Do regional patterns of geological substrate and trends over time show in isotope data of Austrian wines?

Maria HEINRICH[1], Micha HORACEK[2], Heinz REITNER[1]

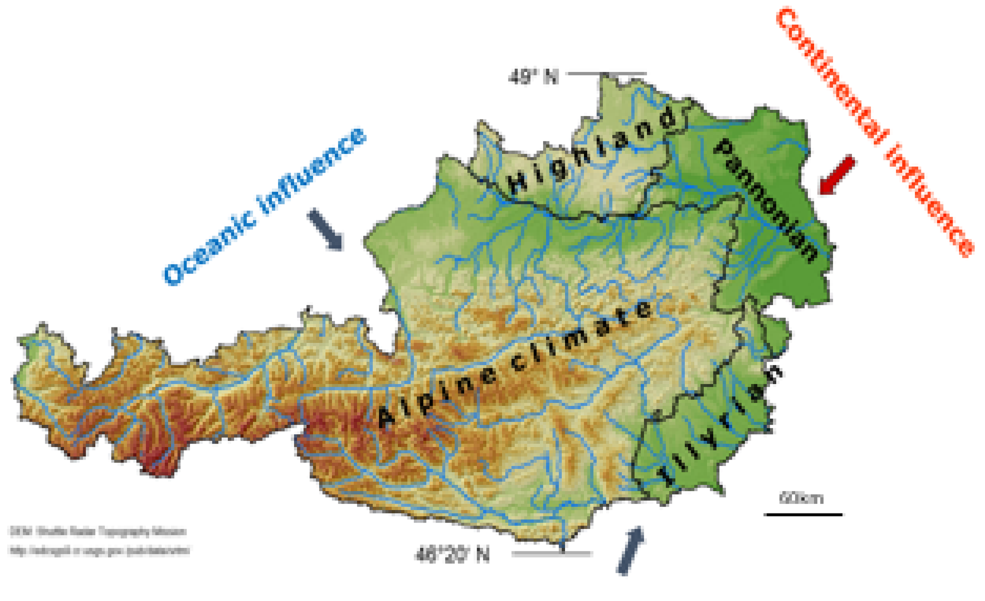
[1]GBA Geological Survey of Austria, A-1030 Wien, Neulinggasse 38, Austria [2]HBLFA Francisco-Josephinum–Research Center BLT Wieselburg, A-3250 Wieselburg, Rottenhauserstr. 1, Austria

Background

Neubauer & Höck 2000

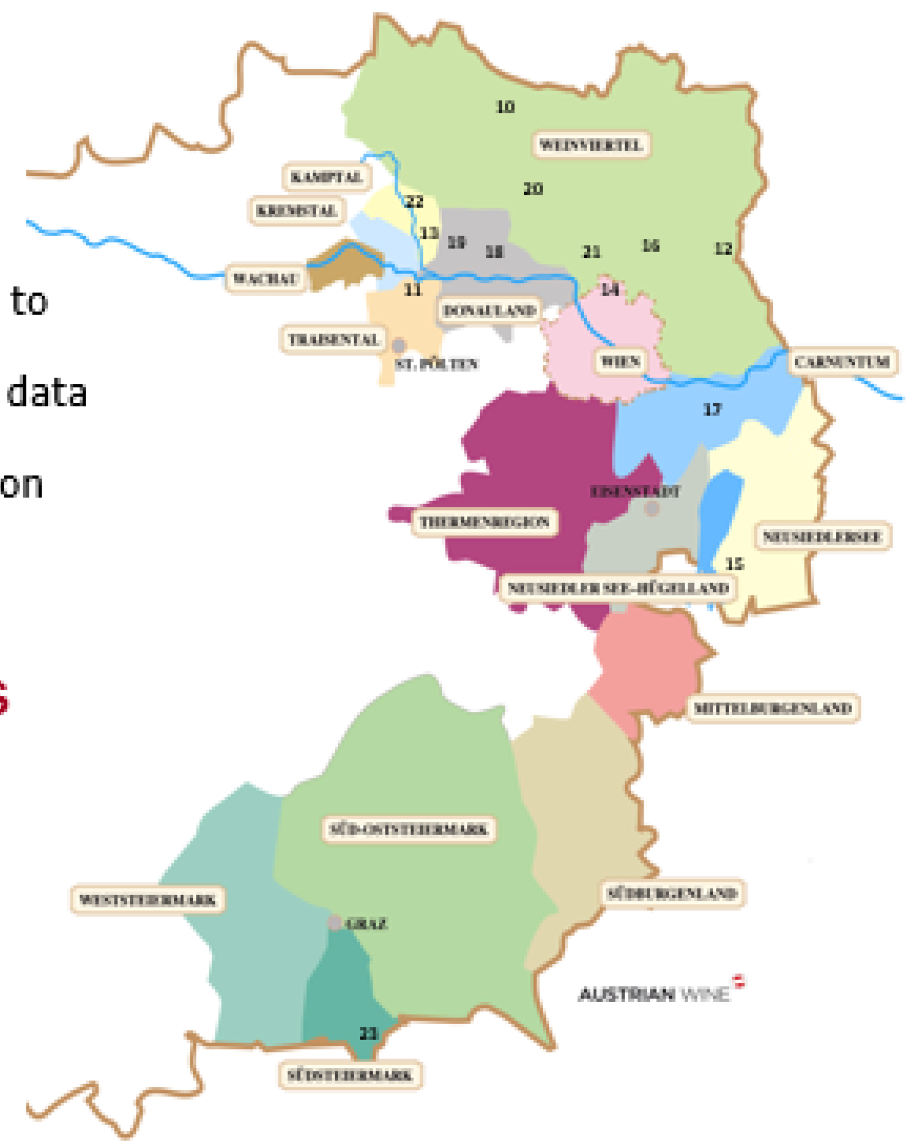
Austria is a small, landlocked republic in the center of Europe. The mostly mountainous country covers an area of 83,871 km² and has 8,474,000 inhabitants.
Situated between the 46°20' and 49° N parallels, Austria lies near the northern fringe of the northern hemisphere's wine-growing belt. Due to plate tectonics, Variscan and Alpine mountainous areas slope down to basins in the eastern part of the country.

