

Geographic Information Technology Training Alliance (GITTA) presents:

Topographic Cartography

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1. Topographic Cartography

One of the most widely used map types is the topographic map. Indeed, the wide range of information provided by topographic maps makes them extremely useful to both professional and recreational map users.

Topographic maps are used as basic tools for planning and executing projects. They are of prime importance in planning settlements, airports, highways, dams, pipelines, transmission lines, industrial plants, and countless other types of construction. They are an essential part of ecological studies and environmental control, geologic research, studies of the quantity and quality of water, and projects for flood control, soil conservation, and reforestation. Intelligent and efficient development of our natural resources depends on the availability of adequate topographic maps. Topographic maps are also utilised by outdoor enthusiasts, including hunters and hikers, to show relief features, wooded areas, and watercourses.

Learning Objectives

- Be able to recognise and to interpret a topographic map
- Be able to depict relief on topographic maps and to create profiles.
- Know the different classes of topographic maps
- Know how maintenance of topographic maps is done
- Be able to recognise different representation styles of topographic maps

1.1. Notions and Intentions

Topographic Maps

Most of you know that topographic maps summarise the earth's topography in two dimensions. But topographic maps do much more. Indeed they also represent landscapes, human features, hydrography, etc. Therefore a topographic map is an interesting tool for many map users.

In this unit, for which you need no prerequisites, you will discover the notions and intentions of topographic maps.

1.1.1. What is a Topographic Map?

The **International Cartographic Association** defines **Topographic Maps** as the following:

"Topographic maps are maps at large and medium scales which incorporate a huge variety of information. The basic coverage (a country's largest map series) is based on measurements made in the field and/or from aerial photographs. Derived topographical maps (of medium and small scales) are prepared by reduction and generalisation from the original basic maps.

All components of a topographic map at a specified scale are of equal importance: water, terrain, communication, built-up areas, vegetation, etc., as well as the lettering of place-names and geographical and cultural features." (Anson et al. 1984, p. 17) (Anson et al. 1984, p. 17)

To simplify matters, we can say that a topographic map is a graphic representation of the three dimensional configuration of the earth's surface. It shows size, shape and distribution of landscape features, and presents the horizontal and vertical positions of those represented features.

Features on topographic maps can be divided into three major groups:

- Relief: Depicted with brown contour lines that show hills, valleys, mountains, plains, etc. Elevations are given in meters (or feet) above mean sea level. There are also spot elevations (shown in black), where lake level, summit of a hill or road intersections are marked for elevation.
- Water features: Depicted in blue, they represent oceans, lakes, rivers, streams, swamps, etc.
- Cultural features: Depicted in black, they represent all the man-made features: buildings, roads, railroads, land boundaries, etc.

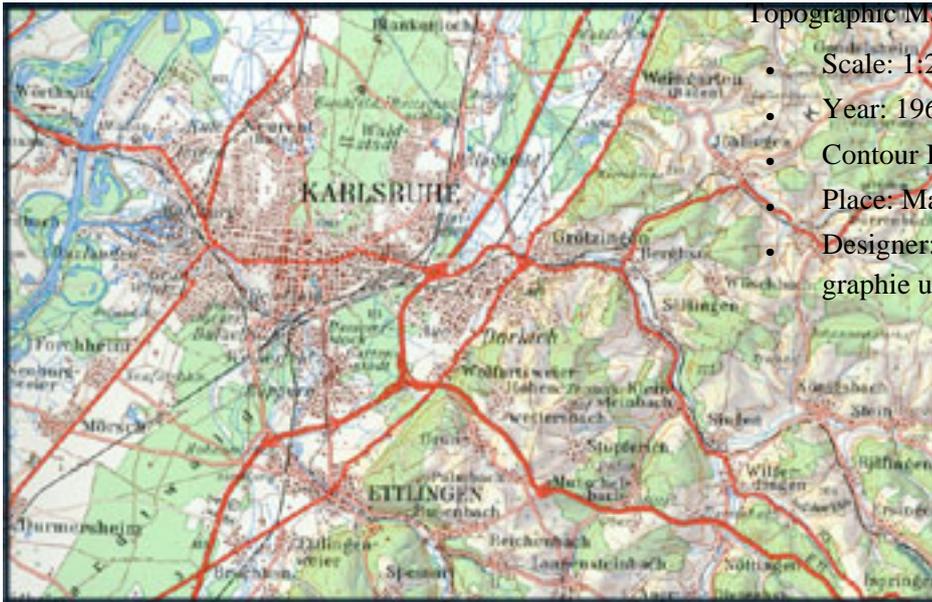


Remark: Topographic maps are distinguished from planimetric maps by the addition of relief in measurable form.

