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To: Grape and Wine Producers

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1. A review of the 2013 Technical Study Tour to Alsace, Burgundy and Champagne.

Fortunately, not all who wander are lost. My colleague Professor Pascal Durand and I hosted another industry technical study tour in December 2013, spending three days in Champagne, two in Alsace/Germany and four in Burgundy. There were many interesting aspects of this excursion including culinary (we were treated to numerous demonstrations of the French genius for the gastronomic marathon-the ability to spend as long at the table as other nationalities spend watching TV), and cultural. The technical ponderings certainly raised my conciseness a few feet, none more engaging than our discussions regarding *terroir.* The following is an outline of some of our discussions related to this subject. In a mereological sense it is interesting to note that reputation tapping (wine marketing by comparing emerging regions such as Virginia with those fully established and esteemed) may be an important strategy (Rickard et al. 2012), an additional justification for Technical Study Tours. (For a review of previous Technical Study Tours, see *Enology Notes* index at www.vtwines.info).

Terroir is the often- and, perhaps, over-used term referring to an ecosystem of a particular place. Attempts to separate the kaleidoscope of variables including geology, geomorphology, soil, climate, the biology of the vine, and human interventions have proven difficult due to the

complexity of interactions. The difficulties in understanding these very complex relationships remind me of Russell's paradox, named for its author, twentieth-century English philosopher Bertrand Russell: "Is the set of all sets that are not members of themselves a member of itself?" – or, perhaps a more modern version such as: true or false, this statement is true. Regardless, the fact that French appellations, based on the uniqueness of the place from which a wine was created, have maintained their status and influence over the years attests to the perceived importance of this concept (Jackson and Lombard 1993).

Soil, Climate and *Terrior.* Virtually every winegrower visited reminded us that the full expression of the vine is not realized without the proper match between the cultivar, climate and soil. This is certainly true of Chablis, a part of Burgundy, but with soils and climate quite different from the rest of Burgundy. Chablis climate is generally cold, similar to that of Champagne to the north, with weather a particularly controlling feature.

Much has been written regarding the impact of soil on wine composition and quality, although at times contradictory. Soil is a complex medium and its role involves the multiple influences of texture, mineral composition, water supply, and root zone temperature, among other variables (van Leeuwen 2010).

Chablis has lots of limestone and Kimmeridgian clay (the limestone clay unique to this region) with fragments of fossilized oyster shells deposited when the region was covered by ocean. At Domaine William Fèvre, we had an extensive discussion of the importance of Kimmeridgian limestone. Reportedly, all of the Chablis Grand Cru wines come from vineyards high in this form of limestone. However, it is likely that at least some of the effects of soil are indirect, in that all of the Grand Cru vineyards are southern facing. Lesser-classified vineyards on soils with less Kimmeridgian limestone have different solar orientations.

In Champagne, we visited Moët et Chandon, Gaston Chiquet at Ay, Vranken-Pommery, and Champagne Mailly at La Montagne de Reims. The annual mean temperature in the Champagne region is about 10°C, just slightly above the temperature needed to support vine growth. The latitude is similar to that of Québec, Canada. Spending time in the vineyards, we were reminded why fully-enclosed spaces are popular in Champagne (winter motto: cold but damp) where winter may seem like it lasts about 17 months! The region is rainy with a large potential problem of spring frost.

The soils of Champagne, like Chablis, are chalk, in some cases almost pure white chalk, and can be hundreds of feet deep. Interestingly, many producers suggested the importance of soil depth as a standard, universal mantra. Low water-holding capacity of shallow soils may be more likely to induce water-deficient stress compared to deeper soils (Seguin 1983, 1986). As such**,** it has been suggested that shallow soils may have a higher grape quality potential, at least for red wines.

