# Terroir study of the satellite appellations of Saint-Emilion

# The "Saint-Elites" winegrowers association


Château Corbin
Château Tour Bayard
Château Vieux Bonneau
Château Guibot La Fourvielle
Château La Couronne
Château La Rose Perrière
Château de la Grenière
La Mauriane

SAINT-ELITES
L'AUTHENTICITÉ DES GRANDS VINS

**By**
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**2022**

## Introduction

The satellite appellations of Saint-Emilion are located towards the northernmost part of the Saint-Emilion AOC, on similar geographical formations. There are four in total: Saint-Georges Saint-Emilion, Montagne Saint-Emilion, Puisseguin Saint-Emilion and Lussac Saint-Emilion. In terms of the grape varieties planted, they are similar to Saint-Emilion with predominant Merlot plots complemented by Cabernet Franc and Cabernet Sauvignon. The region is slightly cooler that Saint-Emilion - historically, this has been something of a handicap, but is now an asset in light of the changing climate. Some of the best estates in the Saint-Emilion satellite appellations have been grouped together into the Saint-Elites association. These estates demonstrate the potential of this zone: the potential for high quality stems from a combination of natural factors (topography, climatology, geology and soil) which are highly favourable to the production of great wines. This comes in addition to the expertise of the people working these estates. Frequently from a long line of vintners, these professionals have chosen the best varieties, clones and rootstock for their soils and their micro-climates, adapting their growing and production techniques to optimise this potential and produce wines of high quality and a clearly recognisable character. They represent the best of what Bordeaux can offer to people passionate about wine.

To give you an idea of the natural conditions of the châteaux in the Saint-Elites association, their plots have been projected onto a soil map of the region (figures 1a and 1b), and a heat summation map (figures 2a and 2b). In each estate, a soil pit was studied in a representative parcel.

## The climate context

The average annual temperature in Saint-Emilion is 13.9°C and the annual average rainfall is 788mm (Cheval Blanc station, 1995-2018). A recent study showed significant temperature variation within the Saint-Emilion and Pomerol region, and their satellites (de Rességuier et al., 2020). The spatial amplitude of minimum temperatures (the difference between the lowest minimum temperature and the highest in the sector) is 3.9°C, and the amplitude is 3.2°C for maximum temperatures. The temperature maps presented in this study are based on the Winkler index heat summation in the vine canopy. The Winkler index is calculated by adding up, from the first of April to the 31 October, the average daily temperatures minus 10°C (for example, a 19°C day counts for 9 degree days). The Winkler method was calculated using temperature sensors located in the vine canopy, inside the plots. More details about the methods employed are given in de Rességuier et al. 2020. The highest temperatures were recorded in the south-west (Libourne commune) and the lowest in the north-east (Lussac commune) of the area studied. The Saint-Emilion satellite appellations are generally a little cooler than the Saint-Emilion and Pomerol appellations (figure 2a). Historically, these lower temperatures were a handicap, as ripeness arrived later and could not be achieved for all of the vines in poorer years. In the face of climate change however, this handicap is gradually becoming an advantage: the cooler conditions help maintain harmony and aromatic complexity in wines produced with a dominant proportion of Merlot. There are also temperature variations within the Saint-Emilion satellites (figure 2b). They are higher on the plateaux (except in Lussac) and on the south-facing slopes, and lower in the valleys and the north-facing slopes. In general, the commune of Lussac is the coolest.

## The geological and geomorphological context

The communes of Lussac, Montagne and Puisseguin are located to the north of Saint-Emilion, separated by the Barbanne River. The geology of the Saint-Emilion satellite communes is dominated by Oligocene formations: *molasses du Fronsadais* at the base, crossing *calcaire à Astéries* and reaching *molasses de l'Agenais*, which partially covers the *calcaire à Astéries*. *Molasses du Fonnsadais* occupies the largest surface area, followed by *calcaire à Astéries* and *molasses de l'Agenais* (DUBREUILH, 1995).

The features of the *molasses du Fronsadais* vary significantly throughout the region. In terms of texture, it varies from sandy to clay-silt. It is generally containing $CaCO_3$, but where there has been colluviation they are occasionally decarbonated. Within the region, we frequently see asymmetrical slopes, with slopes exposed to the south and west at a greater incline than those exposed to the north and east. The origin of this asymmetry dates back to the periods of glaciation in the Quaternary: in colder periods, the region was covered in snow. This snow was able to melt periodically on the slopes exposed to the south and west, causing solifluction, or slippage of land which is thawed on the surface but still frozen at depth. These landslides are the reason for the steeper slopes facing south and west. On these slopes, the soils on the carbonated *molasses* are generally quite shallow, giving rise to CALCOSOLS. On the north and east facing slopes, the slopes are less steep and the *molasses* are generally decarbonated, giving way to deeper and non-calcareous soils (BRUNISOLS and NEOLUVISOLS).

The *calcaire à Astéries* is a hard rock, which structures the landscape. It was formed during the Oligocene, when the region was covered by the Stampian Sea which extended as far as Lussac to the east. The *calcaire à Astéries* was formed on this sea bed. After the Stampian Sea had retreated, the *calcaire à Astéries* was subject to erosion. It disappeared in places where we now find various streams and small rivers, such as the Barbanne, the Barbannotte and the Lavie. In the areas in which the *calcaire à Astéries* resisted erosion, there is now a relief in the form of plateaux. The Montagne and Puisseguin plateaux are connected, while the Lussac plateau is separated by the Lavie River. There is also a remaining scrap of plateau in Lussac, in the hamlet of Lyonnat. The soils which are formed on *calcaire à Astéries* are generally calcareous (CALCOSOLS), and quite shallow.

In areas, the *calcaire à Astéries* was covered by the formation of *molasses de l'Agenais*, which is not carbonated in the region. This has a silty clay texture. The geological map indicates its presence on the northern parts of the Puisseguin plateau and on the Lussac plateau. In reality, it extends much further: this *molasse* is also present in Puisseguin, in the hamlet of Durand, and in Montagne, at Château La Couronne. The soils on the *molasses de l'Agenais* are deep and do not contain limestone (BRUNISOLS or NEOLUVISOLS).

## The soil context

The soil maps (figures 1a and 1b) were made by compiling maps published in van Leeuwen (1989), van Leeuwen et al. (1989), and Anson and van Leeuwen (2020).

The soils of the Saint-Emilion satellite appellations are described from top to bottom (peaks to valleys).

On the *molasses de l'Agenais*, at an altitude of around 100m in Puisseguin and around 80m in Lussac and Montagne, the soil is deep, non-calcareous and has a silty-clay texture. These are BRUNISOLS or NEOLUVISOLS (non-calcareous, clay-silt soil on hard limestone). This type of soil exists at Château La Couronne in Montagne ("Bellevue" plot) and at Château Guibot in Puisseguin ("Le Haut du Bassin" plot).

On *calcaire à Astéries*, the soils are calcareous, shallow and have a silty-clay texture. These are superficial CALCOSOLS (superficial calcareous soil on hard limestone). You can see typical examples of this at Château Rigaud in Puisseguin (the "Face Maison" plot) and at Château La Rose Perrière (plot 4).

On the south-facing slopes carved out of *molasses du Fronsadais*, the soil is calcareous and of moderate depth. The texture is predominantly silt-clay, but in parts can also be sandy or silty. These are moderately deep CALCOSOLS (calcareous silty-clay soils on soft limestone). These exist at Château Corbin (the "La Clide" plot) and at Château Tour Bayard (the "Malbec" plot), both in Montagne. Within the same geological formation, on shallower slopes, the soil is silt-clay and not calcareous. These are BRUNISOLS or NEOLUVISOLS (silt-clay soils). This type of soil has been identified at Château Vieux Bonneau in Montagne (the "Bonneau" plot). To the north of the commune of Lussac, the molasse is fluviatile in origin (Eocene) and is never carbonated. The texture is sandy-silt to silt-clay, and may contain gravel in places. The soils which have developed on these formations are BRUNISOLS, NEOLUVISOLS or LUVISOLS (silt-sand or silt-clay most frequently). An example of this type of soil (with gravel) has been found at the Château de la Grenière (the "Le Caillou" plot, meaning "the stone" and thoroughly deserving of its name).

