

## Session / Séance 09-C

# Perspectives and Design in High Mountain Cartography

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### Abstract

*Cartographic design aspects in mountainous regions and the visualization of three dimensional spatial related phenomena have always played a very important role in central European cartography. Not only the past but also the present time shows us that the discipline of high mountain cartography is evolving around these areas and that the development of new methods and techniques are being taken into consideration. Therefore a new cartographic perspective of the mountains can be presented combining the precision and beauty of the past with the efficiency of present technology.*

### Introduction

A major focus of high mountain cartography nowadays is to be seen in the current modernization of the cartographic discipline and its impact in visualizing mountainous areas. The technological status and its usage for high mountain cartography, the facilities available, the discussion on definitions and terminology, the comparison of past and present solutions, the improvement and usage of cartographic output are some of the major issues that are being discussed and dealt within this area. Furthermore, topics such as the integration of new ideas and possibilities, moving beyond the traditional boundaries of so called classic cartography, adopting methods from neighboring sciences, interdisciplinary cooperation and the need to redefine the cartographic axioms and values become incorporated in the general discussion. It is therefore important to understand the holistic approach in this field without neglecting the meaning of esthetics and design in context with high mountain cartography.

In order to utilize and explain the methodology, theory of design and esthetics in high mountain cartography it is important to understand the broad spectrum this discipline has to offer. This was therefore a major initiative for the foundation of the European Commission on High Mountain Cartography that was consolidated in 1996 within the German Association for Cartography (DGfK Deutsche Gesellschaft für Kartographie) consisting of primary members from the German speaking countries Austria, Germany and Switzerland. The primary goal of this meanwhile growing international group is to deal with all conceivable and even unthinkable matters cartography can offer in mountainous areas.

The following treatise will give an overview on the fundamental areas of interest the European Commission on High Mountain Cartography (Arbeitskreis für Hochgebirgskartographie der DGfK) is momentarily dealing with and will emphasize in the areas of topographic map design, thematic aspects in high mountain cartography and map related representations concerning this matter. An overview of the commissions priorities and a small cross section of examples taken from current topics will be presented. The selection will contain still in progress to state of the art examples and should reflect the diversity and breadth high mountain cartography has to offer today.

## Past and present topographic aspects of high mountain cartography

Past and present aspects of high mountain cartography play an important role in understanding the essence of cartography in mountainous regions. Therefore a short overview of the various proven and utilized cartographic methods applied in mapping high mountain areas from a central European perspective will be outlined. Areas of discussion among other things are for example the controversial Swiss/Austrian relief representation methods in topographic maps (Imhof/Brandstaetter), the relief representation in the Austrian Alpine Club Cartography (Alpenvereinskartographie) with their four main streams of rock and relief depiction and the topographic mapping approaches of the Swiss and Austrian federal mapping agencies. It is interesting to see, that although different approaches are pursued, successful design is still decisive in all cases.

Although relief depiction has a long tradition with a broad spectrum of representation and can look back on to some outstanding solutions in the past, digital multimedia visualization is presently the focal point in modern cartography and is determining the direction. Nether the less, large scale topographic maps still seem to dominate today's visualizing environment in mountainous areas, especially if these cartographic solutions are to be used outdoors. Therefore it is important to understand their structure and intention. Besides the correct evaluated topographic basic elements of every large scale topographic map (e.g. hydrology, height information, land cover, etc.), design and esthetic aspects play an important role. Taking into consideration that most of the basic elements are evaluated from primary data (e.g. stereo photographic extraction, field surveys) there are a few elements often integrated in topographic maps that do not have cartometric features and are seldom derived from primary data sources. Hillshading and rock depiction are such elements. Not every topographic map has them due to the fact of their very specific, often individual depiction.

Hillshading in topographic maps is often responsible for a better perspective view of the earth's surface, giving the observer a three dimensional impression of the relief. Major representatives in this area, documented in outstanding quality, are from a central European "alpine" perspective the Swiss topographic maps. Eduard Imhof documented in his book on cartographic relief representation "Kartographische Gelaendedarstellung" [Imhof, 1965] how hillshading can be effectively integrated in topographic maps. Although this book is over three decades old it is still very valuable for various topics of modern cartography.

