins	Bivacco della pace		2760		9		always
	Battaglion Cadore	1952 (ricostr. 1977)	2250m	CAI	9		always
	De Toni	1960	2578m	CAI	9		“
	Baracca degli Alpini	1982	2922m	-	7		“
	Comici	1961	2000m	CAI	9		“
	Slataper	1965	2600m	CAI	7		“
	Voltolina	1961	2082m	CAI	9		“
	Cosi	1956	3111m	CAI	9		“
	Musatti	1961	2111m	CAI	9		“
	Tiziano	1899 1977	2246m	CAI	17		“
	Fanton	1961	1750m	CAI	9		“
	11				103		
others (malghe, alberghi, ristoranti,etc)							
	0						

	15				30	536	
mountain cabins	Piovan	1969	2070m	CAI	9		always
	Gera	1969	2240m	CAI	9		“
	2				18		
others (malghe, alberghi, ristoranti,etc)							
	0						

6. Puez - Odle/Puez - Geisler/Pöz - Odles

CORE ZONE

	n° (evaluation)		density (p/km)	period
visitors				

	length		density (km/km²)	
footpath				

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Rifugio Gherdenacia	1937	2050	Private		25	chiuso
	Rifugio Puez	1889	2475	CAI		78	VI-X
	Rifugio Stevia		2312	Private		18	VII-X
	Schlüterhütte - Rifugio Genova	1898	2297	CAI		95	VII-X
	4					216	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

BUFFER ZONE

	n° (evaluation)		density (p/km)	period
visitors				

	length		density (km/km²)	
footpath				

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Gampenalm		2062	Private		30	
	1					30	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

7. Sciliar - Catinaccio/Schlern - Rosengarten - Latemar

CORE ZONE

	n° (evaluation)		density (p/km)	period
visitors				

	length		density (km/km²)	
footpath				

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Rif. Bergamo - Grasleitenhütte	1887	2134	CAI Bergamo		70	15.6 - 30.9
	Rif. Alpe di Tires	1963	2440	Private	34	20	15.6 - 30.9
	Rif. Re Alberto I - Gartlhütte	1933	2440	Private	20	20	1.6 - 30.9
	Rif. P.sso Santner	1965	2734	Private		8	1.6 - 30.9
	Rif. Schlernbödele	1960	1733	AVS		20	15.5 - 15.10
	Rif. Bolzano - Schlernhaus	1885	2475	CAI Bolzano	60	30	15.6 - 30.9
	Rif. Al Passo Principe	1950	2601	Private		14	VI-IX
	Rif. Antermoia	1911	2497	SAT		38	VI-IX
	Rif. Paul Preuss	1890	2243	Private		8	VI-IX
	Rif. Roda di Vael	1904	2283	SAT		50	VI-IX
	Rif. Vajolet	1897	2243	SAT	65	58	VI-IX
	11				179	336	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

BUFFER ZONE

	n° (evaluation)		density (p/km)	period
visitors				

	length		density (km/km²)	
footpath				

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Rif. Mahlknechthütte		2054	Private		42	1.6 - 25.10 10.12 - 20.4
	Rif. Dialer (ex T.C.I.)		2145	Private		108	estate - inverno
	Rif. Alpl		1364	Private		15	1.6 - 15.10
	3					165	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

8. Rio delle Foglie/Bletterbach

CORE ZONE

	n° (evaluation)		density (p/km)	period
visitors				

	length		density (km/km²)	
footpath				

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters							
	0						
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

BUFFER ZONE

	n° (evaluation)		density (p/km)	period
visitors				

	length		density (km/km²)	
footpath				

facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters							
	0						
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

9. Dolomiti di Brenta

CORE ZONE

				n° (evaluation)		density (p/km)	period
visitors							
				length		density (km/km²)	
footpath							
facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Al Cacciatore	1957	1820	Private		56	VI-IX
	Alimonta	1970	2580	Private		54	VI-IX
	Croz dell'Altissimo	1964	1431	Private		19	VI-IX
	Dodici Apostoli	1908	2489	SAT		40	VI-IX
	F.F. Tuckett e Q. Sella	1906	2271	SAT	50	62	VI-IX
	Maria e Alberto "ai Brentei"	1932	2182	CAI - Monza	27	70	VI-IX
	Selvata	1979	1630	Private		24	VI-IX
	Silvio Agostini	1937	2410	SAT		54	VI-IX
	8				77	379	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

BUFFER ZONE

				n° (evaluation)		density (p/km)	period
visitors							
				length		density (km/km²)	
footpath							
facilities	inventory	construction year	altitude	ownership	dormitory	sleeping spaces	opening period
shelters	Tosa "Tommaso Pedrotti"	1881	2491	SAT		135	VI-IX
	1					135	
mountain cabins							
	0						
others (malghe, alberghi, ristoranti,etc)							
	0						

ANNEX 5

A5.1 PROTECTIVE DESIGNATION
IN ORDER TO PROVINCE

A5.2 PROTECTIVE DESIGNATION
IN ORDER TO SYSTEMS

A5.1 PROTECTIVE DESIGNATION IN ORDER TO PROVINCE

A_1 Provincia di Belluno

In the nominated property, protection is guaranteed by both general or local control systems. The general control system, operative for all sites, is carried out through: the staff of the National Forestry Corps, which is responsible for surveillance, superintendence, and the prevention of environmental crimes (air and water quality, protection of flora and fauna, the safeguard of palaeontological and mineralogical assets, etc.). The province provides gamekeepers, whose main duty is to protect the heritage as regards fauna. Each municipality has its own police force, which is responsible for protecting the forestry and pasture heritage of its own district. Moreover, control and surveillance is also in the hands of the police force of authoritative bodies which unique to this area, namely the 'Regole' and the 'Magnifiche Communità' (Family Communions that are joint owners of non-transferable property). Actions (plans and projects) in the nominated areas are also subject to authorization processes that foresee various technical assessments and which also depend on the execution of studies on environmental feasibility, environmental impact assessment, environmental incidence assessment, strategic environmental evaluation, etc., based on the plan type. In particular, as regards the Nature 2000 Network areas, most of the impact assessments are first examined by the competent centralized departments of the Veneto Region. With reference to the non-generalized control systems, defined therefore as local, the area of Dolomiti Bellunesi is managed by the Parco Dolomiti Bellunesi Board. Surveillance is carried out by specifically designated personnel belonging to the National Forestry Corps who are members of the so-called Coordinamento Territoriale Ambientale - CTA (Territorial Environmental Coordination), composed of about forty commissioners, deputy superintendents and officers who are at the same time qualified police officers or members of the Investigative Police Force. The areas 'Dolomiti Ampezzane, di Fanes, Senes e Braies' (for the part in the Provincia di Belluno), 'Pelmo – Nuvolau - 5 Torri' (for the part in the municipality of Cortina d'Ampezzo) and 'Cristallo' can count on the surveillance services of six park rangers of the 'Regole d'Ampezzo', who ensure respect for the environmental planning procedures and for the rules governing respect for the environment in general.

Selection of the most important legislation for the protection of landscape, nature and environment

- Regional law No. 11, April 23rd, 2004 (Official Regional Bulletin, BUR No. 45/2004) "Regulations for the administration of the territory".
- Regional law 40, August 16th, 1984 (BUR No. 38/1984) "New regulations for the establishment of regional parks and nature reserves".
- Regional law No. 50, December 9th, 1993 (BUR No. 104/1993) "Regulations for the protection of wild fauna and hunting quotas".
- Regional law No. 17, June 27th, 1996 (BUR No. 61/1996) "Regional fauna and hunting plan (1996-2001)".
- "Provincial Regulations for hunting in the Alpine reserves of the Provincia di Belluno". Provincial Council Decree No. 52/461, May 6th, 1994 and subsequent amendments.
- Regional law No. 19, April 28th, 1998 (BUR No. 38/1998) "Regulations for the protection of hydrobiological resources and fish wildlife and regulations for fishing in inland and coastal waters of the Veneto region".

– "Provincial Regulations for fishing in inland public waters in the Provincia di Belluno". Provincial Council Decree No. 12/2005, January 21st, 2005.
– Regional law No. 53, November 15th, 1974 (BUR No. 47/1974) "Regulations for the protection of certain species of minor fauna and flora" and subsequent amendments.
– Regional law No. 23, August 19th, 1996 (BUR No. 76/1996) "Regulations for the collection and sale of fresh and preserved epigaeal mushrooms".
– Regional law No. 30, June 28th, 1988 (BUR No. 40/1988) "Regulations for the collection of cultivation and sale of truffles".
– Regional law 14, March 31st, 1992 (BUR No. 36/1992) "Regulations for forestry and pastoral viability".
– Regional law 52, September 13th, 1978 (BUR No. 43/1978) "Regional forestry law".
– Law Decree No. 42, February 22nd, 2004 (O.J. No. 45/2004, O.S. No. 28) "Code for cultural and landscape assets, in accordance with article 10 of law No. 137, dated July 6th 2002" paragraph 4, letter a) "items concerning palaeontology, prehistory and primitive civilisations." Related implementing decrees and park regulations:
– Regional law No. 40, August 16th, 1984 (BUR No. 38/1984) "New regulations for the establishment of regional parks and nature reserves", article 6, letter i) "unique geological and mineralogical features";
– Regional law No. 21, march 22nd, 1990 (BUR No. 22/1990) "New regulations for the establishment of the Parco delle Dolomiti d'Ampezzo", article 10, letter g) "unique palaeontological and mineralogical features";
– Ministerial Decree, April 20th 1990, instituting the Parco Nazionale Dolomiti Bellunesi.

A5.1.a Provincia di Belluno

Regional Territorial Coordination Plan, approved in terms of Regional Council Decision NO 250 of 13/12/1991.
Articles of interest for the candidate area:
Article 19 – Directive for protecting natural and environmental resources.
Article 33 – Directives, regulations and restrictions for parks, nature reserves, and areas in which regional countryside is protected.
This article identifies the following parks and nature reserves that are to be set up in the Alpine and Pre-Alpine Sectors:
– Dolomites of Ampezzo (declared a Park in terms of Regional Law N° 21 of 22.3.1990).
– Monte Pelmo.
– Monte Civetta.
– Dolomites of Belluno (Declared a National Park in terms of Ministry of the Environment Decree of 20/4/90).
– Marmolada Ombretta.
– Antelao-Marmarole-Sorapis. In addition the article specifically states that in the "territorial areas identified in the P.T.R.C. for the setting up of regional parks and nature reserves, in the process of instituting the same the local territorial Bodies may carry out or authorise works aimed at restoring and environmental reclamation, with the agreement of the Regional Government in consultation with the technical body. These works may be for the purposes of public use, without prejudice to the need for authorisation by the bodies responsible for protecting the environment and the countryside in terms of Laws 1497/1939 and 431/1985.
Article 34 – Directives, regulations and restrictions for protected countryside of regional interest, un-

der the control of the provincial authorities.

The article states that the "Province is to draw up specific standards in the Provincial Territorial Plan or in special "Sector Plans", that specifically look at the countryside / environmental value of the areas concerned, according to Regional Law N° 9 of 11.3.1986.

When approving the Provincial Territorial Plan or a specific Sector Plan, the Provincial Authority may set up parks or reserves in the areas indicated in the list below, and define who is to manage these.

Until the specific standards laid down in the previous comma are adopted, changing the nature of the territory and any building work is forbidden, excepting for any routine or extraordinary maintenance, static consolidation and conservation restoration that do not alter the status of the places and the external appearance of the buildings."

The article also states that "countryside protection areas" have been identified for the Alpine and Pre-Alpine Sector, in the following areas:

- The Dolomites of Sesto, Auronzo, and Comelico
- Monti Cridola – Duranno

For each area referred to in the previous articles, a list of some protection standards is listed. An example is given for one of the candidate Dolomite systems.

The Dolomiti di Sesto, Auronzo, and Comelico Specific protection regulations

1 Building new roads is forbidden, excepting for roads used to serve agricultural, forestry, pastoral, and rural activities and existing buildings. As far as existing roads are concerned, works allowed are limited to maintenance, with the exclusion of upgrading of structures and asphalting of sand roads, without prejudice to the specific regulations relating to individual areas.
2 Reducing woodlands for the purposes of cultivation is forbidden.
3 Excavations, earth moving, and movement of means is forbidden, where these may alter the environment, with the exclusion of works necessary for executing public works and organising water resources.
4 Opening new quarries or re-opening quarries that have been closed down or abandoned is forbidden.
5 All types of land reclamation are forbidden.
6 Works that change the flow and composition of water are forbidden.
7 Collection, removal, and damaging natural flora and geological and mineralogical elements are forbidden.
8 The introduction of animal and vegetable species from outside the biocenosis, or that may cause ecologically harmful changes is forbidden.
9 The use of motorised vehicles off-road is forbidden, with the exception of those necessary for agricultural work, use of woodlands, civil defence services, and supplies to Alpine huts for maintaining ski tracks, as well as equipment required to construct and operate the electrical systems housed in these.
10 New fencing of property is not allowed, unless this is done using hedgerows or local traditional materials, excepting for temporary fencing to protect forestry / pastoral activities and those that are specifically related to buildings and agricultural and zootechnic uses.
11 Cutting of woodlands is only allowed as indicated in forestry / pastoral economic plans and/or general regulations of the forestry police.
12 Of the works allowed in terms of the previous points, those that relate to works for meeting the need for potable water, those related to hydro-geological protection including civil works involved in redefining the extent of watercourses, as well as protecting banks, dykes, crossings, etc. as well as those for aquaculture, irrigation, and the water drainage, and those related to current agricultural activities or for reinstating agricultural activities in places that were traditionally cul-

tivated.

13 The building index for new buildings within the area may not exceed 0,001 m3/m2 (and not above an altitude of 1300 m), excepting for the indications given in the points that follow.

14 For existing buildings work is allowed for routine and extraordinary maintenance, restoration, conservational refurbishing and compliance with health regulations, as well as redevelopment and extensions of such buildings in compliance with art 4 of Regional Law 24/85, using the type of buildings and materials traditionally found locally.

15 Redevelopment with extension is allowed, within the limits laid down in art. 4 and 6 of Regional Law 24/ 85, to modernise Alpine huts and cheese-making sheds, as well as any change of use of the same to create Alpine huts or farm holiday activities.

16 Ancient types of paving such as cobbles and brick in outdoor areas are to be kept.

17 Work is allowed on constructing or modernising plants for capturing and channelling water to meet the need for potable water, after a study has been carried out into the impact this will have on the fluvial ecosystem.

18 Collecting mushrooms is allowed in terms of Regional Law 53/74.

19 Work is allowed to set up trails fitted with cables and iron steps in terms of Regional Law 52/86.

20 Snowcats are only allowed to operate within the existing areas used for skiing activities.

21 Work is allowed on setting up cross-country skiing tracks and maintenance work on existing tracks .

22 Club huts may be built high up in the mountains in terms of Regional Law 52/1986, provided the types of building and materials used, are those traditionally found locally.

