avec le fonctionnement normal de la plante. Cet ainsi que les études du sol ne son pas, par eux-mêmes, capables de décrire et expliquer le fonctionnement de la plante et l'évolution de la baie. Il est nécessaire, en conséquence, une approche globale (voir 11) qui tienne en compte les niveaux de la plante et de la baie en relation avec le contexte environnemental et la variété.

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Soil chemistry as a measure of the distinctiveness of american viticultural areas of the Columbia basin, USA

Kevin POGUE[1*], Erica PITCAVAGE[1]

[1] *Department of Geology, Whitman College, 345 Boyer Ave., Walla Walla, WA 99362 USA*
[*] *Corresp. author : Pogue, Telephone: 509-527-5955, Fax: 509-527-5904, Email : pogue@whitman.edu*

ABSTRACT

The Columbia Basin, a semi-arid region centered in the eastern part of Washington State, is the second largest wine grape growing region in the United States and presently contains 10 American Viticultural Areas (AVAs). Eight of the Columbia Basin's AVAs are smaller subdivisions (sub-AVAs) of the 46,100 km^2 Columbia Valley AVA. Although legally distinct, the Columbia Basin AVAs are generally similar with regard to climate, landscape, and soils, the principle components of physical terroir.

To test whether the AVAs of the Columbia Basin are distinguishable based on the chemical properties of their soils, 53 samples were collected from vineyards considered to be representative within their respective AVAs. Sampled locations within each vineyard were selected as typical based on the advice of resident viticulturalists. Vineyard soils from the Willamette Valley and Snake River Valley, which are other major viticultural regions of the Pacific Northwest, were also sampled for comparison.

Soils were sampled from a depth of 50-75 cm and analyzed for bulk chemistry and plant-available nutrients. The analyses revealed that, of the 10 AVAs, only the Columbia Gorge, Walla Walla Valley, and Lake Chelan AVAs have distinct differences that could be attributed to variations in climate and parent material. Columbia Basin soils could be readily distinguished from vineyard soils of the Willamette Valley and Snake River Valley based on compositional differences that result primarily from variations in soil parent material and climate-controlled rates of weathering.

Keywords: Columbia Basin, Columbia Valley, soil, chemistry, Pacific Northwest.

INTRODUCTION

The Columbia Basin, in the eastern part of the state of Washington, contains the largest and most productive viticultural region in the United States outside of California. Almost all Columbia Basin vineyards lie within the Columbia Valley American Viticultural Area, a grape-growing area whose boundaries are legally defined by the Alcohol and Tobacco Tax and

Trade Bureau (TTB) of the United States Government. The boundary of each American Viticultural Area (AVA) is established by a petitioner who must submit "evidence that the geographical features of the area produce growing conditions that distinguish the proposed area from surrounding areas" (Section 4.25a(e). Title 27, Code of Federal Regulations). There are no limits on the size of AVAs and the Columbia Valley is the second largest in the United States, encompassing 46,100 km^2 (Fig. 1). Viticulture within the Columbia Valley AVA occurs mostly in semi-arid regions at elevations below 600 m in loess-based soils that overlie Miocene basalt bedrock or silt, sand, and gravel deposited by cataclysmic Pleistocene floods (1). However, in such a large area, there are obviously substantial variations in the principle components physical terroir.

