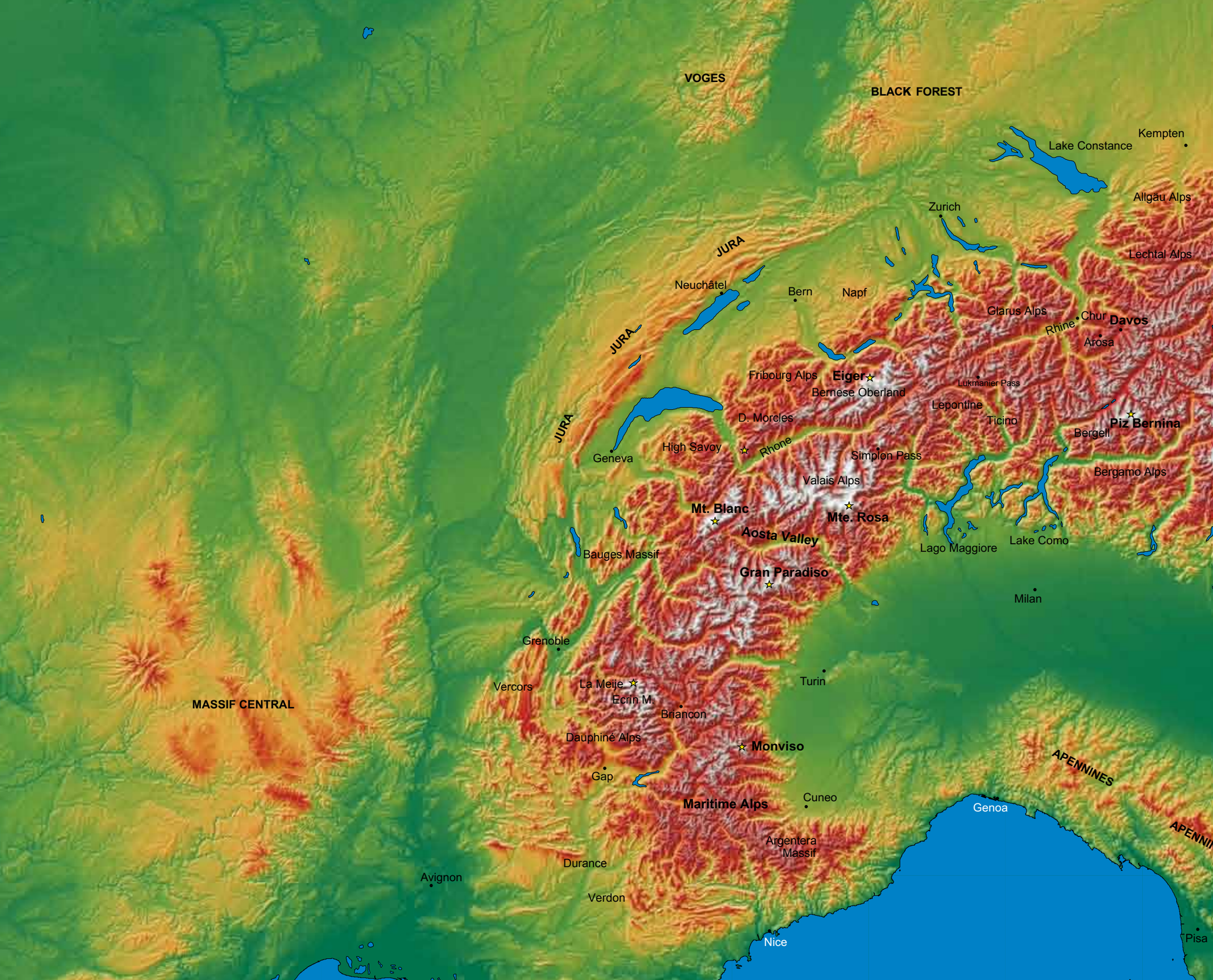