Opponents of integrated hillshading in topographic maps state that essential relief information is obscured when using this variant. It is important to only show authentic evaluated topographic information without any artistic distortions or manipulations. Leonhard Brandstaetter states in his book on mountain cartography "Gebirgskartographie" [Brandstaetter, 1983] that hillshading distorts the view from the essential topographic information and has only the effect of misleading the user. Certain areas become emphasized others get pushed back and can therefore convey false topographic information.

Similar to hillshading in topographic maps rock depiction has been mainly in the hands of artists. Although there are many ways of depicting rock in topographic maps it is important to understand the technique and intentions behind the used method. Present efforts in rock depiction on the one hand are concentrating in automated methods in order to achieve the quality standards of the past. On the other hand experimenting with various methods allows a flexible approach with interesting solutions. Needless to say that once adopted and accepted automated rock depiction can be very cost and time saving.

The Swiss topographic base maps (1:25.000) incorporate a schematic, geometric, perspective rock depiction emphasizing mainly in a three dimensional spatial impression of the area. Only the 100m isolines are drawn and an exposition dependent hachuring is integrated. Realistic detail is not the primary factor. Major ridges are depicted but they are subordinate in order to achieve a holistic impression. Figure 1 shows an example of the Swiss manner of depicting rock in a large scale topographic map 1:25.000.

The topographic base maps (1:50.000) of the Austrian Federal Mapping Agency (Bundesamt für Eich- und Vermessungswesen) pursue a different approach. The maps have a schematic realistic rock depiction trying to

combine a perspective view of the rocks. All isolines, that is if the slope is not too steep, are drawn and the depiction has no primary difference according to the exposition. Figure 2 shows an example of the Austrian Federal Mapping Agency manner of depicting rock in a large scale topographic map.

The Alpine Club Cartography (Alpenvereinskartographie) has a long tradition in mapping mountainous regions and has encountered many different trends in rock depiction. According to Arnberger [Arnberger, 1970] there are four major rock depiction approaches in the maps of the Alpine Club Cartography.

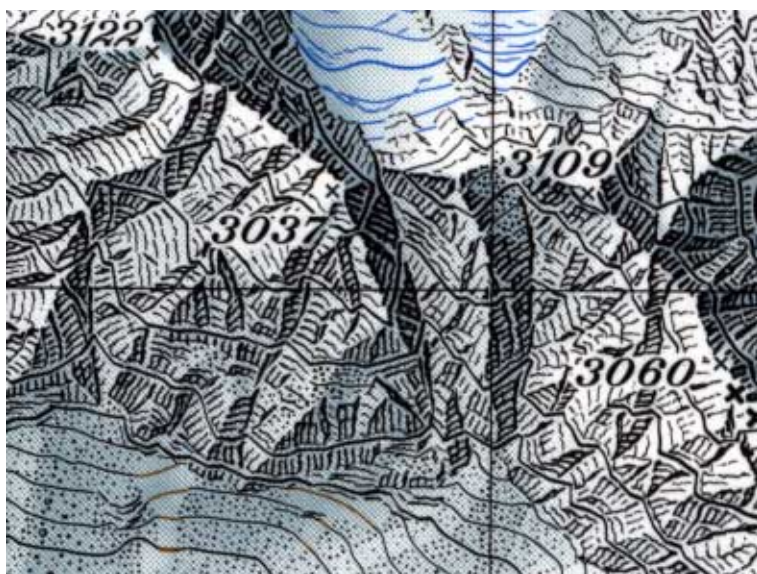
- genetic approach
- signature (delicate hachuring line) approach
- geometric integrated approach
- combined Federal Mapping Agency approach

The so called artistic “genetic” rock depiction approach uses no isolines and has therefore not a very high geometric accuracy, though the overall impression is outstanding. Major representatives are Aegerter/Rohn maps – e.g. Map of the Brenta 1:25.000 (compare figure 3a).

