Cartography

155CART

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Methods of terrain visualisations

Relief

relief – the earth's surface created by natural forces or human activity, without objects and phenomena on it

topografic surface - simplified continuous and smoothed surface replacing the actual relief for representation purposes

The relief display should

- correspond to the state in nature
- express geomorphological characteristics of relief types
- express height ratios
- allow the solution of slope inclination, visibility, etc.
- provide a visual (plastic) impression

Geomorphology

- deals with the description and study of relief shapes

Cartometry

- a discipline dealing with measurements on maps, retrieving data about the earth's surface from a map

Morphometrics

- determining the exact characteristics of relief shapes using maps

Orographic scheme

- characterizes terrain features and their points of contact
- is made up of **points and lines of the terrain skeleton**:

  - points - peaks of hills, saddles

  - ridges - lines connecting the relatively highest points of convex surfaces

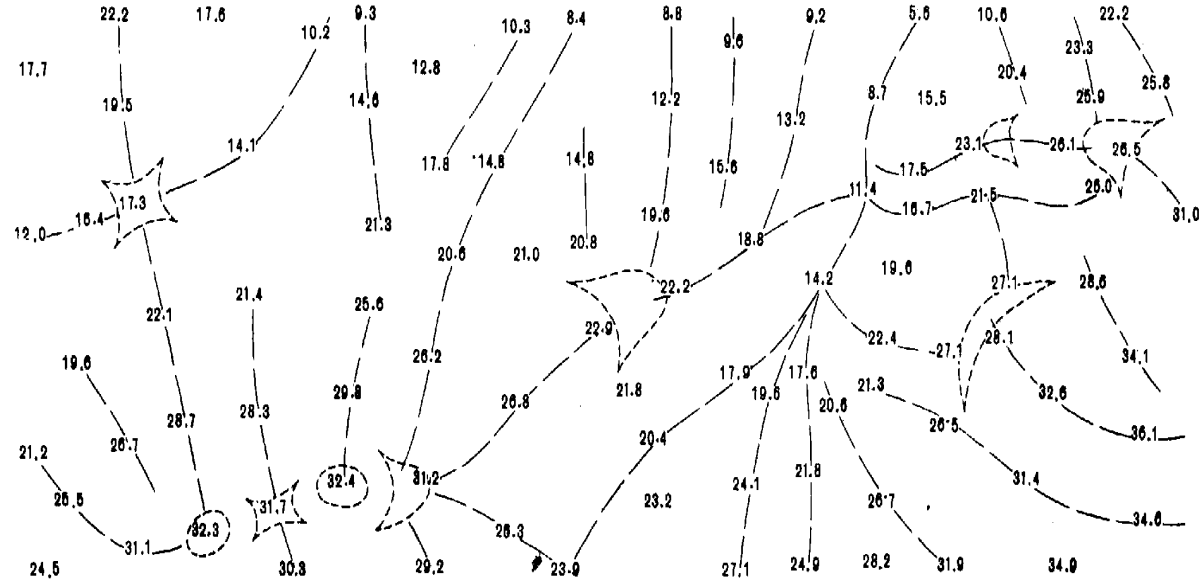
  - valleys - lines connecting the relatively lowest points of concave surfaces

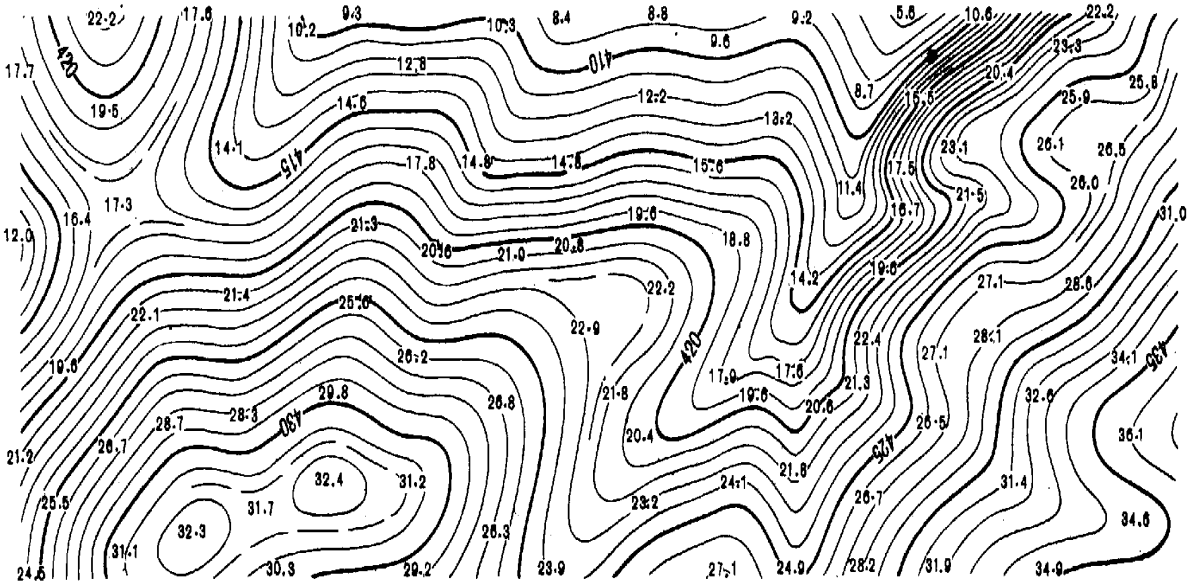
  - edges - delimit significant changes in slope

  - shape lines - delimit horizontal or slightly inclined parts of terrain shapes

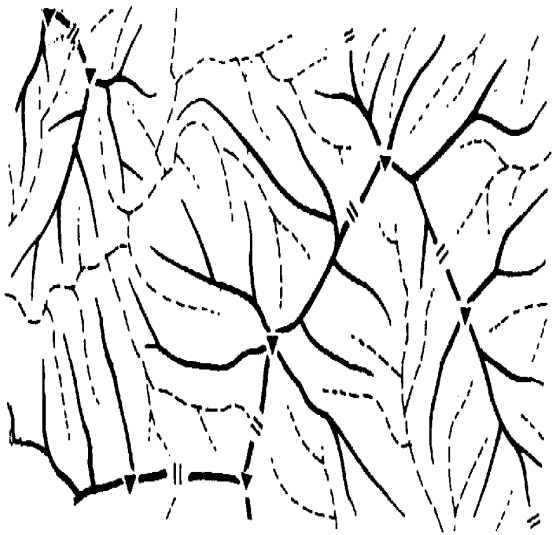
  - dips - lines of the highest slope of a topographic surface, perpendicular to contour lines

  - foothills - lines defining the outline of elevated shapes relative to the surroundings





Orographic scheme



Methods of relief depiction

- height points
- contours
- color hypsometry
- shading
- hatching
- hill method
- view maps
- panoramic maps
- block diagrams
- anaglyphs
- lenticular maps

