HAEBERLING, Christian (Zurich, Switzerland)*

Mountain Maps in School Atlases for Teaching Purposes

Contents

Summary

Today, most printed and electronic school atlases contain numerous mountain maps. These maps enable geography teachers to teach divers physical geographic or socio-cultural topics in mountain regions. Different cartographic techniques have been applied to express topographic aspects within these mountain maps. With the help of shaded relief, contour lines, or height points students learn to analyze mountain-related phenomena and processes. They interpret maps much more easily with additional hypsometric tinting, cliff drawings, hachures, or naturalistic textures. Besides topographic mountain maps, school atlases typically also show thematic maps and map related representations (e.g., block diagrams, profiles). Increasingly mountain maps are also integrated in interactive school atlas systems. The flexibility of interactive mountain maps as projected wall maps or as derived teaching material offers a high added value. As long as geography is part of the education curriculum of different countries, mountain maps will remain an attractive method of knowledge transfer.

Keywords: mountain maps, school atlases, teaching, relief depiction, shaded relief, 3D models

1 Introduction

1.1 Maps in the teaching context

For decades, maps have probably been one of the most attractive forms of teaching aids on different school levels. Especially in the fields of Geography, History and Biology, maps are valuable to visualize the distribution of many aspects of the natural environment. Furthermore they can show anthropogenic aspects like socio-cultural or economic structures as well as temporal developments of human activity and its impact. These manifold topics require topographic or thematic maps in diverse scales and generalization levels.

Efficient transfer of geographic knowledge depends not only on the topical information and labelling, but is also influenced by the depicted regions of the world and landscape types themselves. Ideal for teaching purposes are comprehensive map collections integrated in a school atlas, which focuses on presenting textbook examples rather than exhaustive spatial coverage.

With such atlases, teachers could illustrate geographical phenomena or processes by means of illustrative map examples. Atlas maps often give an excellent visual overview of the complex patterns and circumstances of such contexts. However, this also means that teachers have to intensively instruct and support their students in map reading and interpreting. They have to pay attention to the fact that often, during geography class, many students are encountering maps consciously for the first time in their lives (DIEKMANN-BOUBAKER 2012).

1.2 Mountain maps in general

Besides metropolitan areas and tropic, arid or semi-arid landscapes, mountain regions are often depicted on maps to explain specific features located in or depending on a distinct topography. This article re-

* Dr. Christian HAEBERLING, Institute of Cartography and Geoinformation, ETH Zurich,CH-8093 Zurich, Switzerland

fers to such maps as “mountain maps”, irrespective of whether the region is situated in a high mountain region or in a hilly area.

Additionally, the base map depicting the interesting features could also be characterized by mountain characteristics like rock features (e.g., cliffs at a rocky coastline, volcanic flows) or steep slopes (e.g., big sand dunes, canyons, gorges, or deep valleys). The distinction between mountain maps and other maps is thus fuzzy. Nevertheless, if we characterize mountain maps in this broader sense, most school atlases comprise many of them for different teaching purposes.

1.3 Structure of this contribution

In this article, we present some examples of mountain maps available in school atlases from Europe (Austria, Germany, Switzerland, and the Netherlands) and North America. Although this selection of atlases is limited, the map examples serve to illustrate the typical range of mountain features as well as different cartographic styles. The kind of display (printed versus screen) and presentation mode (e.g., map, block diagram, globe) is also an interesting topic for comparison. In teaching situations, interactive atlas information systems with their functionality can be used differently from static maps in printed school atlases. Hence we also want to show some examples of this modern usage of mountain maps.

2 Landscape aspects and techniques to design mountain maps

2.1 General content and requirements to mountain maps

Depending on the requirements, mountain maps can show and emphasize specific topographic aspects and any kind of thematic features within mountainous areas. Students can learn to interpret interrelationships between the terrain and the existing or even resulting geographic features. What terrain aspects are meant here particularly? And how they are depicted in maps?

2.2 Landscape shapes by shaded relief

For land forms, traditional techniques and geometric data describe the roughness or bumpiness of a terrain. For decades, mountain maps have mostly included manually drawn shaded relief (see Fig. 1). Depending of the map scale, grey scale contrast, and the desired degree of dominance of the relief, such a shaded relief can be integrated as a sculpted clearly visible element, to modulate the ridges and valleys. Or it can be seen as a more suggestive and supportive background layer to give the map a hint of a hilly landscape. However, the thematic map symbolization may be disturbed by the underlying relief presentation if the relief is drawn unprofessionally, contains too much contrast, or is too dark.

