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Analysis of a Workflow for the Automated Generalization of Geological Maps

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Abstract:

Cartographic generalization is a central and complex process within mapmaking. Due to its importance, over the last two decades, almost purely manual production lines have started to be replaced by fully or semi-automatic production workflows. However, since the National Mapping Agencies (NMAs) have been one of the main end-users of the findings regarding automated map generalization, the research in this field has been mainly focused on topographic maps (Steiniger & Weibel, 2005) which has led to gaps in other areas such as geological mapping. This research aims to analyze and evaluate an automatic procedure for the generalization of geological maps.

The nature of geological maps makes it difficult to adapt the amount of detail when reducing the scale. A geological map is a graphic representation of the distribution of rocks, geological structures, and mineral deposits (Downs & Mackaness, 2002). It consists of a topographic map in which colored polygons are mainly overlapped to depict the different types of rocks (Maltman, 1990). Some of its applications include civil engineering, land use planning, mining, and energy resources. Due to the complexity and variety of applications of geological maps, the generalization process normally requires the participation of a geologist with expertise in geological mapping and knowledge of the area (Smirnoff et al., 2012).

Automated geological map generalization could be divided into two main research approaches, vector-based generalization or an integration of vector- and raster-based generalization. For the former one, Downs and Mackaness (2002), Steiniger and Weibel (2005), and Sayidov et al. (2020) provide some examples. While an integrated approach using vector- and raster-based generalization was addressed by Smirnoff et al. (2008), Smirnoff et al. (2012), and Schuff (2019). However, even though Sayidov and Weibel (2017) indicate that vector-raster-vector conversion can lead to a loss of data accuracy, Smirnoff et al.'s (2008) approach, which used an integrated vector- and raster-based generalization showed the accuracy of the target map is sufficiently high.

This analysis aims to standardize a procedure for the upcoming updates of the geological map series of Bavaria. For that purpose, the Bayerisches Landesamt für Umwelt provided the 1:25k scale database and the existing procedure. Currently, a hybrid vector- and raster-based generalization approach is under consideration. First, an aggregation of the vector polygons is carried out, which can be understood as the retention of larger units while eliminating smaller ones with additional consideration of their semantic meaning (Jiang & Slocum, 2020). After that, a raster-based simplification and smoothing are applied. Following Schuff (2019), the vector-raster-vector conversion does not represent an interruption in the process flow. Experts evaluate the quality and potential for improvement of the automatically generalized geological maps.

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