…

Height points

- **height points –** numerically expressed depths or heights of points, contour lines or water surfaces relative to a selected reference plane
  - the simplest and most accurate expression of relief height
  - supplement to other methods (does not provide spatial perception)
- **Absolute heights** – related to zero sea level (significant points of the terrain skeleton, geodetic points, crossroads, contour lines, depth lines)
- **Relative heights** - relative elevation of a point relative to the reference surface in its surroundings or to a specific location (heights or depth of terrain steps, slopes, embankments, banks)

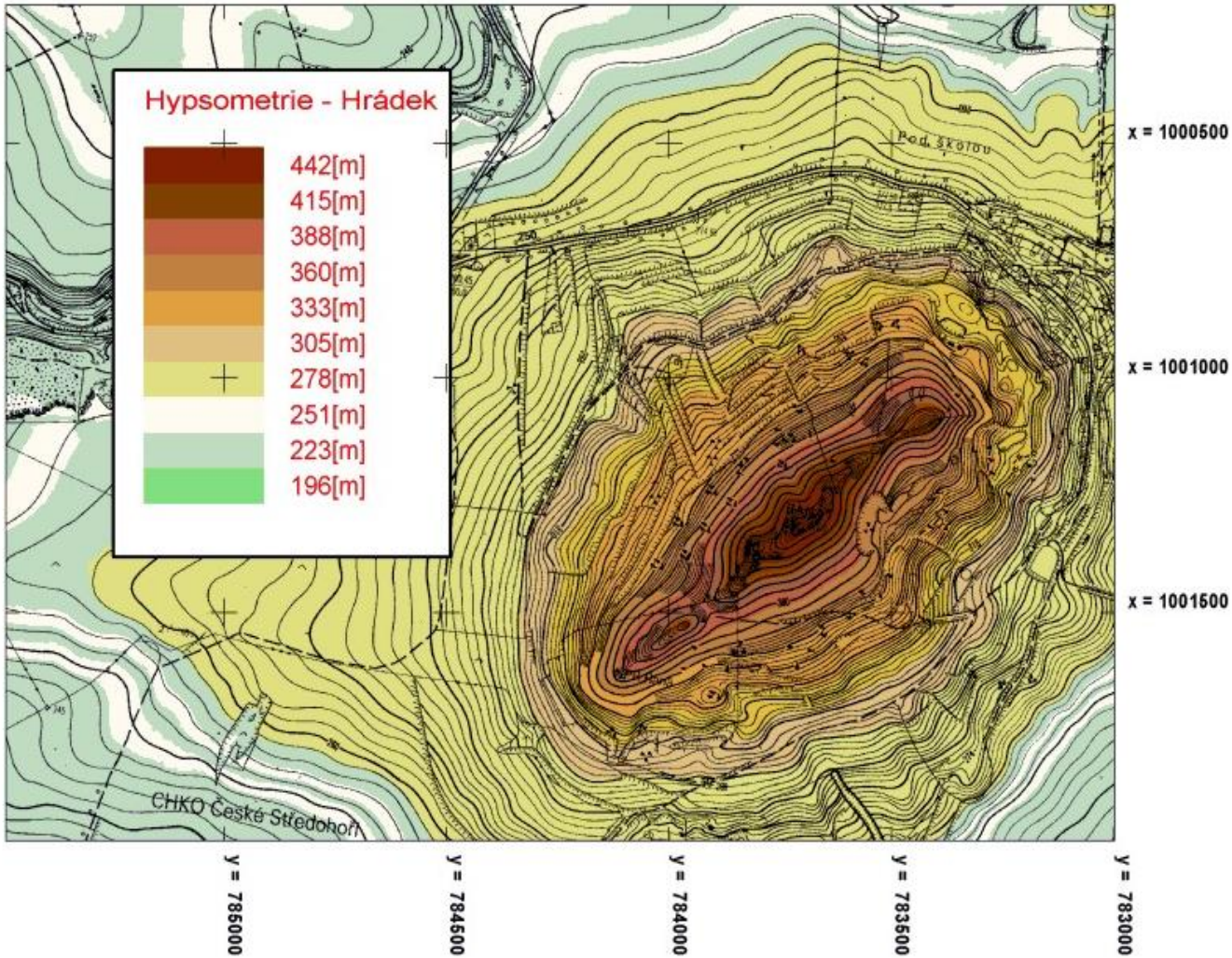
Contour lines

- **horizontals** - lines connecting points of equal elevation on a topographic surface
- **contours** - horizontals of appropriately rounded height
- the most important, most used method of cartographic representation of elevation
- basis for other methods (color hypsometry, shading, block diagrams)
- contour lines: basic, main, supplementary and auxiliary
- **Basic contour interval**:
  - Up to 1 : 5 000 .... 1m
  - from 1 : 10 000.... M / 5 000
- description (elevations) of contour lines - scattered, legibly uphill
- generating contour lines using a digital relief model

Color hypsometry

- **hypsometry** = representation of elevation using colors
- on medium and small scale maps (where contour lines cannot be used)
- based on the contour method
  - drawing contour lines delimiting typical height intervals
  - chosen with regard to the scale, purpose of the map and height differentiation
- evokes a spatial perception
- often simultaneously with shading
- hypsographic scale:
  - usually 6 -10 colors, various types of scales

Hypsometrie v lokalitě Hrádek



Měřítko 1 : 10 000

Shading

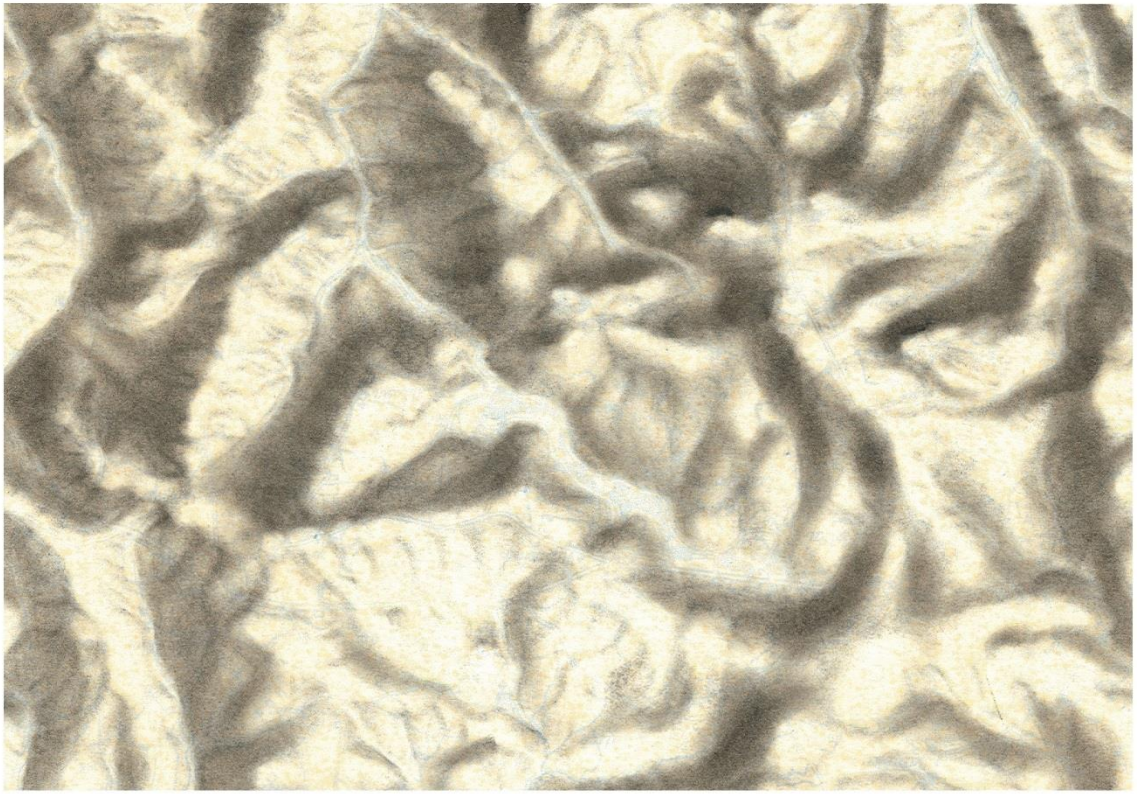
- **shading** - creation of shadows cast by relief when illuminated from different directions
- **choosing the appropriate direction of illumination**
  - natural lighting - from the direction of sunlight
  - vertical lighting - perpendicular light
  - oblique lighting - often used