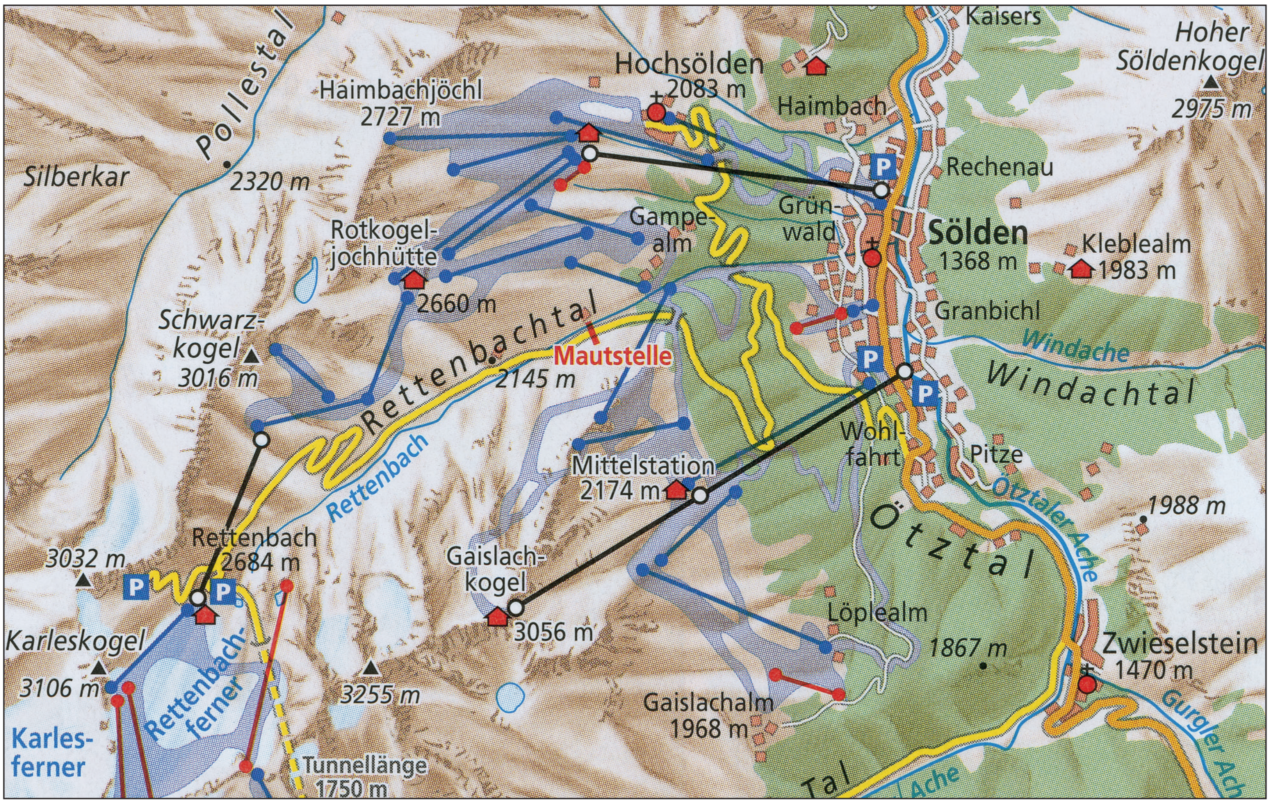

Fig. 1: Section of a tourist mountain map of the Sölden region (Austria) with a manually drawn shaded relief (SEYDLITZ 2004).

The manual techniques and the art of relief shading have to be learned over many years. While Digital Elevation Models (DEM) and available software allow fast and automatized creation of shaded relief, good relief design still requires considerable training and practice. Many useful software packages for the analytical modelling of shaded relief exist today. Examples include Blender (by The Blender Foundation), the landscape generators Bryce 7 Pro (by DAZ Production Inc.) and World Construction Set 6/Visual Nature Studio 3 (both by 3D Nature LLC.), and the tool box 3D Analyst in ArcGIS (by Esri).

Many printed or electronic school atlases contain mountain maps with excellent shaded relief. A map with an integrated shaded relief often conveys a more realistic representation of the mountain region than without. In general, students and other map users show a positive initial response to the coarse representation of land forms by shaded relief.