Combining relief with Continental influence from the east and Mediterranean influence from the south, the Pannonian and Illyrian climate provinces provide favourable conditions of humidity, sunshine and temperature for wine-growing.



The Geological Survey of Austria has performed geological mapping in wine-growing regions with emphasis on lithology and mineralogy of the substrate and on topset beds.

However, results have not been linked to grape-, must- or wine functional parameters so far. The stable isotope data of wines, measured in Austria for authenticity control under EC-Regulation 2676/1990, might provide this link.

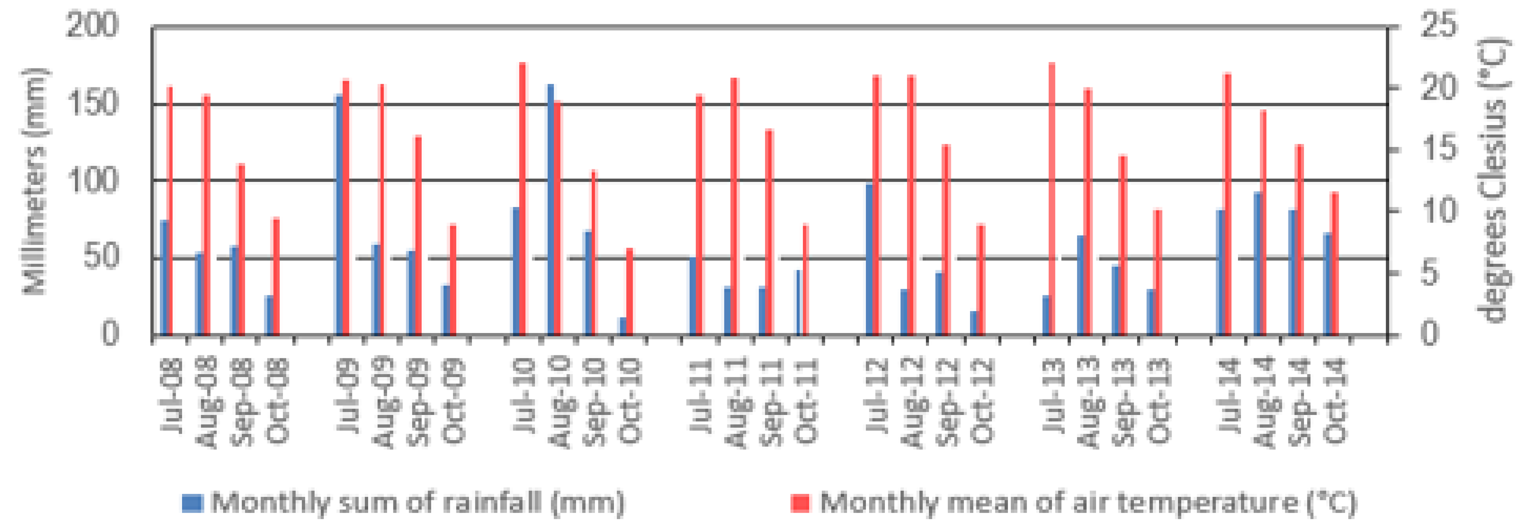


Materials

Altogether, 361 samples of red and white wines of 83 different vineyards were collected during the period of 2008 - 2014. For our study 14 samples of different white wine vineyards were selected.