23 Making plants for producing alternative sources of energy is allowed, provided an environmental compatibility study is carried out beforehand.

24 In the areas subject to the limitations set by Law 1497/1939, as integrated into Law 431/1985, the installation of signage and advertising boards is forbidden, with the exception of those pointing the way to public services or public and private equipment to provide roadside assistance and to market goods. The types of signage for the installations allowed are defined in terms of a Decision by the Regional Government, in line with current regional legislation.

* On Monte Piana, buildings from World War I may be renovated and access roads to the same may be modernised.

At a provincial and municipal level.

The preliminary PTP plan for the Belluno Province, adopted in 1995 but not yet approved by the Provincial Council, and the PRGs for the Municipalities involved, implement the directives contained in the Regional Territorial Coordination Plan (PTRC). For some landscape protection issues, the PTRC has also been implemented by means of specific planning for the area of a strongly environmental nature. This is the case in the Plans for the Cross-Border Area of Comelico – Ost Tirol, Auronzo Misurina and the Biois and Gares valleys, which are also implemented in terms of the PRGs.

The Plan for the Cross-Border Area of Comelico – Ost Tirol is a good example, as it identifies specific criteria for managing the forest and grassland areas, allowing for care and maintenance of the forests, transporting of timber via cableway, maintenance of forestry roads and pastures, and promoting pastoral activities and the running of the forest on the basis of a financial plan (art. 5.6 Of the Technical Standard for Implementing the Plan for the Comelico – Ost Tirol Cross-Border Area).

It also provides incentives for the creation of nature and archaeological trails, and the protection and valorisation of huts, bivouacs, and shelters, as well as allowing for works to improve tourist accommodation and measures for limiting the consumption of energy, along with a commitment to use

renewable sources of energy. (Art. 6 of the Technical Standard for Implementing the Plan for the Comelico – Ost Tirol Cross-Border Area).
In terms of planning for municipal areas, in compliance with the indications given in the PTRC and the Area Plans where applicable, each individual Municipality has drawn up its own town planning scheme. These schemes deal with the areas in which the countryside it to be protected, especially those of particular naturalistic value indicate din the PTRC and the PTCP. For the areas included in the candidature, they provide a general definition of the standards for use that are compatible with the naturalistic and countryside aspects that are prevalently of an agricultural / forestry nature.
Where Municipal areas lie within parks (the Parco Nazionale Dolomiti Bellunesi and the Parco Regionale Dolomiti d'Ampezzo), the use of the land is subject to the Parks Management Plans, and the municipal schemes make reference to these plans.
In most of the Municipalities the areas defined as being at the "heart", which correspond to the rocky outcrops that are included in the candidature, are classified in the town planning documents as agricultural areas of the Alpine sub-zone of particular naturalistic importance, zoned for use for tourism, recreation and didactic purposes. Here work is allowed that aims to enhance the environment (e.g. setting out of new hiking trails) but no new construction is allowed. Alternatively, they are classified as sterile, unproductive areas, characterised by the presence of rock and scree, where no works are allowed.
In the "intermediate" areas the land is mainly used for agricultural and forestry pursuits, characterised by forests that act as hydro-geological, landscape, or environmental protection areas in which particular care must be taken of the countryside and environmental aspects, and where only the building of bivouacs and Alpine huts, etc can be built, under specific conditions.
In other cases the "intermediate" areas are used for agricultural-forestry-pastoral activities used as pastures characterised by a high degree of naturalness, in which work is allowed that is related to limited economic productivity associated with bush clearing and mowing carried out with a view to caring for and respecting the woodland and environmental resource on the basis of a specific economic plan. In general, for existing buildings (Alpine shelters, mountain cabins, cheese-making sheds, refuges, etc) restoration and redevelopment are allowed, as well as limited extension, as well as the demolition and rebuilding of derelict buildings that pose a danger to public safety.
Only in a few isolated cases are there areas in which, in addition to the agricultural / forestry use, production is also allowed or the land may be necessary for organising rural centres and villages in which mixed activities such as light industry, tourism hospitality, and services activities are permitted, provided these are on a small scale.
The various town planning zones are described for each Municipality in the attachment that refers to the specific regulations for the use of the land.
By way of example, a summary of the current regulations for the Municipality of San Vito di Cadore is given below:

ZTO E/1.1 Alpine sub-zone (about 65% heart and 11% buffer)	art. 45 NTA	This is zoned for tourism, recreation, sports, and didactic purposes	Construction is allowed for Alpine huts, permanent bivouacs open to the public and similar structures, work on upgrading, refurbishing, and setting out new hiking trails, hydrological works, avalanche barrier systems, and infrastructures for preventing and fighting fires. Change of use is not allowed. Routine and extraordinary maintenance, restoration and redevelopment as well as extensions are allowed to the extent provided for in Art 4 of Regional Law 24/1985 (for buildings for public use).
ZTO E/1.2 Forestry sub-zone (about 30% buffer)	art. 46 NTA	Forestry areas for productive ends	The following are permitted: routine and extraordinary maintenance, restoration and redevelopment, demolition and re-building for essential reasons of stability, in terms of Art 4 and 7 of Regional Law 24/1985, as well as building and upgrading of roads and tracks to serve the forests, and equipment, plants, and temporary depots for forestry works.
ZTO E/1.3 Protected forestry sub-zone (about 19% buffer)	art. 47 NTA	Forestry areas used for hydro-geological protection and for protecting the countryside and environment.	No building is allowed in this sub-zone. Forestry areas are managed in terms of a forestry redevelopment plan, as provided for in Art 24 of Regional Law 52/1978 and in the manner expressed in the regional forestry planning directives and regulations. In general, surfaces are left to spontaneous evolution and use of the forests is normally not allowed, excepting for the cases laid down in the forestry redevelopment plan for cultivation and phytosanitary purposes.
ZTO E/1.4 Bush areas at high altitude (about 10% heart and 14% buffer)	art. 48 NTA	Zoned for protecting the countryside and the environment	No building allowed. The bush cannot be used excepting for phytosanitary purposes.
ZTO E/1.5 Forest/ pasture sub-zone (about 6% buffer)	art. 49 NTA	Privately-owned grassland and pastures, used for forestry and pastoral purposes	No building is allowed in this sub-zone. Changing the use of existing buildings is not allowed, although routine and extraordinary maintenance, restoration, and redevelopment may be carried out on them, in compliance with Art 4 and 7 of Regional Law 24/1985. The building and maintenance of roads and tracks to serve the grasslands and bush is allowed, as is agricultural use of marginal areas, when these are already naturally or artificially covered by bush or trees. Use for forestry is subject to specific regulations.
ZTO E/1.6 Pastoral sub-zone (about 25% “heart” and 16% buffer)	art. 50 NTA	Alpine huts on grasslands for running pastoral and recreational activities	Building of new clusters of Alpine huts is allowed as are routine and extraordinary maintenance, restoration and redevelopment, as laid down in Art 4 and 7 of Regional Law 24/1985. The construction and maintenance of roads and tracks to serve the pastures is allowed as is pastoral activity subject to specific regulations
ZTO E/3.3 Sports facilities sub-zone (about 4% buffer)	art. 54 NTA	Winter tourist use	The grass in this area must be kept properly cut. The provisions of Regional Law 18/1990 must be applied.

A_2 The Provincia Autonoma di Bolzano/ Autonome Provinz Bozen-Südtirol

In the nominated property, protection is guaranteed by general or local control systems. The general control system, in force in all sites, is in the hands of: the staff of the National Forestry Corps, which is responsible for surveillance, superintendence, and the prevention of environmental crimes (interventions involving the movement of the earth of the landscape, protection of flora and fauna etc.). The Province, like most hunting reserves, has gamekeepers whose duties include surveillance and protection of the animal heritage. Control is also carried out by the staff of the provincial Natural Parks Office, which is responsible for management and development in the park areas. Controls carried out by the staff members also cover building activities, earth movement, ensuring that no interventions are carried out on the landscape without due authorization, transit on roads closed to traffic, protection of flora and fauna, and control of mineral and fossil collecting. Actions (plans and projects) in the nominated areas are also subject to authorization procedures that foresee various technical assessments and which are also subject to direct authorization issued by the mayor for minor interventions, to the execution of studies on environmental feasibility, environmental impact assessment, environmental incidence assessment, strategic environmental evaluation, etc., based on the plan types. In particular, as regards landscape assessment and depending on the entity of the action, an assessment is made either by a special commission, the 2nd Commission for Landscape Protection, by the directors of the office, or by the EIA Committee. For the areas included in the Nature 2000 Network, interventions are subject to impact assessments carried out by the staff of the Natural Parks Office of the Provincia Autonoma di Bolzano.

Selection of the most important legislation for the protection of landscape, nature and environment

- PL 1970 / No. 16 Protection of the landscape
- PL 1972 / No. 13 Regulations for the protection of Alpine flora
- PL 1973 / No. 27 Regulations for the protection of fauna
- PL 1975 / No. 29 Regulations for the protection of basins
- PL 1977/ No. 33 Regulations for the extraction of minerals and fossils
- PL 1981 / No.7 Provisions and plans for the improvement of nature reserves
- PL 1997 / No. 15 Regulations for powered flight for the protection of the environment

The Province of Bolzano also has a well developed system of town planning standards that are based on the principles of landscape protection and nature conservation.
The basic instrument is the Provincial Plan for territorial coordination and development (LEROP, implemented in accordance with Provincial Law No. 3 of 18 January 1995. In addition to being applied via the Municipalities' General Town Planning Schemes, it is also enforced via ruling instruments for individual action sectors, such as the Plan for Ski-lift and Ski Slopes Systems (Provincial Board Resolution No. 13 of 10.01.2005), the Plan for Cycling Paths (Provincial Board Resolution No. 2894 of 29.06.1998), the Provincial Transport Plan (Provincial Board Resolution No. 2445 of 21st July 2003), as well as the more specifically protective provisions listed previously.
All the Municipalities have Municipal Town Planning Schemes (PUC) that are approved via Provincial Board Resolution. These schemes must also provide the regulations for protecting the natural landscape.
For the purposes of conservation of the nominated area, other law provisions may also be relevant, for example: Provincial Law No. 13 of 11th August 1997 that is the Provincial Town Planning Law, Decree of the President of the Provincial Board No. 22 of 23rd May 1977 that contains the Regulations for Health and Hygiene standards applying, among others, to mountain huts at high altitude,

Provincial Law No. 16 of 25th July 1970 on Landscape Protection, and finally, Provincial law No. 7 of 24th July 1998 on the Assessment of the Environmental Impact. In particular, Provincial Law 16/1970 implemented the landscape planning schemes, defining the principles and categories of landscape protection and laying down the procedures for applying the relevant restraints in favour of the landscape, and coordinating town planning with landscape protection rules.

A_3 Provinces of Pordenone and Udine

In the Friuli-Venezia Giulia region, surveillance is ensured by the CFR (Regional Forestry Corps) personnel. Some of the municipalities in the nominated property have Forestry Corps departments whose personnel are qualified as police officers/superintendents or as officers of the Investigative Police Force. These have the power of control, surveillance, and prevention of environmental crimes. They also carry out important work for the census of the animal and vegetal heritage and of environmental upheaval events. Environmental surveillance of the territory is also in the hands of the Environmental Surveillance Corps of the two provinces and, for the individual municipalities, the Local Police Forces also take responsibility for the task of the protection of the local forestry and pasture heritage.

Selection of the most important legislation for the protection of landscape, nature and environment

- RL 8 18.02.1977 Regulations for the protection of woodland against fire
- RL 39 08.05.1978 Protection of wild birds
- RL 34 03.06.1981 Regulations for the protection of nature and modifications to RL 27.12.1979 No. 78
- RL 22 08.04.1982 Regulations concerning forestry
- RL 38 25.08.1986 Amendments and supplements to RL 22 concerning forestry
- RL 56 19.12.1986 Regulations concerning hunting, breeding, taxidermy and inland fishing
- RL 22 07.05.1990 Modifications to existing provisions regarding taxidermy. Provisions regarding the verification of violations of legislation for hunting and for the protection of fauna and birds.
- RL 8 18.02.1977 Regulations for the protection of woodland against fire
- RL 39 08.05.1978 Protection of wild birds
- RL 34 03.06.1981 Regulations for the protection of nature and modifications to RL 27.12.1979 No. 78
- RL 22 08.04.1982 Regulations concerning forestry
- RL 38 25.08.1986 Amendments and supplements to RL 22 concerning forestry
- RL 56 19.12.1986 Regulations concerning hunting, breeding, taxidermy and inland fishing
- RL 22 07.05.1990 Modifications to existing provisions regarding taxidermy. Provisions regarding the verification of violations of legislation for hunting and for the protection of fauna and birds.
- RL 8 18.02.1977 Regulations for the protection of woodland against fire
- RL 39 08.05.1978 Protection of wild birds
- RL 34 03.06.1981 Regulations for the protection of nature and modifications to RL 27.12.1979 No. 78
- RL 22 08.04.1982 Regulations concerning forestry
- RL 38 25.08.1986 Amendments and supplements to RL 22 concerning forestry
- RL 56 19.12.1986 Regulations concerning hunting, breeding, taxidermy and inland fishing

- RL 22 07.05.1990 Modifications to existing provisions regarding taxidermy. Provisions regarding the verification of violations of legislation for hunting and for the protection of fauna and birds.
- RL 43 07.09.1990 Institution of Environmental Impact regulations in the Friuli-Venezia Giulia region
- RL 52 19.11.1991 Regional regulations for landscape and town planning
- RL 8 18.02.1977 Regulations for the protection of woodland against fire
- RL 39 08.05.1978 Protection of wild birds
- RL 34 03.06.1981 Regulations for the protection of nature and modifications to RL 27.12.1979 No. 78
- RL 22 08.04.1982 Regulations concerning forestry
- RL 38 25.08.1986 Amendments and supplements to RL 22 concerning forestry
- RL 56 19.12.1986 Regulations concerning hunting, breeding, taxidermy and inland fishing
- RL 22 07.05.1990 Modifications to existing provisions regarding taxidermy. Provisions regarding the verification of violations of legislation for hunting and for the protection of fauna and birds.
- RL 43 07.09.1990 Institution of Environmental Impact regulations in the Regione Autonoma Friuli-Venezia Giulia
- RL 52 19.11.1991 Regional regulations for landscape and town planning
- RL 21 18.05.1993 Amending and supplementary legislation concerning hunting
- RL 35 08.06.1993 Provisions for the protection of natural monuments and plant life heritage.
- RL 24 17.07.1996 Regulations regarding game species and hunting seasons and other amending and supplementary legislation regarding professional hunting and fishing
- RL 32 19.08.1996 Provisions concerning supplementary, amending and deferring rules regarding and the protection of indigenous flora
- RL 42 30.09.1996 Regulations concerning regional natural parks and reserves
- RL 30 31.12.1999 Management and administration of hunting in the Regione Autonoma Friuli-Venezia Giulia
- RL 12 15.05.2000 Regulations for the collection and sale of epigaeal mushrooms in the region. Supplement to art. 23 of RL No. 34/1981 concerning enforcement surveillance

The fundamental town planning standards for the Friuli Venezia Giulia Region are embodied in Regional law 52/91 and subsequent amendments – "Regional standards for territorial and town planning" – that governs the use and zoning of the territory by means of the formation of a General Regional Territorial Plan (PTRG), and regional sector plans.
These laws also contain the special provisions for the regional areas of particular importance in terms of countryside and the environment, and the areas set aside for parks or nature reserves. Provincial coordination plans are drawn up at a provincial level.
Each municipality in the region has its own general municipal town planning scheme, which is the basic instrument that covers all the provisions for the use of the municipality's territory.
Among other things, this is intended to guarantee the protection and reasonable use of natural resources as well as to protect assets of cultural, countryside, and environmental interest.
Chapter X of the Regional Law is entitled "Provisions for the protection of natural Property".