2.3 Graphic and numerical height information by hypsometric tinting, contour lines, and height points

Students and teachers are not only interested in the rough depiction of land forms. They also want to know the exact heights of specific landmarks or terrain parts. Labelled height points or contour lines are often integrated in mountain maps. In addition, a discrete, colored area tinting, represented by classified hypsometric layers, can quickly show the approximate altitude of map objects of interest (see Fig. 2 and 3).

The graphic or numerical height information allows a direct comparison of topographic characteristics within a depicted region. Especially for students, such numerical height information offers the possibility of determining vertical height differences between two or more interesting places like villages or single buildings, mountain peaks or valley bottoms, intersections, mountain passes, and many other features. Additionally, height information facilitates relating terrain and landscape features to climate and vegetation patterns.

2.4 Terrain characteristics by hachures, cliff drawings, or typical textures

Land cover and geometric terrain characteristics like the slope and aspect of a mountain region should also be clearly recognizable for students. With this information students can analyze many natural or man-made phenomena within a dynamic landscape. Examples include the effect of topography on precipitation, gorge formation by rivers, as well as the construction of dams, bridges, or curvy mountain pass roads.

Besides the already mentioned cartographic representation techniques like shaded relief, height points and contour lines, there are other graphic means to characterize a mountain map. So-called hachures depict the steepness and the aspect of mountain slopes in quite a systematic way (see Fig. 4). This technique was mainly developed and applied in the 18th and 19th centuries before shaded relief was introduced. Even though it was primarily a means of expression during the analogue map making era, hachures still are an excellent tool for teaching of terrain analysis.

Typical mountain features may also be represented with graphic area symbols or colors. Especially sophisticated cliff drawings characterize rocky parts in mountain maps in an expressive manner. The so-called "Swiss manner" of cliff drawings is perhaps the world's best developed example of this technique (see Fig. 5). Students as well as other map users intuitively recognize this special land cover category.

Today, forested or glaciated areas can also easily be symbolized in a pseudo-naturalistic appearance (see Fig. 5). Such textured map features attract the students (with their possible background as computer gamers) often more than areas that are only homogeneously colored. Especially remote mountain regions can be visualized in a very attractive way with these modern techniques.

3 Mountain map types and their characteristics

3.1 Mountain map types

Every comprehensive school atlas contains many different types of mountain maps. However, an explicit differentiation between these types is not possible. Cartographic theory lists numerous criteria for this distinction (Hake et al. 2002; Slocum et al. 2008). The range can be really wide. As in general cartography, we distinguish between topographic and thematic maps, large scale and small scale maps, static and interactive maps, or classic oblique maps as opposed to map related representations. So, every single map can be characterized in different ways, depending on the specific criterion. This section offers a non-exhaustive classification of some of these main mountain map types.

3.2 Topographic mountain maps

Topographic mountain maps are best suited to training students in map reading and the geographical interpretation of the terrain. A section of an official national map or a simplified or generalized version depicting a mountain landscape is often most appropriate. Students can concentrate on the land forms illustrated by the shaded relief, the contour lines, the river network, and added numerical information like height points

Fig. 2: Section of the Rocky Mountains (Canada) showing the different height levels using a hypsometric tinting (CANADIAN OXFORD WORLD ATLAS 2008).