In the valleys, there are colluvium soils and hydromorphic soils. These are COLLUVIOSOLS, REDOXISOLS or REDUCTISOLS (soils with a water table).

## Bibliography and references


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## Acknowledgements


The profile photos and the GPS point readings were conducted by Guillaume Darrieutort.

## Soils and temperature summations in the Saint-Elites estates

The plots belonging to each estate have been projected onto the region's soil map (figure 1a and 1b), and onto the temperature summation map (figure 2a and 2b). A soil pit was studied for each estate, in an iconic and representative plot. The exact location of each sample is given on an insert in the description page.

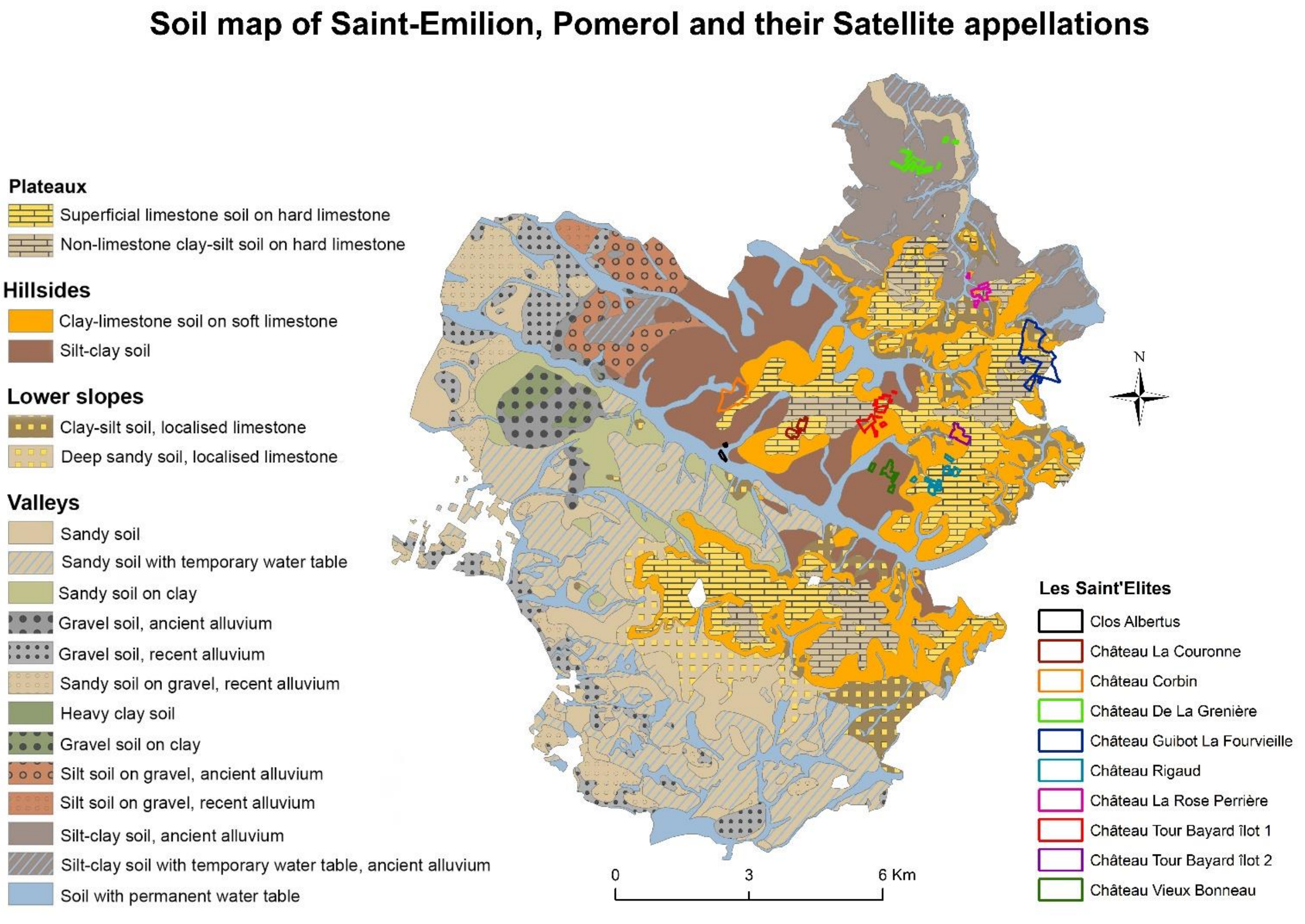



Figure 1a - Projection of the plots belonging to the Saint-Elites estates on the soil map of Saint-Emilion, Pomerol and their satellites.

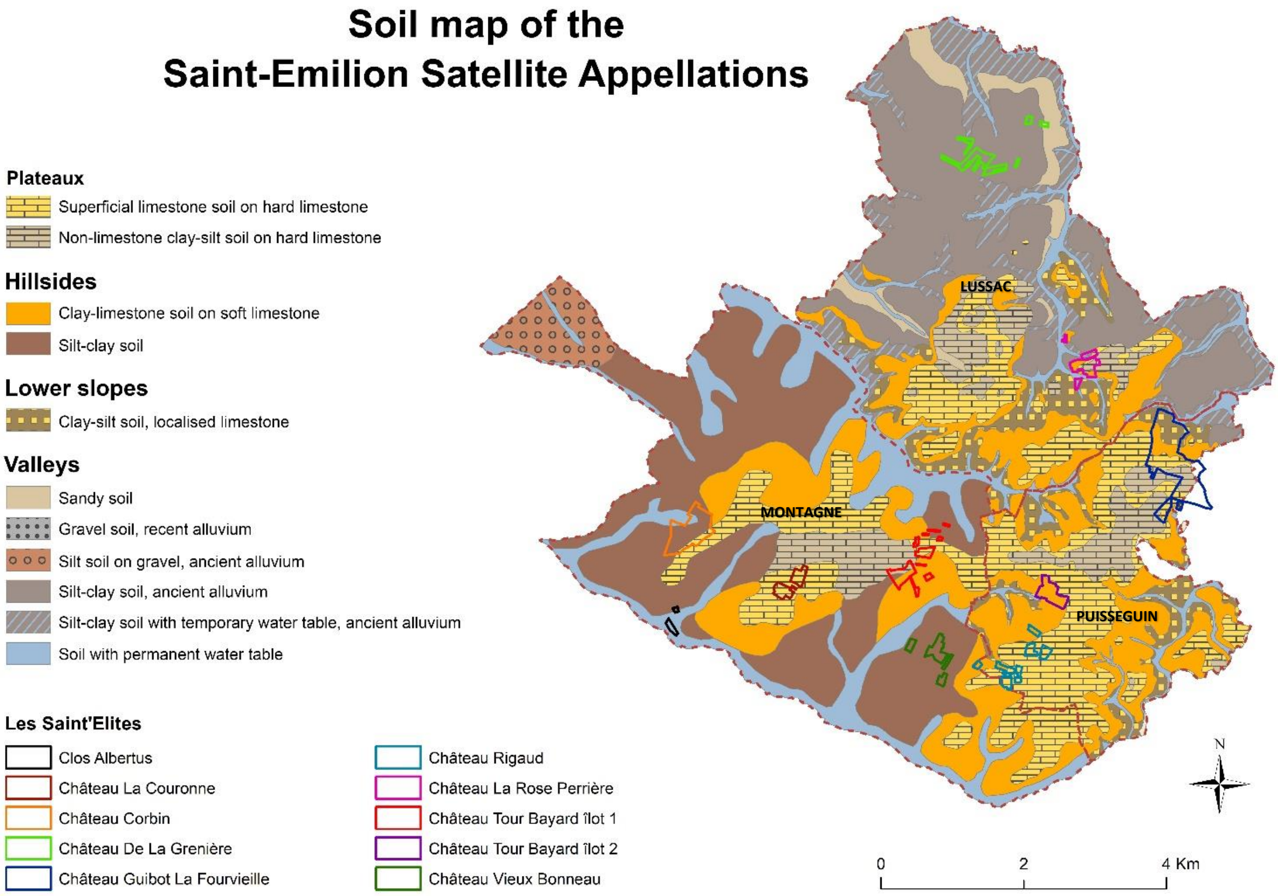



Figure 1a - Projection of the plots belonging to the Saint-Elites estates on the soil map of the Saint-Emilion satellite appellations.