Alsace, another region visited, is abundantly blessed with the crucial, yet essential natural ingredient that most Americans believe is needed to support a healthy wine region, namely tourists. The grapes grown in Alsace are for the most part not grown predominately in other French wine regions, adding uniqueness. Alsace, along with the area northwest called Lorraine, was formerly part of Germany. Like Germany's, the wines are mainly white, predominantly unblended, and usually without oak influence. The most important landscape is the Vosges Mountains to the west, where most of the better vineyards are planted on the slopes. The soils are granite with some heavier schist soils and clay. This region is remarkably dry, with an average annual rainfall of about 19 inches.

Climate Change. Many of the French *vignerons* that I have met over the years live rather aesthetic lives, are somewhat polemic and embrace the philosophy of Pierre Teilhard de Chardin (expressed in his famous book *The Phenomenon of Man*) and/or that of James Lovelock (Gaia hypothesis) – that the earth is influenced by life to sustain life, and that the planet is the core of a single, unified living system. As such, issues like global climate change and genetically-modified organisms (GMOs) cause them a certain limited degree of conflict, pretty much in the same context that the Atlantic Ocean has a certain limited amount of water!

Several reported their concern for warmer, and therefore earlier vintages. One producer reported the average harvest dates of his parcels had advanced as much as 30 days in the last 20 years (even discounting the effects of the 2003 vintage – one of the warmest recorded in France). Like they say – There is no time like the past. The question is: How does this impact *terroir* expression and overall quality in general?

Site climate is one of the most important variables impacting aroma/flavor and phenol compounds. The production of these secondary metabolites is influenced by the temperature during the final period of fruit maturation (Jackson and Lombard 1993). Maximum concentrations of these metabolites are produced when the fruit ripens within certain temperature ranges. Therefore, the best variety for a particular site is one that matches the

length of the growing season, so that fruit maturation occurs when the season is cool, but warm enough to allow the fruit to continue to accumulate desirable metabolites. Site or mesoclimate has been divided into types, Alpha and Beta, dependent on the mean temperature during late stage ripening (Jackson 1987).

Alpha zones are those where the mean temperature at the time of ripening for a particular variety is 9-15°C. In Alpha zones, day temperatures are moderate and night temperatures usually cool, creating desirable conditions for the development of aroma/flavor and phenols. In Beta zones, the majority of grapes ripen well before temperatures begin to drop. Beta zones are those with a mean temperature above 16°C at the time of ripening for a particular variety. Thus, days and nights are still warm.

In many grape-growing regions, the choice of cultivars allows fruit maturity to occur just before the mean monthly temperature drops below about 10°C. Traditionally, this has occurred in mid-September to mid-October. Now that more fruit is maturing earlier, in the warmer part of the season, the concern is the effect on *terroir* expression due to quantitative and qualitative impacts on aroma/flavor and phenolic metabolites. It remains up to the industry to determine how to best adapt to the changing site-climate environment.

Soils. We visited Burgundy which contains a staggering number of AOC wines, more than 650. The climate is continental with warm summers, cold winters and the constant threat of hail. The soils are extremely varied in their richness, depth and mineral content. It is said that this variation explains the enormous range of wines that come from this region. Most vineyards have a base of limestone covered by limestone and marl (a mixture of clay and limestone), sometimes mixed with gravel and/or sand. The presence of so much calcium in the soil is said to improve the soil structure, thus enhancing soil drainage. Active calcium carbonate reduces soil organic matter turnover, thus limiting plant nitrogen availability, an important feature.

Where limestone is dominant, Chardonnay or Aligoté is planted, and where more marl exists, generally Pinot noir is grown. Good vineyard soil for the production of red wines are those that help limit yield and vine vigor either by limiting water supply or available nitrogen, two very important *terroir* features (van Leeuwen 2010)**.** Heavy clay soils produce more sugar, anthocyanins and total phenols. Tools such as electrical conductivity may allow us to more precisely differentiate soils, allowing for enhanced cultivar-site matching (Beasley 2014).