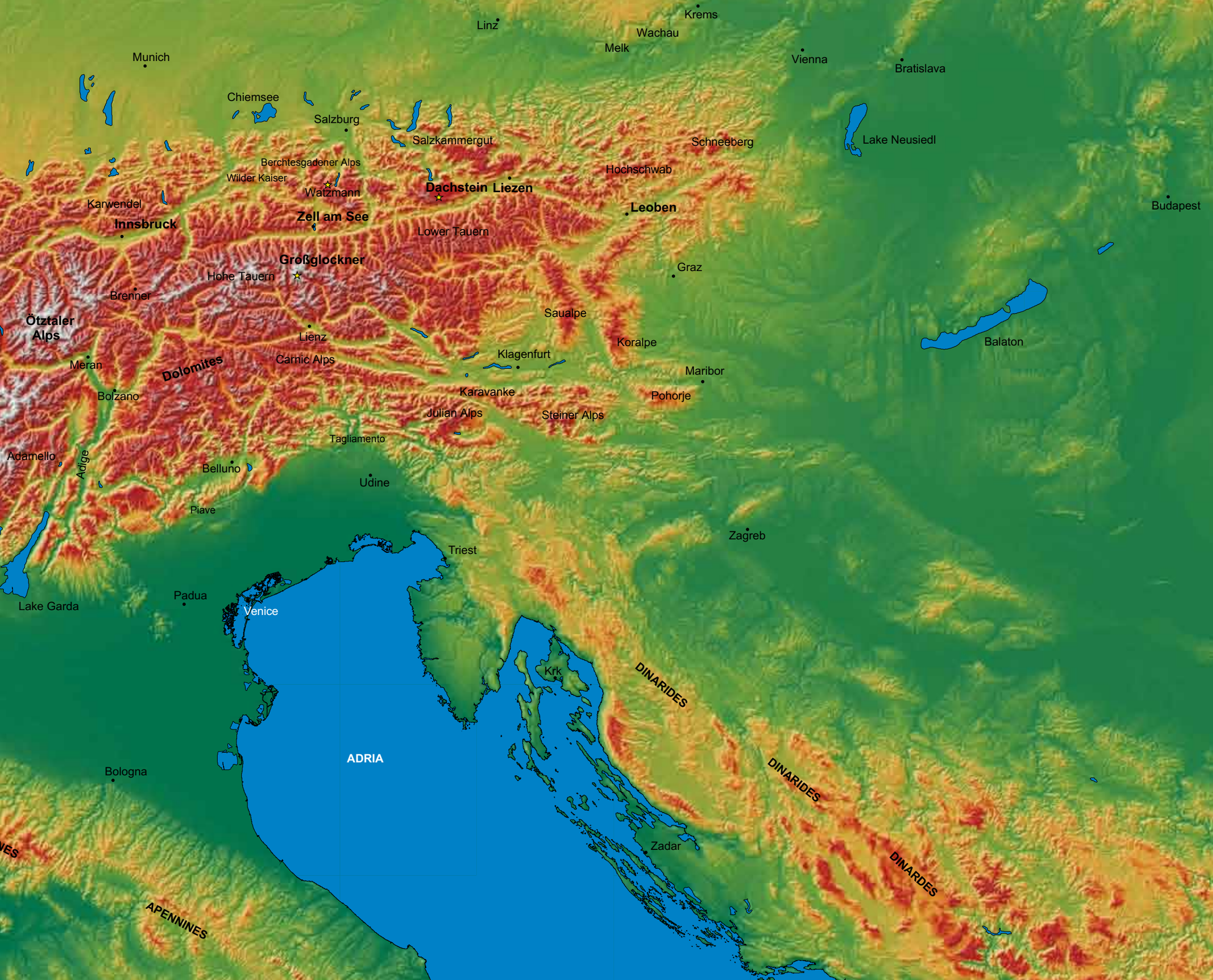
High Above the Alps