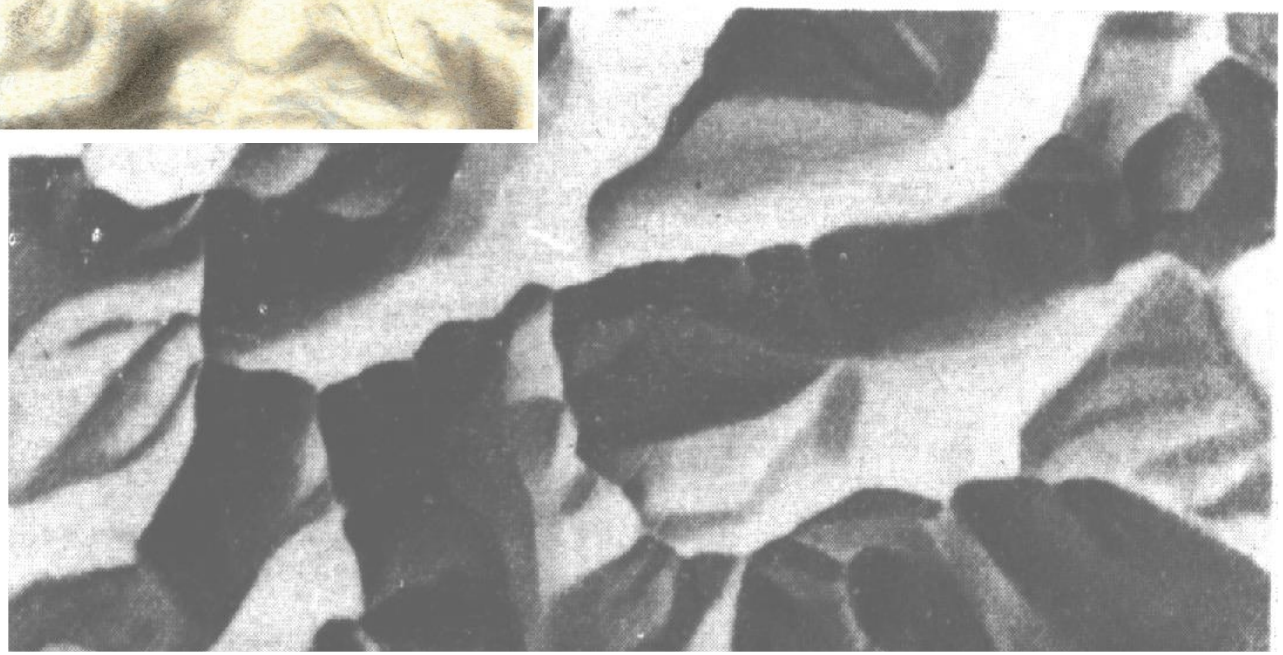
conventional terrain illumination:

beam at an angle of 45º - direction from the northwest

- **shading techniques:**

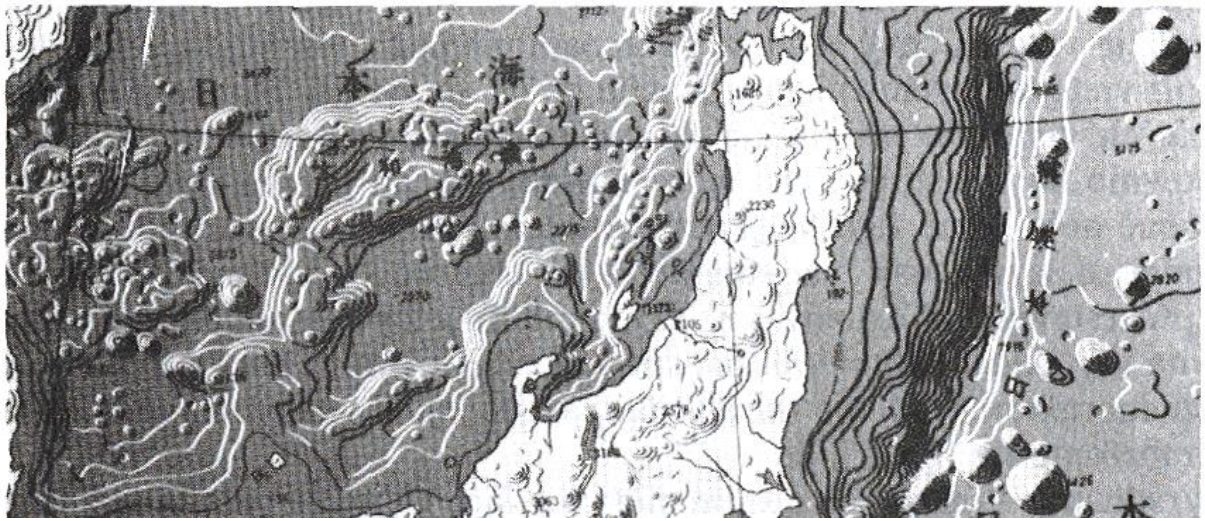
  - previously **hand shading** - laborious, high-quality pencil, tumbling (spreading graphite or chalk powder), washing (washing out ink or paint with water)
  - today using a **computer based** on a digital terrain model