Microbiological *Terroir*. At Domaine de la Vougeraie at Premeaux Prissey in Burgundy, we discussed *terroir* expression as related to soil ecology, specifically the microbiology of the soil. The vineyard is certified organic and they farm biodynamically. Although a good soil should have adequate microbiological flora to aid in mineralization, little scientific evidence is available to suggest the link between soil microbes and wine quality or *terroir* (van Leeuwen 2013). It was interesting to note their level of copper use as a vineyard spay (previously 5, but now 3 kg/ha/year). Such sprays over many years may have a detrimental impact on soil microorganisms (Courde et al. 1998). Copper, along with sulfur, is used by some in biodynamic practices.

Most, but not all, producers we visited reported the use of un-inoculated red fermentations**.** Yeasts and bacteria are part of a complex series of interactions where competition, equilibrium and collaboration form a dynamic ecosystem. As discussed in the previous edition of *Enology Notes* (# 167), the concept of microbial ecology is gaining attention. Even with the addition of sulfur dioxide and cultured yeasts to a red must, a portion of a fermentation can be conducted by other, native organisms (Bokulich et al. 2012). There can be a substantial difference in microbial populations among different wines produced at the same facility with the same inoculated yeast. It is becoming increasingly apparent that microbial ecology can be a source of *terroir* variation.

Vine Moisture Status. Several studies have demonstrated that *terroir* expression is correlated to water deficits (van Leeuwen 2010). Vine water status is influenced by rainfall, evaporation, soil water-holding capacity and vineyard management strategies. In a study I conducted with Dr. Keith Patterson in California's Central Coast, we demonstrated that limited water availability increases the production of glycoconjugates, the main aromatic precursors in grapes. Subsequent research has demonstrated that vine water status, which relates strongly to nitrogen availability, may have a stronger influence on wine style and wine quality than soil mineral composition.

Vine Nitrogen. Vine nitrogen availability is related to soil type, depth, moisture and increases with increases in organic matter. During our visit, it was discussed that most vineyards producing high-quality red wines receive no or very little nitrogen fertilization. Limiting nitrogen uptake for red-fruited varieties reduces vine vigor, berry weight, and yield, while increasing anthocyanins and tannin concentration.

For white wine production, low nitrogen availability to the vine may be a detriment because of the potential limit in the production of aromatic compounds and, thus, wine quality (Chone et al. 2006). As reported in *Enology Notes* #167, Petit Manseng wine volatiles are increased by vine nitrogen addition**.** It should also be noted that white grapes with low nitrogen levels produce low-fruit N and relatively lower concentrations of glutathione (Chone et al. 2006). Glutathione is a naturally occurring peptide that is an important white wine antioxidant (see *Enology Notes* # 101,102, 112, 127, 129, 134, 144 and 159). Again, more effort should be directed at specific fertilization regimes for specific cultivars on specific soil types in our region.

They say that fools with tools are still fools. Several producers, however, reminded us of a great tool. They determine vine nitrogen status using juice analysis of YAN (yeast assimilable nitrogen) at harvest. This is not a new concept; I have suggested the use of YAN analysis as a plant barometer for some time. This is not only a simple way of evaluating vine N status, it also allows for the assessment of parcel or block variations.

Winegrowers we visited reported they generally have adequate native YAN, avoiding the need to supplement, even if they accepted such practices. In the New World, many assume additional N is needed for fermentation and that there is no difference between native YAN produced by the plant and addition products, an unwarranted assumption. To understand the full potential and expression of a variety under specific site conditions, we must be able to evaluate the full, intrinsic potential of the grape. Such evaluations may be obscured by excessive wine addition products.

This visit was a reminder that the typology *terroir* is difficult to understand. However, research suggests, climatic conditions have the greatest impact, followed by soil type and cultivar and that soil effects are largely mediated through vine water status (van Leeuwen 2010). Like a Zen coagon (example-what is the sound of one hand clapping?), there may not be answers to questions regarding *terrior.* That may not be a bad thing.

Without logic, reason is useless. With it, you can win arguments and alienate multitudes.

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2. Research Review – Influence of nitrogen fertilization on grape-derived volatiles of Petit Manseng. Molly Kelly, Enology Extension Specialist, Virginia Tech.