A_4 Provincia Autonoma di Trento

In the Provincia Autonoma di Trento, surveillance and control is entrusted to various legally authoritative bodies. The provincial Forestry Corps, the provincial parks' management boards, and the forest guards of the municipalities control the conservation status of the species and natural and semi-natural habitats, of the flora and wild fauna. In particular, the several dozen officers and executive staff of the provincial Forestry Corps are qualified as police officers and officers of the Investigative Police Force; the Park Rangers (the Parco Adamello – Brenta has twelve rangers in force; the Parco Paneveggio – Pale di San Martino has six, four of which in the Dolomites area) are qualified as officers of the Investigative Police Force; and the Forest Guards employed by the Municipalities are Sworn Security Guards with the same authority as Investigative Police Force officers. For action in the Nature 2000 areas, an impact assessment for each project must be carried out by the staff of the provincial department responsible for nature conservation. With regard to landscape-environment protection in the natural park areas, the Provincial Commission for Landscape and Environmental Protection must authorize any works that could alter the physical state of the places, always providing that such works are not included in the types of action subject to the EIA (Environmental Impact Assessment) procedure. For works below the threshold above which the EIA is required, in the zones included in the "Areas for Environmental Protection" of the Provincial Land Planning, however, the District Commissions for Landscape and Environmental Protection are responsible for issuing authorization.

Selection of the most important legislation for the protection of landscape, nature and environment

- PL No. 18, May 6th 1988, Natural parks law;
- PL No. 11, May 23rd, 2007, Forestry and mountain territory, rivers and protected areas management;
- PL No. 1, March 4th, 2008, Land planning and territory management;
- PL No. 5, May 27th, 2008, New provincial Land Plan;
- PL No. 17, July 25th, 1976 and subsequent amendments, Protection of Alpine flora;
- PL No. 24, December 9th, 1991, Regulations for the protection of wild fauna and for hunting;
- PL No. 16, July 25th, 1973, Regulations for the protection of certain species of minor fauna;
- PL No. 60, December 12th, 1978, Regulations for fishing in the Provincia Autonoma di Trento;
- PL No. 16, August 6th, 1991, Regulations for the collection of mushrooms;
- PL No. 37, October 31st, 1983, Protection of mineralogical, palaeontological and karstic heritage;
- PL No. 5, August 12th, 1996, Regulations for the protection of the environment relative to the operation of aircraft;
- PL No. 48, November 23rd, 1978, Provisions for the expansion of forest areas and their resources;
- PL No. 8, March 15th, 1993, Regulations for mountain huts, shelters, paths and equipped ways.

The Provincia Autonoma di Trento, within the limits established by the Constitution, has exclusive authority as regards the protection of the landscape, and for town and country planning, as foreseen by the Statute of the Autonomous Province, drawn up in 1971. In this framework of responsibility, the Province, through provincial territorial development planning, defines the general guidelines for the organisation and development of the territory, and in fact protects the landscape and envi-

ronment by introducing into the plans the contents and landscaping limits laid down by Law No. 1497/1939 and Law No. 431/1985. In particular, with reference to the Dolomites, the "Areas for environmental protection" include those areas at an altitude of over 1,600 metres, the woods, and the areas designated as natural parks.

In the provincial territorial development plan, approved by legislation (the first provincial territorial development plan was approved in 1967, and the third was approved in 2008), instructions are given for the municipal planning as regards the specific destinations of use of the territory. Among other things it identifies and delimits the areas designated as natural parkland. It was precisely with the first provincial territorial development plan, approved in 1967, that the Parco naturale Adamello-Brenta and the Parco naturale Paneveggio-Pale di San Martino were founded; a specific law (Prov. Law No. 18/1988) was later passed to discipline these Parks, together with their own management plan. As foreseen by Prov. Law No. 22/1991 and now by Prov. Law No. 1/2008, a consolidated act containing the provincial provisions on urban planning and protection of the territory, the provincial territorial development plan is followed hierarchically by the District Coordination Plans, an instrument on a sopra-municipal scale, and above all by the general urban development plans of the municipal councils, which are responsible for direct management of the land.

The nominated areas that fall within the territory of the Provincia Autonoma di Trento, and their relative buffer zones, are entirely disciplined by the provincial territorial development plan, according to modalities and functions aimed at conservation and protection. All the proposed areas are included in the "Areas for Environmental Protection" defined by the Environmental System of the Provincial Land Planning, to ensure protection of the landscape and environment of the provincial territory. In the "structural framework" of the Provincial Land Planning, the said nominated areas and their relative buffer zones are also included in the "Pasture Areas, "Wooded Areas" and "High integrity Areas", respectively disciplined by articles 39, 40 and 28 of the Plan provisions, based on criteria of strict environmental protection, and which are required to be faithfully reflected in the general urban planning of the municipalities.

The new provincial territorial Plan, approved in May 2008, identifies the "invariants", permanent elements of the territory subjects to special protection to ensure the sustainable and correct development of the province. Between the invariants are covered elements geological and geomorphological, the areas of the nomination for the Unesco List, the hydrographic net, the forest owned by the province, the properties representative for the high landscape and cultural values. These elements are governed by the article 8 of the Plan's rules, that prescribes the conservation and valorization of these areas and that, particulary, subjects the regulations of the areas of the Dolomites nominated for the Unesco List to the programme agreement approved by the five provinces.

Planning instruments relative to specific sectors complete the framework laid down by the provincial territorial development plan. The Parks plan has been mentioned, prepared pursuant to Prov. Law No. 18/1988 "Natural Parks Law" that establishes the guidelines for the administrative and management structure of the natural parks, not only based on the concept of conserving the natural and environmental aspects of the territory that are in danger, but also on the maintenance of the traditional uses to which the land has always been put by the civil population, by which man has gained a livelihood in a symbiotic relationship with the mountain, the woods, and the alpine pastures, and guaranteeing the local communities direct management of the territory. Other instruments must be borne in mind, considering the wide extension of the areas of the Province covered by woods and forests, i.e. the general forestry plan approved by the local Provincial government, in order to define the large scale choices for the management of the wooded areas and, within it, the management plans for the municipalities and for private citizens, containing the rules and regulations for management of the woods and for felling.

Regarding the glacier of Dolomites it's important to note that the new provincial territorial plan also prescribes that a special protection for the glaciers. The article 28 – "High integrity Areas" – includes

glaciers, between the glacier of the Marmolada, in areas with high integrity and in these areas provides the only maintenance and rationalization of plant and the existing structures linked to the practice of skiing, including time limits and conditions that will be fixed in a program that must be approved by the provincial executive administration. The conditions prescribe that in the programme
a) must be guaranteed the structural integrity of the glacier, even with regard to the practice of skiing;
b) the rationalization measures and the valorization intervents must ensure better environmental and landscape.

Property

- Provincial Land Planning, Environmental System: Areas for environmental protection (art. 11), Natural Park Areas (art. 26);
- Provincial Land Planning, Structural framework: Pasture Areas (art. 39), Forested Areas (art. 40), High integrity Areas (art. 28)

Buffer Zone

- Provincial Land Planning, Environmental System: Areas for environmental protection (art. 11), Natural Park Areas (art. 26)
- Provincial Land Planning, Settlement and Productive System: Forested Areas (art. 40), Pasture Areas (art. 39), High integrity Areas (art. 28)

ANNEX 5.2 PROTECTIVE DESIGNATION IN ORDER TO SYSTEM

systems	
1. Pelmo-Nuvolau	The Provincia di Belluno – SCI IT3230017 Monte Pelmo - Mondeval – Formin – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 9 Monte Pelmo. Destination: regional natural park-reserve – Areas subject to landscaping restrictions, as per art. 136 LD 42/2004 (formerly L. 1497/39): the entire area of Comune di Cortina d'Ampezzo, established by MD 10/06/1952
2. Marmolada	Regarding the portion within the Provincia Autonoma di Trento – SCI IT3120129 Ghiacciaio Marmolada (TN) – Areas subject to landscaping and environmental restrictions (Provincial Land Planning approved by Provincial Law No. 5/2008, Provincial Law of 4 of March 2008, No. 1: "Land planning and territory management") Regarding the portion within the Provincia di Belluno – SCI IT3230005 Gruppo Marmolada (BL) – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 12 Marmolada Ombretta. Destination: regional natural park-reserve – Areas subject to landscaping restrictions, as per art. 136 LD 42/2004 (formerly L. 1497/39): the entire area of Comune di Falcade, established by MD 07/11/1961

3. Pale di San Martino-San Lucano - Dolomiti Bellunesi	Regarding the portion within the Provincia Autonoma di Trento – SCI IT3120010 Pale di San Martino – SCI IT3120011 Val Venegia – SCI IT3120126 Val Noana – Parco naturale provinciale Paneveggio-Pale di San Martino (Provincial Law of 12 September 1967, No. 7: "Approval of the provincial town planning map"; Provincial Law of 6 May 1988, No. 18: "Natural Parks Law") – Areas subject to landscaping and environmental restrictions (Provincial Land Planning approved by Provincial Law No. 5/2008, Provincial Law of 4 of March 2008, No. 1: "Land planning and territory management") Regarding the portion within the Provincia di Belluno – Parco Nazionale Dolomiti Bellunesi (ME decree 20/4/1990) – SCI/SPZ IT3230083 Dolomiti Feltrine and Dolomiti Bellunesi – Riserva naturale integrale Piazza del Daivolo (Ministerial Decree 28.12.1971 – O.J. No. 19, 22.01.1972) – Riserva naturale Monte Pavione (Ministerial Decree 20.12.75 – O.J. No. 24, 28.01.76) – Riserva naturale Schiara Occidentale (Ministerial Decree 29.12.75 – O.J. No. 36, 10.02.76) – Riserva naturale Piani Eterni – Erera – Val Falcina (Ministerial Decree 29.12.1975 – O.J. No. 52, 26.02.1976) – Riserva naturale Vette Feltrine (Ministerial Decree 29.12.75 – O.J. No. 56, 02.03.1976) – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 49 Masiere and Lago di Vedana. Destination: protected landscape area of regional importance, administered by local authorities – Areas subject to landscaping restrictions, as per art. 136 LD 42/2004 (formerly L. 1497/39): Northern area of Monte Serva Comune di Belluno, established by MD 22/10/1975 – SCI/SPZ IT3230043 Pale di San Martino: Focobon, Pape -San Lucano, Agner Croda Granda – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 46 Valli di Gares and San Lucano. Destination: protected landscape area of regional importance, administered by local authorities – Areas subject to landscaping restrictions, as per art. 136 LD 42/2004 (formerly L. 1497/39): the entire area of Comune di Falcade, established by MD 07/11/1961; Valle di San Lucano, established by MD 21/02/1977; and Valle di Gares, instituted by MD 08/04/1976 – SCI/SPZ IT3230084 Civetta - Cime di San Sebastiano – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 10 Monte Civetta. Destination: regional natural park-reserve – Areas subject to landscaping restrictions, as per art. 136 LD 42/2004 (formerly L. 1497/39): the entire area of Comune di Alleghe, established by MD 12/03/1958
4. Dolomiti Friulane/ Dolomitis Furlanis e d'Oltre Piave	Regarding the portion within Provincia di Belluno – SCI IT3230080 Val Talagona - Gruppo Monte Cridola - Monte Duranno – SPZ IT3230089 Dolomiti del Cadore and Dolomiti di Comelico – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 30 Monti Cridola – Duranno. Destination: protected landscape area of regional importance, administered by provincial authorities. Regarding the portion in the Province di Pordenone and Udine – Parco delle Dolomiti Friulane – Parco naturale - Dolomiti Friulane – SCI - IT3310001 Dolomiti Friulane – SPZ - N.IT3311001 Dolomiti Friulane

5. Dolomiti Settentrionali/ Nördliche Dolomiten	Regarding the portion within the Provincia Autonoma di Bolzano The site is completely subject to protection as a nature reserve and as a SPZ. The area is also protected according to Directive 92/43/EEC, with three different sites of Community importance, covering almost the entire reserve. – Parco Naturale Fanes-Senes-Braies – Naturpark Fanes-Sennes-Prags (PDPC March 4th, 1980, No. 72/V/LS) – SPZ IT3110049 Parco Naturale Fanes-Senes-Braies – Naturpark Fanes-Sennes-Prags – SCI IT3110023 Picco di Vallando-Pratopiazza-Lago di Landro nel P.N. FSB.; Dürrenstein-Plätzwiese-Dürrensee im NP. FSP – SCI IT3110024 Val Foresta-Val Ciastlins nel PN FSB.; Grünwaldtal-Val de Ciastlins im NP. FSP – SCI IT3110025 Alpe di Fanes nel PN FSB – Fanesalpe im NP FSP – Parco Naturale Dolomiti di Sesto nei Comuni di Dobbiaco, Sesto and San Candido - Naturpark Sextner Dolomiten in den Gemeinden Toblach, Sexten und Innichen (P.D.P.C. 22 December 1981, No. 103/V/81) – SPZ IT3110050 Parco Naturale Dolomiti di Sesto – Naturpark Sextner Dolomiten – SCI IT3110021 Val Campo di Dentro – Val Fiscalina – Praticasella nel Parco Naturale Dolomiti di Sesto -Innerfeldtal – Fischleintal –Gsellwiesen im Naturpark Sextner Dolomiten Regarding the portion within the Provincia di Belluno – SCI IT3230078 Gruppo del Popera - Dolomiti di Auronzo and Dolomiti di Val Comelico – SPZ IT3230089 Dolomiti del Cadore and Dolomiti di Comelico – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 29 Dolomiti di Sesto, Dolomiti di Auronzo and Dolomiti di Comelico. Destination: protected landscape area of regional importance, administered by provincial authorities. – SCI/SPZ IT3230071 Dolomiti di Ampezzo – Parco Naturale Regionale delle Dolomiti d'Ampezzo (RL 22.03.1990 No. 21) – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 8 Dolomiti d'Ampezzo. Destination: regional nature reserve, established by RL 22.3.1990, No. 21 – Areas subject to landscaping restrictions, as per art. 136 LD 42/2004 (formerly L. 1497/39): the entire area of the municipality of Cortina d'Ampezzo, established by MD 10/06/1952 – SCI/SPZ IT3230081 Gruppi Antelao - Marmarole – Sorapis – Riserva Naturale Orientata Somadida (Ministerial Decree 29.03.1972 – O.J. No. 209, 11.08.1972) – Guidelines for the institution of regional natural and archaeological parks and reserves and of areas subject to landscape protection (PTRC): 14 Antelao, Marmarole and Sorapis. Destination: regional natural park-reserve – Areas subject to landscaping restrictions, as per art. 136 LD 42/2004 (formerly L. 1497/39): the entire area of the municipality of Cortina d'Ampezzo, established by MD 10/06/1952 – SPZ IT3230086 Col di Lana – Settsas - Cherz
6. Puez-Odle / Puez-Geisler / Pöz-Odles	The Provincia Autonoma di Bolzano The site is completely subject to protection as a nature reserve and as a SPZ. The area is also protected according to Directive 92/43/EEC, with three different site of Community importance, covering almost the entire reserve. – Parco Naturale Puez-Odle – Naturpark Puez-Geisler (PDPC October 31st, 1977, No. 29/V/LS) – SCI and SPZ IT3110026 Valle di Funes-Sas de Putia nel Parco Naturale Puez-Odle – Villnöß-Peitlerkofel im Naturpark Puez-Geisler – SCI IT3110027 Gardena-Valle Lunga-Puez nel PN Puez-Odle – Gröden-Langental-Puez im Naturpark Puez-Geisler