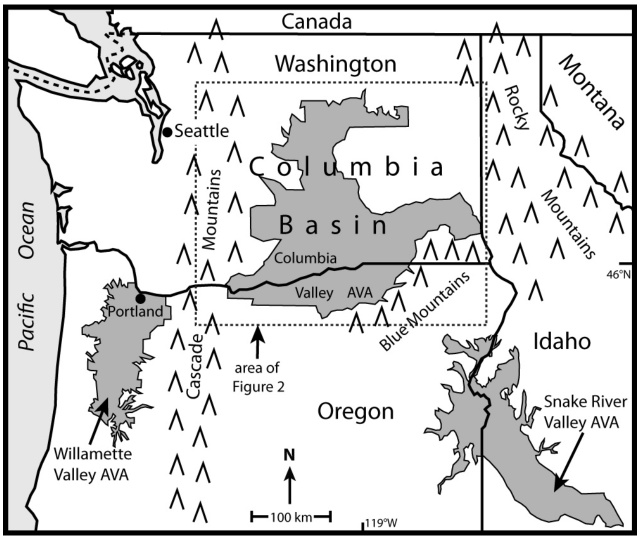

Figure 1. Location of major viticultural regions of the US Pacific Northwest.

In the 28 years since the Columbia Valley AVA was established, the desire of viticulturalists and winemakers to highlight variations in Columbia Basin terroir led to the creation of nine smaller AVAs, eight of which lie within the boundaries of the Columbia Valley AVA (Fig. 2). These sub-AVAs range in area from 18.4 km^2 (Red Mountain) to 2830 km^2 (Yakima Valley). Although the terroir of some Columbia Basin AVAs can be readily differentiated based on geomorphology, climate, or bedrock type, it is not known whether their terroir could be differentiated based on soil chemistry. This study examines the chemistry of vineyard soils of the Columbia Basin, and discusses whether chemical variations can be used to discriminate the basin's AVAs. The distinctiveness of Columbia Basin vineyard soils relative to the soils of other major viticultural regions of the US Pacific Northwest is also examined.

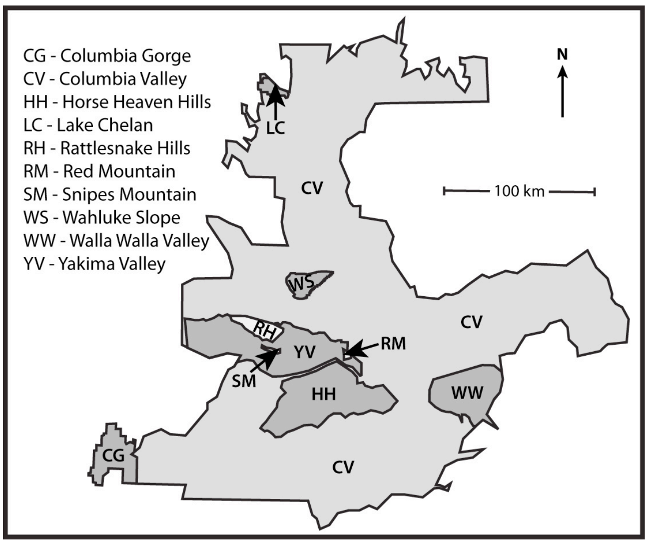

Figure 2. Location of American Viticultural Areas (AVAs) of the Columbia Basin.

MATERIALS AND METHODS

Fifty-six samples were obtained from vineyards throughout the Columbia Basin, three from the Columbia Gorge AVA and 53 from the Columbia Valley AVA. The samples from the Columbia Valley AVA include 44 from the eight sub-AVAs and nine from vineyards not within a sub AVA. The sampled vineyards all have terroirs that are widely considered to be representative of their respective AVAs and include all 20 of Washington's premier vineyards, according to wine critic Paul Gregutt (2). For regional comparisons, samples were obtained from four representative vineyards within Oregon's Willamette Valley AVA and from three Idaho vineyards that lie within the Snake River Valley AVA. Sample locations were selected with the assistance of the local vineyard managers who helped to identify representative sites within each vineyard. Multiple sites were sampled within a few of the larger vineyards. At most sites, samples were collected from a depth of 50 to 75 cm using a bucket auger. In a few sites, the presence of large rocks or hardpans required that samples be obtained from shallower depths.

