

A MULTILAYER INTERACTIVE WEB MAP OF THE WINE GROWING REGION CARNUNTUM WITH EMPHASIS ON GEOCHEMICAL AND MINERALOGICAL ZONING

Maria HEINRICH^{1*}, Ingeborg WIMMER-FREY¹, Heinz REITNER¹, Josef EITZINGER², Johann GRASSL³, Gerhard HOBIGER¹, Erwin MURER⁴, Herbert PIRKL⁵, Julia RABEDER¹, Johann REISCHER¹, Martin SCHIEGL¹ & Heide SPIEGEL⁶

¹ Geological Survey of Austria, Vienna, Austria, ² University of Natural Resources and Applied Life Sciences, Vienna, Austria, ³ Carnuntum Wine Region Cooperation, Bruck an der Leitha, Austria, ⁴ Federal Agency for Water Management, Petzenkirchen, Austria, ⁵ Technical Office for Geology, Vienna, Austria, ⁶ Austrian Agency for Health and Food Safety, Vienna, Austria

* Corresponding author: Maria Heinrich. E-mail: maria.heinrich@geologie.ac.at

Abstract

During a three-year study the vineyards of the wine-growing region Carnuntum have been investigated for their terroir characteristics (climate, soil, rocks) and major viticulture functions. As an outcome of the study, various thematic layers and geodata analyses describe the geo-environmental properties and variability of the wine growing region and delimit homogenous multilayer mapping units by using a Geographic Information System. These results have been converted to multilayer web services which are presented with a web map application (<http://www.geologie.ac.at/en/research-development/mapping/substrate-floor/naturraum-carnuntum/>).

The web map gives access to grouped thematic layers which represent climatic parameters (e.g. HUGLIN-Index, risk of frost), soil physics (e.g. available water capacity), soil chemistry and nutrients, rock geochemistry, geology, mineralogy and apparent resistivity maps. Using the web map interface one is able to navigate on-screen to areas of interest and select the desired layers in any combination and transparency for display on aerial images. As the study results are made available to winemakers of the region and to the general public, the web map shall primarily serve as an information tool but is also intended to promote and communicate scientific research for the exploration of winegrowing regions.

The functions of the web map focus on the evaluation of the vertical and lateral variations of rocks and soils. In the study area more than 200 samples were taken by drilling or at sampling pits and analysed for grain size distribution, clay mineral and bulk mineral content and whole rock geochemistry. By exploratory data analysis of the sample data the parameters were used to compare regional areas and lithostratigraphic units with graphs and descriptive statistics. The results of the exploratory data analysis contribute to the characterization of the stratigraphic units and the zoning of the study region.

Keywords: Carnuntum, Web Map, Mineralogy, Geochemistry, Grainsize Distribution

1 INTRODUCTION

The region of Carnuntum is a small wine growing area of Austria with scattered vineyards, located east of Vienna and south of the Danube river (Fig. 1). The main varieties are Grüner Veltliner, Zweigelt and Blaufränkisch.



Figure 1: Wine growing regions of Austria, the red arrow points at Carnuntum region

During a three year study the physiogeographic characteristics of the region have been studied regarding to climate, soil and bedrock (Heinrich et al. 2010). Microclimatic measurements have been implemented to derive climatic maps, extensive fieldwork has been carried out to investigate soils and prepare detailed geological maps. The field work placed emphasis on sampling of soil and rock materials, with hand augers or by soil pits, the samples were analysed for grainsize distribution, clay mineral and bulk mineral content and whole rock geochemistry. Shallow geophysical measurements of apparent resistivity were also carried out in selected vineyards.

For investigation and visualization, these results have been digitally integrated by means of a Geographic Information System (Reitner et al. 2011), the software product ArcGis (ver. 10.x, ESRI, Redlands, USA) was used. Within the GIS framework, the resulting various thematic layers and geodata analyses expose the geoenvironmental properties and variability of the wine growing region to define the physiogeographic characteristics of the vineyards. Finally the study report combined written text, graphics and printed maps to present these results. The compendium of maps consists of 54 thematic maps for each of the 15 study regions.