7. Sciliar-Catinaccio / Schlern-Rosengarten - Latemar	Regarding the portion within the Provincia Autonoma di Trento – SCI IT3120119 Val Duron – SCI IT3120106 Nodo del Latemar – Areas subject to landscaping and environmental restrictions (Provincial Land Planning approved by Provincial Law No. 5/2008, Provincial Law of 4 of March 2008, No. 1: "Land planning and territory management") Regarding the portion within the Provincia Autonoma di Bolzano – Parco naturale dello Sciliar (Presidential Decree of the Provincial Council, September 16th, 1974, No. 68 – Landscape plan for the Alpe di Siusi – Art. 3) – SCI/SPZ – code IT 3110029 Parco Naturale dello Sciliar (N.B. the area for the site considered is in reference to the 'old boundaries' and therefore does not include the recent extension with the Catinaccio); - see descriptive dossier
8. Rio delle Foglie/ Bletterbach	Regarding the portion within the Provincia Autonoma di Bolzano – D.D.R.- Regional directive no. 2/28.1 of 15.03.2001 – Approval of natural heritage plan redrafted by the Municipality of Aldino
9. Dolomiti di Brenta	Regarding the portion within the Provincia Autonoma di Trento. The site is completely subject to protection as a nature reserve and as a SPZ. The area is also protected according to Directive 92/43/EEC, with three different site of Community importance, covering almost the entire reserve. – SCI IT3120009 Dolomiti di Brenta – Parco naturale provinciale Adamello-Brenta (Provincial Law of 12 September 1967, No. 7: "Approval of the provincial town planning map"; Provincial Law of 6 May 1988, No. 18: "Natural Parks Law") – Areas subject to landscaping and environmental restrictions (Provincial Land Planning approved by Provincial Law No. 5/2008, Provincial Law of 4 of March 2008, No. 1: "Land planning and territory management")

ANNEX 6

A6.1 ENVIROMENTAL MONITORING

ANNEX 6. ENVIROMENTAL MONITORING

A6.1 Provincia di Belluno

	Study	Year	Place	Authors
1	The golden eagle in the Provinces of Belluno and Treviso	1991	Entire Province	Giuseppe Tormen and Antonello Cibien
2	Wildlife and Hunting Management Plan for the Provincia di Belluno	1993-1998	Entire Province	R. De Battisti and L. Masutti
3	Up-date of Wildlife and Hunting Management Plan	1998-2003	Entire Province	Maurizio Ramanzin
4	Free-ranging hoofed mammals in the Belluno Province	2001	Entire Province	Maurizio Ramanzin
5	The chamois – management and health. Euro-Symposium 26/27 February 1999	2001	Entire Province	Provincia di Belluno and Università degli studi di Torino
6	Up-date of Wildlife and Hunting Management Plan 2003/2008	2003-2008	Entire Province	Maurizio Ramanzin and Gianmaria Sommavilla
7	The black grouse	2004	Entire Province	Maurizio Ramanzin
8	Monitoring of free-ranging hoofed mammals: roe deer, European deer, chamois and European mouflon	Yearly	Entire Province	Provincial Police Corps-Alpine Hunting Reserves
9	Monitoring of Alpine gallinaceans: black grouse, rock partridge and snow grouse	Yearly	Entire Province	Provincial Police Corps-Alpine Hunting Reserves
10	Monitoring of white hare and European brown hare	Yearly	Entire Province	Provincial Police Corps-Alpine Hunting Reserve

The golden eagle in the Province di Belluno and di Treviso
This book describes the habitat and living conditions of this bird of prey that are of interest to experts rather than the golden eagle itself. The publication, although exclusively scientific in content, is aimed at a wider readership and all those interested in learning more about the habits and behaviour of a splendid bird of prey such as the eagle.

Wildlife and Hunting Management Plan for the Provincia di Belluno 1993-1998
The Wildlife and Hunting Management Plan is a tool that permits hunting activities in the Province to be scheduled, ensuring that they are compatible with the natural resources and in accord with the management of the territory. The plan contains the guidelines for managing the freeranging wildlife during the period under examination.

Up-date of the Wildlife and Hunting Management Plan for the Provincia di Belluno 1998
The original Wildlife and Hunting Management Plan was up-dated using more recent survey methods. The plan contains the guidelines for managing the free-ranging wildlife during the period under examination.

Free-ranging hoofed mammals in the Provincia di Belluno
This text focuses on the wild, hoofed mammal population and, in particular, on the roe deer, to which a good fifty percent of the book is dedicated. The book is edited with two complementary readerships in mind; the first, professional operators who will appreciate the more scientific information and those readers who do not have a scientific background but will be able to access the general lines.

The chamois – management and health. Papers from he Euro-Symposium 26/27 February 1999
The chamois and ibex populations in the Provincia di Belluno have been hit over recent years by a new parasite epidemic causing a high mortality rate. An international symposium to look into the problem was organised by the Province taking as its starting point an analysis of the mange epidemic, particularly focusing on problems linked to the chamois populations, with the aid of input offered by five major European countries.

Up-date of Province Wildlife and Hunting Management Plan 2003-2008
The initial Wildlife and Hunting Management Plan was updated incorporating more sophisticated survey techniques. The plan contains the guidelines for managing the free-ranging wildlife during the period under examination.

The black grouse
This book has two aims; the first, to publish the most important conclusions regarding the conservation and management of this species, which have been arrived at via a research project conducted in the Province and, the second, to re-examine and generally discuss what is known about this tetraonid bird.

Yearly monitoring of free-ranging hoofed mammals: roe deer, European deer, chamois and European mouflon
Every year, comprehensive surveys are carried out or on sample areas of these species that are part of hunting management. The head counts are used to analyse population growth trends, to check breeding success and establish the game quotas to be applied during the hunting season.

Monitoring of Alpine gallinaceans: black grouse, rock partridge and snow grouse
Comprehensive population censuses are carried out on a yearly basis or on sample areas of these mountain game gallinaceans. The head counts are used to analyse population growth trends, to check breeding success and establish the hunting quotas to be applied during the hunting season.

Monitoring of white hare and European brown hare
Each year, censuses and population estimates are carried out on the two species in the Province. A sample area method is used for the European brown hare, while the population of the white hare is estimated based on breeding success of the black grouse and using cynegetic abundance indexes.

A6.2 Provincia Autonoma di Bolzano-Alto Adige – Autonome Provinz Bozen-Südtirol

	Study	Year		Authors
1.	Development of a meadow protection and management concept for the Armentara in the Parco naturale di Fanes-Sennes-Braies (German)	1998	Parco Naturale di Fanes-Senes-Braies	Dipl. Ing. Dietmar Gstrein -Innsbruck
2.	Research on the grouse populations in the Parco Naturale delle Dolomiti di Sesto (German)	1998-2000	Parco Naturale Dolomiti di Sesto	Dott. Rainer Ploner, Dott. Lothar Gerstgrasser
3.	Research on the diurnal and nocturnal birds of prey in the Parco naturale di Fanes-Sennes-Braies (Italian)	1999-2000	Parco Naturale di Fanes-Senes-Braies	Dott. Antonio Borgo
4.	Research on the diurnal and nocturnal communities of birds of prey in the Parco naturale di Puez-Odle (Italian)	2001	Parco Naturale Puez-Odle	Dott. Antonio Borgo
5.	Research on the black woodpecker, Dryocopus martius, as an umbrellaindicator species for mature forest ecosystems in natural conditions	2001-2002	Parco Naturale dello Sciliar	Wildbiologische Gesellschaft
6.	Monitoring of the capercaillie, Tetrao urogallus, and the black grouse, Tetrao tetrix	Annuale	Latemar state-owned forests	State Property Office
7.	Interregional Italy-Austria project – the Golden Eagle in the Eastern Alps	2002-2005	Parco Naturale Fanes-Senes-Braies	Dottor Antonio Borgo
8.	Nature2000 management plan	2003-2004	Parco Naturale dello Sciliar	Studio Ing. Mattanovich -Vienna
9.	Nature 2000 management plan	2004	Parco Naturale Fanes-Senes-Braies	Studio Cassol -Belluno
10.	Nature 2000 management plan	2005	Parco Naturale Dolomiti di Sesto	Studio Cassol -Belluno
11.	Nature 2000 management plan	2005	Parco Naturale Puez-Odle	Studio Revital -Lienz

1. Protection and management of meadows of the Armentara in the Parco naturale di Fanes-Senes-Braies

This study was carried out in 1998-1999 by Ing. Dietmar Gstrein, of Innsbruck, at the request of the Natural Parks Office. The Armentara meadows stretch over a large plateau in Val Badia, between the towns of La Valle and Badia. This area features extensively used Alpine pastures, interspersed with peat bogs, resurgences, small thickets of trees or bushes, and has rich and varied flora and fauna populations. The avian fauna is particularly varied and rich. The purpose of the study was to draw up a framework of the species and types of habitat present and to develop management concepts for their conservation. The study is published in German. A booklet summarizing the work is available in both German and Italian.

2. Grouse populations in the Parco Naturale delle Dolomiti di Sesto

This was a three-year research project started in 1999, carried out by Rainer Ploner and Lothar Ger-

stgrasser, at the request of the Natural Parks Office. It involved the monitoring of various Alpine grouse species throughout the park. Information was obtained by interviewing park rangers, hunters and employees of the Forestry Authority. Successively, zones were selected for the intensive study of the rock partridge, the rock ptarmigan, the capercaillie and the black grouse. On the basis of parameters such as exposure, altitude, gradient, vegetation cover and type, vocational maps were drawn up of the zones for the two species in consideration. The spring and summer song census, with the aid of dogs, then allowed for testing the cartographic models developed and to make an estimation of the populations. The study is published in German.

3-4. Research on the diurnal and nocturnal birds of prey in the Parco Naturale di Fanes-Senes-Braies and the Parco Naturale Puez-Odle.
The study was carried out in 1999-2001, by Antonio Borgo at the request of the Natural Parks Office. The purpose of the work was to trace an outline of the presence and distribution of the various species of diurnal and nocturnal birds of prey in the two parks. Use and selection of habitat were also analyzed, and on the basis of the data collected the environmental preferences of the species were studied, in order to develop models for the evaluation of environment suitability. These models serve for forecasting, since they can be used to assess the potential suitability of areas that have not been studied, as habitats for nesting pairs of the various species. The study is published in Italian.

5. Research on the black woodpecker, Dryocopus martius, as an umbrella-indicator species of mature forest ecosystems in natural conditions
The research, carried out in the Parco Naturale Vedrette di Ries-Aurina and the Parco Naturale Sciliar, at the request of the Natural Parks Office, with the scientific coordination of the Wildbiologische Gesellschaft - Munich and Andrea Pirovano (Milan University), was to assess the distribution and density of the black woodpecker in the two parks. Particular attention was given to density in relationship to the different forestry management methods, in order to assess whether the black woodpecker can be considered as an indicator species for mature forest ecosystems in highly natural conditions.

6. Monitoring of the capercaillie, Tetrao urogallus, and of the black grouse, Tetrao tetrix
A census is carried out on the two above-mentioned species every year in the state-owned forests of the Latemar. The purpose of the counts is to analyze the evolution trend of the populations and to assess the success of reproduction each year.

7. Interregional Italy-Austria Project – the Golden Eagle, Aquila chrysaetos, in the Eastern Alps
The golden eagle is at the end of the food chain in the Alps, and for this reason and because of its ecological needs it is considered as an umbrella species, indicating which ecosystems are still stable and well conserved. The aim of the project, carried out in collaboration between the Parco Nazionale degli Alti Tauri (A), the Parco Naturale Dolomiti Bellunesi, the Parco Naturale dello Stelvio and the Parco Naturale Fanes-Senes-Braies, is to monitor the populations of this bird of prey in an extensive area representing diverse geomorphological and environmental situations. The parameters recorded (status, reproductive success, alimentation, localization of nests and of feeding areas, presence and intensity of human activity near nesting areas) serve for conservation of this bird of prey in the long term.

8-9-10-11. Nature 2000 Management Plans
Pursuant to EC directives 92/43 and 79/409, special Nature 2000 plans are being drawn up for the parks mentioned, nominated also as SCI (Sites of Community Importance) and/or SPZ (Special

Protection Zones). During the preparation stage of the plans, a detailed vegetational survey is carried out, with particular focus on the habitats referred to in annex I of Directive 92/43. For every habitat, the conservation status, possible risk factors, and any measures proposed for improved management are assessed.

