QUESTIONS NEEDING ANSWERS

Are there minerals in wine?

Can you smell and/or taste minerals in wine?

Is minerality derived only from minerals or other substances as well?

Which wine components act to diminish/accentuate the perception of minerality?

Can you have terroir without minerality?

Is minerality universal and international?

Can minerality be associated with all colors of wine?

Should we be using minerality as a valid & useful tasting term?
“Minerality” is a made-up English word… derived from a French word, also recently invented Mineralité.

Mineralité or reference to the “mineral” taste or smell of wines cannot be found in old French wine texts:

Chaptal (1756-1832)
Pijassou (1798-1820)
Jullien (1766-1832)
Mineralité or “minerality” or reference to the “mineral” taste or smell of wines cannot be found in contemporary references:

- French or English dictionaries
- Larousse “Wines & Vineyards of France”
- Aroma wheel of UC-Davis
- Emile Peynaud’s “The Taste of Wine”
- Michael Broadbent’s books on wine tasting
- “The Oxford Companion to Wine” - until the latest edition

“no direct connection between the flavour of a wine and the geological minerals in the rocks...or the mineral elements in the soil. In any case, the minerals found in wine are below the threshold of sensory perception.”

The Oxford Companion to Wine, 4th edition
THE BELIEVER (AND PROMOTER):

“If one were to look for all the shared characteristics of Chablis, one would speak of freshness, finesse, purity and minerality.”

BIVB press kit, 
Chablis-The Crystalline Expression of a Terroir
THE SCIENTIST (AND SKEPTIC):

“Minerality is an abstract sensory descriptor and cannot be taken literally.”
Denis Dubourdieu, Professor of Oenology, University of Bordeaux
château owner & winemaker

“The idea that vineyard geology can be literally tasted in the wine glass is mechanistically impossible.”
Alex Maltman, University of Wales
Journal of Wine Research, 2008
“On one side we know that the direct causal transfer of minerals from the soil to the finished wine is nothing we can prove. On the other side we observe varying styles of wines from different soils and geology.”

Roman Horvath MW, Domäne Wachau, Austria
Decanter, Dec 2014
**WINE REGIONS & THEIR MINERALS...JUST SOME EXAMPLES**

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphite</td>
<td>Priorat, Spain</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Vulture, Campania &amp; Etna, Italy</td>
</tr>
<tr>
<td>Pyrolusite</td>
<td>Moulin à Vent, France</td>
</tr>
<tr>
<td>Hematite (iron oxide)</td>
<td>Coonawarra, Australia</td>
</tr>
<tr>
<td>Gypsum (calcium sulfate)</td>
<td>Ribera del Duero, Spain</td>
</tr>
<tr>
<td>Calcite (calcium carbonate)</td>
<td>Champagne, Chablis, Côte de Beaune, France</td>
</tr>
<tr>
<td>Amphibole (amphibolite)</td>
<td>Muscadet, France</td>
</tr>
<tr>
<td>Muscovite, biotite (mica)</td>
<td>Fleurie, Alsace &amp; Vinho Verde</td>
</tr>
<tr>
<td>Clay minerals (montmorillonite)</td>
<td>Côte de Nuits &amp; Tokay, Hungary</td>
</tr>
<tr>
<td>(vermiculite)</td>
<td>Finger Lakes, New York</td>
</tr>
<tr>
<td>Feldspar &amp; kaolinite</td>
<td>Dão, Portugal</td>
</tr>
<tr>
<td>Quartz (silicon dioxide) &amp; flint</td>
<td>Loire, France &amp; many others</td>
</tr>
<tr>
<td>Quartzite</td>
<td>galets of Rhône Valley</td>
</tr>
</tbody>
</table>

*And we could go on adding to the list!*  
Source: Alex Maltman
GEOLOGICAL minerals make up stones & rocks
NUTRIENT minerals are derived from geological minerals but are not identical
These nutrients are needed by the grapevine in minuscule quantities

The roots of vines take up mineral nutrients in a soluble form
Nutrient minerals are dissolved...geological minerals are insoluble complex compounds

Of the 16 essential nutrients for plant physiology...
Nitrogen, phosphorus & sulfur come principally from organic content of soil
Calcium, magnesium & potassium are all derived from soil
Calcium influences pH of soil & availability of other nutrients
Some minerals in wine result partly from winemaking procedures

BASIC TRUTH: ALL ROCKS ARE COMPOSED OF MINERALS, SO ALL ROCKS ARE “MINERAL RICH”
### Are There Minerals in Wine?