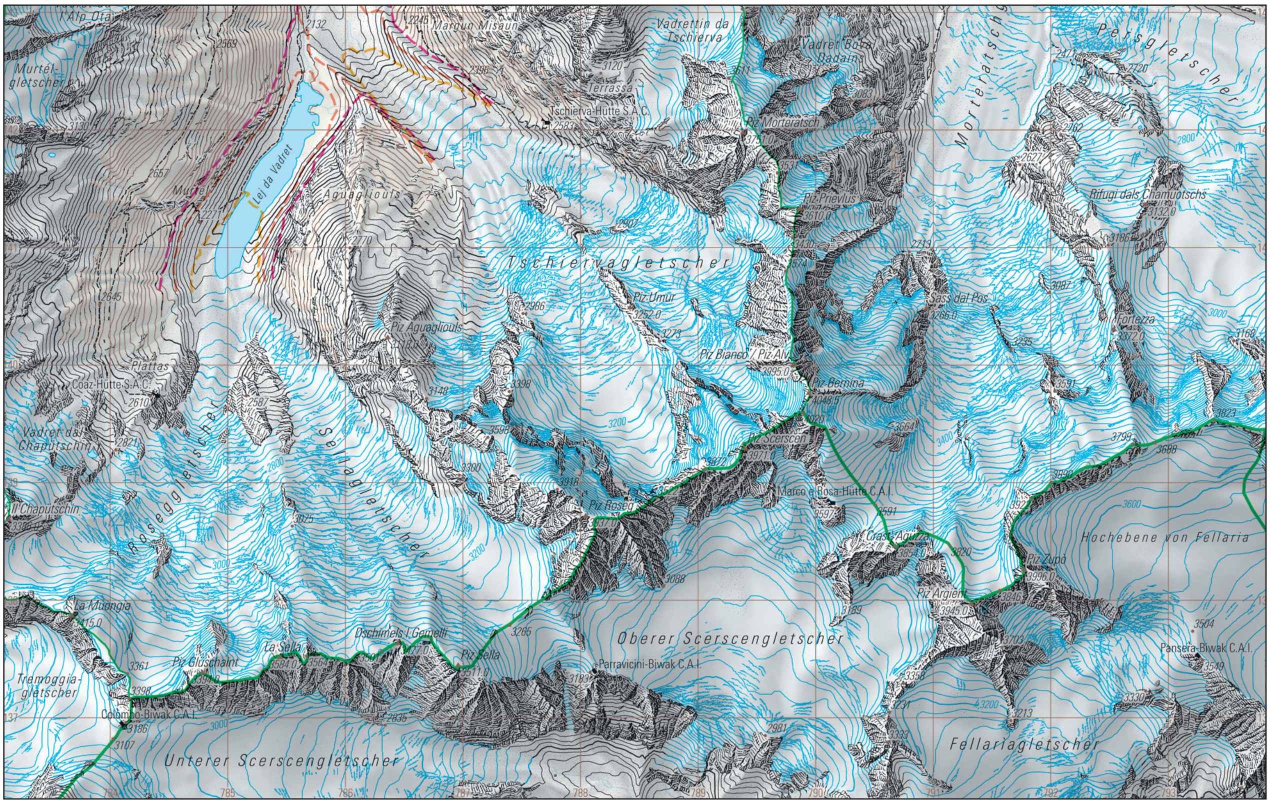

Fig. 3: Contour lines and numerical point information characterize the topographic situation of different mountain related features shown with a section of the future map edition depicting the Bernina massif (Switzerland) (SWISS WORLD ATLAS 2010).