As an interactive approach should accompany the study report, a selected set of the thematic layers and geodata analysis results have been converted to multilayer web services and an accompanying web map application. Using the web map interface, the study results are readily available to winemakers of the region, enabling on screen navigation to areas of interest and selection of layers for display in any desired combination, by using a familiar web browser.

The web map shall serve as a hands-on tool for the winemakers, to investigate the study results according to their vineyards and to perceive their variable characteristics, to support zoning, vineyard management and future planning, i.e. choosing rootstock and varieties. The web map may also be used as an auxiliary tool to investigate the interdependence of grainsize, mineralogy and geochemistry of soil and geology of the vineyards to explore the lateral and regional variation.

2 MATERIALS AND METHODS

The compendium of maps (54 thematic maps for each of the 15 study regions), is based on thematic GIS layers which result out of an extensive multidisciplinary investigation programme, consisting of:

- measurement of microclimatic parameters (i.e. wind speed and direction, air temperature, solar radiation, precipitation, air humidity, evapotranspiration),
- measurement of soil temperature,
- compilation of geological maps, showing the lithostratigraphic units within the vineyards of the region
- detailed mapping of the quaternary loess and loam cover of the region at the scale of 1:10,000,
- compilation of soil maps at the scale of 1:25,000 and 1:10,000,
- integrative pedologic and geological survey of sampling pits,
- geomorphologic evaluation of high-resolution digital terrain models,
- shallow geophysical measurements of apparent resistivity,
- hydrologic investigation and
- sampling for grainsize, mineralogical and geochemical analysis of soil and bedrock.

Conjointly, these layers describe the physiogeographic characteristics of the vineyards, varying between and within the study regions and also showing within-vineyard variation. Therefore the information content should be made easily accessible to the winemakers.

Unfortunately the GIS layers themselves are only accessible to winemakers who do own a Geographic Information System software product on their own computers at home and who do have sufficient computer skills to use it, as these software products often require a certain amount of computer training and insight. Furthermore, the results of the sample analyses have to be identified by their point number on the maps and searched after in the data tables for their corresponding results. For a large number of points this can be time consuming and complicated.

As recent web map developments are very popular within the user community of the internet, i.e. Google Maps, Bing Maps or internet maps for street navigation, we found that especially the young generation of the winemakers is very familiar with these technologies, which are nowadays readily available on smartphones, tablets and other mobile devices. Therefore we decided that a similar web map application should provide an easily available interactive access to the GIS layers, using familiar web browsers as interface.

A representative set of thematic layers was chosen of the collection of GIS layers for the web map to represent climate, soil, geochemistry, mineralogy, geology and geophysics. There was also the need to fulfill the requirement of copyright provisions, therefore the contributing research institutions had to grant the rights for the chosen layers to present them in the world wide web to the public.

After discussion of the web map project with the project team and the winemakers, the final layout of the web map should consist of a selection of map layers and datasets as follows:

- Administrative layer, for identification of the different study regions
- Climate: Precipitation, air temperature and humidity, solar radiation, soil moisture and soil temperature
- Soil Physics: Available water capacity, hydraulic permeability and lime content
- Soil Chemistry: K, P and Mg in CAL-extract, humus and N content, at 0 – 30 cm and 30 – 60 cm soil depth
- Geochemistry: Analysis of elements Al, K, Ca, Mg, P, Fe, of sample materials of grain size < 2 mm
- Geology: Geological maps 1:10,000 and 1:200,000, grain size analyses, mineralogy and clay mineralogy analyses, location of sample points and soil pits
- Geophysics: Apparent resistivity maps for measurement depths 0 to 0.5 m, 0 to 1.0 m and 0 to 1.7 m

The maps had to be prepared within the Geographic Information System for the Internet with respect to map symbology, map legend and attribute data. Afterwards, the layer datasets have been exported into a central geodatabase at the geological survey of Austria. The maps have then been published as web services, which are hosted also at the Web Server of the survey. Additionally a web map application was built, combining the web services with base maps, i.e. aerial images or topographic maps (Reitner et al. 2014). The application is accessed using a common web browser.