A6.3 Provincia Autonoma di Trento

Monitoring

	Study	Year	Authority	Authors
1	"Spatial behaviour, seasonal movements and dispersion of deer" in the Parco Naturale Paneveggio Pale di San Martino	2001-2006	Parco Naturale Paneveggio -Pale di San Martino, Forest and Fauna Service, Parks and Wildlife Conservation Service	Prof. Sandro Lovari (Behavioural Ethology and Ecology Group of Siena University)
2	LIFE URSUS Project: protection of the population of brown bears in the Dolimiti di Brenta	1996-2004	Parco Naturale Adamello Brenta, Forest and Fauna Service, I.N.F.S, Trentini Hunters Association	Parco Naturale Adamello Brenta
3	"Spatial behaviour and environmental preferences of the colony of rock goats Capra ibex ibex in the district of the Marmolada"	Started in 2002; still in progress	Forest and Fauna Service	Dr. Andrea Monaco, Dr. Filippo Nicoli, Dr. Nicola Gilio
4	Map of the vegetation and dynamic tendencies showing the vegetation mosaic of the SIC -Val Duron Biotope	1996	Parks and State Forests Service	Prof. Franco Pedrotti
5	Management policy of the Biotope of provincial interest SIC Malga Flavona	2004	Parks and Wildlife Conservation Service	Dr. Michele Caldonazzi -Albatros srl
6	Management policy of the Biotope of provincial interest -SIC Lake Tovel	2004	Parks and Wildlife Conservation Service	Dr. Michele Caldonazzi -Albatros srl
7	Deer and roe deer: study on the winter interspecific relations	1992 and 1996	Parco Naturale Adamello Brenta	Mustoni A. -Pedrotti L., Chiozzini S.-Saraceni S.
8	Compilation of the vegetation map of the park	1993-2000	Parco Naturale Adamello Brenta	Franco Pedrotti -University of Camerino
9	Hydrobiology of mountain and subalpine springs in the park	1995-1997	Parco Naturale Adamello Brenta	Museo Tridentino di Scienze Naturali
10	ROCK GOAT project -The reintroduction of the rock goat in the Parco Naturale Adamello Brenta	1995-1999 e 2005	Parco Naturale Adamello Brenta	Mustoni A., Pedrotti L., Scherini G., Tosi G. (1995-1999) -Adamello Brenta Nature Park (2005)
11	Presence and distribution of bats (Chiroptera) in the area of the Parco Naturale Adamello Brenta	1998-2000	Parco Naturale Adamello Brenta	Departiment of Structural and Functional Biology – Insubria University of Studies

12	The Strigiformes in the Parco Naturale Adamello Brenta	1999-2001	Parco Naturale Adamello Brenta	Tridentine Museum of Natural Sciences
13	SALTO project (study on the lack of reddening of Lake Tovel)	2001-2004	Parco Naturale Adamello Brenta	Territorial and Agro-Forestry Department of Padova University – Trento University – Camerino University
14	Project of fauna monitoring	2005	Parco Naturale Adamello Brenta	Parco Naturale Adamello Brenta
15	"Sanitary monitoring of the wild ungulates in the Parco Naturale Paneveggio -Pale di San Martino"	19922005	Parco Naturale Paneveggio Pale di San Martino	Prof. Claudio Genchi, Paolo Lanfranchi (Milan University)
16	"The Flora in the Parco Naturale Paneveggio -Pale di San Martino"	19921997	Parco Naturale Paneveggio Pale di San Martino	Prof. Francesco Festi, Filippo Prosser, Cesare Lasen
17	"Study on the micro and mesoteriofauna in the Parco Naturale Paneveggio -Pale di San Martino"	19952005	Parco Naturale Paneveggio Pale di San Martino	Paolo Paolucci (Padova University)
18	"Study on the damage caused by wild ungulates on reforestation in the Paneveggio Pale di San Martino Park"	1995-1998 2003-2005	Parco Naturale Paneveggio Pale di San Martino	Prof. Renzo Motta (University of Turin)
19	"Study on the ecology of the Paneveggio subalpine red fir wood"	19922005	Parco Naturale Paneveggio Pale di San Martino, Forest and Fauna Service of the P.A.T.	Prof. Pietro Pissi (University of Florence Prof. Renzo Motta (University of Turin
20	"Study on the spatial behaviour of chamois in the Paneveggio Pale di San Martino Park"	19982001	Parco Naturale Paneveggio Pale di San Martino	Prof. Sandro Lovari (University di Siena)
21	"Monitoring of the group of rock goats released in the Pale di San Martino Mountains"	20002005	Parco Naturale Paneveggio Pale di San Martino	Parco Naturale Paneveggio Pale di San Martino

1 The study begun in 2001 will be concluded at the end of 2006 and it is being conducted by the Parco Naturale Paneveggio-Pale di San Martino and the two services of the Provincia Autonoma di Trento, under the scientific supervision of Prof. Sandro Lovari. The research intends to study the spatial behaviour of the deer and its ability to range in relation to the seasons, and also the dispersion of the younger specimens. The study area is located in the upper and central part of Valle del Travignolo and lies mostly within the boundaries of the Nature Park and Provincial State Forests.

2 Prompted by the Fauna Policy of the Park (Schroder, 1995) to create a vital group of bears in the Central Alps, the project led to the re-introduction of the bear in the Brenta chain, where the species was by then biologically extinct. The first bears from Slovenia were released in 1999 and the re-introduction continued until 2002. Ten bears (7 females and 3 males) were set free and monitored until the transmitters were dead. Numerous activities of communication and scientific research were carried out by the Group of Research and Conservation of the brown bear, set up by the Parco Naturale Adamello Brenta in 2004. Detailed studies concerned the use of space (assessment of the home ranges, core areas, movements, hibernation sites), the choice of habi-

tat and food ecology. In the summer of 2003 genetic monitoring was experimented on the new population of bears, with the collection of important data on the biology, behaviour and habits of the species.

3 In 2002 a project was started to assess the spatial behaviour and environmental preferences of the colony of rock goats on the Marmolada, and also to discover the relations between this colony and other populations affected by Sarcoptoidea mange and the consequences of these relations on the spatial-temporal evolution of the infestation. To this end, operations were begun in 2003 for the capture of rock goats (and relative sanitary monitoring) to pro-vide them with identification marks and electronic tags for radio-telemetric monitoring.

4 The vegetation maps show the current state of coenoses defining the present ecosystems, both with regard to those of local significance and those of European importance. The various evolving tendencies are also highlighted and ordered in a spatial and temporal manner.

5., 6. These management policies were set out in conformity with the Habitats Directives guidelines (92/43/EEC) and the Birds Directives (409/79/EEC) and contain a detailed analysis of the vegetation forms linked to the habitats and the species of European interest. The conservation state of the habitats is examined and specific intervention measures and a monitoring plan are also advanced. Specific analyses on invertebrate fauna are included in the policies described in points 8 and 9.

7. In-depth study on the winter interactions between deer and roe-deer, with particular reference to the use of the "space" resource in an area of the Parco Naturale Adamello Brenta, home to a considerable number of roe-deer and a constantly and rapidly expanding colony of deer. Study carried out in 1992 and repeated, for comparison, in 1996.

8 A study to cover the whole area of the Park with a 1:50,000 scale phytosociological map of the existing natural vegetation or actual vegetation.

9 Hydro-biological study of 30 representative springs present in the area of the Park.

10 Prompted by the Fauna Plan of the Park (Schroder, 1995), the project was started in 1995 with the release of 23 rock goats on the Adamello massif and 20 on the Presanella one. All the animals set free had been electronically tagged and marked. The constant monitoring of the new colony lasted until the batteries in the transmitters ran out (1999). To understand density, rate of increase and dynamics of the current population, a second phase of monitoring was started on the species in 2005.

11 Research to find the species of chiropterans present in the territory of the Parco Naturale Adamello Brenta and to determine their local distribution. The study also examines the ecology of the individual species and suggests possible conservation measures for safeguarding this important systematic group.

12 Survey on the presence, distribution and ecology of nocturnal birds of prey in the Parco Naturale Adamello Brenta with a study defining the food spectrum, the environmental characteristics of nesting sites and the quantification of productivity and dispersion of the nests.

13 Multidisciplinary study to find the factors that may have caused the disappearance of the very special and unique phenomenon of the reddening of the water of Lake Tovel. The multi-year research involved a careful analysis of the hydrological, chemical and biological characteristics of the lake water.

14 Project, begun in 2005, concerning the monitoring of a representative component of the zoocoenosis of terrestrial vertebrates, to be carried out in a regular and continuative way by the staff of the Parco Naturale Adamello Brenta. The data obtained, of a qualitative-quantitative nature, should permit the verification of the development of the zoocoenosis present, both spatially and numerically. The comparison of the data collected over several years will highlight any alterations in the composition and complexity of the zoocoenosis. Moreover, constant monitoring of some components of the zoocoenosis present will permit us to assess the result of the specific actions

undertaken to protect and manage the fauna, as well as evidence the need for specific operational interventions in the territory of the Park.

15 The study intends to monitor the sanitary state of the ungulates present in the Park, with particular reference to the sanitary interactions between domestic and wild ungulates.

16 This study of the flora assumes the form of a real atlas of distribution of the vascular species in the Park.

17 Research on the population dynamics and use of the habitats of some species of field-mice and mice; a study on the prey-predator relations, with particular reference to the relations between micro-mammals, foxes and badgers.

18 The monitoring envisages the control of damage to the forest vegetation caused by wild ungulates in the Park.

19 The research proposes to study the evolution of the subalpine red fir wood of Paneveggio, with particular reference to the restrictive factors of reforestation.

20 An analysis on the use of the habitat by chamois within a protected area.

21 The purpose of monitoring the rock goats released in the three-year period 2000/2002, within the project of re-introduction of the species, is to verify the success of the operation.

A6.4 Provincia di Udine

Monitoring

	Study	Year		Authors
1.	Organising wildlife management	1998	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento
2.	Repopulation and monitoring of the Alpine marmot in the reserve	1998-1999	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
3.	Management of wildlife	1999	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento
4.	Monitoring and setting up of eagle and lammergeier in the reserve area	1999	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
5.	Health management of the Andreis bird wildlife sanctuary and reserve health protocol	1999	Parco Naturale Dolomiti Friulane	Paolo Zucca -Trieste
6.	Qualitative and quantitative monitoring of nesting birds in the reserve and ringing for scientific purposes	1999	Parco Naturale Dolomiti Friulane	Gianluca Rassati – Tolmezzo (UD)
7.	Management of wildlife	2000	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento
8.	Health management of reserve wildlife of the park and veterinary clinic in the Andreis bird wildlife sanctuary	2000	Parco Naturale Dolomiti Friulane	Paolo Zucca -Trieste
9.	Creation of reserve nesting bird population atlas	2000	Parco Naturale Dolomiti Friulane	Gianluca Rassati – Tolmezzo (UD)
10.	Conservation of reserve ibex colonies	2000	Parco Naturale Dolomiti Friulane	Marco Favalli – Tarcento (UD)

11.	Monitoring, environmental suitability factors, anthropic disturbance and breeding success of the Golden eagle	2000	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
12.	Creation of reserve micromammal atlas	2000	Parco Naturale Dolomiti Friulane	Andrea Dall'Asta -Udine
13.	Creation of reserve amphibian and reptile atlas	2000	Parco Naturale Dolomiti Friulane	Andrea Dall'Asta -Udine
14.	Monitoring and conservation of reserve Alpine gallinaceans populations	2000	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento
15.	Evolution of the marmot population and environmental suitability of a number of candidate sites	2000-2001	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
16.	Health management of the Andreis bird wildlife sanctuary and reserve health protocol	2001	Parco Naturale Dolomiti Friulane	Paolo Zucca -Trieste
17.	Management of wildlife	2001	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento
18.	Monitoring, environmental suitability factors, anthropic disturbance and breeding success of the golden eagle (Aquila chrysaetos)	2001	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
19.	Conservation of reserve ibex colonies	2001	Parco Naturale Dolomiti Friulane	Marco Favalli – Tarcento (UD)
20.	Creation of reserve amphibian and reptile atlas	2001	Parco Naturale Dolomiti Friulane	Andrea Dall'Asta -Udine
21.	Monitoring of deer in the reserve with particular attention to spatial needs of the species	2001	Parco Naturale Dolomiti Friulane	Franco Perco
22.	Vegetation and productive potential of meadows in the reserve	2002-2004	Parco Naturale Dolomiti Friulane	Antonio De Mezzo – Maiano (UD)
23.	Management of wildlife	2002	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento
24.	Creation of reserve nesting bird population atlas	2002	Parco Naturale Dolomiti Friulane	Roberto Parodi – Basiliano (UD)
25.	Health management of the Andreis bird wildlife sanctuary and reserve health protocol	2002	Parco Naturale Dolomiti Friulane	Paolo Zucca -Trieste
26.	Conservation of the ibex colony: monitoring and re-introduction of new animals	2002	Parco Naturale Dolomiti Friulane	Marco Favalli – Tarcento (UD)
27.	Monitoring of the golden eagle within the Programme of the Alpine network of protected areas	2002	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
28.	Conservation of the marmot population: monitoring and reintroduction in compatible areas	2002	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
29.	Wildlife management	2003	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento

30.	Monitoring and ecology of the golden eagle within the Programme of the Alpine network of protected areas	2003	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
31.	Health management of reserve wildlife of the park and veterinary clinic in the Andreis bird wildlife sanctuary	2003	Parco Naturale Dolomiti Friulane	Paolo Zucca – Trieste
32.	Conservation of the ibex colony: monitoring and completion of new animal re-introduction program.	2003	Parco Naturale Dolomiti Friulane	Marco Favalli – Tarcento (UD)
33.	Creation of reserve nesting bird population atlas	2003	Parco Naturale Dolomiti Friulane	Roberto Parodi – Basiliano (UD)
34	Management of the Andreis bird sanctuary and educational activities of the visitors' centre	2003	Parco Naturale Dolomiti Friulane	PierGiuliano Filippin – Erto e Casso (PN)
35.	Conservation of the marmot population and re-introduction in compatible areas	2003	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
36.	Wildlife management	2004	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento
37.	Conservation of the ibex colony: monitoring and completion of new animal re-introduction program.	2004	Parco Naturale Dolomiti Friulane	Marco Favalli – Tarcento (UD)
38.	Health management of wildlife and veterinary clinic of the Andreis bird sanctuary	2004	Parco Naturale Dolomiti Friulane	Paolo Zucca -Trieste
39	Management of the Andreis bird sanctuary and educational activities of the visitors' centre	2003	Parco Naturale Dolomiti Friulane	PierGiuliano Filippin – Erto e Casso (PN)
40.	Monitoring and ecology of the golden eagle within the Programme of the Alpine network of protected areas	2004	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
41.	Monitoring and ecology of daytime and night birds of prey	2004	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
42.	Conservation of the marmot population: monitoring of results of most recent releases and colonisation of recent release areas	2004	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
43.	Creation of reserve nesting bird population atlas	2004	Parco Naturale Dolomiti Friulane	Roberto Parodi – Basiliano (UD)
44.	Creation of reserve amphibian and reptile atlas	2004	Parco Naturale Dolomiti Friulane	Museo Friulano di Storia Naturale of Udine
45.	Wildlife management	2005	Parco Naturale Dolomiti Friulane	Silvano Mattedi -Trento
46.	Health management of wildlife and veterinary clinic of the Andreis bird wildlife sanctuary	2005	Parco Naturale Dolomiti Friulane	Paolo Zucca -Trieste
47.	Creation of a reserve nesting bird population atlas	2005	Parco Naturale Dolomiti Friulane	Roberto Parodi – Basiliano (UD)
48.	Monitoring and ecology of daytime and night birds of prey	2005	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)

49.	Conservation of the ibex colony and co-operation in chamois and deer programs.	2005	Parco Naturale Dolomiti Friulane	Marco Favalli – Tarcento (UD)
50.	Biological and ecological monitoring of the golden eagle	2005	Parco Naturale Dolomiti Friulane	Antonio Borgo – Quinto Vic.no (VI)
51.	Management of the Andreis bird sanctuary and educational activities of the visitors' centre	2005	Parco Naturale Dolomiti Friulane	PierGiuliano Filippin – Erto e Casso

1-3-7-17-23-29-36-45. Organisation of reserve wildlife management
This project concerns the organisation of all reserve wildlife management that comes under the single annual and long-term plans, specifically co-ordination, supervision and checking of wildlife research projects, the organisation and management of wildlife study and activity planning meetings (relations with surveillance services, with the Regional Wildlife Institute and other organisations involved), as well as the collection and registration of wildlife data, and specifically those concerning population censuses. Directed since 1998 by Silvano Mattedi of Trento, wildlife management also includes the controlled sampling plan, which identifies the taking of chamois sample animals directed towards establishing the state of health of the species population within the Reserve.