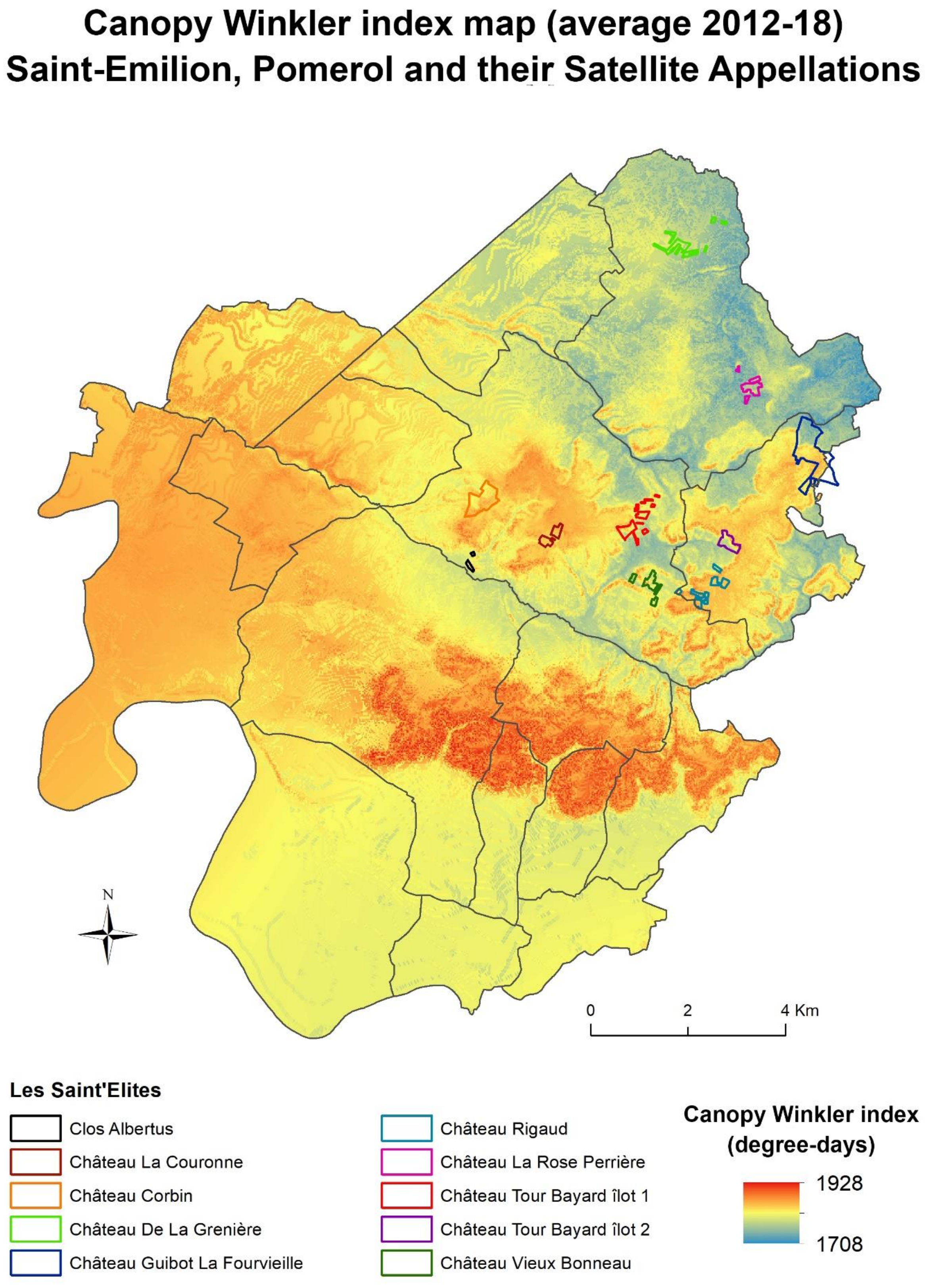



Figure 2a - Projection of the plots belonging to the Saint-Elites estates on the temperature summation map (Canopy Winkler Index) of Saint-Emilion, Pomerol and their satellites.

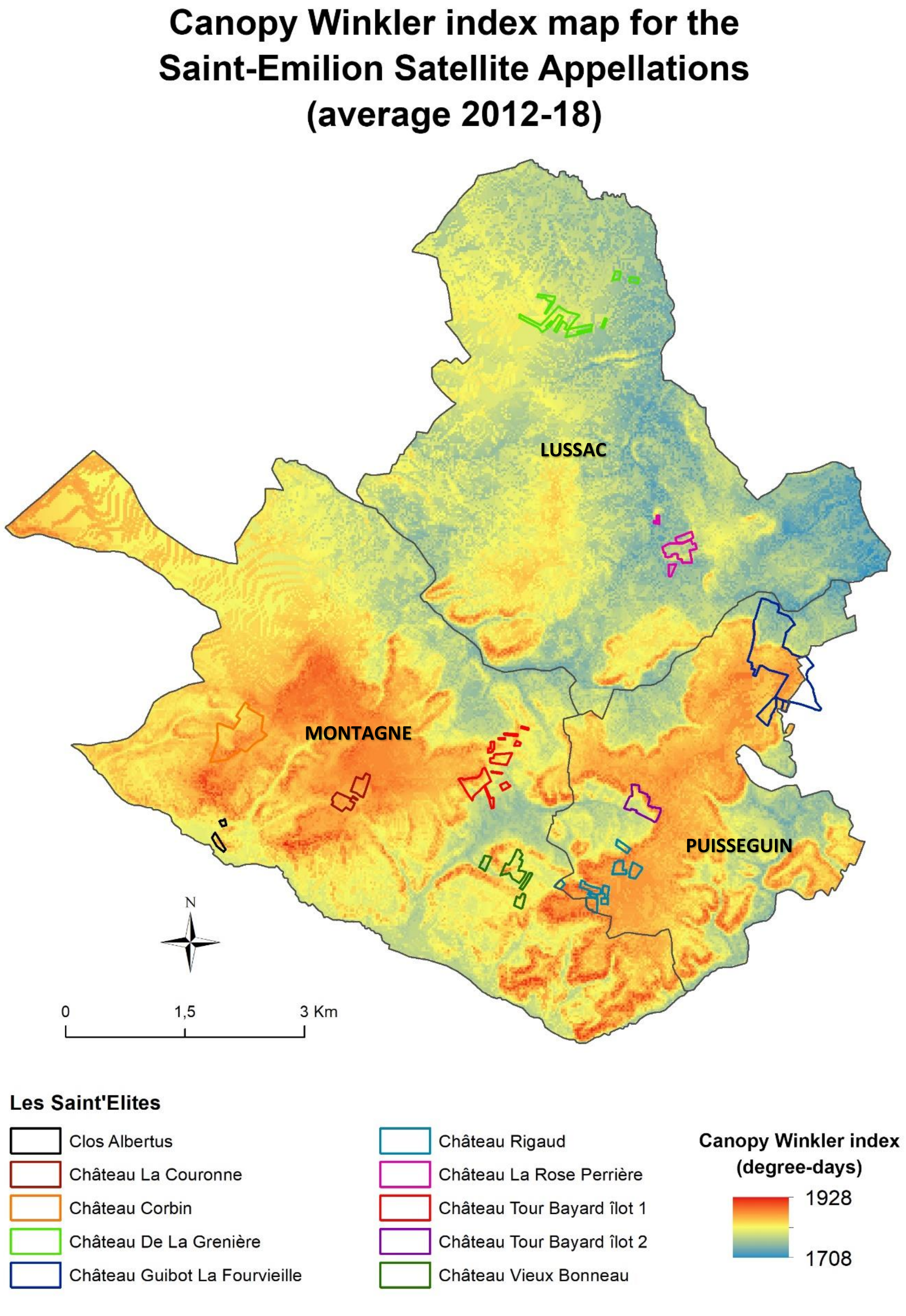
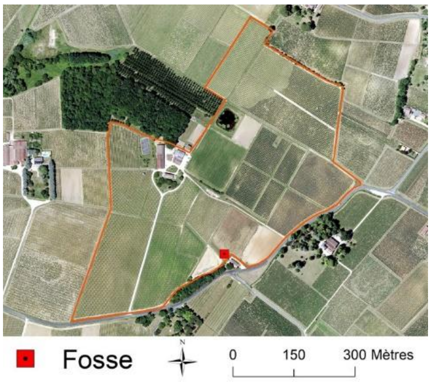