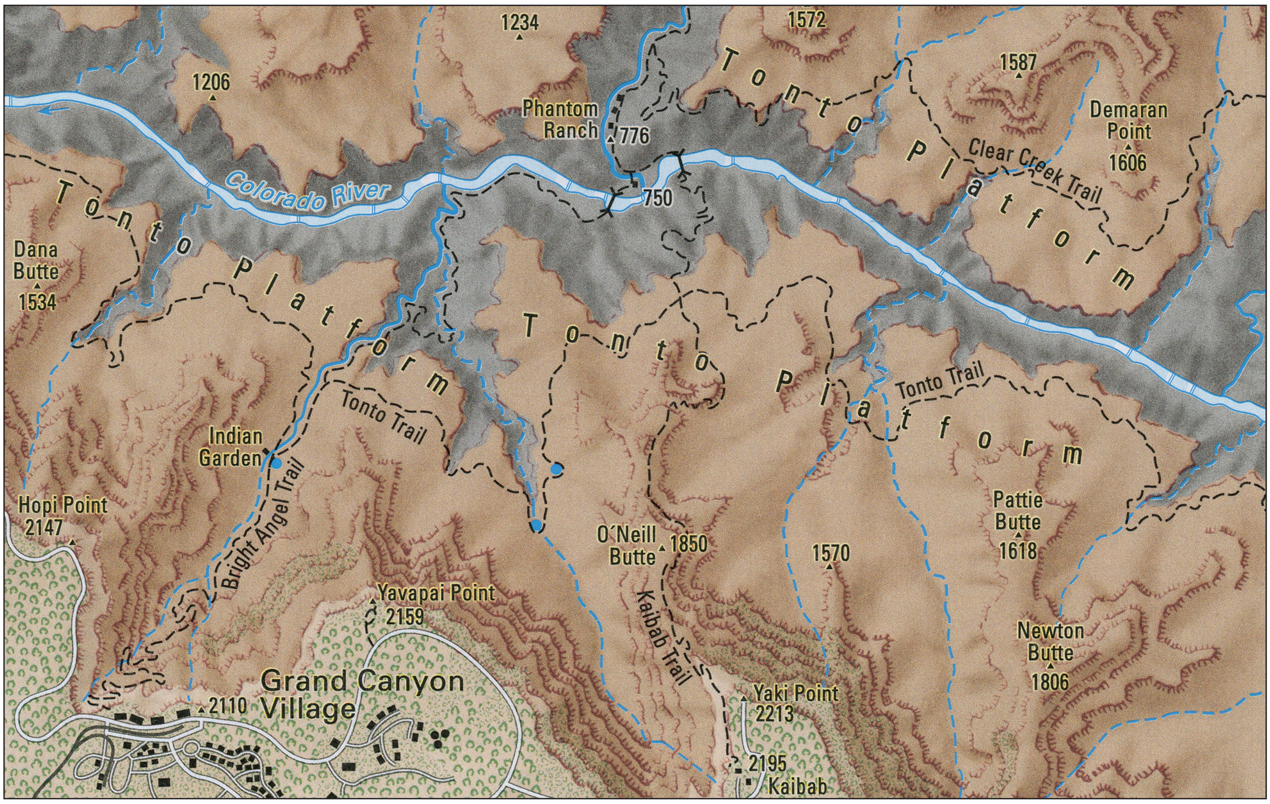

Fig. 4: Map section depicting the Grand Canyon (USA) by hachures (HAACK WELTATLAS 2011).

