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170 years of Cartography at ETH Zurich: the Contributions to Relief Cartography

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Abstract:
The Institute of Cartography and Geoinformation (IKG) at ETH Zurich celebrated its 100th anniversary in 2025 with a festive symposium. The institute was founded in 1925 by Professor Eduard Imhof. However, cartography was already taught since the foundation of ETH Zurich in 1855. On this occasion the institute's history was explored by staff members. A commemorative monography was published in 2025 which contains over 200 figures, mainly of maps and other work carried out at the institute (Hurni et al. 2025). Based on this publication, this abstract examines the evolution of relief representation through the scholarly and pedagogical contributions of key professors whose work shaped both theoretical cartography and applied map design. Their collective legacy demonstrates how scientific rigor, aesthetic sensitivity, and technological innovation converged to advance the depiction of terrain as an expressive and analytical cartographic element.

Early methodological foundations are traced to Johannes Wild's contour-centric approach to topographic mapping. The *Topographic Map of the Canton of Zurich* (1:25,000)—although not covering high mountain areas—demonstrates one of the first systematic use of dense contour intervals and colour separation to encode terrain morphology. This work established contours as a primary analytical framework for mountainous terrain, enabling quantitative interpretation while supporting visual inference of slope, ridgelines, and valley systems. The map was especially useful and trendsetting for the early industrial and transportation (mainly railroad) development in Zurich and Switzerland, providing topographic base date with an up to then unrivalled precision.

Wild's successor Fridolin Becker at ETH Zurich introduced methodologically explicit shaded relief as a complementary terrain encoding. His relief map of the *Canton of Glarus* (1889) serves as a key case study for illumination testing and tonal calibration. Becker systematically evaluated illumination azimuths—including vertical lighting, southern illumination, and northwest lighting—documenting their perceptual effects on landform recognition. A visual comparison of Becker's map with Hans Conrad Gyger's pioneering hand-drawn relief map of the Canton of Zurich from 1667 reveals a similar, greenish colour scheme, which is based on natural features. We can assume that Becker drew inspiration from this. His progressive print proofs for the *Davos Route Map* presented in the book provide a rare procedural record of setting up a relief map, illustrating sequential layer integration (base colour, contours, sun tone, shaded relief) and demonstrating early principles of layer hierarchy and tonal economy still relevant to modern GIS-based workflows.

Eduard Imhof formalized shaded relief into a rule-based cartographic method. Imhof's monochromatic relief drawings function as methodological references for slope-dependent tonal gradation, ridge exaggeration, valley widening, and selective generalization. As regards his colour relief maps, we can assume that Imhof, too, drew to a considerable extent on the work of his predecessor Becker, as he again employs similar greenish, nature-inspired elevation scales here. Imhof's approach combined field observation, photogrammetric data, and manual synthesis to ensure geomorphological coherence across scales. Imhof also refined the method of depicting rock formations: in contrast to the hatching method favoured in Switzerland's official national maps, he developed the 'ribbed line' method, in which only rock ridges and crevices are indicated with shading, whilst the actual rock surfaces are left blank or depicted through the underlying relief pattern. A fine example of this is the colour relief map of the Everest region (Fig. 1) in the *Swiss Secondary School Atlas* (today *Swiss World Atlas*). In the atlas, these methods were operationalized into standardized production workflows, where shaded relief was structurally integrated with topographic and thematic layers rather than treated as a decorative background.

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Imhof's successor Ernst Spiess addressed the methodological translation of classical topographic representation principles into early digital environments. His map contributions represent controlled analog test cases used to evaluate how manual conventions could inform raster-based shading and especially orthophoto processing. He placed particular emphasis on thematic cartography and investigated the combination of orthophotos with thematic layers, for example for studies on changes in the cultural landscape. Spiess's work highlighted limitations of early digital systems, thereby establishing criteria for quality control in computer-assisted relief depiction.

In the last 30 years, these methods were extended into contemporary GIScience research, focusing on digital terrain models, multiscale relief generalization, and interactive atlas cartography. Case studies from the *Atlas of Switzerland* and *Swiss World Atlas* demonstrate how classical Swiss relief principles—illumination consistency, tonal balance, and geomorphological prioritization—can be algorithmically supported by analytical and AI methods while retaining cartographic authorship.

Overall, the commemorative publication, as well as this proposed conference contribution positions cartography as a method-driven discipline, in which relief depiction emerges from graphic to explicit analytical procedures. The ETH Zurich tradition continues to define international standards for relief and terrain depiction and the cartographic representation of landscapes with complex topography and thematic overlays.

Figure 1. 1:100,000 colour relief map of Mount Everest in the *Swiss Secondary School Atlas*, 1962 edition. Eduard Imhof used the 1:25,000 Alpine Association map by Erwin Schneider from 1957 as a basis. From left to right: draft of the topographic line art elements, contour lines and rock areas; rock and relief originals; complete colour composite print of the map.

References

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