Figure 2b - Projection of the plots belonging to the Saint-Elites estates on the temperature summation map (Canopy Winkler Index) of the Saint-Emilion satellite appellations.

## Château Corbin, “La Clie” plot (F1)
## Moderately deep CALCISOL on *molasses du Fronsadais*




**Description of the profile on the 29 July 2020**
Plot located at 66m above sea level

**Horizon 1: 0 - 50cm**
Texture: Clay and silt
Large particles: 2%, limestone
Colour: Clear brown
Structure: Subangular blocky
Compact horizon
Humidity: Dry
Reaction with hydrochloric acid: weak
Rooting: Many fine and medium roots, horizontal and oblique, in good health

**Horizon 2: 50 - 75 cm**
Texture: Clay and silt
Large particles: 2%, limestone
Colour: Brown
Structure: Subangular blocky
Very compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: average
Rooting: Few roots, fine, horizontal and oblique, some dead roots

**Horizon 3: 75 - 100 cm**
Texture: Silt clay
Large particles: 5%, limestone
Colour: Beige with white patches of calcium carbonate
Structure: Angular blocky
Quite compact horizon
Humidity: Dry
Reaction with hydrochloric acid: strong
Rooting: Many thin dead roots, very few visible living roots

**Horizon 4: 100 - 120 cm (parent rock)**
Texture: Silt clay
Large particles: none
Colour: Blue grey with ochre patches (colour of the parent rock)
Structure: Angular blocky
Compact horizon
Humidity: Costs
Reaction with hydrochloric acid: average
Rooting: Many fine dead roots, located between the structural elements (photo)

## Analytical results

| Parcel "La Clie" | Horizon 1 | Horizon 2 | Horizon 3 | Horizon 4 |
|---|---|---|---|---|
| **DEPTH (cm)** | 0-50 | 50-75 | 75-100 | 100-120 |
| **COURSE ELEMENTS (>2 mm) (%)** | 2% | 2% | 5% | 0% |
| **FINE EARTH (%)** | 98% | 98% | 95% | 100% |
| Coarse sand | 25% | 23% | 8% | 3% |
| Fine sand | 21% | 8% | 8% | 25% |
| Coarse silt | 17% | 17% | 33% | 25% |
| Fine silt | 7% | 22% | 28% | 30% |
| Clay | 31% | 31% | 24% | 18% |
| **TEXTURE** | Clay-silt | Clay-silt | silty clay | silty clay |
| **ORGANIC MATTER (%)** | 1.6 | 1.0 | <0.4 | - |
| **ORGANIC CARBON (%)** | 0.9 | 0.6 | - | - |
| **TOTAL NITROGEN (%)** | 0.101 | 0.077 | 0.035 | 0.033 |
| **C/N ratio** | 9.2 | 7.6 | - | - |
| **pH (water)** | 8.4 | 8.5 | 8.6 | 8.8 |
| **pH (KCl)** | 7.5 | 7.6 | 7.7 | 7.9 |
| **ADSORBANT COMPLEX** | | | | |
| $K^+$ $cmol^+/kg$ | 0.58 | 0.49 | 0.29 | 0.28 |
| $Mg^{2+}$ $cmol^+/kg$ | 3.55 | 4.03 | 4.67 | 3.93 |
| $Ca^{2+}$ $cmol^+/kg$ | ++ | ++ | ++ | ++ |
| S (sum of cations) | ++ | ++ | ++ | ++ |
| V (saturation rate) | Sat. | Sat. | Sat. | Sat. |
| **C.E.C $cmol^+/kg$** | 13.6 | 13.7 | 11.3 | 9.6 |
| **Total Ca (%)** | 3.6 | 1.3 | 35.2 | 7.8 |
| **Active Ca (%)** | - | - | 3.6 | 0.5 |
| **IPC** | - | - | 90 | 12 |
| **$P_2O_5$ g/kg Joret-Hébert** | 0.037 | 0.03 | 0.03 | 0.03 |
| **TRACE ELEMENTS** | | | | |
| Cu exch. mg/kg | 2.7 | 5.7 | 0.6 | <0.5 |
| Mn exch. mg/kg | 1.2 | 0.7 | 0.5 | 0.5 |

## Interpretation of the analytical results

The sample was extracted from the top of a hill with a fairly shallow slope, exposed to west-north-west, at an altitude of 66m. The soil type is moderately deep CALCISOL, developed on the geological formation of the *molasses du Fronsadais* (Oligocene). The soft, unaltered parent rock appears at a depth of 100cm. The texture of the soil is predominantly silt and clay, with few large particles. The soil is relatively compact, which limits the rooting depth. The parent rock is colonised by the rooting system, but the roots are dead and located between the structural elements (photo on the profile description page). While silt is reputed to preserve a large quantity of water which is available to vines, the water accessible to the vines at the sample location would be rather limited. The location of the plot in an elevated topographical location encourages run-off during rainy periods, limiting the quantity of water which actually penetrates the soil. Moreover, the compacting of the subsoil limits rooting depth. Soil compacting on the surface, caused by agricultural vehicles, is harmful, as it prevents the vines' roots from developing correctly. The compacting of the sub-soil however, whether pedological or geological in origin, is favourable for the quality of the wine (it protects the vines from an excess of water).

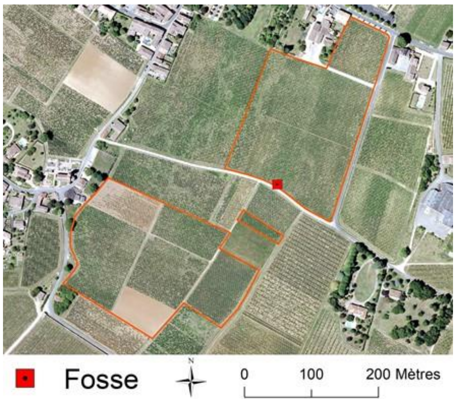
At the sample location, the organic matter and nitrogen content is moderate. It is likely that, as a result of erosion and earth movement prior to planting the plot, the organic matter (and therefore the vines' nitrogen status) in the soil will vary significantly within the plot. This situation may cause some variability in terms of the growth and productivity of the vine.