#### Cations AKA Minerals in Wine

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Typical Range (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium (K)</td>
<td>500-1500</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>50-150</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>50-150</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>10-50</td>
</tr>
<tr>
<td>Lithium (L)</td>
<td>5-60</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>5-6</td>
</tr>
</tbody>
</table>

#### Anions AKA Minerals in Wine

<table>
<thead>
<tr>
<th>Anion</th>
<th>Typical Range (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphate</td>
<td>150-1000 red/75-500 white</td>
</tr>
<tr>
<td>Sulfate</td>
<td>100-400</td>
</tr>
</tbody>
</table>

**Sources:**
- Concepts in Wine Chemistry, Y. Margalit
- Enological Chemistry, J. Moreno & R. Peinado
- UC Davis/Waterhouse Lab

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- **May enter wine via fining/filtration** (bentonite, DE, pad)
  - Perceived as sour/bitter taste
- **May enter wine via SO2 addition** (sodium metabisulfite), bentonite, egg white fining
  - Can reach 1 g/l in wines from seaside vineyards
- **Heavy metals may come from chemical treatments** (via roots, grapes), fining & filtering media
- **Additive to reduce hydrogen sulfide**

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- May enter wine via fining/filtration (bentonite, DE, pad)
- Perceived as sour/bitter taste
MINERALS IN WINE: SCARCE OR PLENTIFUL?

Christopher Griffith, New York Times

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>85%</td>
</tr>
<tr>
<td>Ethanol</td>
<td>13%</td>
</tr>
<tr>
<td>Glycerol</td>
<td>1%</td>
</tr>
<tr>
<td>Organic acids</td>
<td>0.4%</td>
</tr>
<tr>
<td>All other constituents</td>
<td>0.6%</td>
</tr>
<tr>
<td></td>
<td>99.4%</td>
</tr>
</tbody>
</table>

Inorganic content 0.2%
MINERAL WATER: BONA FIDE MINERALITY
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Gerolsteinen Sprudel/Medium</th>
<th>San Pellegrino</th>
<th>Perrier</th>
<th>Ferrarelle</th>
<th>Calistoga Mineral Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>348mg</td>
<td>44%</td>
<td>179mg</td>
<td>22%</td>
<td>155mg</td>
</tr>
<tr>
<td>Magnesium</td>
<td>108mg</td>
<td>29%</td>
<td>52mg</td>
<td>14%</td>
<td>6mg</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>1.816mg</td>
<td>-</td>
<td>239mg</td>
<td>-</td>
<td>445mg</td>
</tr>
<tr>
<td>Potassium</td>
<td>11mg</td>
<td>1%</td>
<td>0mg</td>
<td>-</td>
<td>0mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>118mg</td>
<td>21%</td>
<td>33mg</td>
<td>6%</td>
<td>11mg</td>
</tr>
<tr>
<td>Chloride</td>
<td>40mg</td>
<td>5%</td>
<td>54mg</td>
<td>7%</td>
<td>25mg</td>
</tr>
<tr>
<td>Sulphate</td>
<td>38mg</td>
<td>-</td>
<td>445mg</td>
<td>-</td>
<td>46mg</td>
</tr>
<tr>
<td>Total mineralization</td>
<td>2.479mg</td>
<td></td>
<td>1.002mg</td>
<td></td>
<td>688mg</td>
</tr>
</tbody>
</table>

Comparative quantity = 1 litre | Percentage = Proportion of recommended Daily requirements

Values taken from respective manufacturer
Vine roots take up nutrient minerals in parts per million to facilitate carbohydrate reactions. Minerals pass through the plant into the fruit, whose juice is fermented, resulting in a finished liquid with an entirely different profile.