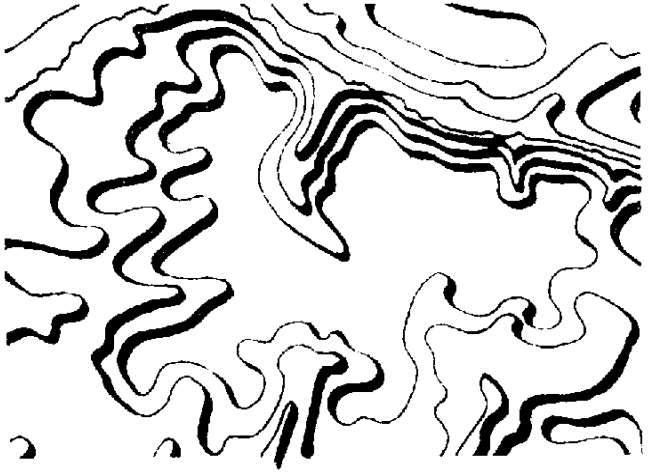




Shading contours

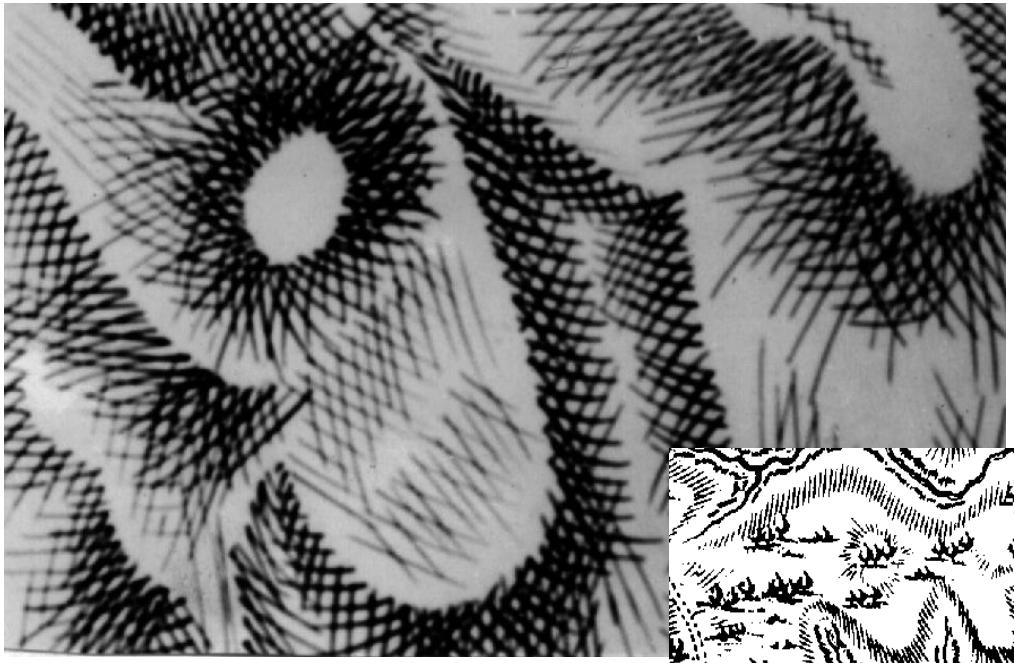
- combination of shading and contour lines
- illuminated contour lines are drawn white, shaded ones are drawn black and the intercontour areas remain gray
- the map resembles a stepped relief model
- also illustrative for depicting the seabed and partly also when drawing rocks
- northwestern exposure of the area





Hatching

- **hatches** - short, plan projections of part of the slopes arranged in layers or along a certain line
- originally more of an artistic drawing, later on a mathematical basis
- they are laborious and graphically burden the map
- today they only have an additional function - displaying smaller terrain shapes (especially steep ones) that cannot be accurately drawn using contour lines
- **different types of hatches**
  - artistic, landscape, slope, shadow, technical, topographic, physiographic
- **true hatches** – hatches that have a mathematical basis:
  - slope and shadow




Höhen Embringen
Tregelhum

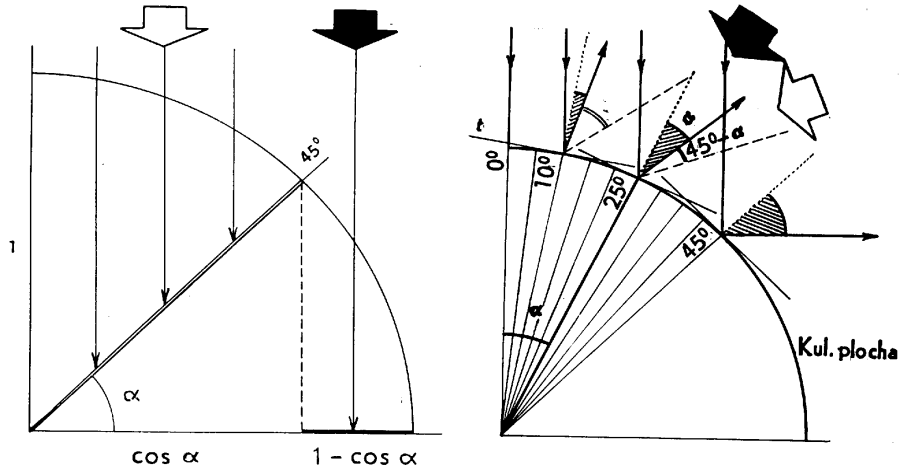
Slope hatches

- the thickness of the hatches corresponds to the slope of the slope
- **author Lehmann (1799) -** "the steeper the darker", the illumination of a surface inclined to the horizon by an angle α is $\cos \alpha$, the shading of the area is $1-\cos \alpha$