Finally a manual for using the web map has been written and handed over to the winemakers. This manual will guide the winemakers through the first steps when using the web map and will explain the « look and feel » of the web application to new users of the web map.

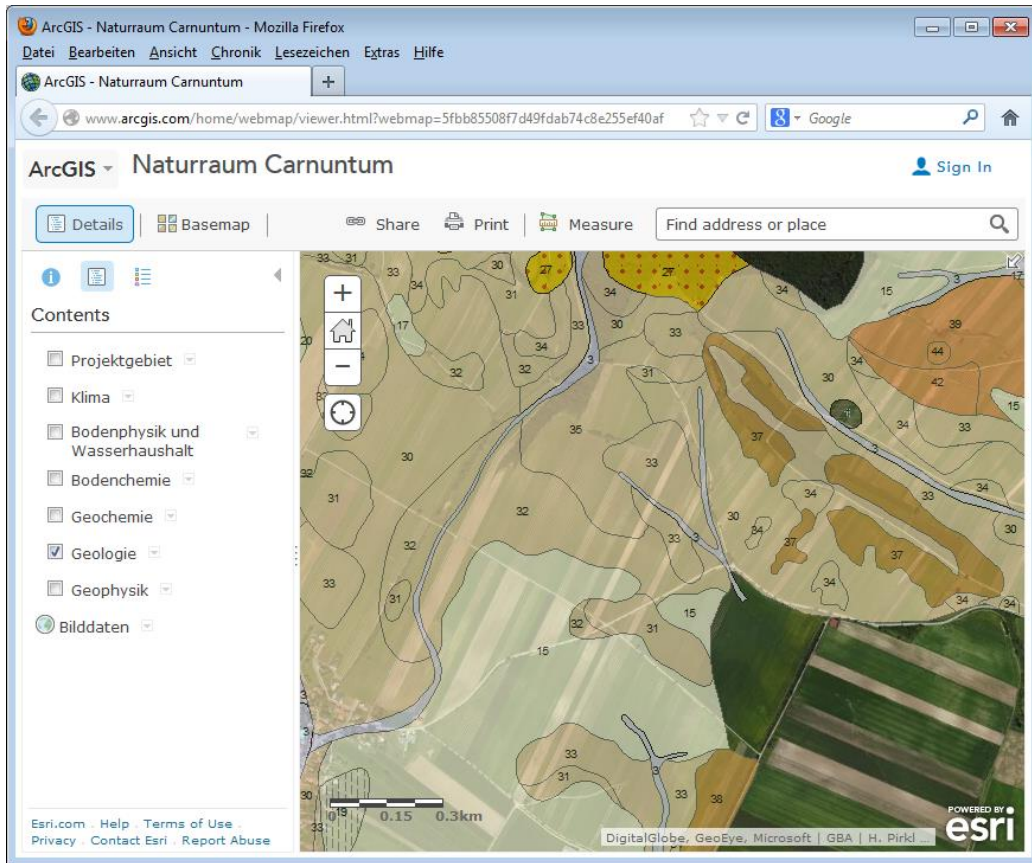
3 RESULTS AND DISCUSSION

After completion, the web map of the Natural Region Carnuntum has been presented at the Rubin Carnuntum association of winemakers and generated a lot of interest (Fig. 2). Using the web map interface, the study results are made easily available to the winemakers of the region, allowing on screen navigation to areas of interest and optional selection of layers for display in any desired combination within a web browser familiar to the winemakers (i.e. Internet Explorer, Mozilla Firefox, Safari, etc.). For example, the geology map may be drawn in optional transparent mode on an aerial image, showing the variation of lithostratigraphic units in the study area for zoning (Fig. 2), or apparent resistivity maps may be displayed on aerial images showing intra-vineyard zones of variation (Fig. 3).