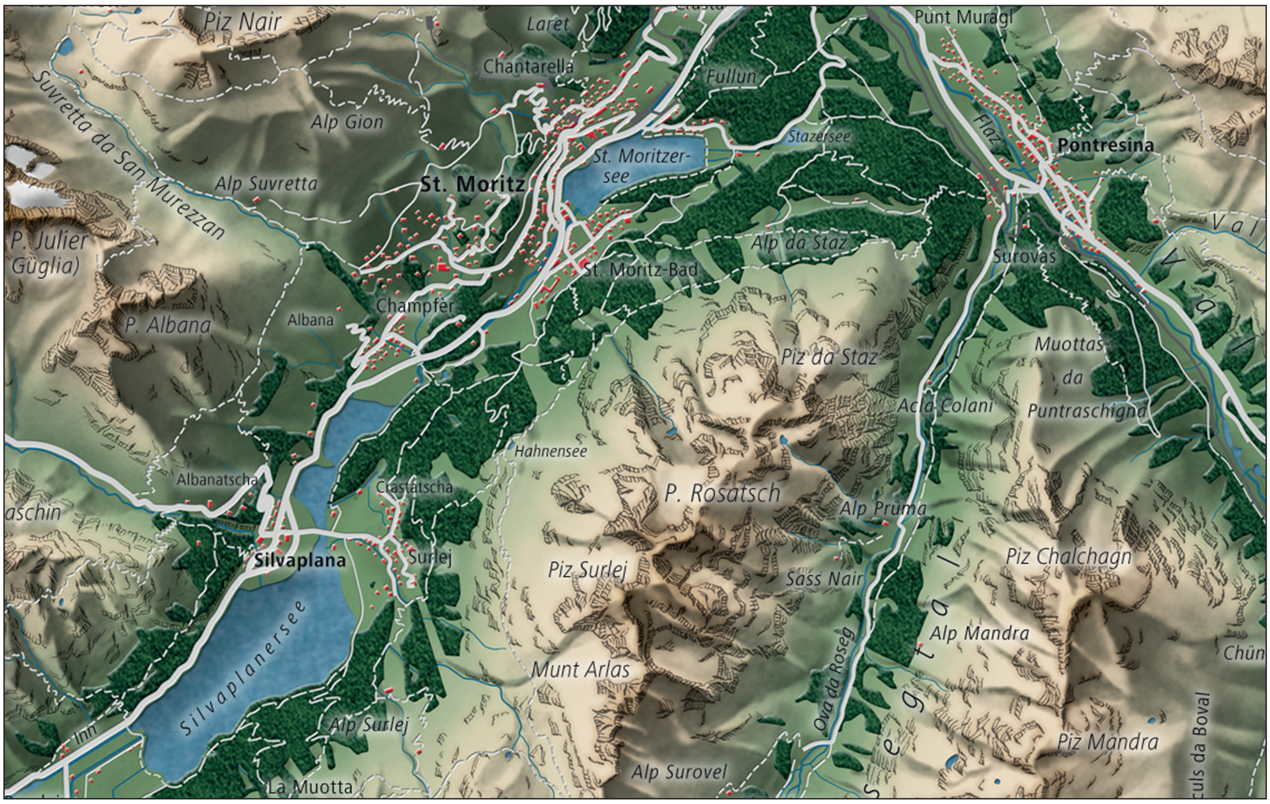

Fig. 5: Map section depicting a summer situation of the Oberengadin area (Switzerland) using cliff drawings for the rocky land cover and a naturalistic forest texture (SWISS WORLD ATLAS INTERACTIVE 2015).

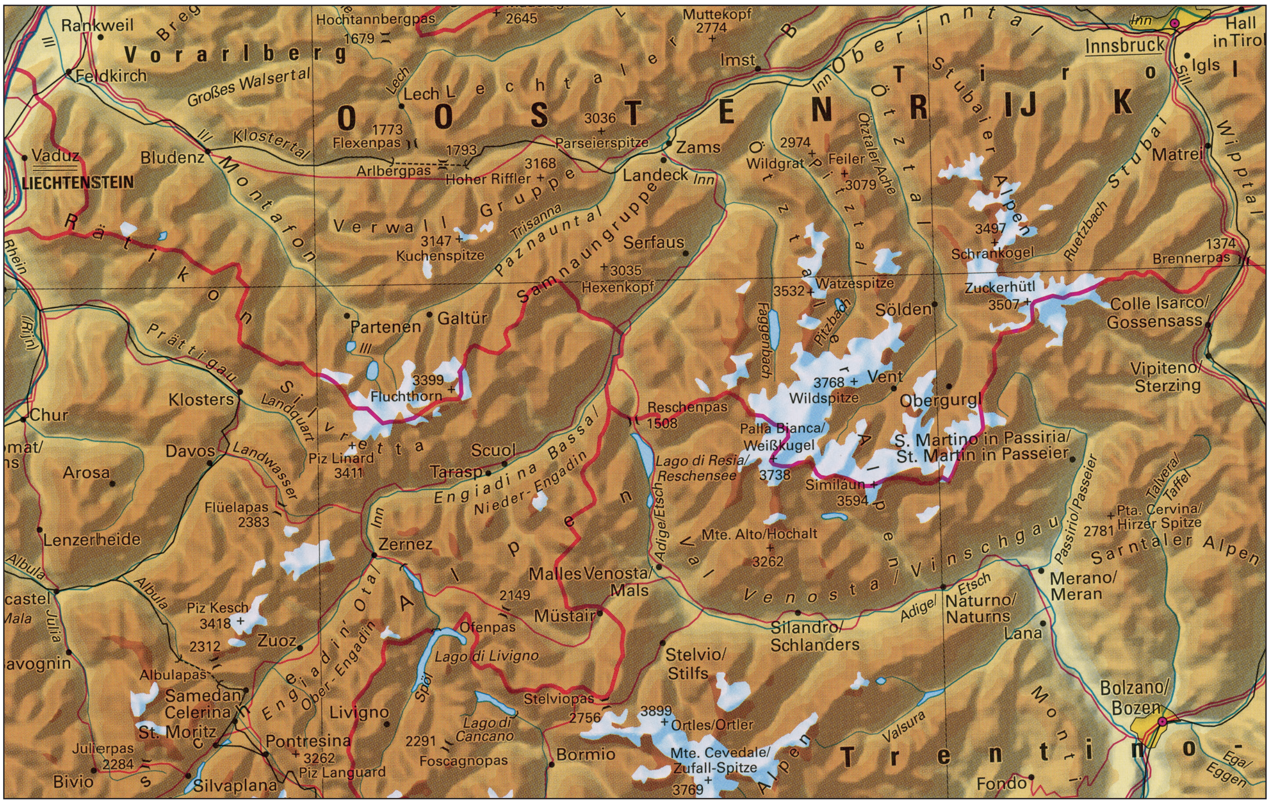

Fig. 6: Section of a topographic mountain map of the alpine countries in Europe showing the border region of Tyrol (Austria), South Tyrol (Italy), and Switzerland, depicted by a distinctive shaded relief and a brownish hypsometric tinting (De Grote Bosatlas 2012).