No.	Variety	Wine-growing region	Lithology-Geology
10	Grüner Veltliner	Weinviertel	sandy clay-silt (Miocene) partially covered by loess
11	Grüner Veltliner	Traisental	sandy gravel-konglomerate (Miocene) partially covered by loess
12	Welschriesling	Weinviertel	sand-silt (Miocene) partially covered by loess
13	Grüner Veltliner	Kamptal	loess covering clay-silt-sand and gravel (Miocene) and crystalline rocks
14	Chardonnay	Wien	loess covering sandy gravel (Quaternary)
15	Welschriesling	Neusiedlersee	sandy gravel (Quaternary)
16	Grüner Veltliner	Weinviertel	loess (Quaternary)
17	Grüner Veltliner	Carnuntum	sand-silt (Miocene) partially covered by loess
18	Chardonnay	Donauland	loess covering sandy gravel (Quaternary)
19	Grüner Veltliner	Donauland	loess (Quaternary)
20	Rheinriesling	Weinviertel	sandy gravel, layers of silt (Miocene)
21	Grüner Veltliner	Weinviertel	sandstone with layers of silt or marl (Paleogene) partially covered by loess
22	Rheinriesling	Kamptal	crystalline rocks, conglomerate-arkose (Paleozoic) partially covered by loess
23	Chardonnay	Südsteiermark	silt/marl-sand, conglomerate (Miocene)

➡ Materials



Five weather stations were selected in the vicinity of the vineyards sampled for wine isotope analysis. Datasets include monthly sums of rainfall (MRF) in millimeters (mm) and monthly means of air temperature (MAT) in degrees Celsius (°C). The figure above shows the range of values at a weather station in the Kamptal/Traisental/Wagram region.

Summary statistics of meteorological data (n=35) for the period 2008 to 2014. MRF = monthly sum of rainfall in millimeters (mm), MAT = monthly mean of air temperatures in degrees Celsius (°C)

(climate data source: URL https://www.zamg.ac.at/cms/de/klima/klimauebersichten/jahrbuch)

	MRF Jul	MRF Aug	MRF Sep	MRF Oct	MAT Jul	MAT Aug	MAT Sep	MAT Oct
Min.	4	23	15	12	19,3	17,9	13,1	6,7
1st Qu.	67	43	41	25	20,3	19,5	14,5	8,9
Median	83	59	58	32	21,2	20,4	15,4	9,5
Mean	89	75	64	37	21,2	20,2	15,4	9,7
3rd Qu.	113	96	77	44	22,0	21,0	16,6	10,7
Max.	258	232	9	29	23,7	22,6	18,6	12,4

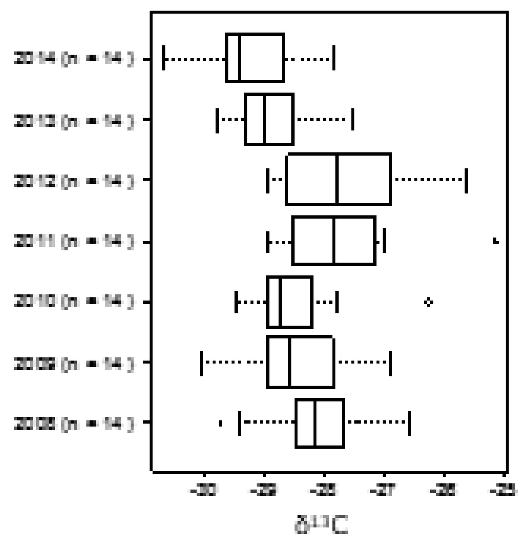
Results

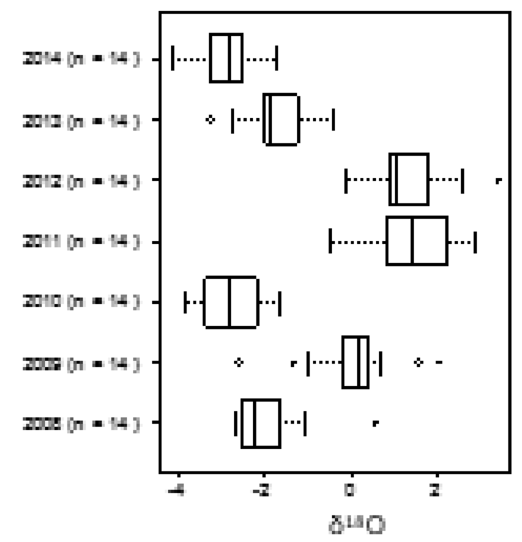
Summary statistics of $\delta^{13}C$ and $\delta^{18}O$ data for the selected white wine samples from the period 2008 - 2014.