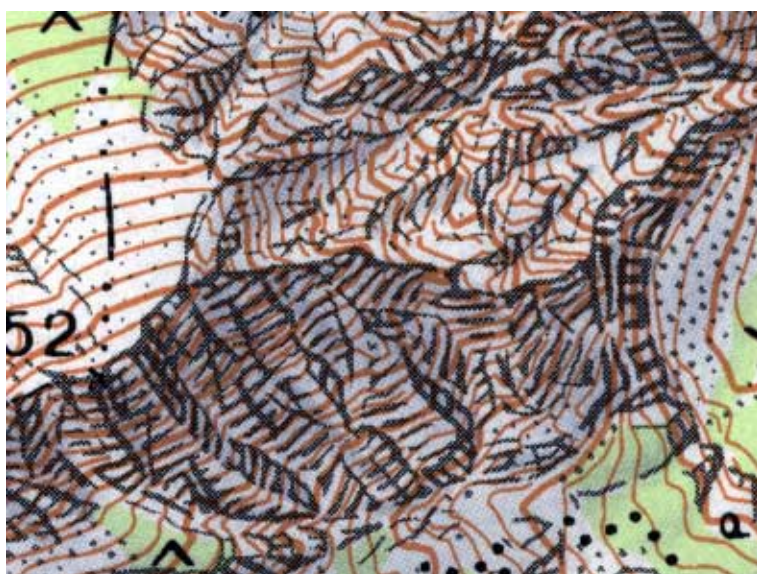
The signature approach does incorporate isolines, has a reasonable geometric accuracy in the rock areas and the rock depiction is represented by using very delicate hachuring lines. Major representatives are the Ebster maps (compare figure 3b).

The geometric integrated approach is the most recent method used in Alpine Club maps and has the isolines as the central information for rock representation. Furthermore, rock depiction is supported by using schematic, geometric hachuring and in most cases originally not combined with hillshading in order not to distort the genuine topographic information. Major representatives are the Brandstaetter maps (compare figure 3c).

The combined Federal Mapping Agency approach is just a reproduction of special areas of the official base map used by the Federal Mapping Agency.