I. Lehmanns scale – black for 90°

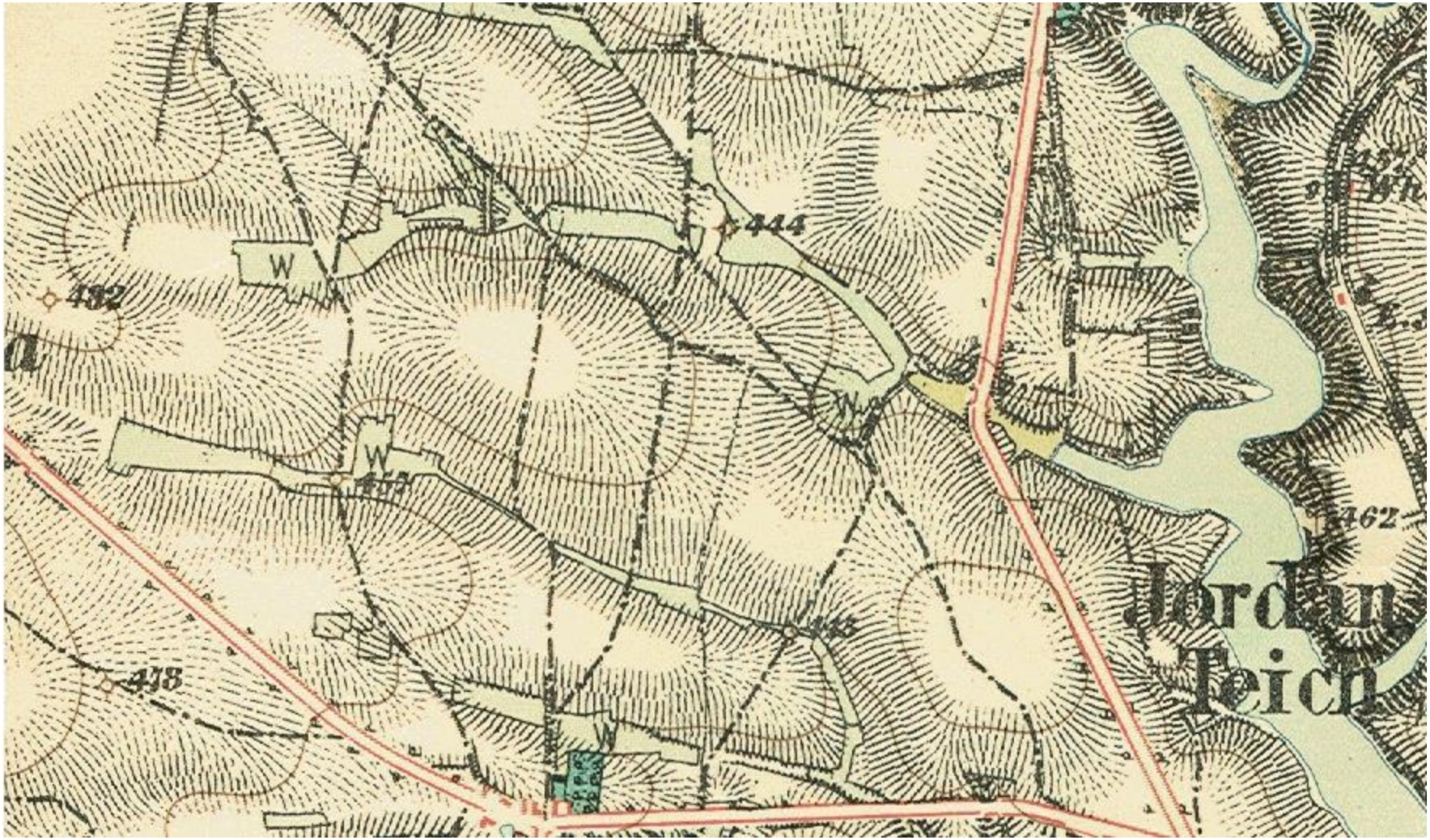
shadow/light = $(1-\cos \alpha)/\cos \alpha$ = hatch/space

II. Lehmanns (practical) scale - black for 45 °



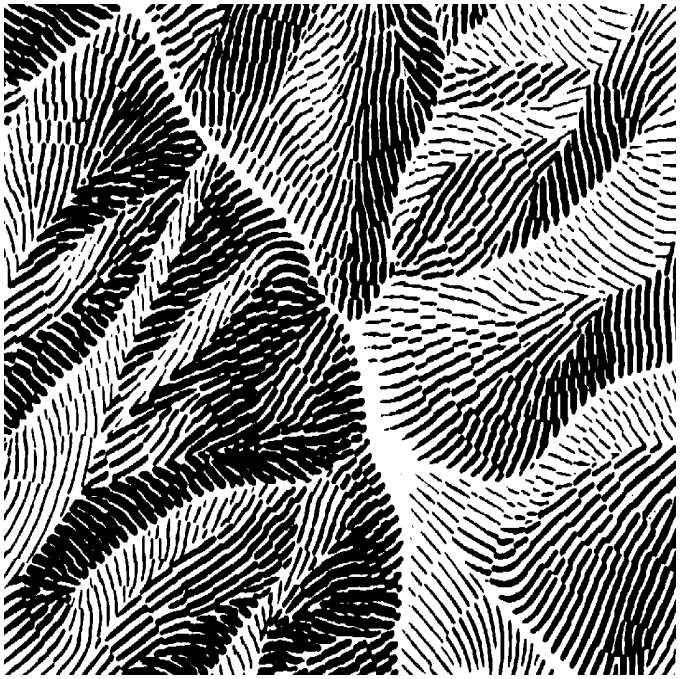
Slope hatches

On the map III. Military Mapping Survey (1870-1883) – Austria-Hungary



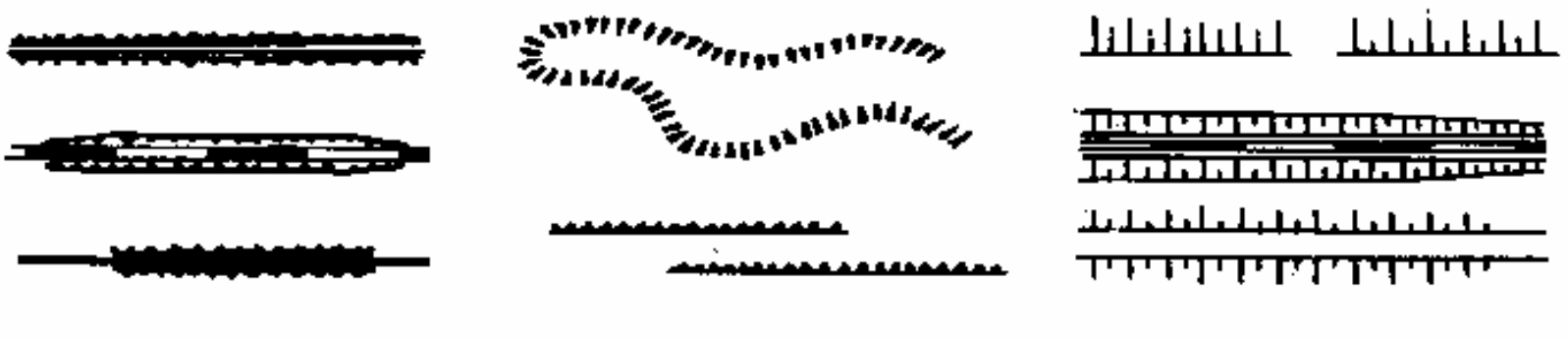
Shadow hatches

- hatch thickness expresses oblique illumination of the relief - combination of shading method and inclined hatches
- Dufour 1836
- NW illumination, variable hatch thickness - shadow modeling
- disadvantage - valleys (opposite slopes) - "white tongues" - perception of paths



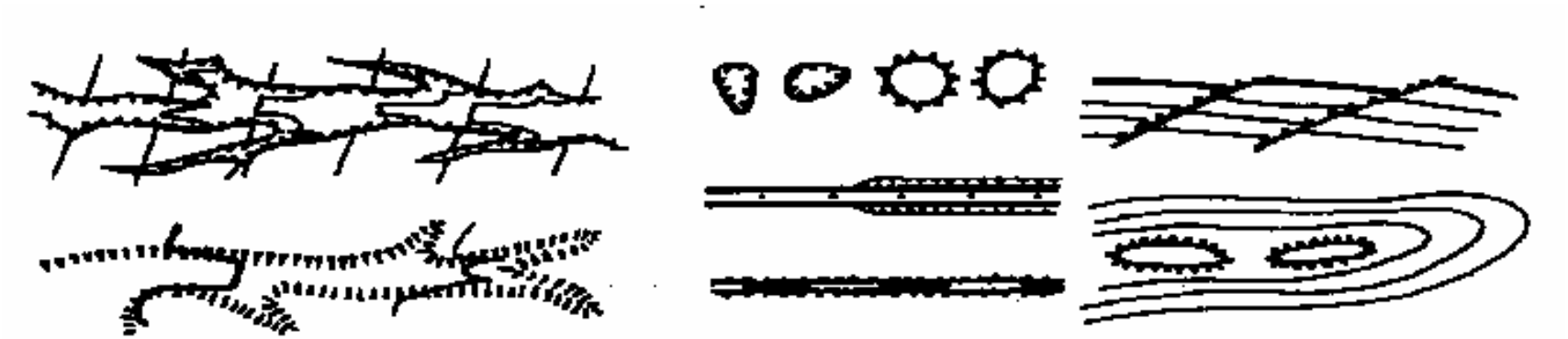
Technical hatches

- a series of alternating short and long lines (starting at the top edge of the slope), for artificial and natural slopes - terraces, embankments, dams