2. Repopulation and monitoring of the alpine marmot within the reserve
This project concerns the "Repopulation and monitoring of the marmot in the reserve area" coming under the umbrella program of "Wildlife intervention" financed with funds from Regional Law no. 11/1983. Supervised by Antonio Borgo of Quinto Vicentino, the project included research analysing the status of the marmot colonies living in the Reserve and previous data, checking of the number of animals available, capture and marking using coloured sprays, recovering and surveying of biometrical data of captured marmots and registration of new data for animals and subsequent release in the areas identified by the project (1998), captured in the 'Buscada' area (Erto and Casso) and released in the vicinity of the 'Flaiban-Pacherini' refuge.

4. Monitoring and organisation of the eagle and lammergeier network in the reserve area
This project, set up by Antonio Borgo of Quinto Vicentino, aimed at carrying out detailed monitoring of golden eagle (Aquila crysaetos) couples in, or gravitating to, the area; activities included spot investigation to check qualitative and quantitative presence within the Reserve and an environmental parameter study to check the suitability of the nesting areas. This project was also the first time that co-operation was set up with the Alpine Network of Protected Areas on the Eagle and Lammergeier projects, as well as maintaining relations with the agencies and structures responsible for the 'Lammergeier' area projects.

6. Qualitative and quantitative monitoring of nesting birds in the reserve and ringing for scientific purposes
This assignment conducted by Gianluca Rassati of Tolmezzo had the aim of updating the list of birds within the Reserve and providing an analysis of the local atlas of nesting birds in an approximate 10,000-hectare sample area, with particular reference to a number of important species. During the course of the project, spot surveys where conducted to check qualitative and quantitative presence of the nesting birds, particular environments or ringing sites for scientific purposes in compliance with the I.N.F.S. guidelines, and within the framework of the 'Alps' project, as well as a number of ringing operations in compliance with the I.N.F.S. guidelines that took place during post-reproductive migration.

5-8-16-25-31--38-46. Health management of wildlife and veterinary clinic in the andreis bird wildlife sanctuary

This project regards the health management of wildlife in the Reserve on the basis of the annual and long-term wildlife management plan. It has been supervised by veterinary surgeon Paolo Zucca of Trieste since 1999 and includes provision of veterinary assistance during the capture of wildlife (chamois, ibex and marmots), veterinary services at the Bird Wildlife Sanctuary where animals are treated and regular check-ups at the Bird Wildlife Sanctuary as well as zoonoses controls on animals receiving treatment.

11. Monitoring, environmental suitability factors, anthropic disturbance and breeding success o the golden eagle

This project, conducted by Antonio Borgo of Quinto Vicentino (VI), included detailed monitoring of reproductive trends of resident couples and monitoring of the outcome of breeding, breeding success and annual productivity. A detailed analysis study was commenced on environmental suitability factors in the hunting and nesting areas of the golden eagle, taking into account all the couples in the Reserve, with the aim of producing a predictive model of increasing accuracy for the purpose of identifying those areas suitable for nesting by the species. This aspect was of prime importance to managing the Reserve, taking into account the trend of couples over recent years to set up nesting sites in areas that have not been previously used for this purpose.

12. Creation of a reserve micromammal atlas

This project, assigned by the Agency to Andrea Dall'Asta of Udine, covered the sampling of micromammals across the area, rendered necessary for setting up a micromammal atlas and maps of data using the UTM system, normally employed for compiling atlases internationally.

13. Creation of a reserve amphibian and reptile atlas

This project, assigned by the Agency to Andrea Dall'Asta of Udine, included the recording and computer storage of data to create a computer data base on the distribution of the various species and relative maps using the UTM system, normally employed for compiling Atlases internationally.

14. Monitoring and conservation of alpine gallinaceans populations in the reserve

This research project, commenced by Silvano Mattedi of Trento, achieved the aim of acquiring and organising data regarding the nesting of the black grouse and the capercaillie and extensive knowledge was also gained concerning the Alpine gallinaceans in the area, with the aim of monitoring their annual breeding success, the dynamics of the population and habitat preferences on the basis of indications provided by the 'Alpine Network of Protected Areas'.

15. Development of the marmot population and evaluation of environmental suitability of a number of candidate sites

This assignment, supervised by Antonio Borgo of Quinto Vicentino (VI), included identifying the best sites for release, capture and introduction of marmots in the areas of Pramaggiore and Dosaip and subsequent monitoring of settlement dynamics.

18. Monitoring, environmental suitability factors, anthropic disturbance and breeding success of the golden eagle (aquila chrysaetos)

This project, set up by Antonio Borgo of Quinto Vicentino, included monitoring of breeding trends of couples resident in the protected area, the search for nests and nesting areas still scarcely known because of difficulties in accessing and studying the area concerned and the commencement of research regarding the home range of couples.

10-19- 26-32-37. Conservation of the ibex colony and monitoring and reintroduction of new animals to the reserve

This project, supervised by Marco Favalli of Tarcento (UD), made a major contribution to controlling the colony and collection of data regarding the organisation and dynamics of the population. The on-going monitoring and knowledge of the situation enabled census activities to be planned in a more rational manner, and, likewise other research and management tasks. From the scientific standpoint, this project received the approval of the National Wildlife Institute and contributed to the continuity of monitoring of tagged ibex in the Reserve area and the radio- tracking of marked animals. Data collected to date using radio-tracking has led to valuable information about the areas occupied by the animals during the various seasons of the year. In addition, two complete censuses have been organised annually (one in winter and one in summer) with the aim of obtaining reliable estimates of the size of the metapopulations in the Re-serve.

20-44. Creation of a reserve amphibian and reptile atlas

This project, assigned to Andrea Dall'Asta of Udine and subsequently to the Museo Friulano di Storia Naturale of the municipality of Udine includes the recording and computer storage of data regarding the distribution of the various species, as well as providing texts for the preparation of a popular work to be published at a future date. The scope of this project is to complete the research begun in 2000 by Andrea Dall'Asta of Udine, who followed the project during 2001, with the aim of creating a distribution atlas of the amphibian and reptile species in the Parco Naturale delle Dolomiti Friulane. The project, which plans to collect data and identify the amphibian and reptile species in the Reserve area on the field, will then use this information to create the final distribution atlas. Observation studies will be carried out by cordoning off suitable environments and capturing-identifying-releasing any specimens. The field trips will be carried out primarily in the spring, which is generally the period of the year when all species are most active.

21. Monitoring of deer within the reserve with particular attention to the spatial needs of the species

This project, assigned by the Agency to Franco Perco of Stregna (Udine), has enabled the history of the deer within the Reserve and surrounding areas to be reconstructed and identification of the Management Units (MU) of the species by including the areas outside the Reserve, as well as the drafting of a management protocol for each Management Unit aimed at carrying out routine monitoring activities.

22. Vegetation and productive potential of meadows in the reserve

This three-year research project, assigned by the Agency to Antonio De Mezzo of Maiano (Udine), has enabled the study of the valleys of the Reserve area (Val Cimoliana: Pian Pagnon, Meluzzo and Lodina; Val Settimana: Sette Fontane, Pussa, Col de Post and Senons Val di Gere Casamento; Val Silisia: Cavallotto and Valine; Forni di Sotto: Chiavalut; Val Zemola: Ferrera). The project has three steps:

1. Organic gathering of existing scientific material regarding vegetation growing in the Reserve meadows; analysis of the ecological and environmental conditions of the single locations; measurement and surveying of boundaries, on the basis of C.T.R. maps on a scale 1:5,000 of the non-surveyed grazing pastures in relation to livestock use or management of wildlife.
2. Setting up of cordoned off sites within which production studies can be conducted; study of methodologies used to run the 'malghe' or Alpine dairy farm pastures; setting up of guidelines and recommendations regarding the rational use of pasture resources also with regard to technological tools currently available on the market.

3. Final processing of research data and drafting of a complementary report regarding productivity of forage resources indicating the domestic animal load sustainable by each Alpine pasture system or the estimated load capacity for the Alpine pastures that are not used by farm livestock with reference to hoofed mammals.

9-24-33-43. Creation of a reserve bird wildlife atlas

With the aim of meeting the objectives established by the long-term Wildlife Management Plan, this project, supervised by Gianluca Rassati of Tolmezzo (Udine) and Robero Parodi of Basiliano (Udine), included up-dating the check-list of bird species in the Parco Naturale Dolomiti Friulane, the gathering of other historical and bibliographic data and information, and the monitoring of nesting bird wildlife in one of the Reserve areas (continuation of the survey carried out in 1999 in the Carnic sector of the Reserve and the start of the survey in the Tramontino sector of the Reserve). Work carried out has contributed to understanding the actual size of the species living and nesting, required in order to plan any conservation and management measures and with the prime goal of editing an atlas of bird wildlife nesting in the Reserve within the next three years.

27-30-40. Monitoring and ecology of the golden eagle (aquila chrysaetos) within the program of the alpine network of protected areas

The golden eagle is the subject of particular attention across the entire Alpine Arc, with regard to its status as a species sensitive to environmental changes and thus vulnerable. The Reserve has promoted monitoring of the species since 1999, as part of its membership of and involvement in the 'Alpine Network of Protected Areas'. This three-year project, which was launched in 2002 by Antonio Borgo of Quinto Vicentino (Vicenza), has the aim of continuing monitoring of the eagle population in the Reserve and of the breeding trend of surveyed couples, also in team cooperation with the Forestry Corps Stations and the Provincia di Pordenone. The need to ensure long-term monitoring was also emphasised by the Alpine Network of Protected Areas, in consideration of the fact that the more long-term the monitoring process, the more abundant and significant the results, as already illustrated by the three works that have already been presented at national symposiums between 2001 and 2003.

28-35-42. Conservation of the marmot population: monitoring and reintroduction in compatible areas

This three-year project, which was set up in 2002 by Antonio Brogo of Quinto Vicentino to ensure continuity and general moving forward of the activities which had been launched over the previous years, has the aim of gaining knowledge and auditing the 'wildlife biodiversity' within the Reserve, as well as identifying an opportunity for enhancing and promoting these wildlife assets. It was deemed essential to carry out detailed monitoring of the recent release areas (the areas of Campoross and Senons) to check on the survival of the animals and any settlement in surrounding areas. In particular, the entire area of the Val di Suola, Val d'Inferno, Val di Brica valleys, Campoross, Lavinal and Monfalconi di Forni and di Cimoliana was monitored.

34-39-51. Management of the bird wildlife sanctuary and of educational activities of the andreis visitors' centre

This annual project set up by PierGiuliano Filippin of Erto (Pordenone) arose out of the need for managing and maintaining the Bird Wildlife Sanctuary, as well as educational activities linked to these. As a result, the food supply of the birds that are hosted by sanctuary and the correct upkeep of the structures are ensured. The main tasks include taking in injured animals that are brought to the veterinary facilities and providing assistance to the resident vet by helping supervise the rehabilitation of animals that have regained health under the instructions of the vet.

41-48. Monitoring and ecology of daytime and night birds of prey
Taking into account what has been achieved to date, and the importance that the birds of prey sector occupies right across the Alps (both from a national and international standpoint), this project, set up by Antonio Borgo of Quinto Vicentino (Vicenza), has completed the gathering of data on the distribution of the various species in the Reserve areas that were not part of the studies carried out in past years. All data collected in recent years will be used to generate environmental evaluation models to set up (using GIS) a comprehensive mapping of the potential distribution of the various species and the environmental suitability of the Reserve.

47. Creation of a reserve bird wildlife nesting atlas
This project that follows on from what has been carried out to date and set up by Roberto Parodi of Brasiliano (Udine) has the aim of constituting a number of meetings of the 'working group', involving also Reserve operators and all surveying staff that have taken part in the surveys (Forestry Police, Gamekeepers and other co-workers), to check up on the collection of data, to set up a survey schedule for 2005 and to distribute material needed for surveying. The scope of this project is to computerise and follow all data collection, edit the contents and co-ordinate the printing of a publication.

49. Conservation of the ibex colony and co-operation within chamois and deer projects
2005 will be almost entirely given over to data collection with the aim of confirming the success of operations that have been undertaken, in particular with regard to the other hoofed species in the Reserve, in consideration of the plan of action implemented by this Agency against the epidemic of sarcoptic mange that has broken out amongst the ungulate populations and which has affected the entire Dolomite zone. The research in question has been assigned to Marco Favalli of Tarcento (Udine).
For the purpose of carrying out detailed monitoring of the spread of the disease, also within the protected area, close co-operation is planned with the projects focussing on the other ungulates resident in the Reserve, and, specifically, assistance in surveying chamois and deer populations with regard to the action plan to combat sarcoptic mange, as well as biometric studies of the horns of chamois and age checks on animals that have been killed.

50. Monitoring, biology and ecology of the golden eagle
This project, assigned to Antonio Borgo of Quinto Vicentino (Vicenza), aims at continuing monitoring biological reproduction and feeding habits of the population and undertaking a comprehensive analysis of available data. The continuance of the monitoring of the breeding trend of the Reserve population is essential both from the standpoint of the dynamics that characterise population reproduction rates and the changes in spatial usage. These two parameters in fact reflect changes in the state of the environment. For this reason, the golden eagle is an indicator of the quality and dynamics of ecosystems. Thus, it is important to maintain monitoring of reproductive dynamics over long periods of time. Given the increasingly critical situation caused by the mange epidemic arriving on the Reserve's doorstep, monitoring of the golden eagle represents a 'golden' opportunity for studying the response of the eagle population to the possible arrival of the epidemic in the Reserve.