A Bird's Eye View of Geology

Kurt Stüwe and Ruedi Homberger

Weishaupt Publishing


VOGES
BLACK FOREST
Kempten
Lake Constance
Allgäu Alps
Zurich
JURA
Lechtal Alps
Neuchâtel
Bern
Napf
Glarus Alps
Chur
Davos
Rhine
Arosa
JURA
Fribourg Alps
Eiger
Lukmanier Pass
Bernese Oberland
Lepontine
JURA
D. Morcles
Ticino
Piz Bernina
Bergell
High Savoy
Rhone
Geneva
Simplon Pass
Bergamo Alps
Valais Alps
Mt. Blanc
Mte. Rosa
Aosta Valley
Lago Maggiore
Lake Como
Bauges Massif
Gran Paradiso
Milan
Grenoble
Turin
Vercors
La Meije
Ecrin M.
MASSIF CENTRAL
Briancon
Dauphiné Alps
Monviso
APENNINES
Gap
Cuneo
Maritime Alps
Genoa
Argentera
Massif
Durance
Avignon
Verdon
Nice
Pisa


Krems
Linz
Wachau
Melk
Munich
Vienna
Bratislava
Chiemsee
Salzburg
Salzkammergut
Schneeberg
Lake Neusiedl
Berchtesgadener Alps
Wilder Kaiser
Watzmann
Dachstein Liezen
Hochschwab
Karwendel
Innsbruck
Zell am See
Leoben
Budapest
Lower Tauern
Großglockner
Hohe Tauern
Graz
Brenner
Saualpe
Ötztaler Alps
Lienz
Koralpe
Balaton
Klagenfurt
Meran
Carnic Alps
Dolomites
Maribor
Karavanke
Bolzano
Pohorje
Julian Alps
Steiner Alps
Tagliamento
Adamello
Adige
Belluno
Udine
Piave
Zagreb
Triest
Padua
Lake Garda
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Krk
DINARIDES
ADRIA
Bologna
DINARDES
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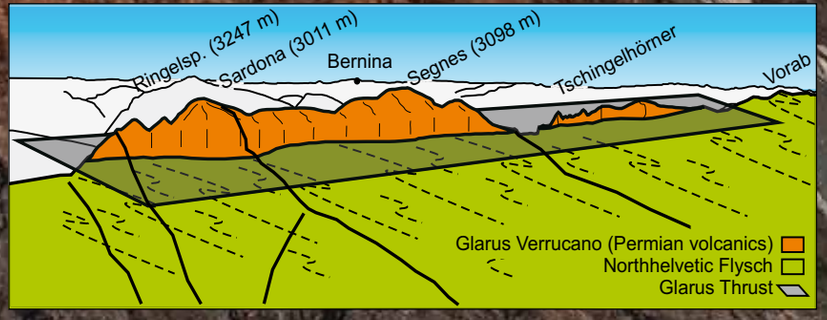
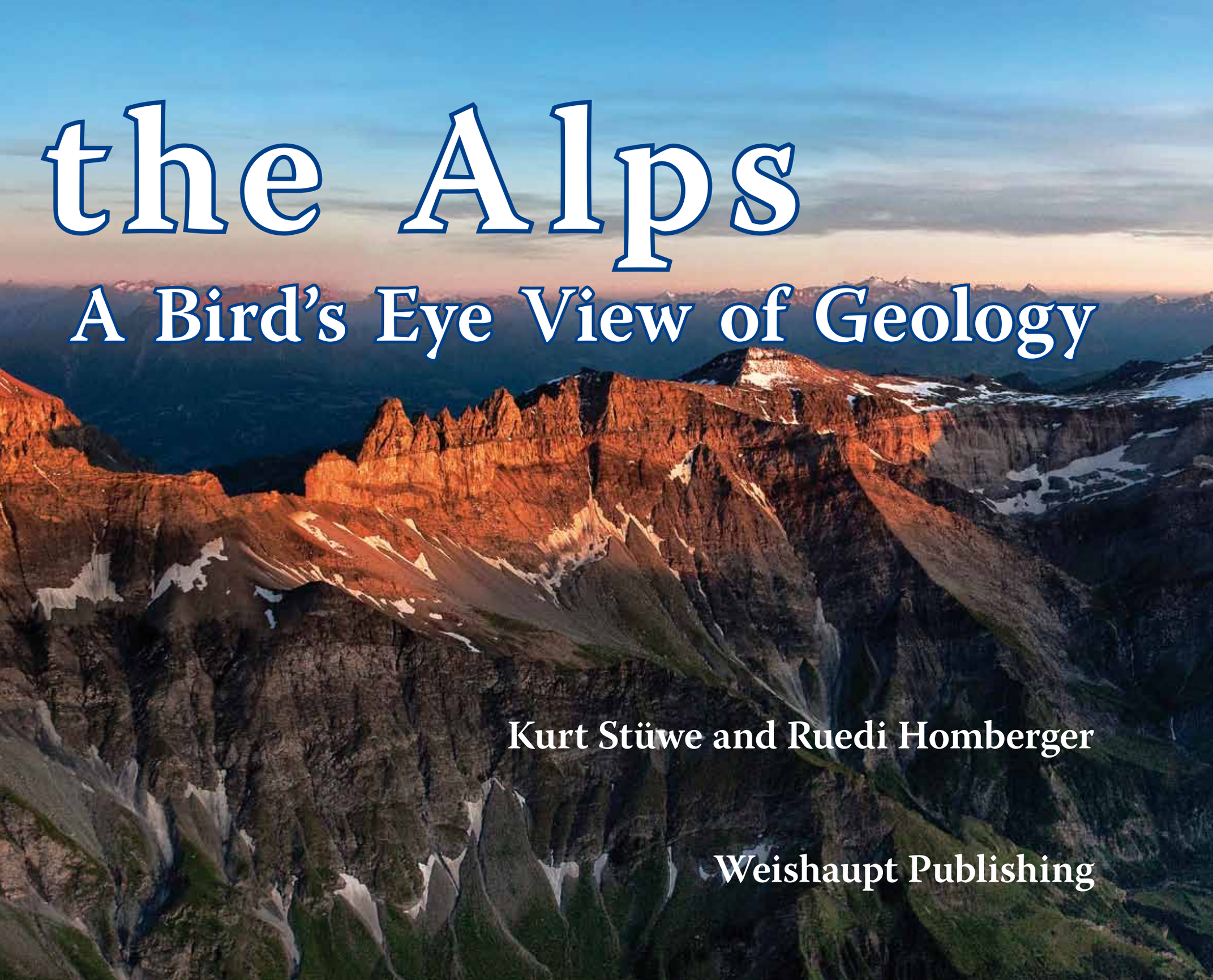
Zadar
APENNINES