Topographic Map Examples.

Find below some extracts of topographic maps from different countries.

Observe the difference in colour, typography, detail, etc.



Topographic Map of Germany:

- Scale: 1:200 000
- Year: 1968
- Contour Interval: 50 m
- Place: Mannheim
- Designer: Bundesamt für Kartographie und Geodäsie

*Topographic Map of Germany, DTK200-V ©
Bundesamt für Kartographie und Geodäsie 2005*



Topographic Map of Russia:

- Scale: 1:200 000
- Year: 1991
- Contour Interval: 20 m
- Place: TBEpb

Topographic Map of Russia



Topographic Map of Greece:

- Scale: 1:50 000
- Year: 1989,
- Contour Interval: 20 m
- Place: Kimolos
- Designer: Hellenic Military Geographical Service

Topographic Map of Greece



Topographic Map of Spain:

- Scale: 1:50 000
- Year: 1965
- Contour Interval: 20 m
- Place: Las Palmas de Gran Canaria
- Designer: Instituto Geográfico Nacional

Topographic Map of Spain, Map of the National Geographic Institute of Spain

Topographic Map of Switzerland, reproduces with the permission of swisstopo (BA057224)

Topographic Map of Switzerland:

- Scale: 1:100 000
- Year: 2002
- Contour Interval: 20 m
- Place: Rotkreuz
- Designer: **Bundesamt für Landestopographie**

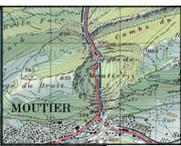
1.1.2. What are the Intentions of a Topographic Map?

A topographic map provides information on the existence, the location, and the distance between features. It also indicates variations in terrain, heights of natural features, and the extent of vegetation cover. Therefore, topographic maps have many intentions, but the first is still to give a graphic representation of a portion of the earth's surface drawn to scale. This ideal representation would be realised if every mapped feature of the area could be shown in true shape. Obviously, this is impossible: if each feature was represented in true shape, the map would result in a product impossible to read, even with a magnifying glass. This is why the map has to be generalised.

 Remark: Topographic maps are often used as background information in thematic cartography.

Topographic Map versus Reality

Shown on the following example, how a topographic map provides a graphic representation of a portion of earth's surface. You will see that the main characteristics of the reality are preserved in the topographic map, and that all features are at the same level of importance (contrary to a thematic map). However, most of the features go through the generalisation process and are therefore distorted.

	 <p><i>Corresponding topographic map (Spiess 1993)</i></p>
<p><i>Oblique aerial picture (Spiess 1993)</i></p>	
<p>Oblique aerial picture from the south of the transverse valley of Moutier.</p>	<p>Topographic map of the transverse valley of Moutier</p>

1.1.3. What are the Different Classes of Topographic Maps ?

According to International Cartographic Association (1984) it is possible to classify topographic maps as being either:

- **Official Cartography:** maps that are edited by official institutions such as Bundesamt für Landestopographie (Switzerland), Institut Géographique National (France, Belgium), etc. Commercial Cartography: maps that are edited by private companies as Orell Füssli (Switzerland), etc.
- **Commercial Cartography:** maps that are edited by private companies as Orell Füssli (Switzerland), etc..

Topographic Cartography

Another important classification criterion is the scale. One can differentiate within topographic maps:

- Large scale: larger than 1:25 000
- Medium scale: 1:25 000 to approximately 1:250 000
- Small scale: smaller than 1:250 000 to approximately 1:2 500 000
- Very small scale: smaller than 1:2 500 000, usually atlas-maps

Furthermore, various subclasses may be recognised within scale categories depending upon their representational characteristics.