Mineral water is drawn from the ground after having passed through soil layers, directly transferring minerals which are present in the bottled liquid after minimal handling.
Village of Sainte-Gemme - Loire Valley  
Clay & flint (silex)  
100% Sauvignon Blanc, 35-year old vines  
Stainless steel, aging on fine lees with bâtonnage 2 X per week  
No malo

Roger Voss, Wine Enthusiast:  
“From vines grown on flint soil, this is a perfumed, crisp wine, hinting at almonds and spice. The background is a reminder of the soil, very mineral and severe.”

Notes from producer:  
“The unusual concentration of flint in this parcel confers subtle aromas of gunflint”

Flint: a type of silica, odorless & tasteless  
A. Maltman

13% alcohol  
7.1 TA  
3.06 pH
The starting place: “the term ‘mineral’ as applied to wine sensory attributes is metaphorical”

The basics:
31 New Zealand & 32 French wine professionals experienced with Sauvignon wines evaluated 16 Sauvignon Blanc wines from Marlborough, NZ & France

20 “scales” in English & French including:
Variatel markers - passion fruit, herbaceous, citrus
Mineral and/or reductive - flinty/stony/gun flint, chalky/calcareous, iodine/oyster shell, matchstick, burnt rubber
Tastes - sweetness, bitterness, acidity/sourness, freshness/ziny
PERCEPTION OF MINERALITY: MANY FACES OF VOLATILE THIOLS

Aroma of **gunflint** corresponds to **Methylbenzene thiol** detectable at extremely low concentrations - 0.3 billionth of g/l

Research of Denis Dubourdieu & others

"Many faces of volatile thiols in wine - Passion fruit with a hint of mineral, some smokiness but kind of skunky" Practical Winery & Vineyard, January 2014 - Ugliano, M., Diéval, J-B., Bégrand, S., Vidal, S. (Nomacorc France)
Conclusions:
- Both NZ & French tasters reported mineral characters via olfaction & in-mouth perception.
- French participants relied more on olfaction relative to minerality.
- Degree of consensus found was “unexpected”.
- Negative predictors of minerality: passion fruit, herbaceous, sourness, sweetness, reductive notes.
- Positive predictors: bitterness, fresh/zingy**
  **BUT: could be interpreted as acidity/sourness...was translated as frâicheur.

Summary finding:
The more flavorsome the Sauvignon, the less minerality was perceived.
DOMAINE GUIBERTEAU
SAUMUR 2014

Brézé, Saumur - Anjou, Loire Valley
Clay & limestone soil
Organic cultivation
100% Chenin Blanc
Whole cluster pressing, indigenous yeast
Stainless steel, aging on fine lees

13% alcohol
9.3 TA
3.15 pH

Notes from Becky Wasserman:
“on the hill of Brézé, chenins taste like none other in the Loire. They are so uncompromising, so violently assertive, so brilliantly mineral…”

Courtesy of Becky Wasserman & Co.
DOMAINE PATRICK BAUDOUIIN
ANJOU “EFFUSION” 2014

Chaudefonds sur Layon - Anjou, Loire Valley
2 parcels on volcanic (“effusive”) soils:
Ardenay - shale, silica, sandstone
St.-Aubin de Luigné - shale, sandstone
100% Chenin Blanc
Certified organic wine
Fermented in Burgundian barrels (1-4 years old)
Very limited use of sulfur (30 mg/l total, 14 free)

12.5% alcohol
3.2 g/l RS
6.3 TA
3.18 pH

Courtesy of Becky Wasserman & Co.
Fritsch Grüner Veltliner “Steinberg” 2015

Wagram, Austria
Steinberg vineyard
Loess, slate & granite
Biodynamic cultivation
100% Grüner Veltliner
Whole cluster pressing
Stainless steel

Tasting notes of importer:
“Very refined, true to its name (Steinberg) mineralic, puristic and finely structured. Its salty minerality is revealed straight through to the finale.”