All samples were desiccated in an oven and sieved to <2 mm particle size. Soiltest Farm Consultants Inc. of Moses Lake, Washington, conducted analyses for plant-available elements, pH, organic matter, and soluble salts. Analyses for bulk elemental composition were performed at Whitman College using an Innov-X Alpha Series portable X-ray fluorescence spectroscoper (PXRF). Precision and accuracy were evaluated by periodic measurements of US Geological Survey reference samples. A more detailed description of analytical methods is presented by Pitcavage (3).

RESULTS AND DISCUSSION

Complete results from the chemical analyses are presented by Pitcavage (3). The following discussion will focus on the results of 12 analyses, which are presented in Figures 3 and 4. The Yakima Valley (YV) and Columbia Valley (CV) columns on figures 3 and 4 incorporate data from all of the sub-AVA's within each region. The Columbia Basin (CB) column combines the data from the Columbia Valley and Columbia Gorge AVAs.

The graph of weight percent iron (Fig. 3A) shows substantial overlap between the AVAs of the Columbia Basin with the exceptions of Lake Chelan, which has consistently lower values, and the Columbia Gorge, which has slightly higher values. The weight percent iron values for the Willamette Valley are significantly higher than for the Columbia Basin and those for the Snake River Valley are slightly lower. On the graph of plant available iron (Fig. 3B) the Walla Walla Valley has higher values than other Columbia Valley AVAs and the Columbia Gorge has values that range as high as those in the Willamette Valley. Plant available iron values for the Snake River Valley are low, but overlap those of the Columbia Basin.

Bulk manganese concentrations (Fig. 3C) closely mimic those of iron except that the Columbia Gorge values overlap with those of other Columbia Basin AVAs. There is minor variability and considerable overlap in plant-available manganese concentrations (Fig. 3D) within the Columbia Basin AVAs, with the exception of higher values in the Columbia Gorge.