Different Class Examples of Topographic Maps

Have a look at the following slides, showing the huge range of topographic maps provided by Swisstopo, the Federal Office of Topography of Switzerland. Click on the next button to reach the examples.

Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]

1.1.4. Production and Revision of Topographic Maps.

Production of Topographic Maps.

Years ago, topographic maps were compiled and sketched by hand. Nowadays, topographic maps are to a large extent compiled in the office with the help of a complex process based on photogrammetry. However, producing an accurate topographic map is still a long and complex process. It can take up to 3-4 years from the identification of a mapping requirement to the efficient printing of the map.

Revision of Topographic Maps.

Currently, landscapes can change quickly, especially in terms of buildings and roads. Because topographic maps are the basis for every thematic map, the official institutions avoid long time intervals between each topographic map revision. Most of the topographic maps revisions are carried out with the help of new measurements made in the field, or with recent aerial photography. In this case, topographic maps are sometimes called photorevised maps.

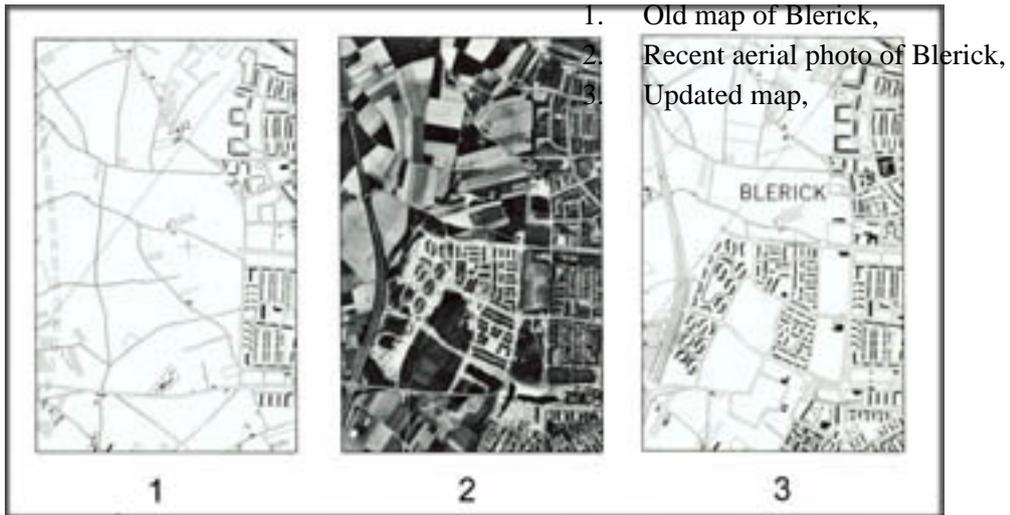


Remarks: Some U.S. topographic maps include the new features in purple, they can represent newly urbanised areas, new roads, and even new lakes.

Revision of Topographic Map Example.

In Switzerland, the revision of the national topographic maps is done approximately every six years by the Federal Office of Topography (Swisstopo).

The example below shows a revision of a topographic map 1:25.000 of Blerick county (Great Britain).



*Revision of Topographic Map
Example (Anson et al. 1984)*

1.2. Content of Topographic Maps

Topographic Maps

As you learnt in the previous unit, topographic maps are different from other maps because they render the three-dimensional mountains and valleys on a two dimensional surface. This is why topographic maps should be compared to any piece of equipment. Indeed, before they are placed into operation, the user must read the instructions. Therefore, both building and reading a topographic map is not an easy task. In this unit, you will learn by which means topographic maps give such a correct representation of reality. Therefore, you will learn their specificity for representing relief, the symbolisation they use, their specific layout, etc.

You will not necessarily need prerequisites for this unit, but a quick review of the previous unit (Notions and Intentions of Topographic Maps), can be helpful for a better understanding.