In the previous *Enology Notes* (#167), we reported on the effect of foliar and soil nitrogen applications on Petit Manseng grape wine composition. This review reports on the influence of these same applications on the concentration of free and bound volatiles in Petit Manseng fruit using two hydrolytic techniques.

Some grape-derived aroma and flavor compounds exist as free volatiles that possibly contribute to aroma and flavor, and some as non-volatile bound conjugates. Bound components include terpenes, lactones, C_{13} norisoprenoids, alcohols, esters and shikimic acid compounds (Ibarz et al. 2006). These precursors (including glycosides) can be released and form aroma and flavor compounds by different mechanisms. Bound glycosides can be cleaved enzymatically (Allen et al. 1991), resulting from the action of enzymes that are endogenous in the fruit and/or added during processing. Additionally, acid-catalyzed reactions during winemaking can result in the formation of various aroma and flavor compounds such as norisoprenoids and terpenes

(Ugliano et al. 2006). Sensory analysis of acid and/or enzyme hydrolysates has shown their impact on aroma and flavor profiles (Webster et al. 1993).

The formation of free and bound aromas and flavors may be influenced by nitrogen fertilization (Bell and Henschke 2005, Webster et al. 1993). The relationships between vineyard nitrogen and development of aroma and flavor compounds have been evaluated (Castor and Guymon 1952, Chen 1978), but not for the cultivar Petit Manseng.
Vines were planted in 2008 in Dobson, North Carolina (elevation 2,000 feet), using 101-14 MGT rootstock, cordon-trained, and spur-pruned on a vertically shoot positioned (VSP) trellis. Four treatments were applied each season with six replicates of six vines each and included
(1) control – no nitrogen or sulfur applications
(2) nitrogen (calcium nitrate) at 30 kg/ha applied to soil just after flowering
(3) 15 kg/ha of urea nitrogen in two foliar applications prior to véraison
(4) 15 kg/ha of nitrogen (as urea) and 5 kg of micronized sulfur (microthiol) in two applications prior to véraison.

It should be noted that wine is a complex matrix, with wine and juice aromas and flavors resulting from many interactions among a large number of compounds. Compounds may show synergistic (one compound enhances the perception of another) and/or antagonistic (one compound suppresses the perception of another) interactions (Gustav et al. 2011). These interactions can determine the overall aroma and flavor of wine, without being recognized for their aroma threshold (Etievant 1991). Aroma and flavor compounds in mixtures almost always show reciprocal suppression, in which each compound decreases the perceived intensity of the others (Laing et al. 1984). Some aroma and flavor increases may be due to volatiles binding to proteins, resulting in a decrease in their suppressive effect on other free volatiles (Jones et al. 2008).

The current research showed that both acid and enzymatic hydrolysis demonstrated potential to release bound aroma and flavor compounds. Acid hydrolysis released more terpenes with nitrogen applications than did enzymatic hydrolysis, while ester content increased in both treatments with nitrogen-treated vines. Esters are known to contribute floral and fruity aromas and flavors to wine, while terpenes contribute citrus, floral and sweet aromas and flavors.

This study demonstrated that seven major groups of aroma and flavor compounds are potentially responsible for the varietal aroma and flavor of Petit Manseng. The use of various winemaking practices to release glycosidically-bound aroma and flavor compounds may be

needed for expression of full aroma and flavor potential. Data presented in this study may be useful in establishing recommendations for vineyard nitrogen fertilization for Petit Manseng.

More to follow

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3. *Winery Planning and Design*, Edition 16, Available.

This publication, in CD format, is the result of a number of short courses and seminars, covering various aspects of winery planning, held in several wine regions around the country. While not regionally specific, the information provided is from a number of authoritative sources, covering such diverse topics as sustainable design, winery equipment, and winery economics. *Winery Planning and Design*, Edition 16, is available through the industry trade journal *Wines and Vines-Practical Winery* (phone 415-444-6695, email: tlv100@sonic.net) or Tina Vierra (tina@winesandvines.com, or tina@practicalwinery.com). The entire index and additional information is available on my web site at www.vtwines.info.