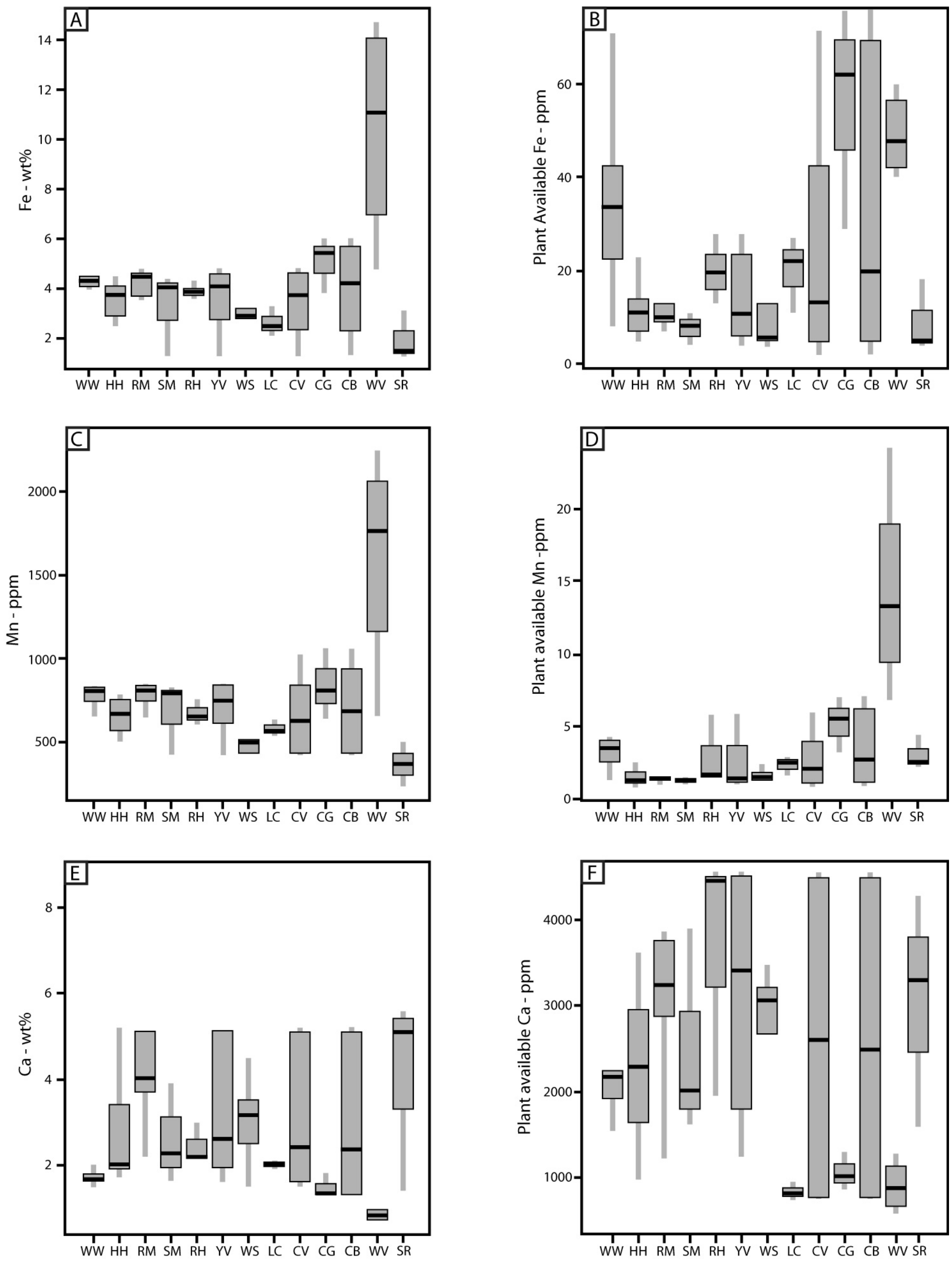

Figure 3. Results of chemical analyses of soils from Pacific Northwest AVAs.

Median manganese concentrations in the Snake River Valley are similar to those in the Columbia Basin, but values for the Willamette Valley samples were all significantly higher.

On the graph of weight percent calcium (Fig. 3E), the Walla Walla Valley, Lake Chelan, and Columbia Gorge have lower values and Red Mountain higher values than other Columbia Basin AVAs. Values for the Snake River Valley largely overlap with the relatively high values from Red Mountain, while concentrations in the Willamette Valley were consistently below those of the Columbia Basin. Plant available calcium (figure 3F), shows much greater variation, and the Lake Chelan and Columbia Gorge AVAs have values that are similar to the Willamette Valley and considerably lower than the rest of the Columbia Basin.