1.2.1. Object Representation / Symbolisation.

Topographic Map Symbolisation

Topographic maps use a wide variety of symbols to represent man made and physical features, for example highways, railroads, gravel pits, buildings, etc. Ideally, all these features should appear on a map in their true proportion, position, and shape. This is however, still not feasible because many of the features would be unimportant and others would be unrecognisable because of their reduction in size. Furthermore, some symbols have to be created to represent the man-made and natural features. These symbols are as closely as possible to the real features themselves. If this is not possible, a new symbol is created that logically implies the feature(s) it portrays. For example, a campsite is represented by a small black triangular tent. Symbols are positioned on a topographic map in such a manner that the centre of the symbol remains its true location. However, an exception to this would be the position of a feature adjacent to an important road. If the width of the road has been exaggerated, then the feature is moved from its true position to preserve its relation to the road.



Remark: All the methods and rules to resolve symbolisation problems are described in the lesson Generalisation.

Topographic Map Colours

Topographic maps use standardised cartographic conventions to represent features. Therefore, the following colours will still represent the same feature groups on topographic maps:

- Black: Man-made or cultural features, such as roads, buildings, names, boundaries, and transmission lines.
- Blue: Water or hydrographic features, such as lakes, rivers, canals, glaciers, and swamps.
- Brown: Contour lines, which show relief, but also terrain variation.
- Green / White: Landscape cover.
- Red: Important roads.
- Yellow: Secondary roads.

Topographic Map Symbols

The following animation presents some common symbols found on recent Swiss topographic maps. They do not include symbols used on older maps. Click on the group symbol name to reach different visual examples of symbols, and roll over them to have a real-word picture of this symbol.

**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version.
Only screenshots of animations will be displayed. [link]**

Further information about the symbols used in the Swisstopo topographic maps can be accessed in the following pdf documentation (1816 Kb): [Swiss_Symbols.pdf](#)

1.2.2. Relief Representation

Relief is so perfectly and precisely represented on topographic maps that if you look on them at a distance of 1 meter you will see crests and valleys, as on a thermoformed map. In the following, you will learn the different techniques used to represent relief on topographic maps.



Remark: However, some practice and imagination are needed by the map reader to visualise hills and valleys from the contour lines of a topographic map.

Contour lines

Contour lines are an effective device for representing relief on topographic maps. They can be defined as an imaginary line connecting points of equal elevation on the ground surface.

As with all types of isolines, when contour lines are close together, they represent a steep slope, whereas when lines are far from each other, they represent a gradual slope. Every fifth or tenth contour starting at sea level is an index contour, which is drawn as a heavier line and is labelled. Each topographic map uses a contour interval, or equidistance, (the distance in elevation between contour lines) appropriate for that area. While flat areas may be mapped with a 5 meter contour interval, stepped terrain may have a 20 meter or more contour interval. This is why the contour interval is still specified on the topographic map legend.

**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version.
Only screenshots of animations will be displayed. [link]**

Pull the slider (small black triangle on the left) along the red line to see a cross profile corresponding to the relief along the red line. The red points on the profile symbolise the contour lines. You can add / remove a grid and features on the profile by selecting the adequate buttons on the right.

The following optional link opens an internet SVG tool for creating profiles from contour lines: <http://contourmapcreator.ugr8.ch/>



Remark: You can optionally reach some further information about contour lines in the following PDF documentation: [contour_lines.pdf](#) (7 Kb)