High Above



The Glarus Thrust is the most famous geological structure of the Alps. As part of the "Tectonic Arena Sardona" it became part of the world nature heritage of UNESCO in 2008. The photo shows the thrust in the region of Piz Sardona near the border between the three Swiss cantons Glarus, St. Gallen and Grisons. The thrust plane forms a flat lying knife-sharp boundary between rock types of completely different origin and age. Above the structure the rocks are undeformed Permian volcanics ("Verrucano"), that are about 250 million years in age. Below the structure the rocks are much younger: sediments that were deposited only 50 million years ago into the Penninic ocean ("Flysch"). The thrusting itself occurred at about 30 Ma. Erosion exposed the structure only much later: the valleys flanking the entire range between Vorab and Ringelspitz were incised only in the last 1–2 million years. In the rugged rock needles of the Tschingelhörner the ridge has become so narrow that a gigantic hole has broken through the range: the Martinsloch.



the Alps

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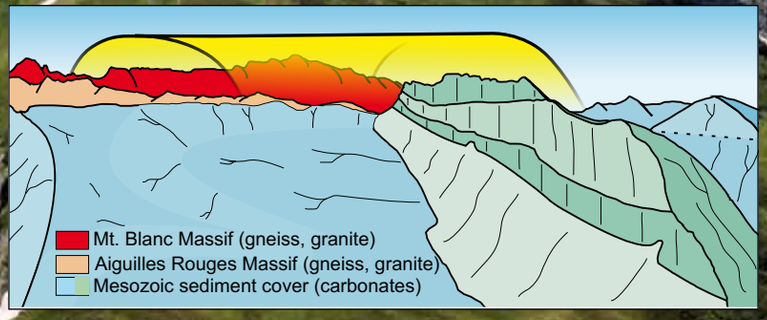

Mt. Blanc (4807 m) is the highest peak of the Alps and its impressive grandeur can keep up with the high peaks of any mountain range in the world. Geologically the Mt. Blanc Massif consists of coarse-grained granites and gneisses that form the basement of the Alps and once were part of the Mesozoic European middle crust. In the Alps, these rocks are seen in the so called "External Massifs" which form large dome-shaped structures surrounded by sedimentary rocks that once were deposited onto the Mesozoic European plate. In many places of the Swiss Alps these sediments were later scraped off their base and thrown into surreal folds: these are the Helvetic nappes of Switzerland. Here at the Tête à l'Ane, north of Mt. Blanc, the limestones and marls that constitute these Mesozoic sediments lie flat. Only some million years ago such sediments still covered the top of Mt. Blanc (as indicated by the yellow dome in the sketch at left).

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Left: The Illgraben on the south side of the Rhône Valley near the settlement of Leuk is one of the most actively eroding rock faces of the Alps. It illustrates the dramatic influence of geological processes on the shaping of the Alps. Continuous landslides destroy the massive dolomite and quartzite layers and rapidly consume the thin veneer of soil and forest from the Illhorn mountain.

Acknowledgements

This book is largely a translation of the German language book "GEOLOGIE DER ALPEN AUS DER LUFT", published by Weishaupt Publishing in early 2011. The German version was out of print more than once within the first year of publication, motivating us now to venture into the English market.

For the original German language version, we received enormous help from many colleagues across Europe, providing us with hints for good photo locations, diagrams to accompany the text, coffees at various airfields around the Alps and, in fact, teaching us a lot about the geology of the range – of which we knew embarrassingly little when the project started in 2008. Thank you all for your encouragement and help (for a full listing of friends and colleagues who helped us, see the original German edition).

With its tectonic interpretation of the Alps, the book leans heavily on modern views as taught by the schools of Niko Froitzheim, Stefan Schmid and Ralf Schuster (see overview papers Froitzheim et al., 2008; Schmid et al., 2004 or Schuster and Stüwe, 2011). Thank you for taking the time to discuss the larger geological picture with us!

For the English language edition, we thank Jessica Hedrick for proofreading the text and Jürg Meyer, Neil Mancktelow, Christoph Spötl, Bernhard Grasemann and Jürgen von Raumer for bringing many geological mistakes in the earlier editions to our attention. Karin Ehlers is thanked for finding many little editorial hiccups and, in fact, for structuring our original thoughts on chapter division and layout of the entire book. Urs Homberger spent many hours into archiving and processing the photos reproduced here. Stefan Hergarten and Georg Stegmüller are thanked for help with the project web pages (www.alpengeologie.org).

Since the publication of the German language version we have continued to expand our photo database with many more hours of flying and photography. Martin Kennedy and Karin Ehlers are thanked for providing logistic support during these flights. Some of these photos are included on additional pages in this English language edition. SPmining is thanked for financial support (for full credit see p. 284).

A lonely trail on the way to the Muttekopf hut near Imst in Tyrol crosses a spectacular fold made of Cretaceous marine sediments (Gosau sediments, 80 million years old). The photo symbolises the entrance to the world of geology.

Making of ...