	$\delta^{13}C$	$\delta^{18}O$
Min.	-30,65	-4,18
1st Qu.	-28,93	-2,53
Median	-28,48	-1,56
Mean	-28,32	-0,92
3rd Qu.	-27,72	0,76
Max.	-25,15	3,44

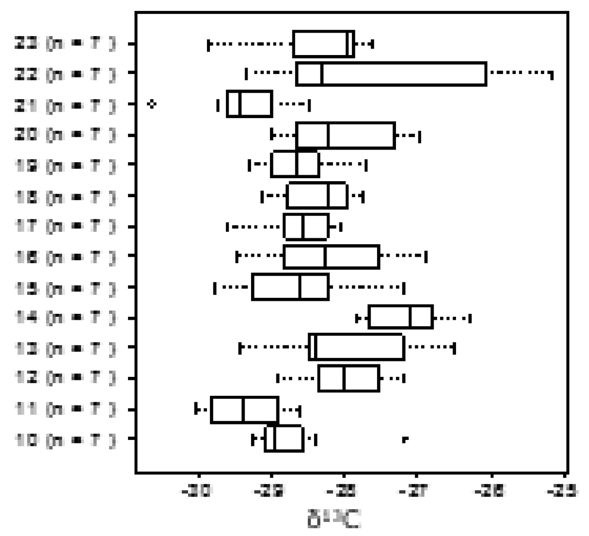
	MRF Jul	MRF Aug	MRF Sep	MRF Oct	MAT Jul	MAT Aug	MAT Sep	MAT Oct
$\delta^{13}C$	-0,03	-0,28	-0,31	-0,05	-0,31	0,29	0,13	-0,26
$\delta^{18}O$	0,15	-0,59	-0,56	0,20	-0,37	0,73	0,69	-0,07

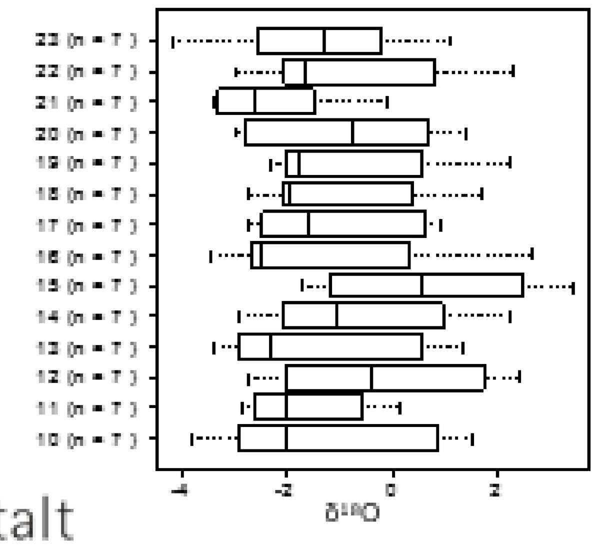
For carbon isotope ratios, there are weak negative correlations with rainfall in August and September. Correlations with mean air temperature are also weak and not consistently positive or negative. Oxygen isotope ratios are negatively correlated to rainfall in August and September, while stronger positive correlations exist with mean air temperatures of August and September.