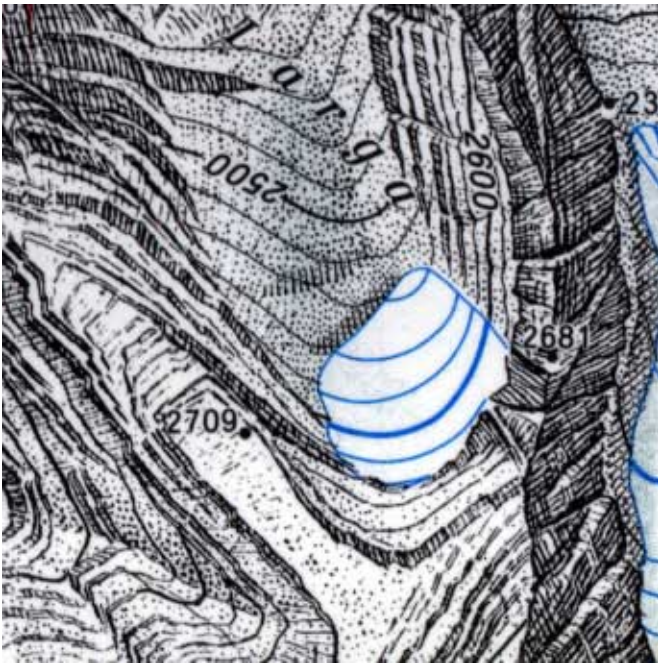


**Figure 1.** Rock depiction in the Swiss topographic base maps (enlargement)

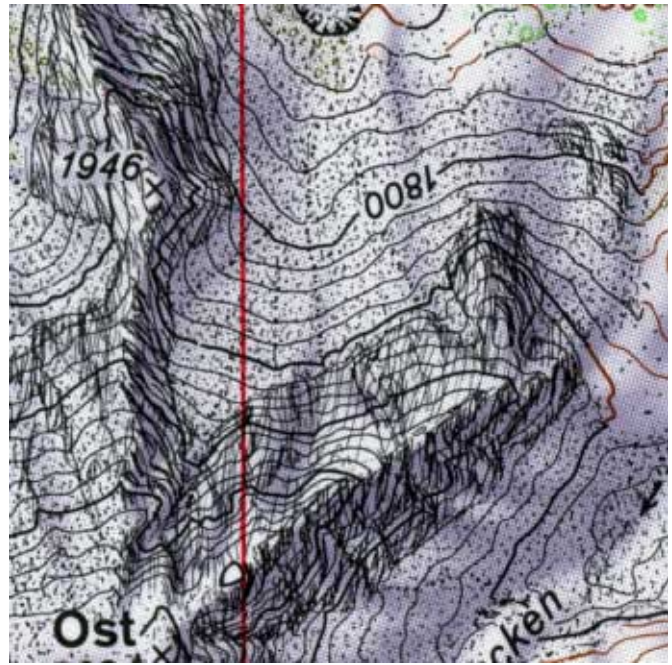


**Figure 2.** Rock depiction in Austrian topographic base maps (enlargement)





**Figure 3a.** Rock depiction in Maps of the Alpine Club Cartography – genetic approach



**Figure 3b.** Rock depiction in Maps of the Alpine Club Cartography – signature approach



**Figure 3c.** Rock depiction in Maps of the Alpine Club Cartography – geometric integrated approach

## European Commission on High Mountain Cartography

A major interest of the European Commission on High Mountain Cartography is to proclaim theoretical and practical aspects of modern cartography in mountainous regions and to bring together scientists as well as users to find a common denominator in the field of high mountain cartography. Another goal of the commission is to set up a forum for scientific knowledge exchange. Therefore every second year a workshop is organized in order to bring together the latest achievements and practical examples in the field of mountain cartography. Furthermore, it is important not only to discuss and present these topics at a workshop but also to publish the results in an adequate way. Consequently after every workshop a detailed arrangement of all current contributions is brought together and published in a book.

The transportation of information and the discussion of current topics is promoted by access to the WWW. Besides the documentary information the homepage of the Commission on High Mountain Cartography offers (<http://www.karto.ethz.ch/hgkarto/hochgeb.html>), a so called scientific information center is also being implemented. This virtual message board should support the exchange of ideas and initiate new cooperation. A few fields that are of interest are for example the establishment of related links to topics on high mountain cartography around the world, possible proposals on joint research projects, specified activities and research areas, available digital data, cartographic study areas, joint projects and resulting output etc.

The major areas of emphasis of the Commission on High Mountain Cartography lie therefore in the following fields:

- Definition, theory and methodology of mountain cartography
- Topographic mapping
- Automated hillshading and rock depiction
- Digital terrain modeling
- Cartographic thematic aspects in mountainous regions
- Map related representations
- Three dimensional visualization
- Multimedia and mountain cartography
- WWW and mountain cartography

Silvretta 1998 was the first workshop organized and successfully carried out by the European Commission on High Mountain Cartography. The results of this meeting were published in 1998 in the book “Hochgebirgskartographie – Silvretta’98 – High Mountain Cartography” in volume 11 of the “Wiener Schriften zur Geographie und Kartographie” (Geography Department of the University of Vienna, Austria, ISBN 3-900830-33-9) [Kriz, 1998].

The following workshops of the Commission on High Mountain Cartography are planned for early spring (April) 2000 in the European Alps at the Rudolfshuette, province of Salzburg, Austria and for late spring (end of May) 2002 in the Rocky Mountains at Mt. Rainier, State Washington, USA. For more details see the commission homepage.

Main areas of interest of the Silvretta Workshop that took place in spring 1998 in the Austrian Alps at the Bielerhoehe (2000 m) consisted of three major areas - Topographic aspects, Thematic aspects, Multimedia and map related representation – and were defined as follows:

### Topographic aspects

- Rock depiction in Swiss topographic maps
- Data acquisition and quality control in Swiss topographic maps
- Map projects in Pamir and Kamtschatka

- Computer-based topographic map production in high mountain regions
- Relief Modeling and representation in Catalunya
- Digital elevation modeling
- Elevation modeling using InSAR-Data
- Rock depiction in the Austrian Alpine Club maps
- High mountain cartography at the Austrian Federal Mapping Agency
- Tasks and methodological development in high mountain cartography