The soil has a comfortable cation exchange capacity, and the distribution of cations on the adsorbent complex is balanced ($Ca^{++} > Mg^{++} > K^{+}$). Potassium levels for the vines will need to be monitored, but there is a high level of magnesium in the soil. The soil is calcareous, but the active limestone content is low, allowing for a wide range of rootstocks to be used. It is however likely that the active limestone content will vary throughout the plot. The soil has an acceptable level of phosphorous.

This soil would be suitable for Merlot, Cabernet Franc or Malbec, grafted onto 420A. In this sort of situation, 161-49C offers a good potential in terms of quality, but there is a (low) risk of tylosis upon planting. The soil should be fed using moderate organic fertiliser and the potassium nutrition should be regularly monitored, either using petiole analysis every 5 years, or by observing the appearance of any deficiencies. The soil must be seeded with grasses which compete to a low to moderate extent.

The moderately deep CALCISOL in the "La Clie" plot at Château Corbin offers excellent potential for quality, both in terms of its exposure on one side of a hill and for the nature of the soil, which moderately inhibits the water and nitrogen supply to the vines. The wines produced on this type of soil are powerful, but maintain a good level of freshness. By blending these with batches produced on other types of soil, it is possible to create very well-rounded wines with an excellent potential for ageing. As the climate changes and temperatures rise, it would be worthwhile to gradually increase the proportion of Cabernet Franc and Malbec in this location.

## Château La Couronne, "Bellevue" plot (F2)
## NEOLUVISOL on *molasses de l'Agenais*




**Description of the profile on the 29 July 2020**
Plot located on the plateau, in a slight dip at 75m above sea level

**Horizon 1: 0 - 20 cm**
Texture: Silt clay
Large particles: none
Colour: Pale brown
Structure: Subangular blocky
Compact horizon (dry)
Humidity: Dry
Reaction with hydrochloric acid: absent
Rooting: Many fine, medium and thick roots, horizontal and oblique in direction

**Horizon 2: 20 - 60 cm**
Texture: Silt clay
Large particles: none
Colour: Pale brown
Structure: Angular blocky
Compact horizon (dry)
Humidity: Dry
Reaction with hydrochloric acid: absent
Rooting: A good number of fine, medium and thick roots, horizontal and oblique in direction

**Horizon 3: 60 - 100 cm**
Texture: Silt clay
Large particles: none
Colour: Pale brown, presence of black ferro-manganic patches
Structure: Subangular blocky
Compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: Few fine roots, all directions

**Horizon 4: 100 - 130 cm**
Texture: Clay silt, clay skins visible on clumps
Large particles: none
Colour: Pale brown, presence of many black ferro-manganic patches
Structure: Angular blocky
Compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: Few roots, but present to the base of the sample

## Interpretation of the profile

The profile was taken from the *molasses de l'Agenais* formation, which covers the *calcaire à Astéries* at the sample zone. The *calcaire à Astéries* is not visible at the base of the pit (130 cm). The profile is located in a slight dip, which implies that the *molasses de l'Agenais* could have formed a minor colluvial deposit here. The pit was not analysed, but analyses had been conducted by the SOVIVINS firm on the property in several similar pits. These analyses show a clay content of around 30% in surface horizons, and around 40% deeper down. This clay gradient is most likely caused by clay washing, justifying the label of NEOLUVISOL on *molasses de l'Agenais* for this soil. The vines' roots run deep, and are present at the base of the pit (130 cm). The high silt content, coupled with the deep rooting, provides an ample reservoir of water for the vine. The vines should never suffer from water deficit stress. Due to the high clay content at depth, it is however possible that moderate water deficit may occur in very dry summers. This water deficit would have a positive impact on quality, as it promotes the synthesis of phenolic compounds in grape berries.

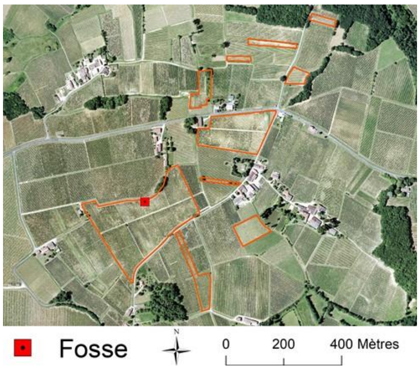
The organic matter content is moderate, and is fairly quickly mineralised in this type of soil. As a result, there should be ample nitrogen availability. It is important to restrict it by seeding grass which will compete to a moderate extent.

The catione exchange capacity is quite high, and the soil has a slightly acidic reaction. Mineral nutrition should proceed under good conditions. The absence of active limestone allows for the use of quite a wide variety of rootstocks.

Traditionally, this soil provides excellent results with Merlot. With global warming, Cabernet Franc will also be a possibility. There may be difficulties achieving full ripeness in one or two years every decade, but it can provide aromatic complexity, freshness and a slightly lower alcohol level. As the growth potential is quite high in this soil (which has few limiting factors), it is important to choose a rootstock inducing low to moderate vigour, such as 101-14MGt. In this soil type the use of cover crop is mandatory to reduce the vine nitrogen status.

The wines produced on NEOLUVISOL on molasses de l'Agenais are powerful with a good level of freshness, despite a tendency towards high alcohol contents. They have a very good potential for ageing. They blend well with batches produced on *calcaire à Astéries* and on *molasses du Fronsadais*, giving wines with a good blend of power and finesse.

## Château Tour Bayard, “Malbec” plot (F3)
## Shallow CALCOSOL on *argile de Castillon* and *molasses du Fronsadais*




**Description of the profile on the 29 July 2020**
Plot located on an upper slope (10%) at 67 m above sea level

**Horizon 1: 0 - 25 cm**
Texture: Clay-silt
Large particles: 2%, limestone
Colour: Dark brown with white patches of calcium carbonate
Structure: Subangular blocky
Very compact horizon
Humidity: Dry
Reaction with hydrochloric acid: strong
Rooting: Many fine, medium and thick roots, horizontal and oblique, in good health


**Horizon 2: 25 - 60 cm**
Texture: Clay-silt
Large particles: 2%, limestone
Colour: Pale grey-brown with many white patches (calcium carbonate)
Structure: Angular blocky
Very compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: strong
Rooting: Many fine and medium roots, all directions; dead roots located between structural elements

**Horizon 3: 60 - 120 cm (parent rock)**
Texture: Silt clay
Large particles: none
Colour: Pale grey with many white patches (calcium carbonate) and a few rust-coloured patches (colour of the bedrock)
Structure: Angular blocky
Very compact horizon
Humidity: Dry
Reaction with hydrochloric acid: strong
Rooting: Many fine roots, mostly dead, no roots visible beyond a depth of 85 cm

## Analytical results

| Parcel "Malbec" | Horizon 1 | Horizon 2 | Horizon 3 |
|---|---|---|---|
| **DEPTH (cm)** | 0-25 | 25-60 | 60-120 |
| **COURSE ELEMENTS (>2 mm) (%)** | 2% | 2% | 0% |
| **FINE EARTH (%)** | 98% | 98% | 100% |
| Coarse sand | 13% | 9% | 2% |
| Fine sand | 8% | 10% | 7% |
| Coarse silt | 20% | 17% | 22% |
| Fine silt | 26% | 30% | 47% |
| Clay | 33% | 35% | 23% |
| **TEXTURE** | Clay-silt | Clay-silt | Silty-clay |
| **ORGANIC MATTER (%)** | 2.2 | <0.6 | - |
| **ORGANIC CARBON (%)** | 1.3 | - | - |
| **TOTAL NITROGEN (%)** | 0.145 | 0.037 | - |
| **C/N ratio** | 8.9 | - | - |
| **pH (water)** | 8.4 | 8.6 | 8.6 |
| **pH (KCl)** | 7.7 | 7.9 | 8.0 |
| **ADSORBANT COMPLEX** | | | |
| $K^+$ $cmol^+/kg$ | 0.68 | 0.36 | 0.25 |
| $Mg^{2+}$ $cmol^+/kg$ | 1.73 | 1.29 | 0.99 |
| $Ca^{2+}$ $cmol^+/kg$ | ++ | ++ | ++ |
| S (sum of cations) | ++ | ++ | ++ |
| V (saturation rate) | Sat. | Sat. | Sat. |
| **C.E.C $cmol^+/kg$** | 16.3 | 11.3 | 7.4 |
| **Total Ca (%)** | 23% | 39% | 69% |
| **Active Ca (%)** | 9% | 15% | 15% |
| **IPC** | >200 | - | - |
| **$P_2O_5$ g/kg Joret-Hébert** | 0.03 | 0.03 | 0.033 |
| **TRACE ELEMENTS** | | | |
| Cu exch. mg/kg | 1.2 | <0.5 | 0.5 |
| Mn exch. mg/kg | 1.1 | 1.9 | 6.7 |