For exploration of the maps an extensive set of interactive tools is provided :

- The order of contents of the thematic groups defines the order of drawing of the thematic layers in the web map, themes on top are „painted over“ the themes at the bottom.
- The winemakers may zoom and navigate to the area of interest and select the themes of interest for display. If one clicks on the label of the themes, the contained data layers and sub themes are shown, with a click on a data layer, the corresponding legend will be shown (Fig. 4). If there are additional sub-layers contained, these will be shown also (Fig. 4). The selected layers may be displayed or be hidden again by switching on and off the corresponding checkboxes (Fig. 4).
- Attributes of selected layers may be displayed by click on the point of interest. There are also pie charts of grain size and mineralogy located at the sample locations, available in the map for display of the analysis results. The winemakers have to click into the center of the pie charts to have a look at the attributes (Fig. 4, Fig. 5).
- Using context menus additional drawing options may be chosen, i.e. the amount of transparency, to use a “shine through” drawing mode. Albeit one may choose other base maps, i.e. a topographic map, the winemakers are most interested in the aerial images to identify their own vineyards.
- To display the legends of the currently drawn themes, the users may click on a “Show Map Legend” button.

There is also a tool provided for printing the map or sharing the web map address to other persons, the winemakers are also able to integrate the web map into their own homepages. An additional tool for drawing and measuring of lines and polygons within the map is also available. Using a mobile device with global positioning hardware (GPS) in the field, the web map will display the current position of the user on the map window.