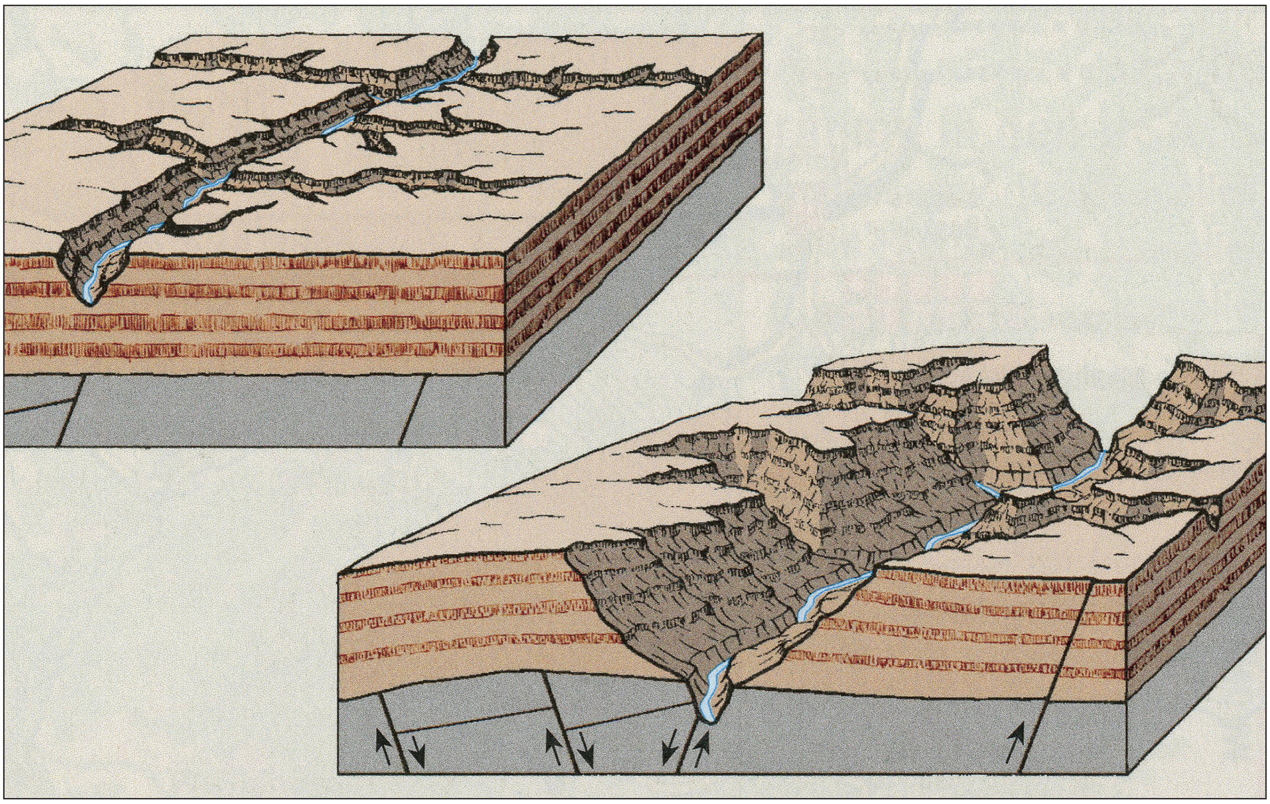

Fig. 7: Manually designed block diagrams of the landscape development of the Grand Canyon (USA) (Haack Weltatlas 2011).

and labelled hills or peaks. Hypsometric tinting can greatly support the interpretation (see Fig. 6).

3.3 Thematic mountain maps

Thematic mountain maps typically use a topographic base map. Such thematic combinations are obviously the most frequent type of mountain maps in school atlases, as teachers often use them to explain natural or anthropogenic developments, and to demonstrate their impacts on the regional or global biosphere or atmosphere. Maps of glacier retreat as a result of climate change are an impressive example of such interrelations (e.g. Schweizer Weltatlas 2010).