## Interpretation of the analytical results

The sample was extracted from the top of a hill exposed to south-south-east, at an altitude of 67 m. The soil type is moderately deep CALCISOL, developed on the geological formation of the *molasses du Fronsadais* (Oligocene). The soft, unaltered parent rock appears at a depth of 60 cm. The texture of the soil is predominantly silt and clay, with few large particles. The soil is highly compact, which limits the rooting depth. The bedrock is colonised by the root system, but the roots are predominantly dead. There are no roots visible beyond a depth of 85 cm. While silt is reputed to preserve a large quantity of water which is available to vines, the water accessible to the vines at the sample location would be rather limited. The location of the plot on quite a steep slope encourages run-off during rainy periods, limiting the quantity of water which actually penetrates the soil. Moreover, the compacting of the subsoil limits rooting depth. Soil compacting on the surface, caused by agricultural vehicles, is harmful, as it prevents the vines' roots from developing correctly. The compacting of the sub-soil however, whether pedological or geological in origin, is favourable for the quality of the wine (it protects the vines from an excess of water).

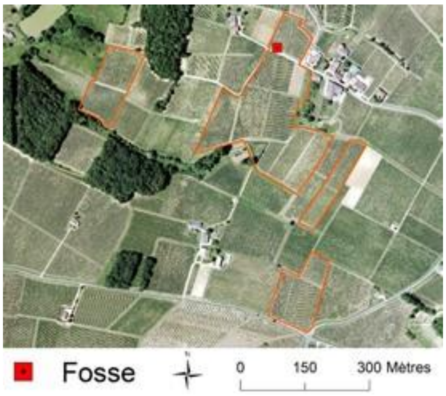
At the sample location, the organic matter and nitrogen content is quite high, but only to a depth of around 20cm only. The vine nitrogen status should be moderately low. A second sample pit, dug at a little over 100m away in a similar topographical location, shows a truncated soil containing very little organic matter. It is likely that, as a result of erosion and earth movement prior to planting the plot, the organic matter (and therefore the vines' nitrogen status) in the soil will vary significantly within the plot. This situation may cause some variability in terms of the growth and productivity of the vine.

The soil has a moderately high cation exchange capacity, and the distribution of cations on the adsorbent complex is balanced ($Ca^{++} > Mg^{++} > K^{+}$). Potassium levels for the vines will need to be monitored, but there is quite a high level of magnesium in the soil. The soil is high in limestone, and the rootstock must be at least moderately resistant to active limestone. It is however likely that the active limestone content will vary throughout the plot. The soil contains relatively low levels of phosphorous, but phosphorous deficiencies on the vines in mid-vineyard are rare.

This soil would be suitable for Merlot, Cabernet Franc or Malbec, grafted onto 420A. In this sort of situation, 161-49C offers a good potential in terms of quality, but there is a (low) risk of tylosis upon planting. The soil should be fed using moderate organic fertiliser and the potassium nutrition should be regularly monitored, either using petiole analysis every 5 years, or by observing the appearance of any deficiencies.

The moderately deep CALCOSOL in the "La Clie" plot at Château Tour Bayard offers excellent potential for quality, both in terms of its exposure on one side of a hill with good exposure and for the nature of the soil, which moderately inhibits the water and nitrogen supply to the vines. The wines produced on this type of soil are powerful, but maintain a good level of freshness. By blending these with batches produced on the *calcaire à Astéries* plateau, it is possible to create very well-rounded wines with an excellent potential for ageing. As the climate changes and temperatures rise, it would be worthwhile to gradually increase the proportion of Cabernet Franc and Malbec in this location.

## Vieux Bonneau, “Bonneau” plot (F4)
## BRUNISOL on reworked *molasses du Fronsadais*




**Description of the profile on the 29 July 2020**
Plot located on a dome at 62 m above sea level

**Horizon 1: 0 - 30 cm**
Texture: silt clay
Large particles: none
Colour: Brown
Structure: Subangular blocky
Very compact horizon (dry)
Humidity: Dry
Reaction with hydrochloric acid: absent
Rooting: Fine, medium and thick roots, horizontal and oblique in direction

**Horizon 2: 30 - 85 cm**
Texture: clay and sand
Large particles: 1% small white pebbles, not limestone (feldspar)
Colour: Reddish brown with grey patches
Structure: Subangular blocky
Very compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: A good number of roots, fine, all directions, partially necrotised

**Horizon 3: 85 - 130 cm**
Texture: Clay and silt
Large particles: none
Colour: Reddish brown, many grey patches
Structure: Angular blocky
Very compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: Many fine roots, all directions, present down to the base of the pit, roots predominantly necrotised

## Analytical results

| Parcel "Bonneau" | Horizon 1 | Horizon 2 | Horizon 3 |
|---|---|---|---|
| **DEPTH (cm)** | 0-30 | 30-85 | 85-130 |
| **COURSE ELEMENTS (>2 mm) (%)** | 0% | 1% | 0% |
| **FINE EARTH (%)** | 100% | 99% | 100% |
| Coarse sand | 37% | 56% | 27% |
| Fine sand | 11% | 5% | 9% |
| Coarse silt | 18% | 8% | 18% |
| Fine silt | 12% | 5% | 12% |
| Clay | 23% | 27% | 34% |
| **TEXTURE** | Silty clay | Clay-silt | Clay-silt |
| **ORGANIC MATTER (%)** | 1.7 | <0.5 | - |
| **ORGANIC CARBON (%)** | 1.0 | - | - |
| **TOTAL NITROGEN (%)** | 0.089 | 0.033 | - |
| **C/N ratio** | 11.4 | - | - |
| **pH (water)** | 6.8 | 7.1 | 5.2 |
| **pH (KCl)** | 5.9 | 6.2 | 4.0 |
| **ADSORBANT COMPLEX** | | | |
| $K^+$ $cmol^+/kg$ | 0.72 | 0.29 | 0.30 |
| $Mg^{2+}$ $cmol^+/kg$ | 2.21 | 3.21 | 3.82 |
| $Ca^{2+}$ $cmol^+/kg$ | 9.49 | 10.78 | 9.36 |
| S (sum of cations) | ++ | ++ | 13.5 |
| V (saturation rate) | Sat. | Sat. | 96% |
| **C.E.C $cmol^+/kg$** | 10.7 | 11.5 | 14.1 |
| **Total Ca (%)** | - | - | - |
| **Active Ca (%)** | - | - | - |
| **IPC** | - | - | - |
| **$P_2O_5$ g/kg Joret-Hébert** | 0.157 | 0.03 | 0.03 |

## Interpretation of the analytical results

The sample pit was dug on a dome at 62 m above sea level. The bedrock consists of reworked *molasses du Fronsadais*. At the pit location, this *molasse* is not carbonated and is high in feldspar. The clay content varies from 25 to 35%, depending on the horizon. The CEC/clay ratio is between 0.40 and 0.45 from a depth of 30cm, indicating that the proportion of swelling clay (agronomically beneficial) is quite high. The soil's water retention capacity, thanks to the balance of sand, silt and clay, is quite high. The water available to the vines is however limited, both by the raised topographical location and by the compacting of the subsoil. This compacting restricts root exploration and, beyond a depth of 85cm, the proportion of living roots is quite low. This compacted subsoil is beneficial for the quality of the wine, as it prevents the vines from accessing too much water. The subsoil shows mottling which is characteristic of the existence of temporary water tables (*pseudogley*). Due to the plot's topographical location, this winter hydromorphism should be highly temporary and in no way damaging to the quality potential of the plot.