12.5% alcohol
5.8 TA
pH not shared

Courtesy of Monika Caha Selections
BENITO FERRARA
GRECO DI TUFO DOCG 2014

Commune of Tufo, Campania, Italy
Calcareous, clayey “rich in minerals”
100% Greco
Whole cluster pressing, inoculated
Stainless steel for 7 months

13.0% alcohol
7.01 g/l TA
3.3 pH

Tasting notes of importer:
“The Greco vineyards stand next to abandoned sulfur mines and sulfur rocks can be found amongst the vines: this gives the wines wonderful mineral notes.”

Courtesy of Mark De Grazia Selections
The starting place:
“so-called minerality remains without a clear scientific consensus” as to chemical bases on which sensory perception is founded

The basics:
- Two tasting panels – wine professionals & winemakers – in Spain were given 17 white & red wines described as “mineral”… they were not advised of the aim of the study
- 6 wines were selected as “most mineral” from the 17
- These wines underwent detailed chemical analysis of many types

A statistical analysis revealed a variety of compounds in “mineral” wines…
<table>
<thead>
<tr>
<th>Chemical classification</th>
<th>White wines</th>
<th>Red wines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Routine parameters</strong></td>
<td>Free sulfur dioxide</td>
<td>Free sulfur dioxide</td>
</tr>
<tr>
<td></td>
<td>Total acidity &amp; pH</td>
<td>Total acidity &amp; pH</td>
</tr>
<tr>
<td></td>
<td>Succininc acid</td>
<td>Succininc acid</td>
</tr>
<tr>
<td><strong>Prefermentary aromatics</strong></td>
<td>phenyl ethanol</td>
<td>phenyl ethanol</td>
</tr>
<tr>
<td></td>
<td>Diethyl succinate</td>
<td>M-Cresol</td>
</tr>
<tr>
<td></td>
<td>Ethyl decanoate</td>
<td>Butyrolactone</td>
</tr>
<tr>
<td><strong>Aging aromatics</strong></td>
<td>Decalactone</td>
<td>Decalactone</td>
</tr>
<tr>
<td></td>
<td>4-ethylphenol</td>
<td>4-ethylphenol</td>
</tr>
<tr>
<td></td>
<td>4-ethylguaiacol</td>
<td>4-ethylguaiacol</td>
</tr>
<tr>
<td></td>
<td>Furfural/ 5-methylfurfural</td>
<td>Furfural/ 5-methylfurfural</td>
</tr>
</tbody>
</table>
Conclusions:
- Presence of succinic acid, low pH & high free SO2 directly related to use of “minerality” “with a probability of 95%”
- Other chemical compounds are also closely correlated, singly or together
- Perception of minerality “not closely related” to levels of minerals in either soil or wine

Summary finding:
Perception of minerality could be “result of synergistic effect of various compounds” acting together
CHRISTIAN MOREAU PÈRE & FILS CHABLIS 2014

Pargues climat, left bank of Serein, Chablis
Calcereous clays of Kimmeridgian & Portlandian
100% Chardonnay, 47-year old vines
Sorted, pneumatic pressing, cold settling
Stainless steel, aging on fine lees for 10 months

Allen Meadows, Burghound (Feb 2016):
“...there is good vibrancy and freshness to the
saline and mineral-inflected middle weight
flavors that terminate in a clean and dry but not
really austere finish. This should be a lovely and
altogether classic villages.”