**Figure 2: Thematic groups of the web map
(Geology currently chosen for transparent display on top of aerial image)**

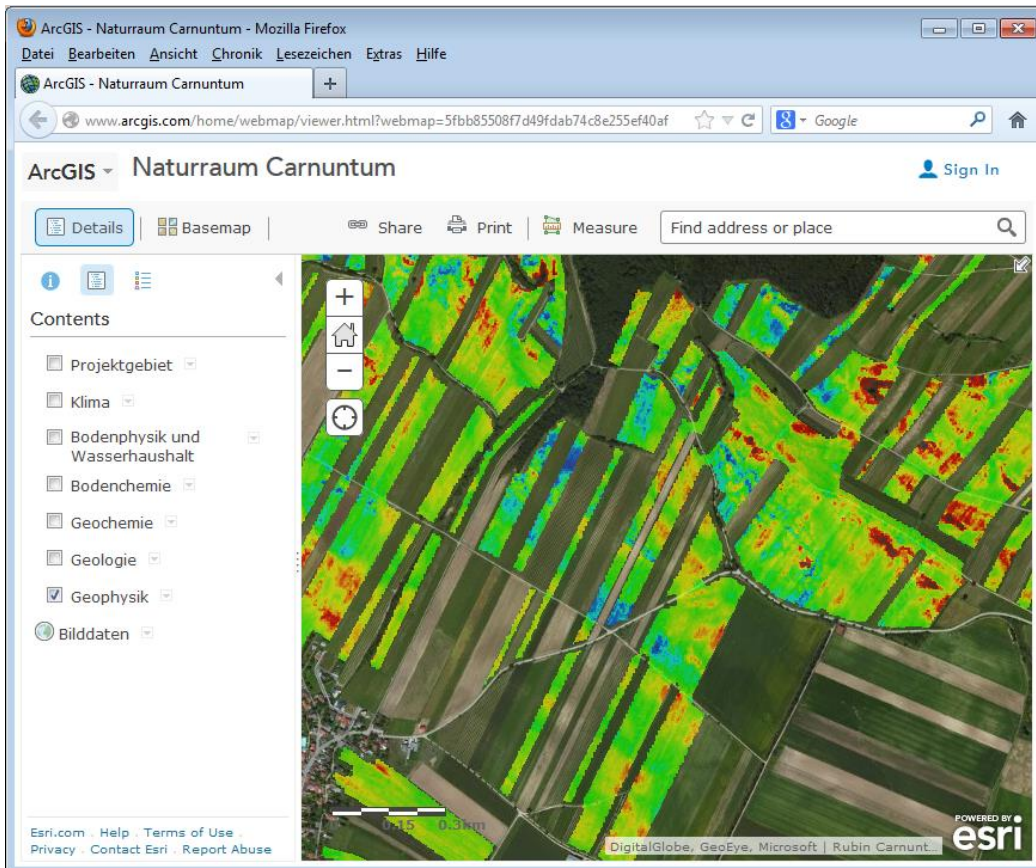


Figure 3: Geophysics map (apparent resistivity) displayed on top of aerial image

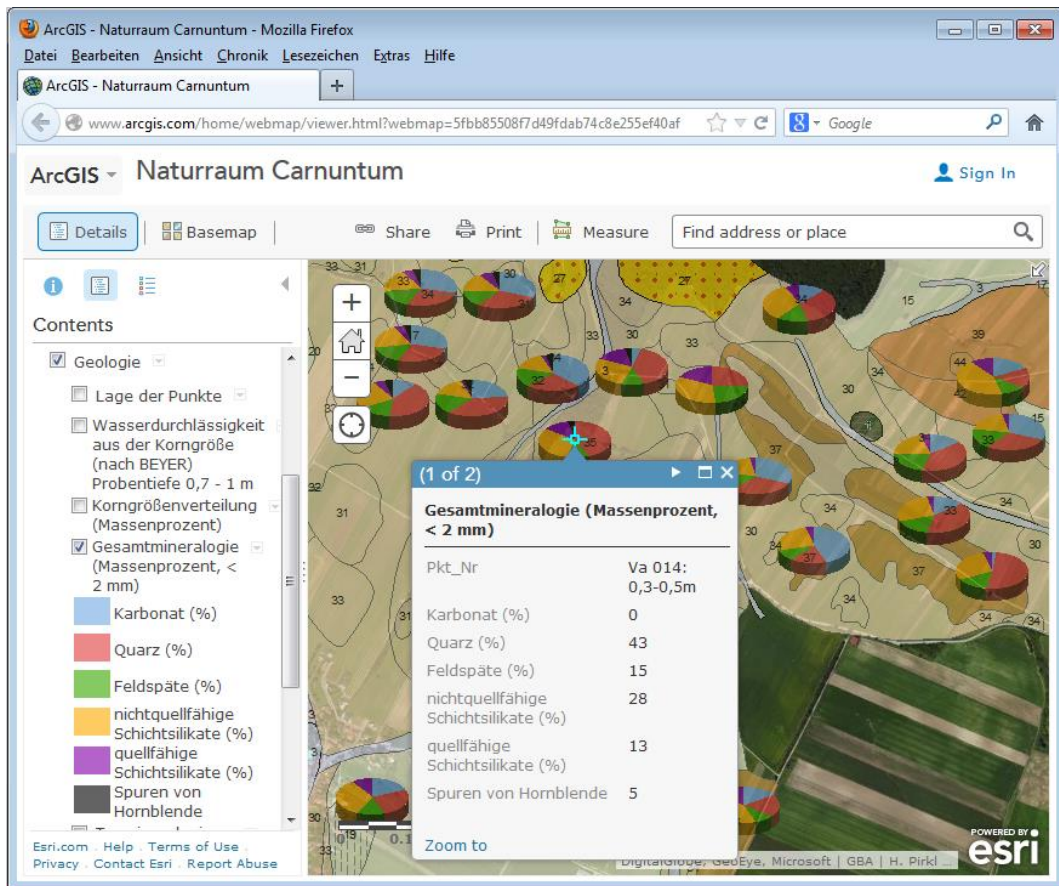


Figure 4: Piecharts of mineralogy analysis displayed on top of geology and aerial image