ANNEX 7

A7.1 DVD (PHOTOGRAPHS)
A7.2 BIBLIOGRAPHICAL INVENTORY

7.1 DOCUMENTATION

IMAGE INVENTORY AND PHOTOGRAPH AND AUDIOVISUAL AUTHORIZATION FORM

Pag. N.	Id. No	Format (slide/ print/ video)	Caption	Date of Photo (mo/yr)	Photographer / Director of the video	Contact details of copyright owner (Name, address, tel/fax, and email)	Copyright owner (if different than photographer / director of video)	Non exclusive cession of rights
2	Cima delle Odle	Digital	Cima delle Odle	2003	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano-		YES
4	11239_cm.jpg	Digital	Torri del Vaiolet e Catinaccio	2004	Ugo Visciani	Trentino S.p.A.		YES
38	Comelicania haueri.jpg	Digital	Comelicania haueri (Stache), a typical Permian brachiopod.	5/2006	R. Posenato	Universty of Ferrara. Earth Science department		YES
38	claraia clarai.jpg	Digital	Pseudomonotis (Claraia) clarai Emmrich, a classical bivalve characterizing the Werfen Formation.	5/2006	R. Posenato	University of Ferrara. Earth Science department		YES
38	Eum Union Siusi.jpg	Digital	A typical faunal association of the Cencenighe Mb: Tirolites cassianus (Questedt), on the left, and Natiria costata Münster, on the right.	5/2006	R. Posenato	University of Ferrara. Earth Science department		YES
40-41	Stitched_001. TIF	digital	Catinaccio/ Rosengarten.	8/2002	A. Riva	University of Ferrara. Earth Science department		YES
41	Cong.Voltago su serla superiore.tif	digital	Mt. Cernera – Voltago Conglomerate over Upper Serla Dolomite	7/2003	A. Riva	University of Ferrara. Earth Science department		YES
42	onlap cernera.tif	digital	Overlapping of volcaniclastic sediments over the flanks….	2002	P. Gianolla	University of Ferrara. Earth Science department		YES
43	Corallo san cassiano.jpg	Digital	Branching coral, San Cassiano Fm	2003	D. Bellodis	Museo delle Regole Ampezzane		YES
43	Img_05.jpg	Digital	Actinastrea coral (size 8 cm - San Cassiano Fm)	2005	D.Bellodis	Museo delle Regole Ampezzane		YES
46	rozes.tif	Digital	View of the west side of the Tofana di Rozes peak. The cliff is entirely of Dolomia Principale.	2003	M. Morsilli	University of Ferrara. Earth Science department		YES
48-49	Gran Fanes1. TIF	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		2004	Uff. Parchi naturali- Via Renon 4 39100 -Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano-		YES

50	Ammoniti.jpg	Digital	Ammonitico Rosso	2004	Uff. Parchi naturali- Via Renon 4 39100 -Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano-		YES
50	Img_08.jpg	Digital	Puez marls, heteromof Ammonoids.	2003	Dario Bellodis	Museo delle Regole Ampezzane		YES
51	Hochflaeche Gardenaccia.tif	Digital	Panoramic view of the Gardenaccia plateau. ..	2003	Tappeiner	Tappeiner		YES
54	Puez-Odle	Digital	Puez-Odle	2005	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
56	DSCN4820	Digital		7/2002	Morsilli M.	University of Ferrara. Earth Science department		YES
58	MP-7.jpg	Digital	Slope karren on Alpe di Fanes.	8/1989	M. Panizza	Università di Modena		YES
60	Vezzana-C della Pala_P.S.Martino. jpg	Digital	Small glacier on Vezzana-C.- Pala_P.S.Martino	2005	A. Caniati	ARPAV. Centro Valanghe di Arabba. Via Pradat n.5- Arabba-BL		YES
62	MP-10.jpg	Digital	Rockglacier at the base of Rocchette cliffs Armentarawiesen	2005	Sandro Furlanis	University of Ferrara. Earth Science department		YES
71	CM_Prati d'Armentara 1.jpg	Digital	Armentarawiesen Prati di Armentara	2003	Erardi Alfred	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
73	CM_Prati d'Armentara 2.jpg	Digital	Armentarawiesen Prati di Armentara	2003	Erardi Alfred	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
80	CM_ dreizinnen.tif	Digital	Drei Zinnen Tre Cime di Lavaredo and Paternkofel Monte Paterno	2003	Erardi Alfred	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
82-83	Schlern-4.jpg	Digital	vista aerea dello Sciliar	2003	Tappeiner	Tappeiner		YES
91	IMG0073.jpg	Diapositiva Orizzontale	Ladin settlement	2001	Roberto Ghedina	Provincia di Belluno		YES
94	CM_Misci.jpg	Digital	Roman model	2003	Cesare Micheletti		Cesare Micheletti via E.Conci, 74 I – 38100 Trento	YES
95	CM_Gardena. jpg	Digital	Germanic model	2003	Cesare Micheletti		Cesare Micheletti via E.Conci, 74 I – 38100 Trento	YES
98-99	2-6-1 nuvolao. JPG	Digital	Panoramic view of Nuvolau and M. Pelmo	2003	Dell'Agnola	Provincia di Belluno		YES
102-103	2-6-1 lastoni. JPG	Digital	Panoramic view of Croda da Lago e Lastoni di Formin	2003	Dell'Agnola	Provincia di Belluno		YES
105	Ammonoids PZonia.jpg	Digital	Ammonoids from the pelagic drape of the Cernera	2002	Dario Bellodis	Museo delle Regole Ampezzane		YES
106	2-6-1 pelmo.jpg	Digital	M. Pelmo	2001	Franco Fiamoi		F. Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it	YES
108	Cernera.jpg	Digital	Onlap of the volcaniclastic Succession on the Mt.Cernera carbonate platform	2004	Alberto Riva	University of Ferrara. Earth Science department		YES
109	MP-11.tif	Digital	Mondeval de Sora (W of Becco di Mezzodì, on background)	1998	M. Panizza	University of Modena. Earth Science department		YES

111	DSCN3861. JPG	Digital	Croda da Lago	2002	P. Gianolla	University of Ferrara. Earth Science department		YES
114-115	2-6-2 11153. jpg	Digital	A 360° view from Col del Cuc, Viael del Pan, Marmolada, Sassolungo, Sella	1999	U.Visciani	Trentino S.P.A		YES
118-119	2-6-2 11302. jpg	Digital	A 360° view from Col del Cuc, Viael del Pan, Marmolada, Sassolungo, Sella	2001	U. Visciani	Trentino S.P.A		YES
120	ladinico marmolada 2.jpg	Digital	Pian dei Fiacconi, gastropods from inner platform	2001	M. Avanzini	Museo tridentino di Scienze naturali		YES
120	ladinico marmolada.jpg	Digital	Pian dei Fiacconi, gastropods from inner platform	2001	D.Bellodis	Museo delle Regole Ampezzane		YES
121	2576.jpg	Digital	Southern face of Marmoloada in "Gran Vernel", S. Nicolò pass	2004	T. Camerano	Trentino S.P.A		YES
122	3495.jpg	Digital	Val di Fassa - Winter view of the Marmolada group	2003	P. Cavagna	Trentino S.P.A		YES
124-125	3794.jpg	Digital	Marmolada	2002	P. Cavagna	Trentino S.P.A		YES
128-129	11221.jpg	Digital	The Pale di San Martino seen from the Rolle pass	1999	U. Visciani	Trentino S.P.A		YES
132-133	4115.jpg	Digital	Paneveggio Forest, the Pale di San Martino in the background	2002	F. Faganello	Trentino S.P.A		YES
136	P8240055_ Fiamoi	Digital	Ra Fusela-Mt. Schiara	2004	Fiamoi F.		Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it	YES
138-139	PC080254_ Fiamoi F.jpg	Digital	Panoramic view of the southern cliffs of the Schiara Group	2004	Fiamoi F.		Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it	YES
140-141	11163.jpg	Digital	Pale di San Martino from Cima Rosetta, a 360° view	2003	U.Visciani	Trentino S.P.A		YES
142	lucano-21.jpg	Digital	The impressive southern cliff of the Pale di San Lucano.	2001	P. Gianolla	University of Ferrara. Earth Science department		YES
143	MP 13 tris.JPG	Digital	Glacial cirque, Val Cantoni glacier on the mount Civetta.	2002	S. Furlanis	University of Ferrara. Earth Science department		YES
144-145	img_5751.JPG	Digital	Northern cliff of M. Civetta	2001	P. Gianolla	University of Ferrara. Earth Science department		YES
146-147	2-6-3 img_6086.JPG	Digital	Pnoramic view of northwestern side of Pale di San Martino Group	2003	Dell'Agnola	Provincia di Belluno		YES
148-149	Piani_Eterni_ Inverno_4	Digital	Erera – Piani Eterni plateau, a glacio-karst depression	2001	G. Riva	University of Ferrara. Earth Science department	A. Riva University of Ferrara. Earth Science department	YES
156-157	FVG69.jpg	Digital	Panoramic view of Val Maontanaia	2/2004	E. Ciol		Elio e Stefano Ciol s.n.c. Via Dante 5 – 33072 Casarsa della Delizia (PN) +39.0434. 86133	YES
158	Librisandaniele1. jpg	Digital	Libri di San Daniele..	7/2003	I.Pecile - Udine		SentieriNatura 0432-524370 pecile@mail. nauta.it	YES

159	2-6-4 FVG74. jpg		Cima dei preti	8/2004	E. Ciol		Elio e Stefano Ciol s.n.c. Via Dante 5 – 33072 Casarsa della Delizia (PN) +39.0434. 86133	YES
160-161	2-6-4 v11.JPG	Digital	The south wall of Cridola.	Mag 2003	Dell'Agnola	Provincia di Belluno		YES
163	Montetoc.jpg	Digital	Mt. Toc – Vajont Landslide	5/2004	I. Pecile - Udine	SentieriNatura 0432-524370 pecile@mail. nauta.it		YES
165	12_Zandonella I.tif	digital	Spalti di Toro	7/1999	Zandonella			YES
168-169	2-6-5 Croda dei Toni.jpg	Digital	Croda de Toni	2001	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
172-173	2-6-5 np_ sextner_ dolomiten.jpg	Digital	Northern side of Tre Cime e Mt. Paterno	2001	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
174	2-6-5 03 armentarawiesen. jpg	Digital	Armentara.	2000	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
175	2-6-5 tre cime versante sudest. JPG	Digital	Southeastern side of Tre Cime	2000	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
177	2-6-5 marmarole.jpg	Digital	Marmarole	2004	Fiamoi F.	Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it		YES
177	2-6-5 s5_pan2. jpg	Digital	Tofane	2004	Fiamoi F.	Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it		YES
178	2-6-5 cristallo-. JPG	Digital	Mt. Cristallo	2001	Dell'Agnola	Provincia di Belluno		YES
179	2-6-5 s5_pan1. jpg	Digital	Punte di Fanis and Cunturines	2004	Fiamoi F.	Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it		YES
179	2-6-5 s5_pan4. jpg	Digital	Fanes	2004	Fiamoi F.	Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it		YES
179	2-6-5 setsas.jpg	Digital	Settsass	5/2003	Dell'Agnola	Provincia di Belluno		YES
180	2-6-5 tofana.jpg	Digital	Tofana di Rozes	2004	Fiamoi F.	Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it		YES
182	Img_01.jpg	Digital	Paramegalodus eupalliatus - (h. 15 cm). Dolomia principale	1999	D. Bellodis	Museo delle Regole Ampezzane		YES
183	Img_02.jpg	Digital	Dicerocardium curionii curionii - (h. 17 cm). Dolomia principale	1999	D. Bellodis	Museo delle Regole Ampezzane		YES
184	Rhynchosauroides braies.JPG	Digital	Braies/Prags Dolomites, Rynchosauroides	2001	M. Avanzini	Museo tridentino di Scienze naturali		YES
184	Gordonopteris lorigae.jpg	Digital	Pra della Vacca/ Kühwiesen Lagerstatten ..	2000	E. Kustatscher	Museo Scienze Naturali Alto Adige/ Naturmuseum Südtirol;		YES

186	MP-15.tif	Digital	Karst morphology: in the foreground a karren slope in massif limestones;	2002	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
187	MP-16.jpg	Digital	Glacial cirque on Marmarole	2001	M. Panizza	University of modena. Earth Science department		YES
192-193	2-6-6 Odle.jpg	Digital	Panoramic view of Odle/Geisler/Odles Group	2003	Tappeiner	Tappeiner		YES
196-197	2-6-6 np_puez_ geisler.jpg	Digital	Sunset on the Odle/ Geisler/Odles Group	2004	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
198	2-6-6 puez.jpg	Digital	Panoramic view of Pöz / Puez	2000	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
199	IMG_0015. JPG	Digital	Seceda, Buchenstein Fm	2002	P. Gianolla	University of Ferrara. Earth Science department		YES
200	MP-19.JPG	Digital	Scree slopes and protalus rampart on Juel valley.	2003	M. Panizza	University of modena. Earth Science department		YES
201	MP-18.jpg	Digital	Fault line valley of Vallonga.	1998	M. Panizza	University of modena. Earth Science department		YES
204-205	2-6-7 Catinaccio_ Sciliar.jpg	Digital	Norther side of Catinaccio/ Rosengarten from Sciliar/Schlern	2005	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
209	2-6-7 1.1sciliar. jpg	Digital	Mt. Sciliar/Schlern and Punta Santner from Alpe di Siusi/ Seiser Alm	2000	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
210	2-6-7 Karersee 2.	Digital	Carezza lake/Karersee and Mt.Latemar in the foreground	2005	Tappeiner	Tappeiner		YES
211	jpg2-6-7 3823. jpg	Digital	Catinaccio/ Rosengarten – Vajolet Valley	2004	P. Lattuada	Trentino SPA		YES
212	2-6-7 3416.jpg	Digital	View of the Schenon of Latemar	2004	M. Benedetti	Trentino SPA		YES
213	frana malknecht.TIF	Digital	Mahlknecht Cliff, Alpe di Siusi/ Seiser Alm.	2005	R. Andreeetta	University of Ferrara. Earth Science department		YES
215	2-6-7 Val Ciamin.jpg	Digital	Val Ciamin / Tschamin Tal.	2004	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
216	2-6-7 Punta Santner.jpg	Digital	Punta Santner and Euringer	2003	R.Sacscor	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
217	calcite molignon.jpg heulandite.jpg	Digital	Sciliar/Schlern area, Calcite and Heulandite.	2002	M. Avanzini	Museo tridentino di Scienze naturali		YES
217	Fassaite.tif prehnite3.jpg	Digital	Sciliar/Schlern area, Fassanite and Prehnite.	2002	M. Avanzini	Museo tridentino di Scienze naturali		YES
219	MP-20.tif	Digital	Crests of Denti di Terrarossa/Rosszähne	2003	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
220	IMG_0017. JPG	Digital	Sunset on Catinaccio/ Rosengarten	2002	P. Gianolla	University of Ferrara. Earth Science department		YES
224-225	2-6-8 Blätterbach-schlucht 2.tif	Digital	Blätterbach ravine and Corno Bianco/ Weisshorn	2003	Tappeiner	Tappeiner		YES

