

Lateral conductivity variations within Austria and its surroundings by extrapolating airborne electromagnetic data

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Motivation

Can geomagnetic storms cause Blackouts in Austria?
Yes they can! (Bailey, 2017)

What to do?

An effective warning system for upcoming extreme space weather events helps to prevent damage to critical infrastructure. For this purpose the development of a near real - time model of geomagnetic induced currents is essential.

Introduction

Steady advances in hardware and improving data acquisition methods lead to accelerated increase of scientific data. While there is a wide range of problem statements and possibilities for using the data, in the best case it may contribute to socio-economic benefit. Helicopter surveys in particular produce huge datasets covering large areas, usually provided for different standard analysis. The herein presented project with its goal concerning the creation of a large-scale conductivity map for implementation in a model of geomagnetically induced currents shows a new application and the value of aero-electromagnetic data gathered recently and also over a long period in the past for an important infrastructural problem.

For the development of a near real - time model of geomagnetic induced currents (Bailey, 2017), it is necessary to know the lateral variability of conductivity of the subsurface all across Austria and its surroundings. Airborne electromagnetic data sets gathered between 1980 and 2014 at the Geological Survey of Austria form the basis of the herein presented surface-covering conductivity map.

Method

Following the approach of Beamish et al. (2012), airborne electromagnetic data, available from more than 50 airborne electromagnetic campaigns from the Geological Survey of Austria, acquired between 1980 and 2014, were partly reprocessed with state-of-the-art technology. The results are conductivity data sets of homogenous half-space inversion results as well as conductivity multi-layer information of the survey areas. In the next step, these data sets were correlated with the hydrogeological map of Austria at a scale of 1:500.000 (Schubert et al, 2003) and average conductivity values were derived for each of the hydrogeological units. Using available geological maps from outside of Austria, conductivity information was extrapolated to a rectangle, including Austria and its European surrounding, resulting in a high-resolution subsurface conductivity map of this area shown in Fig. 3.

Discussion

The conductivity map generated is subject to a strong generalization for the following reasons:

1. due to formation of average values
2. due to extrapolation
3. One conductivity value at one position is an integrative value representing all real values over a certain depth and within a certain lateral surrounding. The depth depends on the real conductivity values of the upper layer, and the extension of the lateral influence is determined by the height of the measurement device.
4. The hydrogeological map of Austria (Schubert et al., 2003) is on the scale of 1: 500,000. The map is focused to factors which are relevant for groundwater use and includes properties such as lithology and productivity. Of all the geological maps available, this map was found to be the most suitable for this issue, since grain sizes and groundwater conditions are relevant for the results of electromagnetic measurements (Fig. 4). Within 5 types of aquifers, 18 lithology classes are distinguished (Fig. 2b) in which average values were calculated. The histograms in Fig. 5 illustrate this. It can be assumed, that the multimodal distributions of the histograms reflect the heterogeneity of the hydrogeological formations. As can be seen from the histograms, mean and median show only representative values for the hydrogeological unit but possibly don't exist as a model value in this unit.

Conclusions

Despite these limitations mentioned above, the distribution of the mean values reflects the trend from high-conductivity regions with mainly sediments and low-conductivity regions with mainly bedrock. The conductivity map generated can therefore be used for geophysical models on a large regional scale.