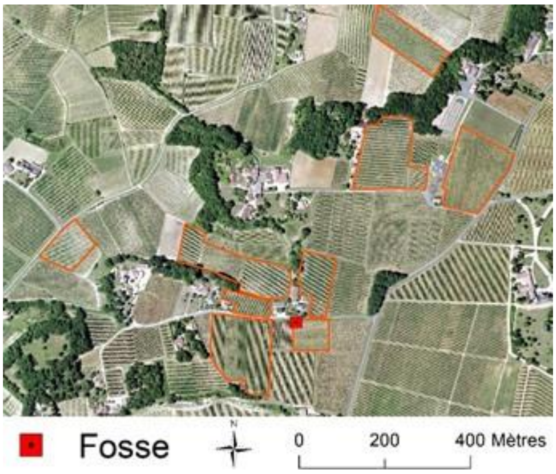
The soil has relatively low levels of organic matter and total nitrogen. This results in moderate nitrogen availability to the vine, which is beneficial to wine quality as it promotes the synthesis of phenolic compounds in the berries (tannins and anthocyanins).

The Catione Exchange Capacity (CEC) is high and this soil contains high levels of calcium and magnesium. The potassium content is lower and it is necessary to monitor the vines' potassium levels using regular petiole analysis (at least every 5 years), and by looking out for any symptoms of deficiencies. The soil has an almost neutral reaction on the surface, and is quite highly acidic in the subsoil. There is no limestone, and there are quite high levels of phosphorous.

This soil could produce good results with Merlot on 101-14MGt or 3309C. Due to the favourable topographical location (at height), as the climate changes, Cabernet Franc could also be planted here.

The BRUNISOL on reworked *molasses du Fronsadais* at Château Vieux Bonneau has a somewhat unusual profile. While it is tertiary in terms of its formation, it is not limestone: it contains feldspar and quite a high proportion of swelling clay. The potential for quality is linked to its topographical location and the compacted nature of the subsoil, two factors which promote the onset of moderate water deficit in dry summers. Moreover, the available nitrogen is also moderate, which is another factor which promotes wine concentration.

## Château Rigaud, the "Face maison" plot (F5)
## Shallow CALCOSOL on calcaire à Astéries




**Description of the profile on the 29 July 2020**
Plot located on the Puisseguin plateau, at 89 m above sea level


**Horizon 1: 0 - 30 cm**
Texture: Silt clay
Large particles: 3%, limestone
Colour: Brown with some white patches of calcium carbonate
Structure: Subangular blocky
Variable compaction horizon
Humidity: Dry
Reaction with hydrochloric acid: strong
Rooting: Many fine, medium and thick roots, horizontal and oblique, generally in good health, many roots in contact with the *calcaire à Astéries* (photo).

**Compact calcaire à Astéries at 30cm deep with many roots in contact with the bedrock**

## Analytical results

| Parcel "Face maison" | Horizon 1 |
| --- | --- |
| **DEPTH (cm)** | 0-30 |
| **COURSE ELEMENTS (>2 mm) (%)** | 3% |
| **FINE EARTH (%)** | 97% |
| Coarse sand | 21% |
| Fine sand | 9% |
| Coarse silt | 21% |
| Fine silt | 27% |
| Clay | 23% |
| **TEXTURE** | Silty-clay |
| **ORGANIC MATTER (%)** | 4.4 |
| **ORGANIC CARBON (%)** | 2.6 |
| **TOTAL NITROGEN (%)** | 0.23 |
| **C/N ratio** | 11.1 |
| **pH (water)** | 8.2 |
| **pH (KCl)** | 7.6 |
| **ADSORBANT COMPLEX** | |
| $K^+$ cmol$^+$/kg | 1.06 |
| $Mg^{2+}$ cmol$^+$/kg | 1.42 |
| $Ca^{2+}$ cmol$^+$/kg | ++ |
| S (sum of cations) | ++ |
| V (saturation rate) | Sat. |
| **C.E.C cmol$^+$/kg** | 15.3 |
| **Total Ca (%)** | 23.8 |
| **Active Ca (%)** | 6.2 |
| **IPC** | 155 |
| **$P_2O_5$ g/kg Joret-Hébert** | 0.395 |
| **TRACE ELEMENTS** | |
| Cu exch. mg/kg | 5.0 |
| Mn exch. mg/kg | 5.3 |

## Interpretation of the analytical results

The soil profile at Château Rigaud was dug from the Puisseguin limestone plateau. The pit is located at 89m above sea level. The *calcaire à Astéries* (a hard limestone) only appears at a depth of 30cm. The soil texture is silt-clay. It is surprising that the vines can grow adequately on such shallow soil. There could be concerns that the low water retention would lead to extreme water deficit stress in dry summers. In reality however, the *calcaire à Astéries* plays an active role in supplying water to the vines. The *calcaire à Astéries* absorbs excess water during heavy rainfall and can wick this water back up during dry periods. It has been demonstrated that this water can cover 40% of a vine's water consumption over the course of a dry summer (Duteau, 1987). The vine develops a very dense root system in contact with the *calcaire à Astéries*, which was clearly visible in the pit (photo on the pit description page). Because of the regulation mechanisms, there is an extremely effective buffered water supply. On the other hand, when the vines are young and their root system is not yet completely developed, they can suffer from drought.

The levels of organic matter and total nitrogen in the soil are high. It is difficult to extrapolate from this result, as it is likely that the levels are not as high throughout the plot. It is nevertheless likely that the vines have comfortable levels of available nitrogen.

The catione exchange capacity (CEC) of the soil is quite high, and the levels of calcium, magnesium, potassium and phosphorous are high. This richness is however relative, as fertility is restricted by the shallow depth afforded to the vines' roots.

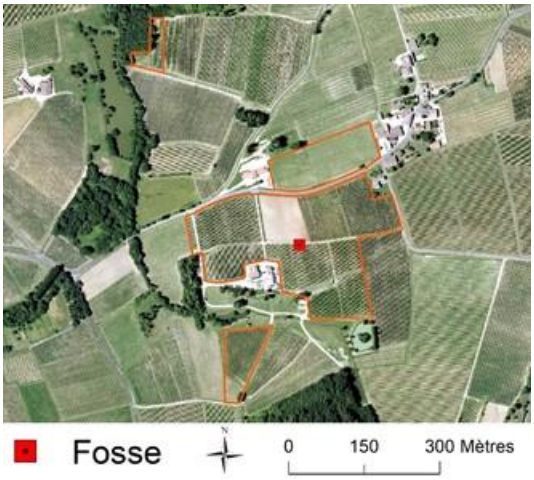
This superficial CALCOSOL is high in limestone and requires a rootstock which is resistant to active limestone, such as Fercal or 41B. 420A may also be suitable, but it comes with a moderate risk of chlorosis symptoms appearing. This soil is suitable for both Merlot and Cabernet Franc.

The superficial CALCOSOL on *calcaire à Astéries* offers a very high potential for quality. The wines are not particularly concentrated, but offer excellent finesse and much freshness. They have an excellent potential for ageing. By blending wines produced on *calcaire à Astéries* and from deeper *molasses du Fronsadais* soils, it will be possible to create wines which are powerful, fine and have excellent potential for ageing.