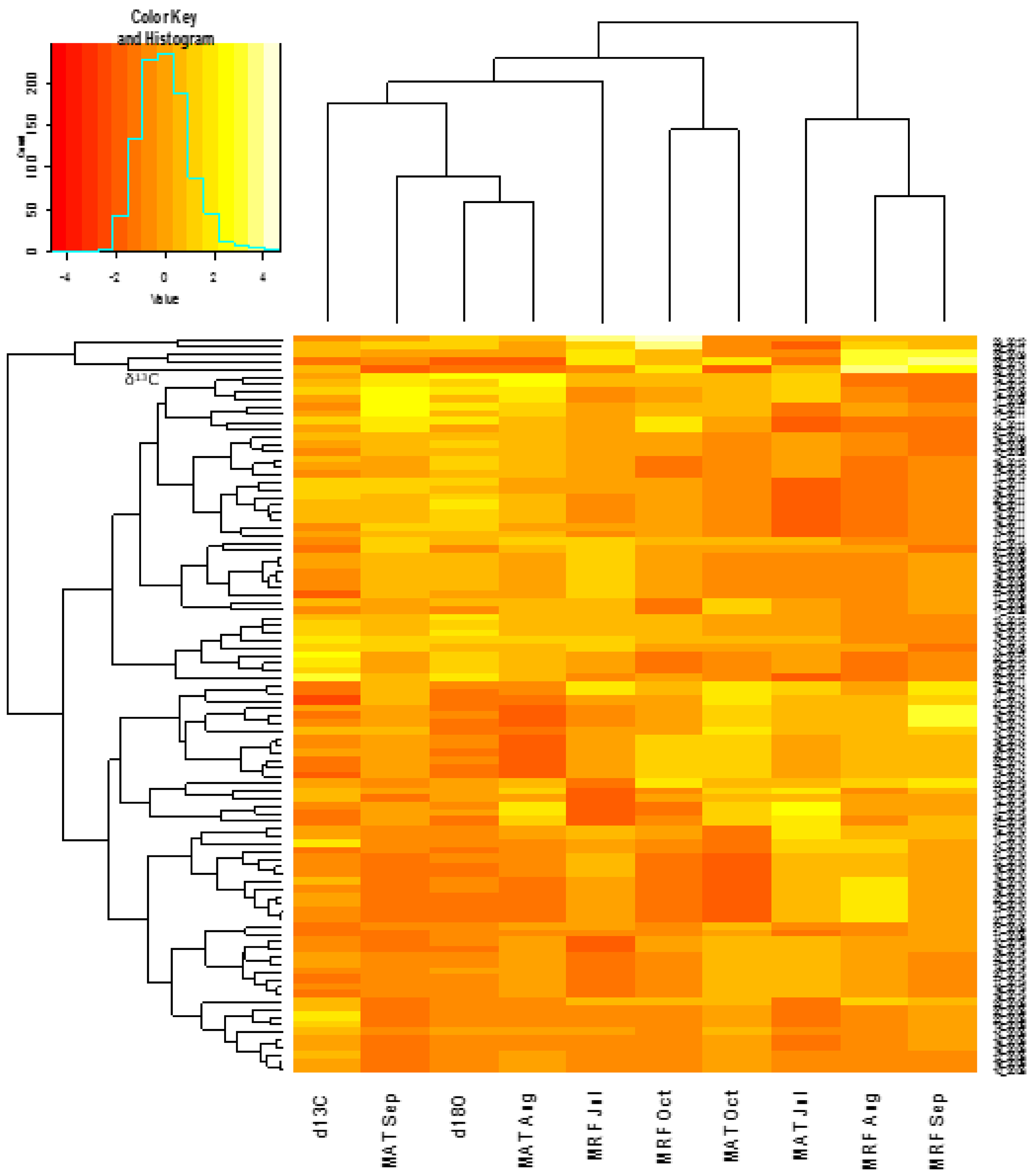
During the six-year period of 2008 – 2014, wine isotope ratios are distinct for each year of sampling. This effect is more pronounced for oxygen than for carbon ratios. For both isotope ratios, a higher variability exists in years of low rainfall.





Between vineyards (number 10 to 23), there are distinct differences in $\delta^{13}C$ ratios while differences in $\delta^{18}O$ ratios are less significant.

➡ Results



The cluster analysis groups the majority of samples according to sampling year, especially for years when a higher amount of rainfall occurred. However, when the amount of rainfall was lower, many samples of one year are statistically correlated to, and grouped with, samples of other years. The results of the isotope and meteorological parameter groups are consistent with the findings of the correlation table, i.e. the sums of rainfall in August and September are combined first.

Conclusions

As carbon isotope ratios reflect the water status of the plants, it is assumed that region and parent rock material of the vineyards play a significant role, in addition to the influences of variety, rootstock, weather, vineyard management and the work of the winemaker. In comparison to large-scale studies, our preliminary results on national level so far do not give a clear indication of correlation of soil/bedrock and its influence on the consequences of climate change for wine production. Possibly a larger number of localities will facilitate the identification of this influence.

Future Work

In future projects, the authors will focus in more detail on the influence of clay mineralogy of soil and substrate on $\delta^{13}C$ ratios measured on grape sugar in order to avoid the influence of wine-making on the isotope ratio of the samples and to gain information on the vulnerability of vineyards to climate change.

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