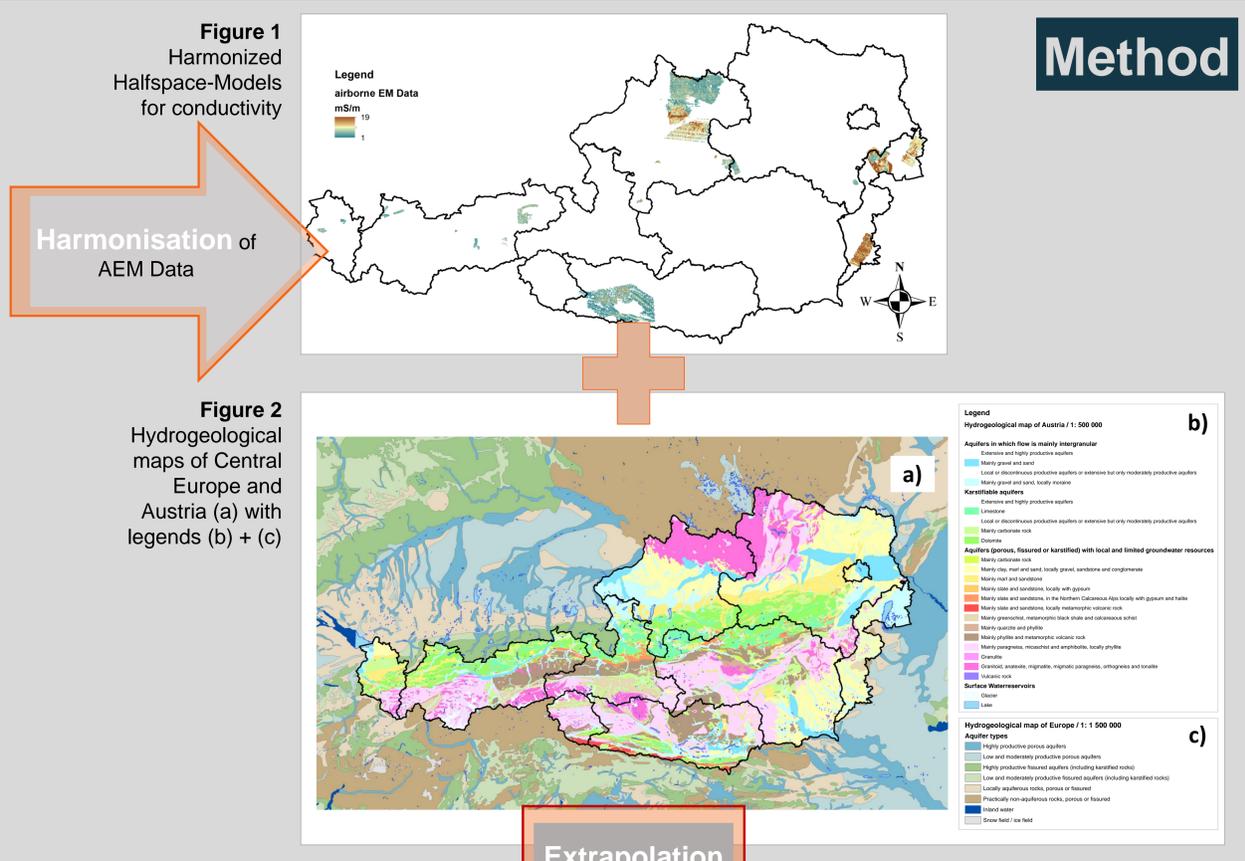
To achieve better resolutions in crucial areas (about 10km² around 8 for the GIC-model important transformer stations) there is multilayer resistivity information available from recently accomplished geoelectrical campaigns.

On a small regional scale this generalized map can not be used to make any statement about conductivity conditions. For the task of estimating the lateral conductivity variation on a large regional scale, however, the result of the presented project satisfies the demands and leads to an improvement of the near real - time model of geomagnetic induced currents.

Acknowledgement

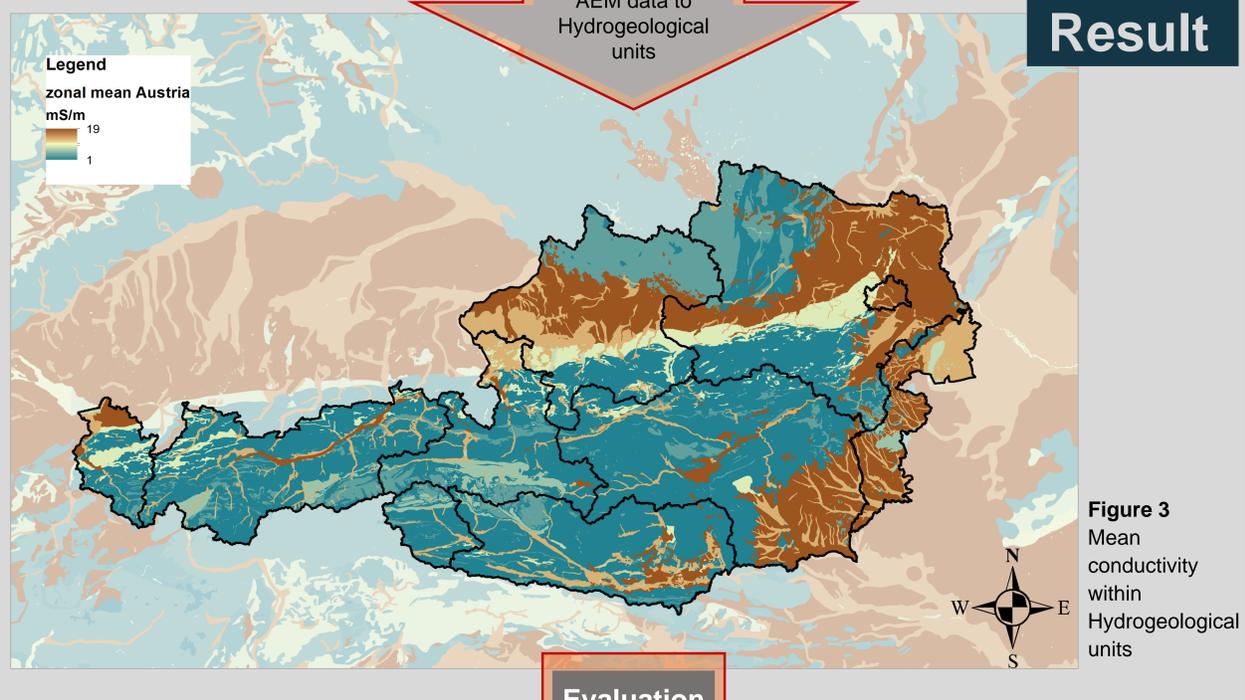
Projektname: "GEOMAGICA" (Geomagnetically Induced Currents in Austria), Projektnummer: 847986, Program: Austrian Space Applications Programs