228-229	MP-21.jpg	Digital	Ravine of Blätterbach and Weisshorn.	2004	Tappeiner	Tappeiner		YES
230	orme rhyncho-sauroides pallinii.jpg orme tridactyli-chnium leonardii.jpg	Digital	Rhynchosauroides and tridactylichnium footprints	2004	Brandoli	University of Ferrara. Earth Science department		YES
231	2-6-8 04 gesicht (leo).jpg	Digital	Blätterbach gourge	2005	Leo Unterholzner	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
233	Bletterbach AVG.jpg	Digital	Blätterbach- Val Gardena sandstones	2006	P. Gianolla	University of Ferrara. Earth Science department		YES
236-237	2-6-9 3615.jpg	Digital	Brenta group, entral chain	2002	Marco Benedetti	Trentino S.p.A.		YES
240-241	2-6-9 13425. jpg	Digital	View of the Brenta group	2002	Ugo Visciani	Trentino S.p.A.		YES
243	2-6-9 2551.jpg	Digital	The central Brenta group at dawn	2005	Valerio Banal	Trentino S.p.A.		YES
244-245	2-6-9 2791.jpg	Digital	Brenta group	2004	Gianni Zotta	Trentino S.p.A	.	YES
247	2-6-9 4074.jpg	Digital	Val Rendena, Adamello Brenta Nature Park, Lake Nero	2002	Gianni Zotta	Trentino S.p.A	.	YES
248-249	2-6-9 VB_13. jpg	Digital	View of Brenta Pinnacles and gullies	2000	Marco Benedetti	Trentino S.p.A.		YES
250	MP-22.jpg	Digital	Series of pinnacles, steeples and rock needles of various sizes	2003	Valerio Banal	Trentino S.p.A.		YES
251	3103.jpg	Digital	Series of ledges shaped on the eastern face of Cima Brenta Bassa.	2005	Franco De Ruvo	Trentino S.p.A.		YES
252	MP-24.JPG	Digital	Pozza Tramontana. Large, ellipsoidal karst depression with	2002	A. Carton	University of Padova. Earth Science department		YES
256-257	CM_np_ schlern.jpg	Digital	Sunset on Alpe di siusi/Seiser Alm.	2004	Tappeiner	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
260-261	CM_19 P9280053.JPG	Digital	Southern view of 5 Torri	2007	Fiamoi F.	Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it		YES
263	P9020005.tif	Digital	Settsas	2004	Fiamoi F.	Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it		YES
264	catinaccio.pdf	Digital	Geological sketch of Catinaccio/ Rosengarten carbonate platform	2003	Piero Gianolla	University of Ferrara. Earth Science department		YES
267	Lago di Braies 1.TIF	Digital	Braies lake/Pragsee	2002	Sascor Renato	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
278	MP-26.jpg	Digital	Structural slope on Alpe di Fanes	1999	M.Panizza	University of Modena. Earth Science department		YES
280	MP27.JPG	Digital	Plain ledge at the top of Sciliar/ Schlern Massif	2003	M.Morsilli	University of Ferrara. Earth Science department		YES
280	MP-28.tif	Digital	Structural ledge between Lagazuoi and Tofane	2002	A. Carton	University of Padova. Earth Science department		YES

281	MP-29.tif	Digital	Extinct small lake, obstructed by a morainic arc (SE of Puez).	1998	M.Panizza	University of Modena. Earth Science department		YES
286-287	CM_ img_6983.JPG	Digital	Armentara.	2000	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano	Uff. Parchi naturali- Via Renon 4 39100 - Bolzano		YES
293	ghiacciaio_ marmolada. JPG	Digital	Marmolada Glacier from Mt.Lagazuoi	2002	P.Gianolla	University of Ferrara. Earth Science department		YES
297	CM_02 bivacchi.jpg	Digital	Bivacco Goitan	8/2004	E. Ciol	Elio e Stefano Ciol s.n.c. Via Dante 5 – 33072 Casarsa della Delizia (PN) +39.0434.86133		YES
326	CM_01 ambiente.jpg	Digital	camosci	2007	Fiamoi F.	Franco Fiamoi via S.Cipriano, 199 32100 Belluno 0039-0437-927634 f.fiamoi@tele2.it		YES
332	Ghiacciaio_ Agola_2005.jpg	Digital	Agola glacier	2005	University of Modena. Earth Science department	M. Panizza		YES

A7.2 BIBLIOGRAPHICAL INVENTORY

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ANNEX 8

A8.1 OTHER LOCAL AUTHORITIES

Provincia di Belluno

MUSEUMS, FOUNDATIONS, OTHER CULTURAL ASSOCIATIONS

CASA NATALE DI TIZIANO VECELLIO
Via Arsenale – I-32044 Pieve di Cadore
0039-0435-32262
0039-0435-32858
segreteria@magnificacomunitadicadore.it

CELLULA MUSEALE DELLE MINIERE DELLA VALLE IMPERINA
Loc. Miniere – I-32020 Rivamonte Agordino
0039-0437-69128
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rivamonte@agordino.bl.it
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CELLULA MUSEALE "LA FUDINA"
Largo 9 febbraio – I-32040 Dosoledo – Comelico Superiore
0039-0435-68830
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CELLULA MUSEALE – MUSEO DI STORIA NATURALE OLIVIA PERINI
Via Roma – I-32040 Borca di Cadore
0039-0435-482015
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COMUNE DI LONGARONE – LUOGHI DEL VAJONT
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FONDAZIONE CENTRO STUDI "TIZIANO E CADORE"
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MUSEO ALL'APERTO DEL MONTE PIANA
E PICCOLO MUSEO DELLA GRANDE GUERRA – RIFUGIO BOSI
Misurina – Monte Piana – Rifugio "A. Bosi" – I-32040 Misurina – Auronzo di Cadore
0039-0435-400001
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info@gemeinde.welschnofen.bz.it

DEUTSCHNOFEN
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0039-0471-617500
0039-0471-617555
info@gemeinde.deutschnofen.bz.it

ALDEIN
Dorf, 11 – I-39040 Aldein
0039-0471-886823
0039-0471-886632
info@gemeinde.aldein.bz.it

Provincia di Pordenone

COMUNI E COMUNITÀ MONTANE

COMUNE DI ANDREIS
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servizi@comune.andreis.pn.it
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COMUNE DI BARCIS
Piazza Vittorio Emanuele II, 5 – I-33080 Barcis (PN)
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Fax 0039-0427-76340

COMUNE DI CIMOLAIS
Via Vittorio Emanuele II, 27 – I-33080 Cimolais (PN)
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Fax 0039-0427-87020
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COMUNE DI CLAUT
Via A. Giordani, 1 – I-33080 Claut (PN)
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Fax 0039-0427-878454
segreteria@com-claut.regione.fvg.it
www.comune.claut.pn.it

COMUNE DI ERTO E CASSO
Via IX Ottobre, 4 – I-33080 Erto e Casso (PN)
Tel. 0039-0427-879001
Fax 0039-0427-879100

COMUNE DI FRISANCO
Via Valdestali, 1 – I-33080 Frisanco (PN)
Tel. 0039-0427-78061
Fax 0039-0427-778062

COMUNE DI MONTEREALE VALCELLINA
Via M. Ciotti, 122 – I-33080 Montereale Valcellina (PN)
Tel. 0039-0427-798782
Fax 0039-0427-799373
www.comune.monterealevalcellina.pn.it

COMUNE DI TRAMONTI DI SOPRA
Via Roma, 1 – I-33080 Tramonti di Sopra (PN)
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Telefax 0039-0427-869263
segreteria@com-tramonti-di-sopra.regione.fvg.it
www.comune.tramonti-di-sopra.pn.it

COMUNITÀ MONTANA DEL FRIULI OCCIDENTALE
Piazzale della vittoria, 1 – I-33080 Barcis (PN)
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Fax 0039-0427-76301
info@cm-friuli-occidentale.regione.fvg.it

OTHER INSTITUTIONS

MONTAGNALEADER
S.C.ARL Via Dante, 28 – I-33080 Maniago (PN)
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Fax 0039-0427-71754
gal@montagnaleader.org
www.montagnaleader.org

Provincia Autonoma di Trento

MUSEUMS, FOUNDATIONS, OTHER CULTURAL ASSOCIATIONS

MUSEO CIVICO DI GEOLOGIA
Piazza SS. Filippo e Giacomo, 1 – I-38037 Predazzo (Trento)
Tel. 0039-0462-502392
Fax 0039-0462-502566
museopre@tin.it

MUSEO MINERALOGICO MONZONI
Via Pilat, 10 – I-38039 Vigo di Fassa (Trento)

MUSEO TRIDENTINO DI SCIENZE NATURALI
Via Calepina, 14 – I-38100 Trento
Tel. 0039-0461-270311
Fax 0039-0461-233830
info@mtsn.tn.it

STAZIONE LIMNOLOGIA DEL LAGO DI TOVEL
Limnology and algology section – I-38019 Tuenno (Trento)
Tel. 0039-0465-507700
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MUSEO LADINO DI FASSA – ISTITUTO CULTURALE LADINO
Via Milano, 5 - loc. San Giovanni – I-38039 Vigo di Fassa (Trento)
Tel. 0039-0462-760182
info@istladin.net

PALAZZO DELLE MINIERE
Piazzetta del Dazio, 1 – I-38054 Fiera di Primiero (Trento)
Tel. 0039-0439-62515

MUSEO DELLA GUERRA 1915-1918
Passo Fedaia c/o Rifugio alla Seggiovia – I-38032 Canazei (Trento)

MUSEO STORICO ITALIANO DELLA GUERRA
Via Castelbarco, 7 – I-38068 Rovereto (Trento)
Tel. 0039-0464-438100
Fax 0039-0464-423410
archivio@museodellaguerra.it

ARCHIVIO SOCIETÀ ALPINISTI TRIDENTINI
at the Mountain Library – SAT (Tridentine Alpinist Society)
Via Manci, 57 – I-38100 Trento
Tel. 0039-0461-980211
Fax 0039-0461-986462
sat@biblio.infotn.it

SERVIZIO ECOMUSEO DELLA JUDICARIA "Dalle Dolomiti al Garda"
c/o Comune di Bleggio Inferiore via G. Prati 1, – I-38077 Ponte Arche (Trento)

ASSOCIAZIONE PRO ECOMUSEO
Library of Valle di Ponte Arche via G. Prati, 1 – I-38077 Ponte Arche (Trento
Tel. 0039-0465-702215
www.dolomiti-garda.it

COMUNI

CONSORZIO DEI COMUNI TRENTINI
Via Torre Verde, 21 – I-38100 Trento
Tel 0039-0461-987139
Fax 0039-0461-981978
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COMUNE DI ANDALO
Piazza Centrale, 1 – I-38010 Andalo (Trento)
Tel. 0039-0461-585824
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COMUNE DI BLEGGIO INFERIORE
Via G. Prati – loc. Ponte Arche – I-38071 Bleggio Inferiore (Trento)
Tel. 0039-0465-701434
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segreteria@comune.bleggioinferiore.it

COMUNE DI CAMPITELLO DI FASSA
Via Dolomiti – I-38031 Campitello di Fassa (Trento)
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comune.campitello@tin.it

COMUNE DI CAMPODENNO
Piazza Centrale, 1 – I-38010 Campodenno (Trento)
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COMUNE DI CANAZEI
Via Roma, 12 – I-38032 Canazei (Trento)
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COMUNE DI CAVEDAGO
Piazza S. Lorenzo, 1 – I-38010 Cavedago (Trento)
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COMUNE DI DORSINO
Fraz. Dorsino, 3 – I-38070 Dorsino (Trento)
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COMUNE DI IMER
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COMUNE DI MAZZIN
Via Dolomiti, 8 - loc. Campestrin – I-38030 Mazzin (Trento)
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COMUNE DI MEZZANO
Via Roma, 87 – I-38050 Mezzano (Trento)
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COMUNE DI MOENA
Piazza C. Battisti, 19 – I-38035 Moena (Trento)
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COMUNE DI MOLVENO
Via Marconi, 1 – I-38018 Molveno (Trento)
Tel. 0039-0461-586936
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COMUNE DI PINZOLO
Via della Pace, 8– I-38086 Pinzolo (Trento)
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COMUNE DI POZZA DI FASSA
Piazza Municipio, 6 – I-38036 Pozza di Fassa (Trento)
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COMUNE DI PREDAZZO
Piazza SS. Filippo e Giacomo, 3 – I-38037 Predazzo (Trento)
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COMUNE DI RAGOLI
Via Roma, 4/A – I-38070 Ragoli (Trento)
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COMUNE DI SAGRON – MIS
Via Parrocchia, 9 – I-38050 Sagron – Mis (Trento)
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COMUNE DI SAN LORENZO IN BANALE
Fraz. Prato, 1 – I-38078 San Lorenzo in Banale (Trento)
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COMUNE DI SIROR
Via Asilo, 4 – I-38054 Siror (Trento)
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COMUNE DI SORAGA
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COMUNE DI SPORMAGGIORE
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COMUNE DI SPORMINORE
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COMUNE DI STENICO
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COMUNE DI TONADICO
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COMUNE DI TRANSACQUA
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COMUNE DI TUENNO
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COMUNE DI VIGO DI FASSA
Via Roma, 16 – I-38039 Vigo di Fassa (Trento)
Tel. 0039-0462-764182
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Provincia di Udine

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MUSEO GEOLOGICO DELLA CARNIA
Piazza Zona Libera della Carnia, 1 – Ampezzo (UD)
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MUSEO FRIULANO DI STORIA NATURALE
Via Lionello 1 – I-33100 Udine
Tel. 0039-0432-584711
Fax 0039-0432-584721
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MUSEO CARNICO DELLE ARTI E TRADIZIONI POPOLARI "MICHELE GORTANI"
Via della Vittoria, 2 – I-33028 Tolmezzo (UD)
Tel. 0039-0433-43233
museo.carnico@agemont.it

CENTRO ETNOGRAFICO S'HAUS VAN DER ZAHRE
I-33020 Sauris – Sauris di Sopra
Tel. 0039-0433-86262/86076
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CENTRO STORIOGRAFICO
I-33020 Sauris – Sauris di Sotto
Tel. 0039-0433-866375

PICCOLO MUSEO DELLA CASA CARNICA
Prato Carnico (Pesariis) – Via Superiore
Tel. 0039-0433-69057
carnia.musei@cmcarnia.regione.fvg.it

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COMUNE DI AMPEZZO
p. Zona Libera 1944, 28 - 33021 Ampezzo (UD)
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amministrativo@com-ampezzo.regione.fvg.it
www.comune.ampezzo.ud.it

COMUNE DI FORNI DI SOPRA
Via Nazionale, 84 – 33024 Forni di Sopra (UD)
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COMUNE DI FORNI DI SOTTO
Via Tredolo, 1 – 33020 Forni di Sotto (UD)
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www.comune.fornidisotto.ud.it

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