Exogyra virgula

FOSSILS ARE MADE OF GEOLOGICAL MINERALS,
HENCE THEY ARE EQUIVALENT TO ROCKS -
NOT UNIQUELY ENDOWED
Alex Maltman

12.52% alcohol
7.0 TA
3.21 pH

Courtesy of Frederick Wildman & Sons
DOMAINE PASCAL & MIREILLE RENAUD
POUILLY-FUISSE
“CUVÉE VIEILLES VIGNES” 2014

Solutré-Pouilly, Mâconnais
Limestone & clay
100% Chardonnay, vines 50 - 80 years old
Picking by hand
Small stainless tanks, some foudres

13 % alcohol
5.5 TA
3.33 pH
STÉPHANE AVIRON CÔTE DE BROUILLY VIEILLES VIGNES 2013

Côte de Brouilly (slopes of Mont Brouilly), Haut Beaujolais
Granite & volcanic soils
Three-fourths from 60-year old vines & one-fourth from 40-year old vines
100% Gamay noir à jus blanc
Origins vinified & matured separately in new/used oak barrels until blending
Very limited use of sulfur (29 mg/l total, 6 free)

Michael Apstein, Wine Review Online (October 2015):
"If your tastes run to firmer rather than floral Beaujolais, turn to Aviron’s 2013 Côte de Brouilly. Also made from old vine fruit, it’s stonier -- you can almost taste the granite soil -- than his Fleurie…"
Etna, Sicily
Selection from all vineyards of estate on northern slope of Etna Volcano @ 2,000 – 3,000 ft.
Black volcanic pumice, volcanic sand, pebbles & ash
98% Nerello Mascalese, 2% Nerello Cappuccio
Parcels 6 & 50 years old
Temp controlled fermentation, spontaneous malo
Aged in large French oak (10-30 hl) for 10 months

Comments from Wikipedia:
“the soil is volcanic and very rich in minerals”

14.35% alcohol
5.1 TA
3.7 pH

Courtesy of Mark De Grazia Selections
LUIGI BOSCA MALBEC 2013

La Linda vineyard @ 3,150 ft. on flat terrain (1.5% slope)
Vistalba, Lujan de Cuyo, Mendoza
Alluvial soils with clay & active lime
100% Malbec, 70-year old vines - hand harvested
Destemmed, selected clusters
Temp controlled fermentation in stainless tanks with cultured yeasts
Aged in new French oak for 14 months

14.1% alcohol
5.2 TA
3.6 pH

Blair Walter, Felton Road, Central Otago, New Zealand (Wine Wisdom, Mar 2014)
"Minerality in red wine is a less overt fruitiness, with some vineyard character; tasting the transparency of terroir."

Courtesy of Frederick Wildman & Sons
COMPETING DEPICTIONS OF MINERALITY

Minerality as a direct expression of minerals

Minerality as a complex sensory phenomenon with many causes & expressions

Hazel Varanese

Christopher Griffith, New York Times
MAPPING OUR PRESENT STATE OF KNOWLEDGE

Perceived MINERALITY

Culture
- Fashion, convention
- Psychology
- Expectation (e.g., fossils = taste of oyster shells)

High total acidity/Low pH
- Succinic acid (salty taste)

Low total acidity/High pH
- Sweet tastes
  - Glucose, fructose, ethanol & glycerol
- Low free SO₂
- Viscosity
  - Glycerol, polysaccharides

Trace elements/salts
- Sodium & potassium chloride & calcium = salty & sour/bitter tastes
- Other chemical compounds
  - 4-ethylphenol, phenylethanol, geosmin

Absence of “fruitiness”/low flavor intensity + reduction
- Volatile thiols (methyl benzene thiol = gunflint)

“Fruitiness”/high flavor intensity
- Esters, high % new oak

Viscosity
- Glycerol, polysaccharides

Factors favoring minerality:
- Sweet tastes
- High total acidity/Low pH
- Trace elements/salts
- Absence of “fruitiness”/low flavor intensity + reduction

Factors suppressing minerality:
- Low total acidity/High pH
- Oxygen
- “Fruitiness”/high flavor intensity
- Viscosity

Factors may act independently or in combination

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Evans, S. J., “What does minerality mean to you?” Decanter (December 2014).


MINERALITY

EXAMINING, CHALLENGING & TASTING ITS MEANING

PRESENTED BY ROGER C BOHMRICHT MW
AUGUST 2016
COMMENTS & QUESTIONS ARE WELCOME: ROGER@VINTRINSIC.COM

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