#### Thematic aspects

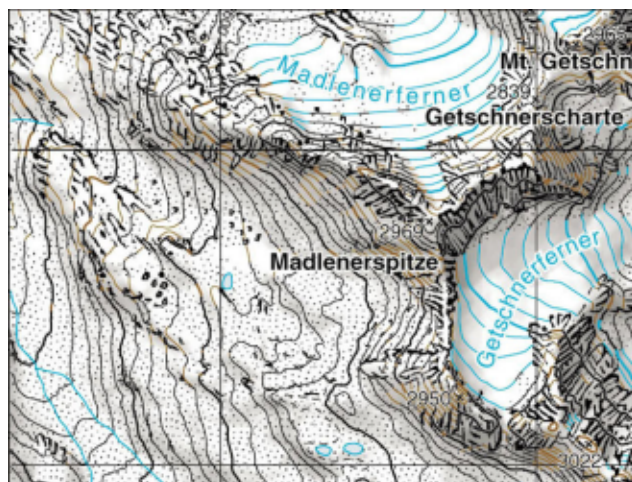
- Derivation of relief information from various cartographic representations
- Optimizing digital terrain models for geomorphological tasks
- New ways of representing glaciers
- Visualizing glacial processes
- Avalanche hazard maps
- Concepts and results of environmental mapping in Siberia
- Geomorphological mapping in the Swiss Alps
- GPS in high mountain regions
- Large scale thematic mapping in high mountain areas

#### Multimedia and map related representation

- Surveying, mapping and 3D visualization of a complex cave system
- Quality in cartography
- Multimedia Alpine Guide
- Multimedia cave information system
- 3D landscape presentation – Experiments at the US National Park Service
- Information system for mountain hikers