Elevation point

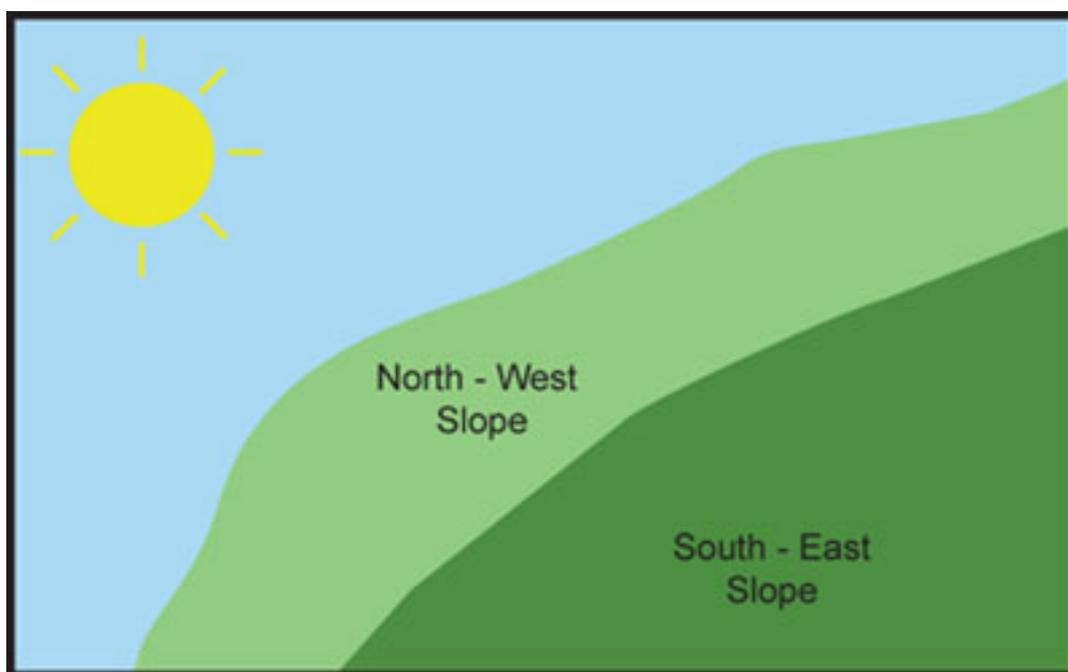
In addition to contour lines, heights of many points occur on the map, such as road intersections, summits of hills, lake shorelines, etc. These points are called Spot Heights. More precisely located and more accurate in elevation, the Trigonometric Points are marked by a plate fixed permanently on the ground. On a 1:25 000 Swisstopo topographic map, those Elevation Points are represented by the following symbols:

**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version.
Only screenshots of animations will be displayed. [link]**

Shading

Shading is a method for representing relief on maps in a natural, aesthetic, and intuitive manner.

The light direction is the most important element for shaded relief. Normally, as shown in the following graphics, the light illuminates the terrain from the upper-left. However, less popular is illumination from the south, as the relief shading tends to look more correct. In extreme cases, relief inversion occurs where mountains appear as valleys and vice versa. Some local adaptations are also possible.



Shading on topographic maps

You can have a look (optional) on the [relief shading website](#), to learn all rules existing for shading: colours, landforms, aerial perspectives, small scales, generalisation, etc.

**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version.
Only screenshots of animations will be displayed. [link]**

Roll over the previous map with your mouse to get the same map with relief shading! Click on it to enlarge!



Remark: At a distance of 1-2meters, topographic map shading is most effective to be recognised for human eyes. Remark: The shading layer is still the base layer for a topographic map.

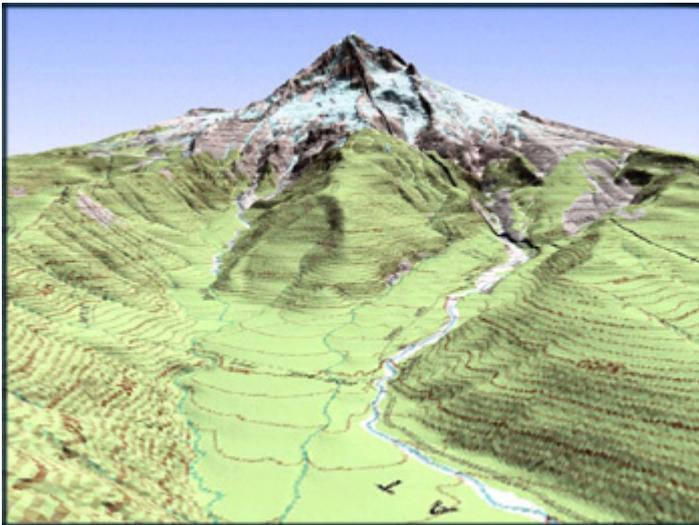
Rocks and cliffs representation

The representation of cliffs and rocks on topographic maps is a very difficult task still yet, even in the realm of digital cartography: the painting of rock hachures is mostly “hand-made”. Furthermore, this expensive method can only be produced by specialists: the painter has to use graphical tricks to give steep rocks depicted on a map equivalent visual importance compared to that observed in nature. During the last two centuries, cartographers have developed different cliff representation styles. On the following slide show, some of those methods are presented.

Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]

Relief versus Contour Lines

The two following pictures and animations are good examples to visualise the relation between relief (here represented using a Digital Elevation Model) and contour lines.



[USGS Geographic Data Download](#) (external link).

Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]

Picture of Old Maid Flat and Lost Creek (Mt-Hood) Digital Elevation Model, overlaid with a raster file of the topographic Map. Created with World Construction Set 4 by M. Dobler (IKA).
Raw Data used:

- USGS 7.5-minute DEMs, 1:24'000, Digital Elevation Model, 10-Meter Resolution
- USGS 7.5-minute DRGs, 1:24'000, Digital Raster Graphics, 4000x6000 Pixels, rgb Colors, 72dpi

Panorama from Timberline Lodge (Mt-Hood) Digital Elevation Model overlaid with the topographic Map. Created with World Construction Set 4 by M. Dobler (IKA). Press left mouse button in the image and move the mouse in a direction you want.

Raw Data used:

- USGS 7.5-minute DEMs, 1:24'000, Digital Elevation Model, 10-Meter Resolution

- USGS 7.5-minute DRGs, 1:24'000, Digital Raster Graphics, 4000x6000 Pixels, rgb Colors, 72dpi

[USGS Geographic Data Download](#) (external link).

Find the correct profile

In the following exercise, you have to find out which topographic isolines representation matches which profile. Drag the isolines on the bottom to the white rectangle corresponding to the correct profile. After you decided the five isolines representations, you can check your evaluation by clicking the button “Check Answers” which will appear. Try to be precise when dropping your isolines!

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1.2.3. Topographic Map Layout

Margin and Map Frame

The official maps present additional information and details in the margin and framework including the neat line, which surrounds the map. These specifications are important for the whole understanding of the map. The assortment and the composition of this additional information vary among different countries. Have a look at the 4 examples showing a Swiss, German, French and an Austrian topographic map.

Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]

An example of the 'International Map of the World'- also called 'Karta Mira'.

Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]

Marginal Information

Above the frame you can usually find the official sheet name of the map type together with the scale denominator, the map title written in bold print and the sheet number of the mapsheet. The mapsheet number belongs to the official system, the specific topographic map is dedicated to.

- The overview for Switzerland you may perceive from: <http://www.swisstopo.ch>. Or have a look at the interactive example below (if necessary, use the right mouse button to open the example enlarged in a separate tab):

- The overview of German topographic mapsheets you can view on: <http://www.geodatenzentrum.de/>
- The Austrian product range and the available mapsheets you may obtain via: <http://www.bev.gv.at/>
- Last but not least, the French product range and the available mapsheets you may obtain via: <http://www.ign.fr/>

One map is usually surrounded by 4 further maps in each direction. You may ask; how can you find out the map number for the one you are looking for? In between the framework, you can find the information concerning the connected mapsheets with its number and labelling. This example shows you a scheme valid for a special German mapsheet:

Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]

The verbal indication of scale is positioned at the top, whereas the linear scale on a usual topographic map you may find underneath the map face. Here you can find out the real distance from the measured distance on the map. Additionally, the notation of the representative fraction is made next to the linear scale. However, be aware, that there are other types of scales. See the *.pdf for explanation. Click [here](#) to open it.

The notation about the equidistance of the contour lines in meters is separately given underneath the linear scale. Further information given underneath the mapface are the gravitation details. This identifies the angle between grid north and magnetic north and its annual deviation for a special part of the map. On Swiss maps, it is labelled textually whereas on German topographic maps it is partly shown graphically. But, what do the different angles represent?

Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]

Considering the publisher, you can see whether the map is an official one and for this reason the most detailed one, or whether they are unofficial. Official topographic maps are based upon geodetic surveys with a minimum of generalised data. Further utilisation of data coming from official institutions usually includes a fee. Duplication is also possible with a written acceptance of the originator.

The status of the data describing the cartographic revisions and its first setup is differs from the data of the geodetic survey and is mentioned underneath the mapface. There you need to identify between:

Topographic Cartography

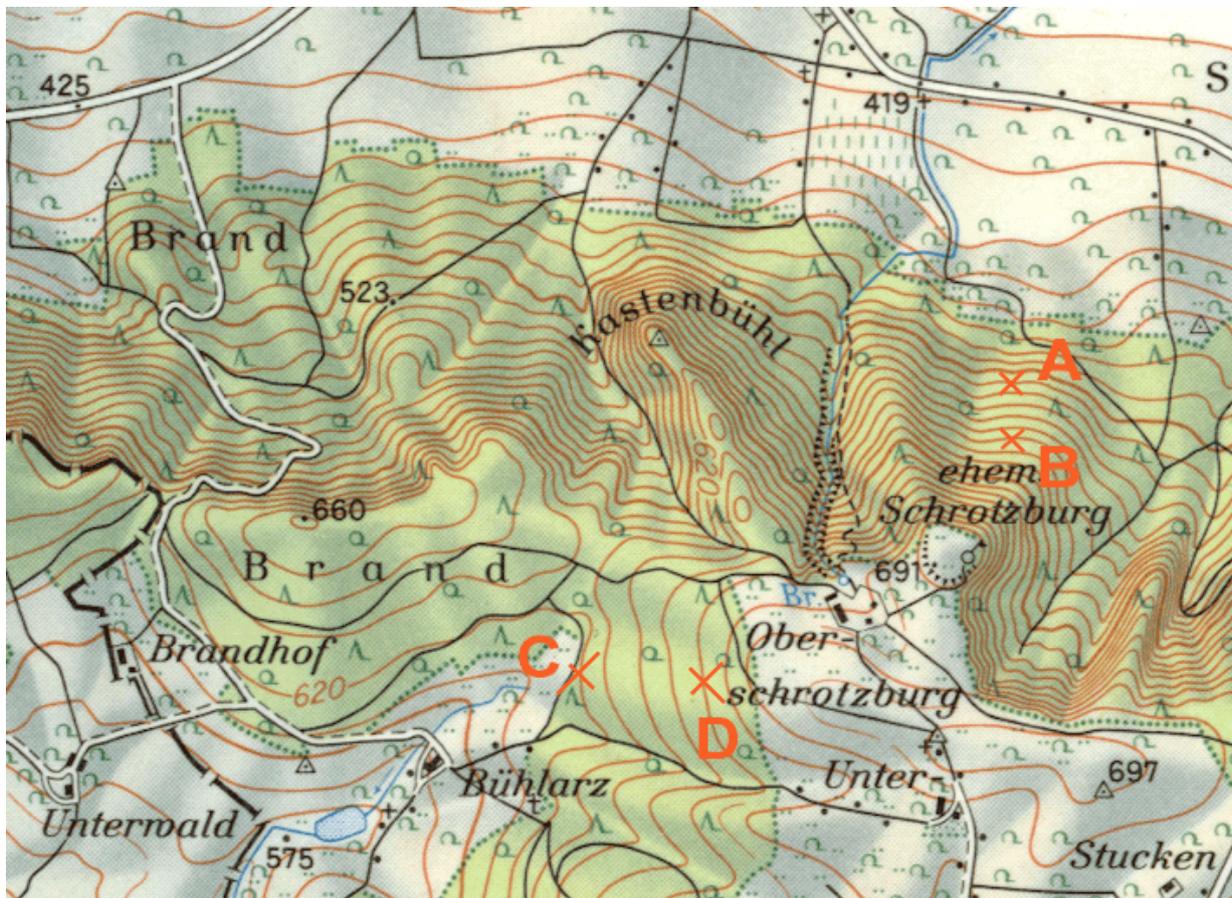
- A full revision, including a complete update of the whole information a map mediates.
- A partial revision, where just important additions are made or slight changes are updated. E.g., separate topographic objects.