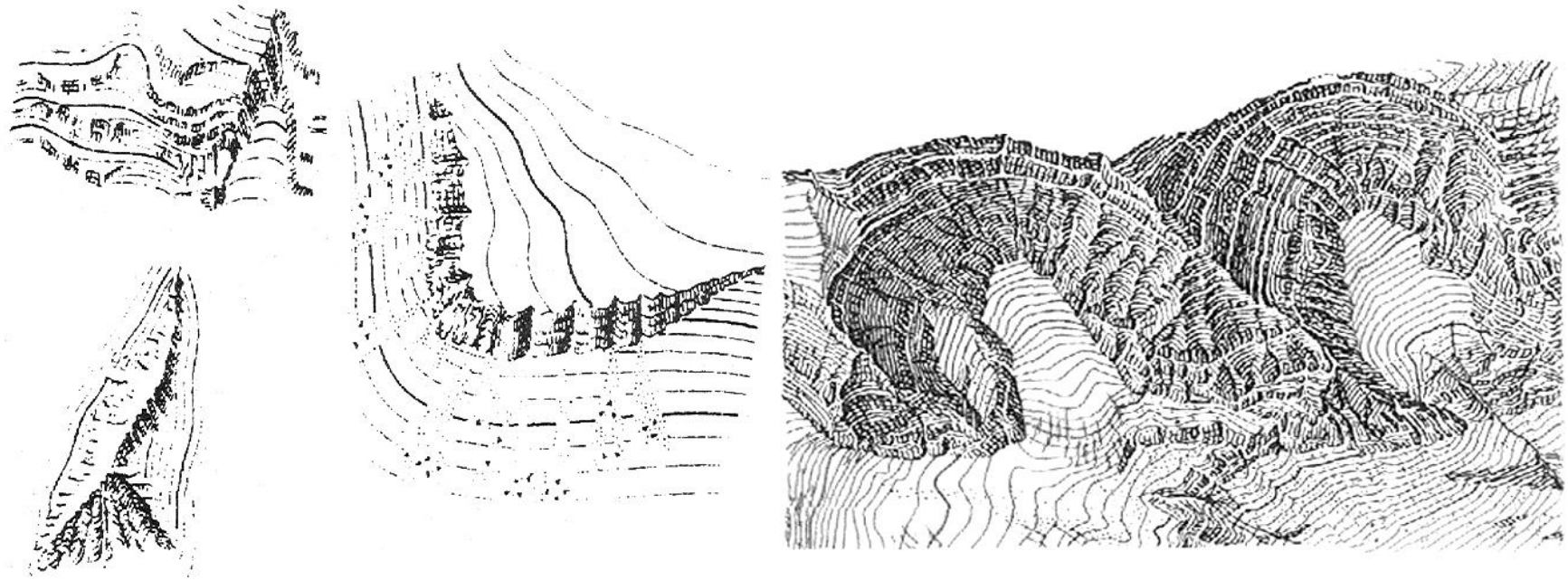
Topographical hatches

- mutually arranged wedges oriented in the direction of the slope - for marking terrain edges
- sand pits, riverbeds, grooves



Physiographic hatches

- vertical and horizontal lines in the direction of the edges + shading and changing the line thickness according to the oblique combined lighting
- depicting rocks, glaciers and rock debris



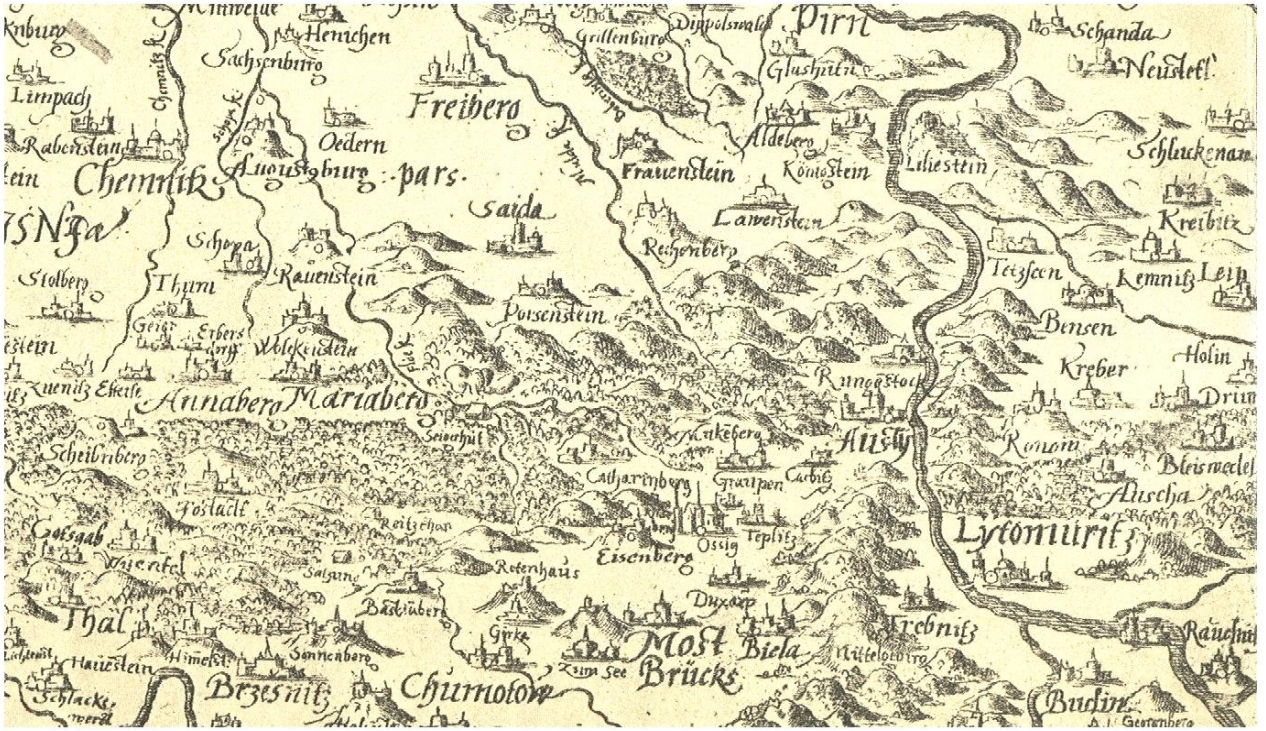
Historical note

- **Prof. Eduard Imhof** (1895-1986)
  - important figure in Swiss cartography

- **author of relief maps**
- **book Cartographic Relief Presentation (1965)**
- **1st President of the ICA (1961-1965)**
- **1979 Mannerfelt Medal of the ICA**