Method



Extrapolation of the harmonized AEM data to Hydrogeological units

Result



Evaluation of the result with statistical Analysis

Discussion

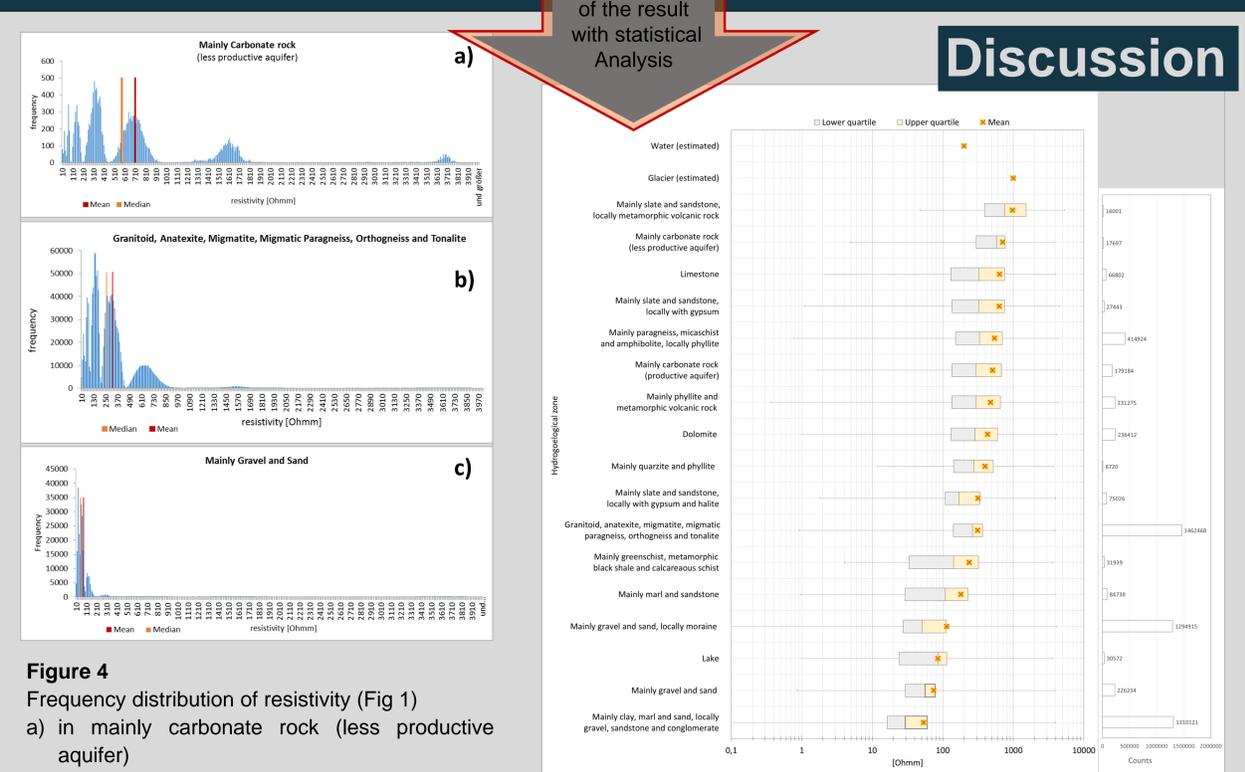


Figure 5 Boxplot (logarithmic) showing statistical values of resistivity (Fig. 1) within hydrogeological zones