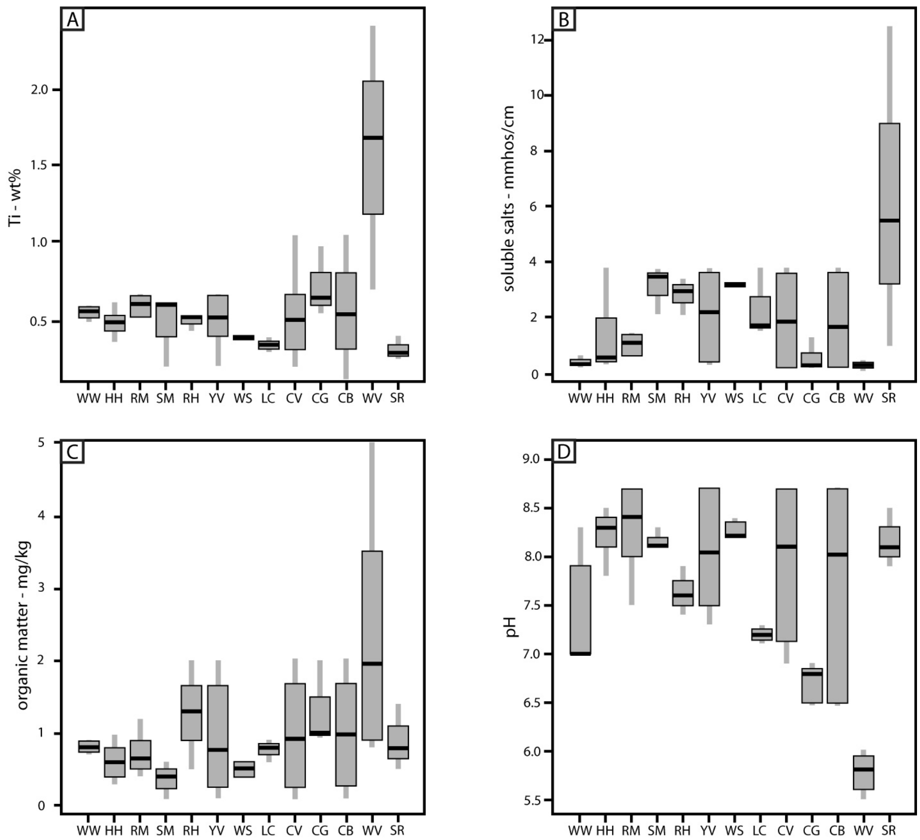

Figure 4. Results of chemical analyses of soils from Pacific Northwest AVAs.

Titanium concentrations (Fig. 4A) are relatively consistent throughout the Columbia Basin AVAs, with slightly lower concentrations at Lake Chelan and slightly higher concentrations in the Columbia Gorge. The lowest values were obtained from the Snake River Valley. Titanium concentrations in all the Willamette Valley samples are well above those of the Columbia Basin.

Soluble salts (Fig. 4B) are somewhat lower in the Walla Walla Valley and the Columbia Gorge than elsewhere in the Columbia Basin and similar to the very low concentrations measured in the Willamette Valley. Soluble salt concentrations in the sampled Snake River Valley vineyards are significantly higher than those in the Columbia Basin.

Organic matter (Fig. 4C) averaged 0.5 to 1.5 mg/kg throughout the Columbia Basin and in the Snake River Valley. The lowest values were measured at Snipes Mountain and the highest in the Rattlesnake Hills. In some Willamette Valley soils, organic matter was more than double the average for the Columbia Basin.

The pH of the sampled Columbia Basin vineyard soils averaged near 8.0 (Fig. 4D). Soils from Lake Chelan and the Walla Walla Valley had the lowest values of the Columbia Valley sub-AVAs. The pH of Columbia Gorge samples was consistently below that of any of the Columbia Valley AVA samples. The Snake River Valley samples had pH values that overlapped with the Columbia Basin samples, but the pH of the samples from the Willamette Valley were well below that of any of the Columbia Basin samples, ranging from 5.7 to 6.0.

The terroirs of three of the Columbia Basin's AVAs (the Columbia Gorge, Walla Walla Valley, and Lake Chelan) can be discriminated based on the analytical results described above. Columbia Gorge AVA soils are the most distinctive, with significantly higher iron, manganese, and titanium, and significantly lower calcium, soluble salts, and pH compared to other Columbia Basin AVAs. These chemical characteristics can be attributed to a combination of thinner loess, which allows a greater influence of basaltic bedrock on soil composition, and an average annual precipitation of 76 cm, which is three times that received by most of the Columbia Basin. The Columbia Gorge, for which the AVA is named, is a major gap in the Cascade Mountains that allows atmospheric moisture derived from the Pacific Ocean to reach the eastern side of the Cascade Mountains. Another wetter-than-normal part of the Columbia Basin is the Walla Walla Valley where orographic lifting by the Blue Mountains increases the average annual precipitation in the eastern part of the AVA to near 50 cm. As a result, vineyard soils of the Walla Walla Valley, like those of the Columbia Gorge, have higher iron, and lower calcium and soluble salts than most other Columbia Basin AVAs. Unlike most Columbia Basin vineyard soils, which are developed primarily in loess, soils of the Lake Chelan AVA are developed in a mixture of loess, volcanic ash and pumice, and glacial till that is largely of granitic composition (4). The uniqueness of Lake Chelan AVA soils is reflected in decreased concentrations of iron, calcium, and titanium, relative to all other Columbia Basin AVAs.