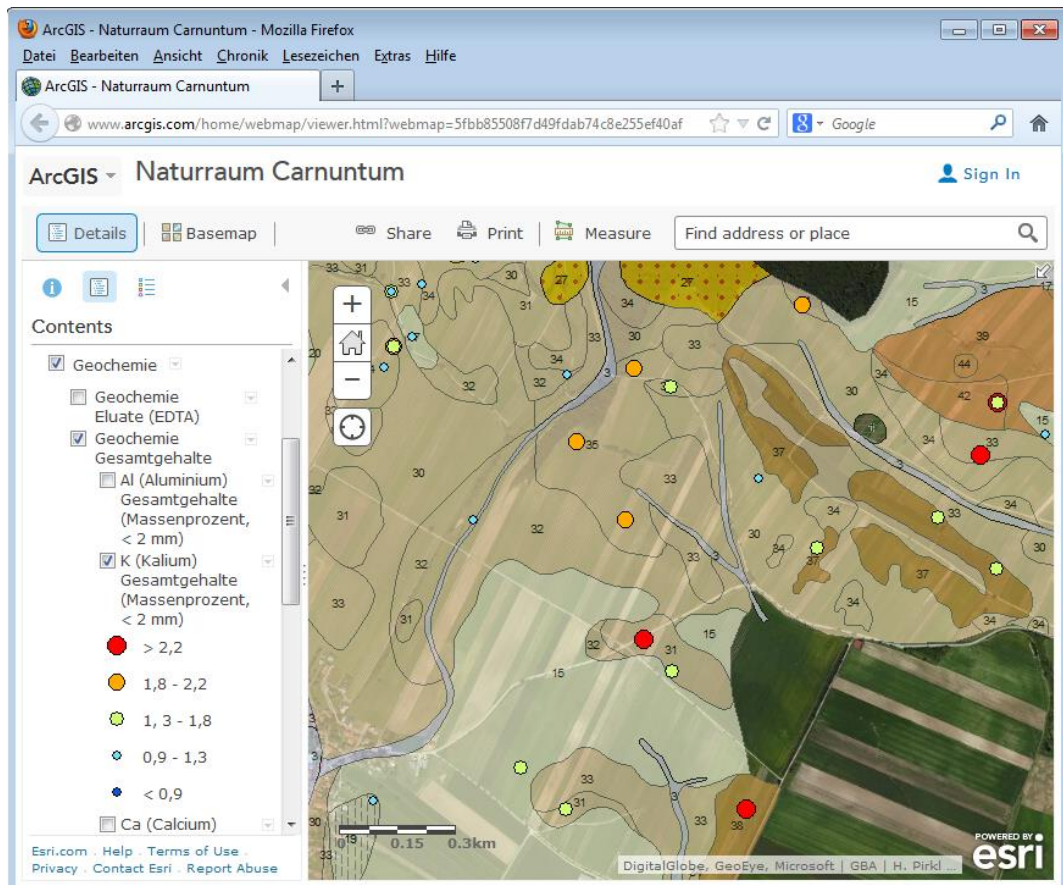


Figure 5: Potassium content (K, wt %) displayed on top of geology and aerial image

Additionally, the web services of the web map (climate, soil physics, soil chemistry, geochemistry, geology and geophysics) can be used separately with other web map applications or GIS software products.

The web map will also be used as an auxiliary tool to investigate the interdependence of grain size, mineralogy and geochemistry of soil and geology of the vineyards to explore their lateral and regional variation. A first investigation of lateral variation has already shown the correlation of grain size and mineralogy content of soil profiles (Heinrich et al. 2012), a further analysis will focus on regional variation of grain size and geochemistry. First results already show a correlation of the content of fines with certain main elements, i.e. Potassium and with the amount of trace element contents. This interpretation will be supplemented using statistical methods for compositional data to describe the multiparametric characteristic and variability of mapped units of the natural environment of Carnuntum.

4 CONCLUSION

When the web map has been presented at the Rubin Carnuntum association of winemakers in spring 2014, the winemakers evidenced a lot of interest in the web map. Regarding the future usage of the web map, there seems to be a generation gap between the younger and older generation of winemakers, as the younger winemakers can be considered as so-called digital natives, they are accustomed to internet-based information. As the Geological Survey of Austria is committed to host the results of its own research studies as web map services, the web map will hopefully serve for years to come and will be hopefully complemented with additional study results and extended to other wine-growing regions. The web map Natural Region Carnuntum shall primarily serve as an information tool for the winemakers, but since it is open available to everyone, it will also communicate scientific research for the investigation of winegrowing regions to the public.

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