Kurt's Impressions:
The idea for this project had been roaming around my head for years, but in absence of a good pilot, photographer and in fact a good plane, it simply never happened. Then, in 2008, I was with my family in one of the back corners of the Alaskan bush for geological field work, and saw some of Hombi's mountain photography in a wilderness lodge. It was there that my wife Karin reminded me that our old climbing friend Hombi had become a pilot in the last few years and might be an ideal partner for such a project. From that day onwards everything fell into place and every day that Hombi and I spent high above the Alps in his Piper Super Cub felt like a unique gift. What an unbelievable angle for a geologist and mountaineer like myself to see and understand our mountain range! Although every single day will be a lasting memory, there is one particular day that sticks in my memory: the 30th June 2009.

After a sticky hot night I woke up at dawn and crawled out of my sleeping bag in the dewy meadow next to the plane somewhere in the Upper Rhône Valley. Bitten by mosquitos, sweaty and barely awake, we climbed into the plane and started towards the thick clouds that covered the sky. 20 minutes later we circled only 100 metres from the summit of Matterhorn in brilliant sunshine and waved to the climbers through the open door of the plane at minus 5°C. An hour later we sorted photos during breakfast in a small cafe in the small township of Raron, before we refueled and started off for the 2nd time that morning. This time we were off to Mt. Blanc so that we could be in Gstaad for lunch …

Hombi's Impressions:
In summer 2008, Kurt asked me if I was interested in taking photos for this project. I had known Kurt from the Himalayas and Alaska as a climber and very dynamic person for many years, but had not seen him for some time. In the meantime I myself had retired from my years as an active climber and had discovered my love for flying – it had been an old childhood dream. Taking photos of mountains from the air quickly had become a great passion.

The idea to cover the entire Alps, all the way from Nice to Vienna, and take good pictures immediately fascinated me. We planned four journeys of 3 to 4 days each, flying through all six countries that contain parts of the Alps, and split this up over

two summers. In total about 60 hours in the air were necessary, and we stopped at 20 different airfields, where we refueled, had to battle with customs formalities, wait for weather or rest for the night. Several times we camped right next to the plane.

The plane is a Piper Super Cub PA-18 built in 1957 and based in Bad Ragaz in the Rhine Valley. The mountain goat that is the symbol of the Swiss canton Grisons is painted on the cloth covered fuselage. The plane is perfect for mountain photography with fantastic slow flying properties. A 160 PS Lycoming Motor takes us safely to the highest peaks and through the deepest gorges. When taking photos, the door is wide open and it is icy cold in the cockpit. In the rear seat there are gale force winds and maps, cameras and navigation equipment can easily fly through the air.

For the photos we mostly used a Canon EOS 5 MarkII with a 24–105 mm tele-zoom lens. The camera endured the rough world of the cockpit very well. Taking photos at the same time as flying a plane takes a lot of concentration, and often steering is done with the knees to keep the plane at the right angle. When Kurt shouted, "Take the picture from 500 m higher", it often took wild manoevers to bring the plane into the right angle. During each stop, the data was transferred to a laptop to make an initial check of the photos. At home many days of work on the computer followed. In particular the joining of the panorama images took a lot of time. In total we took about ten times as many photos as are shown in this book. Learning about the Alps from the air helped us to appreciate the unbelievable beauty of our mountain range.

Geological companion material to the book as well as the entire database of photos can be found on the interactive web page **http://www.alpengeologie.org**