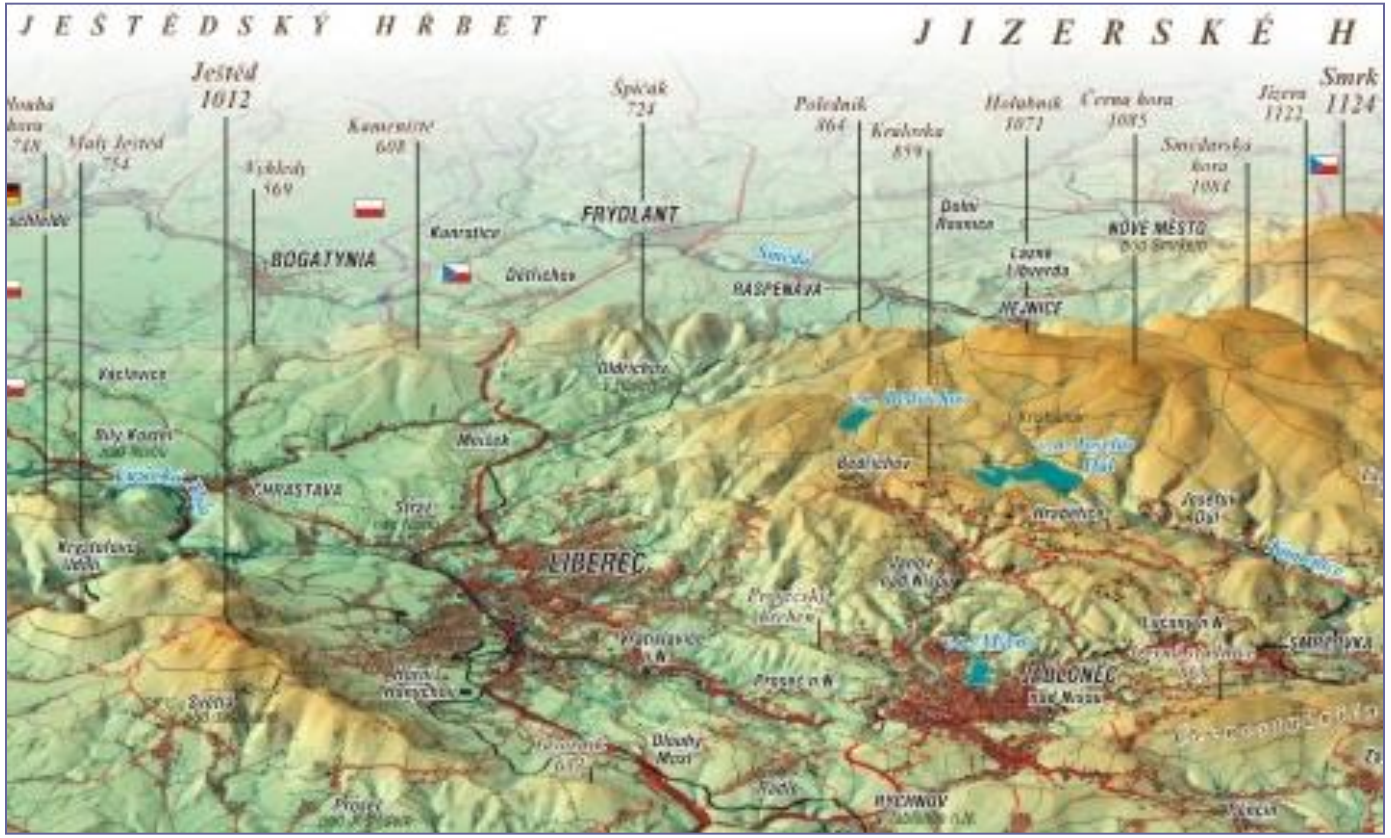
Hill method

- planar view representation of relief
- the oldest way of representing relief (Ptolemy - 1st AD)
- repeated hill drawing - schematic drawing of mountain ranges or significant mountains
- there is no geometric aspect, but it is also quite simple



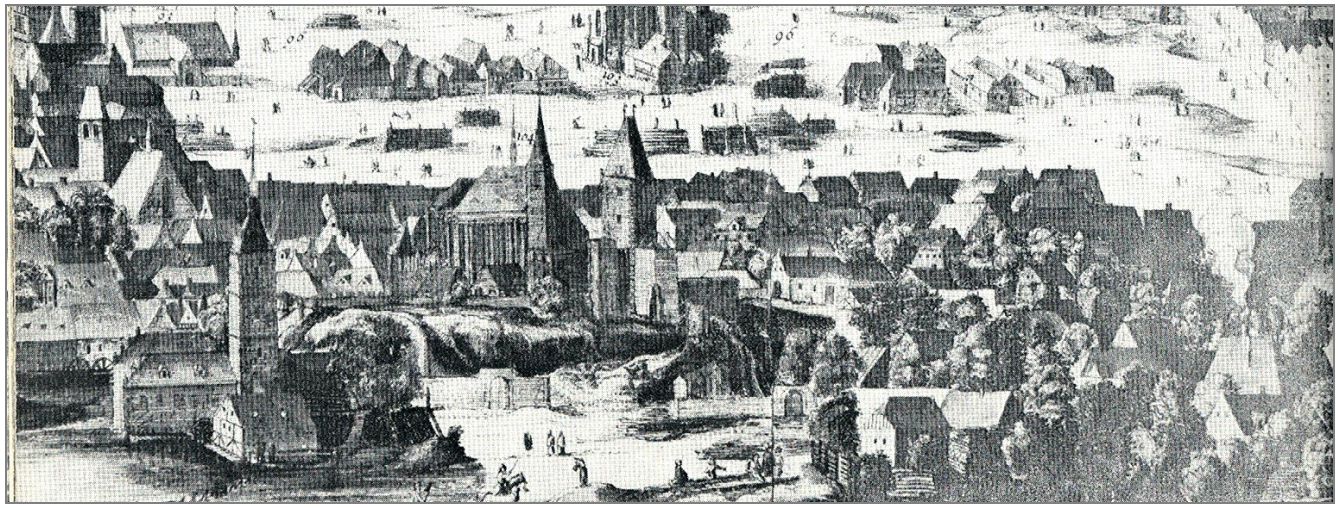
View maps

- perspective view of the relief
- formerly hand-made, now computer-generated
- mainly for tourist and promotional purposes (maps of mountain systems and large territorial units)



Panoramic maps

- central projection of the landscape onto a vertical plane
- supplements to book publications, on lookout towers and elevation points
- veduta - artistically processed panoramic maps, usually a side view of a city, widespread from the 17th to the mid-19th century, often on old maps