Finally yet importantly, there is the need to mention the legend, which some countries, such as Germany and Austria present, on their topographic maps, but others like Switzerland do not present on their map face. On their newly published topographic maps, they print an explanation of the main legend features on the back. The full legend in this case is passed to the user separately in the form of a leaflet. You are invited to have a look at the *.pdf's including:

- Legend of Swiss topographic maps [Swiss_Signatures.pdf](#)
- A partial revision, where just important additions are made or slight changes are updated. E.g., separate topographic objects. [Swiss_Symbols.pdf](#)

A separate book with additional information about map reading can be purchased in a bookshop or from: <http://www.swisstopo.admin.ch/internet/swisstopo/en/home/products/accessories/book.html>

Have a look at the following map example with the entry of point A and B.



*source: topographical map 1:25'000 with the permission of the Landesvermessungsamt BAtten
Württemberg vom 17.08.2005, Az.: 2851.3-A/417 (Landesvermessungsamt Baden Württemberg)*

Print out the *.pdf file of the map excerpt [here](#). Now it is your turn to find out the horizontal contour line interval in the map for the given points A and B as well as C and D. And, what about calculating an unknown scale? The answer for this exercise you may check [here](#).

Map Framework

The framework of the map consists of various lines describing the geographic net and numbers standing for geographic coordinates, the latitude and longitude. The form of presentation here varies due to the different countries' customs. In Germany, the 4 map corners are described with the exact latitude and longitude values whereas, in Switzerland this is not usually done. Because it is much easier to calculate on an orthogonal even grid, many countries make use of presenting this grid instead of the geographic net. The Swiss maps have not included the geographic net in their maps except its specifications in the frame, but their country's coordinate system has an 1 km grid. This differs to maps of Germany and Austria in terms of the kind of presentation. Their presentation is in the form of longitude zone maps. France compared to them measures in gon, not as the others do in the entity of degree, but France has a 1 km grid, similar to Switzerland.

An even greater difference than the presentation lies in the different type of projection each country chooses individually and optimally for their topographic map presentation. In the following, a couple of countries with their projections are listed:

**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version.
Only screenshots of animations will be displayed. [link]**

The information concerning the projection type is arranged mostly underneath the framework or in between the mapface and frame.

The second to last outer double line of the frame is varying its appearance from opaque black to white with a line in the middle. It mirrors the subdivision of the geographic coordinate system of degree, in seconds. The amount of seconds displayed is again varies due to different countries' customs.

Depending on the country, some additional entries like names which would be cut on each mapsheet are added. Some destinations of streets and railway lines can also be either in the map framework or beneath mapface and framework, as it is customary for Switzerland.

1.2.4. Build the profile.

Method for building a profile

Constructing a profile is rather easy and requires only a pencil, a ruler and a sheet of squared paper.

1. Draw the profile line on the map.
2. Lay the sheet of squared paper along the line and mark where each contour line crosses the profile line and indicate the value of the contour line.
3. Measure up a scaled distance corresponding to the elevation of each marked point and put a point.
4. Connect all your points.

Using this method, and with the help of the following indications, construct a topographic profile along A-B.

- Scale: 1 : 25 000
- Contour Interval: 10 m
- Index Contour: each tenth contour line
- On your profile 100 m elevation = 1 cm.



Map for building the profile (Swisstopo)

You can download a printable version (DIN A4, format landscape) of the map here: [Profile_test.jpg](#) (474 Kb)

You should spend about 1/4h to carry out this exercise. There are two solutions to giving your work to the teacher/tutor (before the deadline he /sher gave you) back:

- Scan and send your profile as jpg picture (format: 600 X 280; 72 dpi) to your teacher/tutor by mail.
- Give him/her a photocopy of your original sheet of squared paper (on a DIN A4 white page).

Ask your tutor about the sample solution.

1.3. Recommended Reading

- Schweiz. Gesellschaft für Kartographie, 1977. *Cartographic Generalisation, Topographic Maps.*

1.4. Bibliography

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