There are unlimited topics for thematic mountain maps, and thematic maps focusing on tourism, transportation, economy, vegetation, or climate issues in a mountain area could easily fill a school atlas. The limiting factor is certainly not the availability of thematic content but external factors such as curriculum, budget, or physical page limits.

3.4 Map related representations with mountainous topics

Beside topographic and thematic mountain maps, many school atlases include some other types of mountain map related representations, especially in alpine countries. Static block diagrams of large scale landscape sections depict specific mountain phenomena such as vegetation succession, glacier retreat periods, or anthropogenic land use patterns. These illustrative infographics are often realized using an abstract graphic design to emphasize the important features together with the topographic information (elevation, slope, etc.) in an intuitive manner (see Fig. 7).

To explain the geology of a mountain range or basin, vertical cross sections along profile lines are certainly appropriate. The didactic value of this kind of representations depends on an appropriately reduced complexity compared to representations for experts or professionals. Younger students are only able to understand the interrelation between different geographic topics if the illustration is generalized and/or exaggerated (e.g., in height proportions).

3.5 Interactive mountain maps and 3D models

Within the last decade some school atlases have been supplemented with an electronic section that matches the contents of the printed version (Diercke Globus Online 2015; Swiss World Atlas interactive 2015). Today, these atlas versions are mostly web-based and offer technically sophisticated functionality with integrated interactivity (Haeberling et al. 2011). These electronic atlas sections also contain many mountain maps.

In general, interactive school atlases can be used for different teaching purposes. If classrooms are well equipped with a computer and projector installation, as well as with reasonable internet access, such a web-atlas can easily be used as a flexible modern wall map. Teachers can thus explain geographic features and processes directly in front of the class. Compared to an old-fashioned book, an electronic atlas can also motivate students to make better use of an atlas as a learning tool and information source. Finally, the map material can be a valuable source for teachers to prepare their lessons by creating worksheets or presentation slides, when maps can be exported and then integrated into a text or presentation document (Haeberling & Hurni 2013).

The cartographic content of these interactive representations is more or less the same as that of the static mountain maps mentioned before. However, the additional functionality and the different viewing modes offer important advantages. Different thematic layers can be switched on and off to explain and analyze the topics better than with one complex map. In addition, some of the most attractive mountain landscapes can be presented as independent 3D models in the form of block diagrams (Swiss World Atlas interactive 2015). These fully controllable representations can be visualized independently or in parallel with the supplementary maps (see Fig. 8).

By using interactive school atlases with integrated flexible maps and block diagrams of mountain regions, geography teachers get a wider range of possibilities to create an attractive teaching situation. Students' attention can certainly be increased if mountain related aspects are presented with modern map representations such as these.

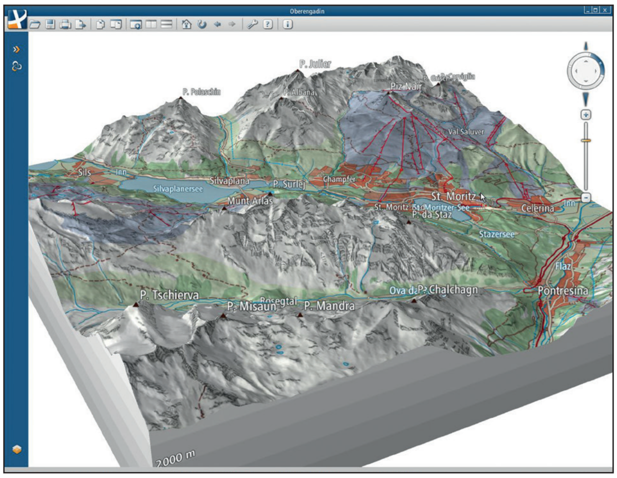

Fig. 8: Block diagram of the Oberengadin region (Switzerland) with dynamic labelling (Swiss World Atlas interactive 2015).

4 Future use of mountain maps in school atlases

The importance of printed maps is expected to decline worldwide compared to electronic screen representations. However, printed school atlases will likely continue to be produced for many decades. Therefore, mountain maps will still be offered in these teaching aids to depict features, spatial distributions and processes in mountain regions.

If electronic and interactive school atlas systems become more and more established in geography teaching, teachers will have a broader variety of options to present all these different topics. In general, as long as geography belongs to the teaching curriculum within different school systems and levels, mountain maps will remain an important source of geographic knowledge and will keep their attractiveness for both teachers and students.

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6 List of figures