Based on the analytical results described above, the vineyard soils of the Columbia Basin can be readily distinguished from those of the Willamette Valley and Snake River Valley. Relative to Columbia Basin soils, Willamette Valley soils are higher in iron, manganese, titanium, and organic matter, and lower in calcium, soluble salts, and pH. The contrasts in soil chemistry are attributable to significant differences in climate and soil parent material. The Willamette Valley receives 100 cm of annual precipitation, which is four times the average for the Columbia Basin, and Willamette Valley vineyard soils are developed not in loess, but in deeply weathered colluvium derived from basalt and sedimentary rocks (5). The sampled vineyard soils of the Snake River Valley could be distinguished from those of the Columbia Basin by lower concentrations of iron, manganese, and titanium and higher concentrations of soluble salts. The differences in soil chemistry can be attributed primarily to contrasting parent materials. Snake River Valley vineyard soils, which are developed primarily in loess and fluvial and lacustrine sediments derived from granitic or silicic volcanic rocks (6), are less influenced by basalt bedrock than their Columbia Basin counterparts.

CONCLUSIONS

Based on the analyses performed by this study, three of ten Columbia Basin AVAs, the Columbia Gorge, Walla Walla Valley, and Lake Chelan, are distinguishable based on soil chemistry. The distinctive soils of these three regions arise from significant differences in climate and soil parent material. The chemical components analyzed in the study allow Columbia Basin viticultural soils to be distinguished from their counterparts in the Willamette Valley and Snake River Valley AVAs.

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Contribution of soil for tipifiyng wines in four geographical indications at Serra Gaúcha, Brazil

Eliana Casco SARMENTO[1,*], Carlos Alberto FLORES[2], Eliseu WEBER[3], Heinrich HASENACK[3], Reinaldo Oscar PÖTTER[4], Elvio GIASSON[1]

[1] *Universidade Federal do Rio Grande do Sul, Faculdade de Agronomia, PPG em Ciência do Solo, Av. Bento Gonçalves, 7712, Caixa Postal 15.100, CEP 91540-000, Porto Alegre/RS, Brasil.*
[2] *Embrapa Clima Temperado, BR. 392, km 78, CP. 403, CEP 96010-971, Pelotas/RS, Brasil.*
[3] *Universidade Federal do Rio Grande do Sul, Centro de Ecologia, Av. Bento Gonçalves, 9500, CP. 15007, CEP 91501-970, Porto Alegre/RS, Brasil.*
[4] *Embrapa Florestas, Estrada da Ribeira, km 11, CP. 319, CEP 83411-000, Colombo/PR, Brasil.*
[*] *Corresp. author: Sarmento, Telephone +55 51 3308-6001, Email : eliana.sarmento@ufrgs.br*

ABSTRACT

Brazil has a recent history on geographical indications and product regulation for high quality wines. The first geographic indication implemented was the Vale dos Vinhedos Indication of Procedence (IP), within the wine production zone named Serra Gaúcha, northeast of State Rio Grande do Sul. During the last decade, the Vale dos Vinhedos ascended to the category of Denomination of Origin (DO) and three new IPs were–delimited in the same region: Pinto Bandeira, Altos Montes and Monte Belo. It is known that production of high quality wines depends on the interaction of environmental factors and human activities. At local scale, soil plays important role since several factors affecting grape and wine quality are related to soil properties. The objective of this study was to evaluate potential contributions of soil to differentiate between wines produced in each of the four geographic indications at Serra Gaúcha. Material used included a digitized soil map in scale 1:50.000 of Serra Gaúcha and digital georeferenced boundaries of