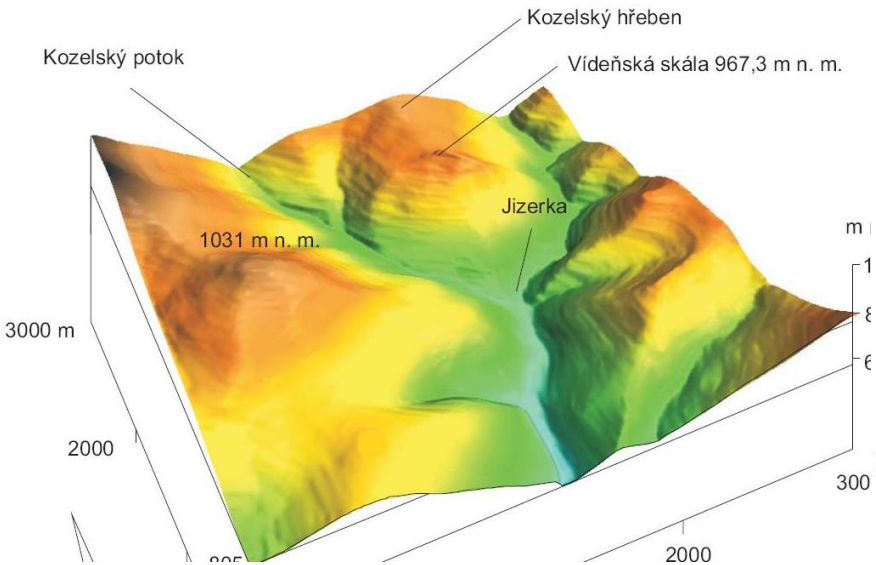


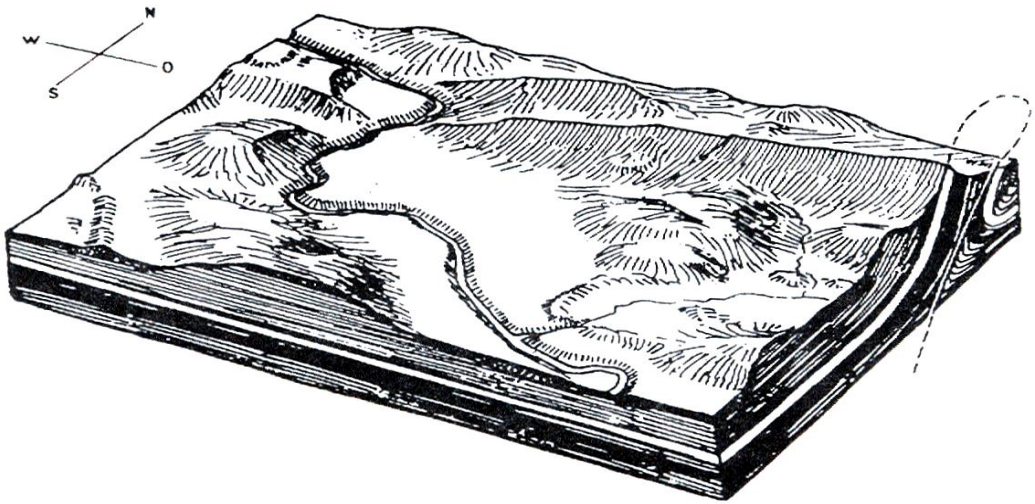
Veduta of Prague – 1606

Panoramic map – veduta of Lisbon 1775

Blockdiagrams

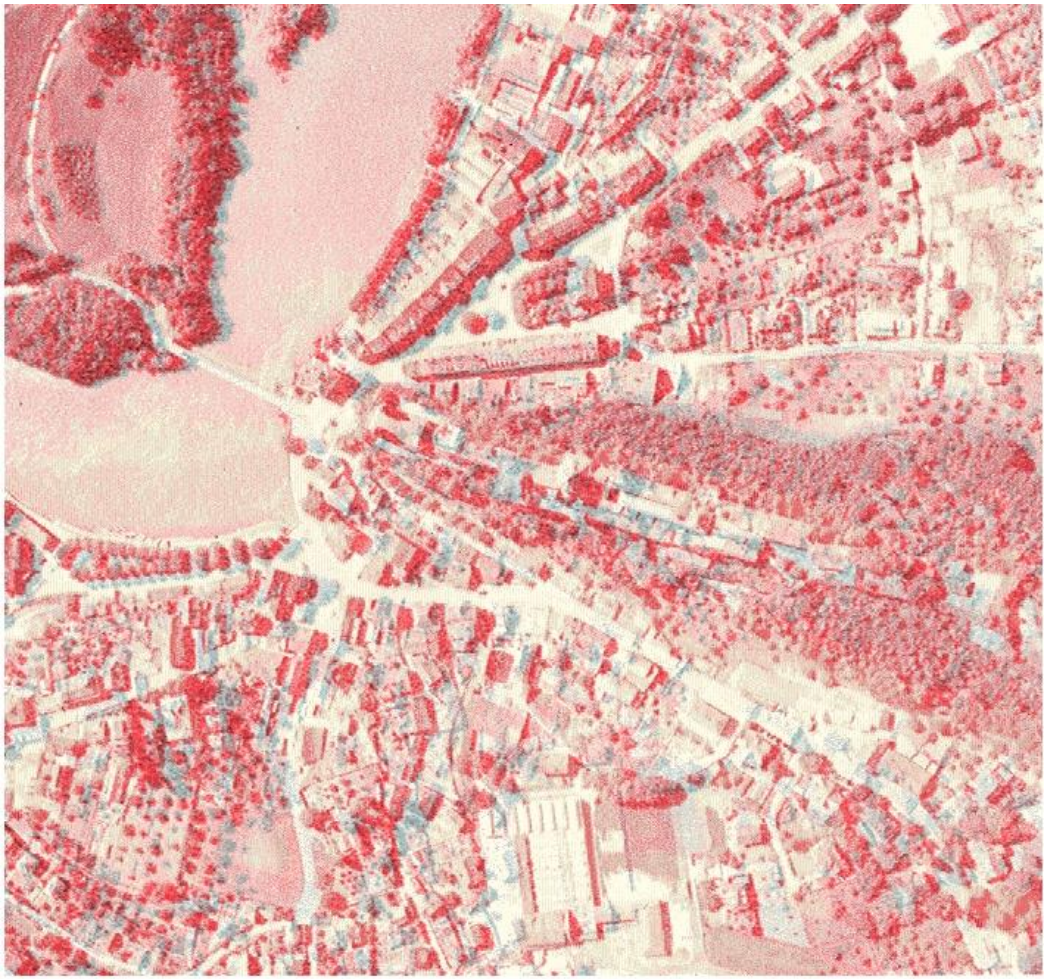
- perspective representation of a part of the earth's surface, rectangularly bounded by vertical planes
- block walls may contain a drawing of a geological structure
- computer technology (DTM)





Anaglyphs

- use of stereoscopic effect to give the impression of spatial perception
- height chart composed of a stereoscopic pair of contour images or a pair of surface images
- observation with a stereoscope or special glasses



Obr. 8 Anaglyf v doplňkových barvách

Other methods

- **lenticular maps**
- **virtual reality**
- **augmented reality**
- **…**