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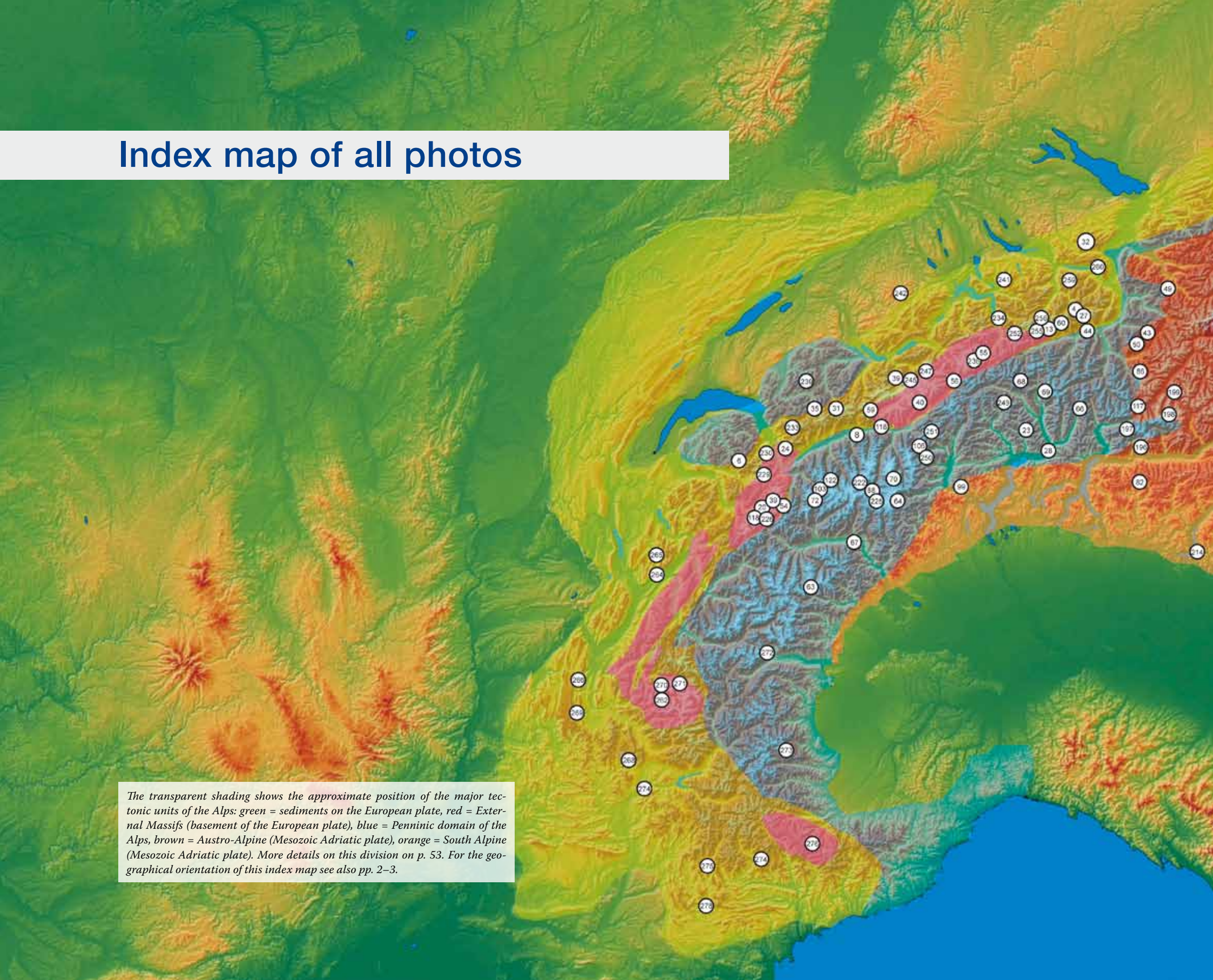
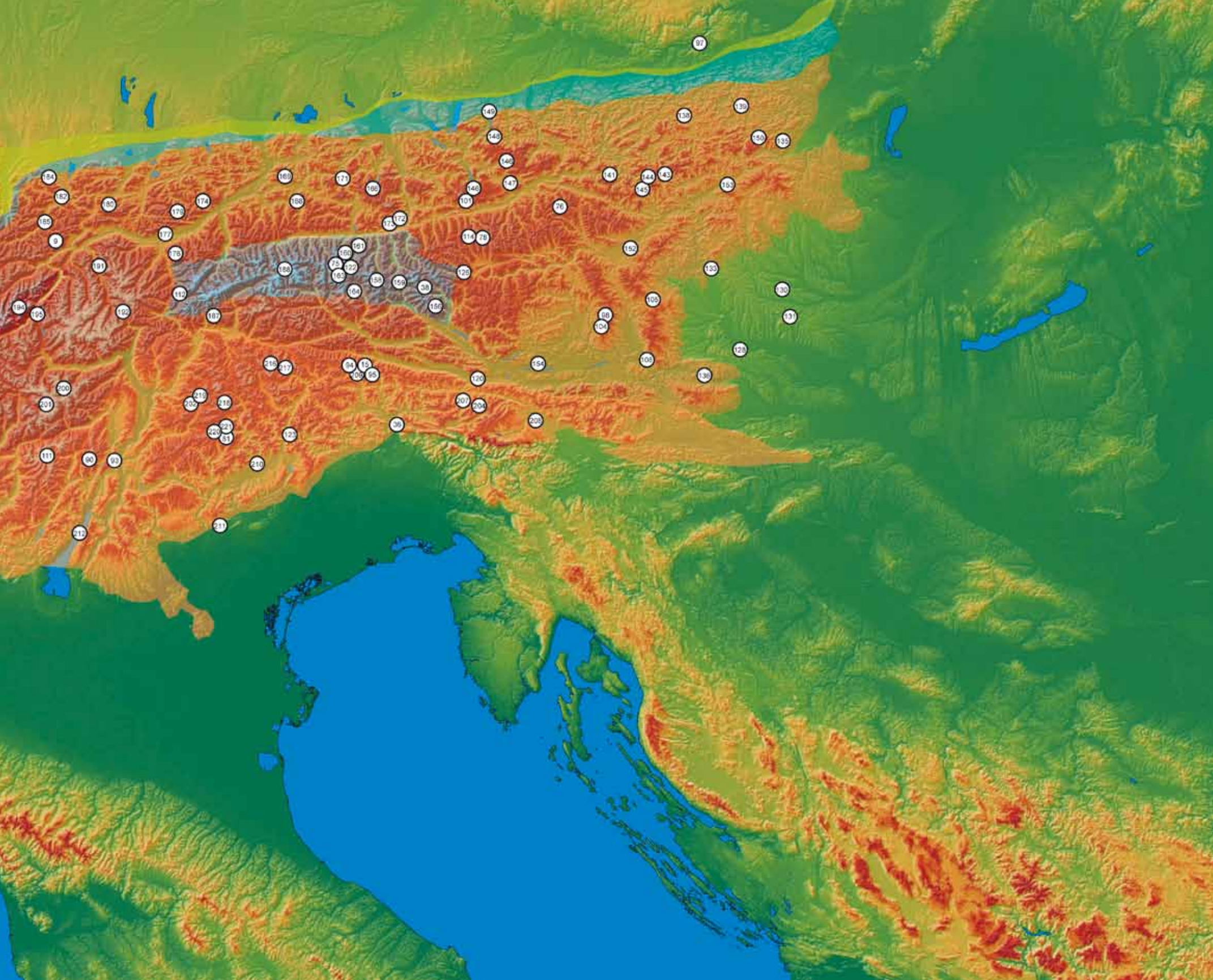


The transparent shading shows the approximate position of the major tectonic units of the Alps: green = sediments on the European plate, red = External Massifs (basement of the European plate), blue = Penninic domain of the Alps, brown = Austro-Alpine (Mesozoic Adriatic plate), orange = South Alpine (Mesozoic Adriatic plate). More details on this division on p. 53. For the geographical orientation of this index map see also pp. 2–3.



The cover picture shows the Alpstein massif in the Appenzell Alps of eastern Switzerland. More details about this photo are available on pp. 32–33. The eight small pictures on the back cover show from top left to bottom right: the Tödi, highest mountain in the Glarus Alps (p. 254); geological sketch of Tödi (p. 254); Mont Aiguille in the Vercors Massif of France (pp. 266–269); the Pala Group in the Dolomites (pp. 216–221); geological map of the Mont Blanc massif; the summit of Mont Blanc (p. 226); fold in the Dent de Morcles (p. 24) and the Styrian Erzberg (p. 144).

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