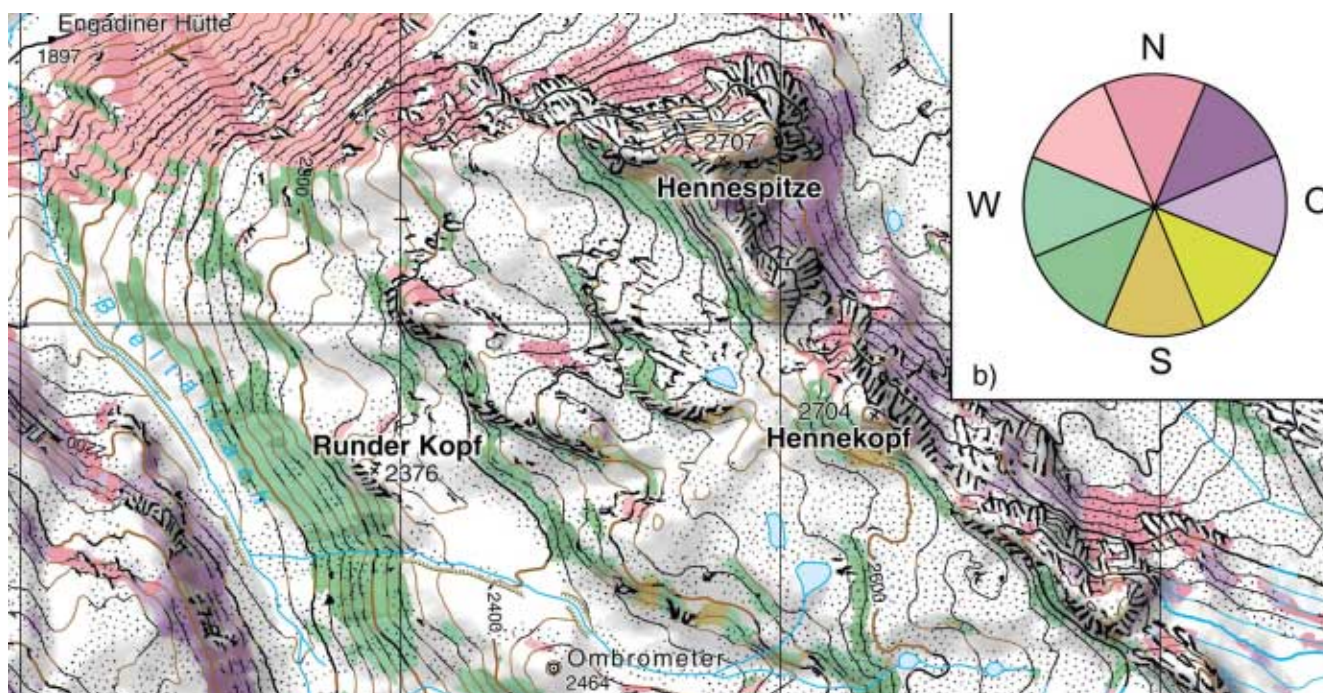
## Examples

The following three examples show a small cross section of the results presented at the Workshop. Figure 4 demonstrates an extraction of the complete digital reproduction of a large scale 1:30.000 topographic map derived from data available at the Austrian Federal Mapping Agency. The main goal of this reproduction was to produce a flexible and easy to manipulate topographic map that can be used equally in an digital information system and as a conventional printed map. The data was imported into a GIS and then structured to fulfill the specified requirements. Isolines were separated in three classes – rock and scree, vegetation, glacier – all areas such as vegetation, woodland, scree, rock, glacier, lakes etc. were divided into layers and all names and height information were integrated. The analytical hillshading was derived from a digital elevation model that again was constructed from the isolines.



**Figure 4.** Digital topographic map 1:30.000 – CK30

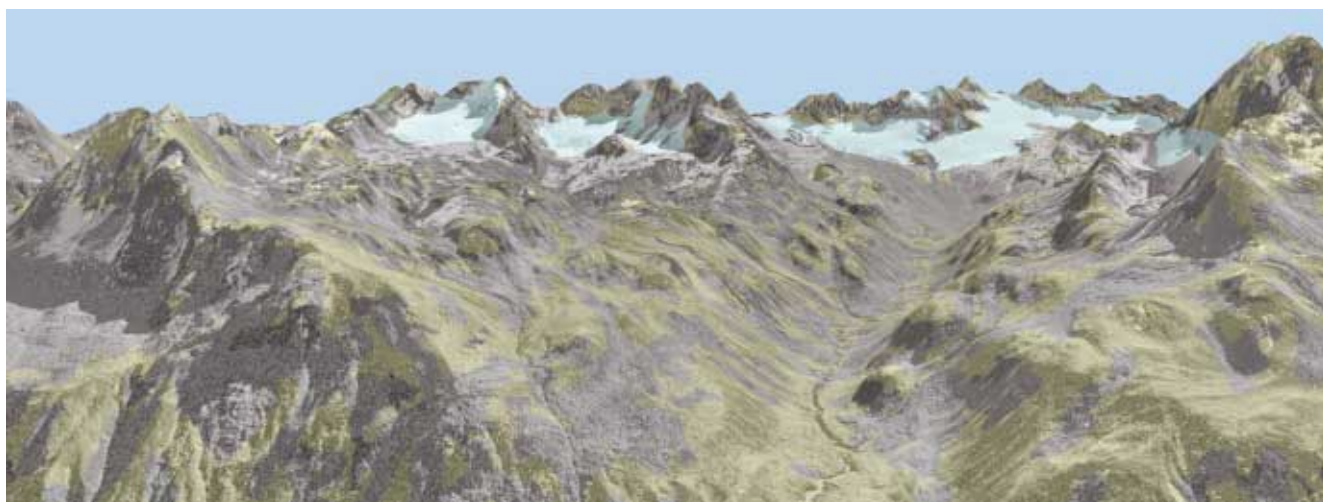




**Figure 5.** Avalanche hazard map for skiers and mountaineers 1:30.000

Figure 5 shows an avalanche hazard map for skiers and mountaineers based on the topographic map 1:30.000 described in figure 4. The basic idea was to visualize the critical slope areas where potential avalanches can occur. These areas are defined as slope between  $25^{\circ}$  to  $45^{\circ}$  and vary with exposition. Slope and exposition information is easily derived from a digital elevation model assuming the resolution is fitting and most of all the model accurate. The challenging question was (and still is) to verify whether all the calculated areas actually coincide with potential hazard regions.

Figure 6 demonstrates the usage of a digital elevation model that was derived from a topographic data source in connection with a combined orthophoto land cover overlay to produce a 3D perspective view of a mountainous region. The goal was not primarily to achieve a realistic view of the region, but to give the observer a map-like perspective view combined with a specific topic. The digital elevation model has a resolution of 20m opposed to a 5m resolution of the overlay. The data was processed in a GIS and visualized with a raytracing software.



**Figure 6.** 3D perspective view – Silvretta Bieltal, Austria

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