## Bibliographical reference

DUTEAU J., 1987. Contribution of deep compact Astéries limestone hydric reserves on water supply to vines in the Bordeaux region. *Agronomie,* **7,** n°10, 859-865.

## Château La Rose Perrière, plot 4 (F6)
## Shallow CALCOSOL on *calcaire à Astéries*





**Description of the profile on the 29 July 2020**
Plot located on the Lussac plateau, at 70 m above sea level

**Horizon 1: 0 - 25 cm**
Texture: Silt clay
Large particles: 3%, limestone
Colour: Brown with some white patches of calcium carbonate
Structure: Subangular blocky
Compact horizon (dry)
Humidity: Dry
Reaction with hydrochloric acid: strong
Rooting: Many fine, medium and thick roots, horizontal and oblique, generally in good health, many roots in contact with the Astéries limestone (photo).

**Compact Astéries limestone at 25 cm deep**

## Analytical results

| Parcel 4 | Horizon 1 |
|---|---|
| **DEPTH (cm)** | 0-25 |
| **COURSE ELEMENTS (>2 mm) (%)** | 3% |
| **FINE EARTH (%)** | 97% |
| Coarse sand | 32% |
| Fine sand | 13% |
| Coarse silt | 15% |
| Fine silt | 20% |
| Clay | 21% |
| **TEXTURE** | Silty-clay |
| **ORGANIC MATTER (%)** | 2.7 |
| **ORGANIC CARBON (%)** | 1.6 |
| **TOTAL NITROGEN (%)** | 0.156 |
| **C/N ratio** | 10.1 |
| **pH (water)** | 8.4 |
| **pH (KCl)** | 7.8 |
| **ADSORBANT COMPLEX** | |
| $K^+$ $cmol^+/kg$ | 0.94 |
| $Mg^{2+}$ $cmol^+/kg$ | 1.25 |
| $Ca^{2+}$ $cmol^+/kg$ | ++ |
| S (sum of cations) | ++ |
| V (saturation rate) | Sat. |
| **C.E.C $cmol^+/kg$** | 10.4 |
| **Total Ca (%)** | 35.7 |
| **Active Ca (%)** | 10.1 |
| **IPC** | >200 |
| **$P_2O_5$ g/kg Joret-Hébert** | 0.138 |
| **TRACE ELEMENTS** | |
| Cu exch. mg/kg | 21.8 |
| Mn exch. mg/kg | 2.9 |

## Interpretation of the analytical results

The profile from Château La Rose Perrière was dug from the *calcaire à Astéries* plateau, at an altitude of 70m. The soil is very shallow and the hard limestone appears at a depth of just 25cm. It is astonishing that the vines can feed adequately on such shallow soil. Studies in Saint-Emilion, however, have demonstrated that the *calcaire à Astéries* plays an active role in supplying water to the vines. During episodes of heavy rainfall, excess water penetrates the limestone. During periods of drought, this water is wicked back up and actively provides water to the vines. In this way, this water can cover 40% of a vine's water consumption over the course of a dry summer (Duteau, 1987). On the other hand, young vines which have not yet developed a dense root system in contact with the *calcaire à Astéries* may suffer from summer droughts.

The total organic matter and nitrogen in the soil is quite high, but the shallowness of the soil obviates any risk of excessive nitrogen uptake.

The catione exchange capacity of the soil is moderately high, and the levels of calcium, magnesium, potassium and phosphorous are satisfactory. As with nitrogen, the availability of these elements is limited by the low volume of earth explored by each vine. The exchangeable copper content is quite high, but there is no risk of toxicity. Rather, it is a reflection of historic growing practices.

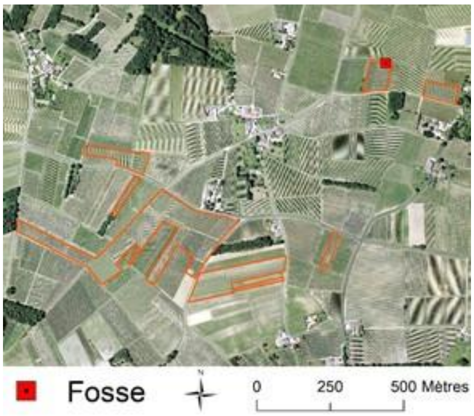
This soil is highly chlorosis-inducing and requires rootstock which is resistant to active limestone, such as Fercal or 41B. It would produce good results with Merlot or Cabernet Franc. Due to the shallow depth, it is preferable not to plough the soil. Cover crop should be used, but with grass which induce very little competition.

The superficial CALCOSOL at Château La Rose Perrière offers a very high potential for quality. The soil is poor due to its shallowness, but the water available to the vines is very well regulated. The wines produced on this type of soil excel more for their finesse and complexity than their power. They blend very well with more powerful wines produced on *molasses du Fronsadais*. This blend produces wines which are finer, more powerful and with a better potential for ageing.

## Bibliographical reference

DUTEAU J., 1987. Contribution of deep compact Astéries limestone hydric reserves on water supply to vines in the Bordeaux region. *Agronomie,* **7,** n°10, 859-865.

## Château de la Grenière, “le Caillou” plot (F7) Low-redox BRUNISOL on ancient fluvial deposits (Eocene)




**Description of the profile on the 29 July 2020**
Plot located on a gently sloping bank at 53 m above sea level


**Horizon 1: 0 - 35 cm**
Texture: Silt and sand
Large particles: 2% (siliceous)
Colour: Pale grey brown
Structure: Subangular blocky
Compact horizon (dry)
Humidity: Dry
Reaction with hydrochloric acid: absent
Rooting: A good number of fine and medium roots, horizontal and oblique in direction

**Horizon 2: 35 - 70 cm**
Texture: silt clay
Large particles: 2%
Colour: Pale brown with rusty patches and some grey patches
Structure: Angular blocky
Compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: A few fine roots, partially necrotised, all directions

**Horizon 3: 70 - 90 cm**
Texture: silt clay
Large particles: 40%
Colour: Pale brown with some rusty and grey patches
Structure: Subangular blocky
Very compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: Few fine roots, all directions, mostly necrotised

**Horizon 4: 90 - 110 cm**
Texture: clay and sand
Large particles: 15%
Colour: Grey-rusty mottling
Structure: Angular blocky
Very compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: Fine roots, fairly many of them, mostly necrotised

**Horizon 5: 110 - 130 cm**
Texture: sandy clay
Large particles: 10%
Colour: Grey-rusty mottling, much feldspar
Structure: Angular blocky
Compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: No visible roots
Horizon not sampled

### Analytical results

| Parcel "le Caillou" | Horizon 1 | Horizon 2 | Horizon 3 | Horizon 4 |
|---|---|---|---|---|
| **DEPTH (cm)** | **0-35** | **35-70** | **70-90** | **90-110** |
| **COURSE ELEMENTS (>2 mm) (%)** | 2% | 2% | 40% | 15% |
| **FINE EARTH (%)** | 98% | 98% | 60% | 85% |
| Coarse sand | 26% | 20% | 24% | 33% |
| Fine sand | 12% | 11% | 11% | 14% |
| Coarse silt | 32% | 24% | 20% | 12% |
| Fine silt | 21% | 21% | 19% | 11% |
| Clay | 9% | 24% | 26% | 30% |
| **TEXTURE** | Sandy-silt | Silty-clay | Silty-clay | Sandy-clay |
| **ORGANIC MATTER (%)** | 1.0 | <0.6 | - | - |
| **ORGANIC CARBON (%)** | 0.6 | - | - | - |
| **TOTAL NITROGEN (%)** | 0.058 | 0.037 | 0,034 | - |
| **C/N ratio** | 10.4 | - | - | - |
| **pH (water)** | 7.1 | 6.6 | 6.0 | 5.2 |
| **pH (KCl)** | 6.2 | 5.5 | 4.9 | 4.0 |
| **ADSORBANT COMPLEX** | | | | |
| $K^+$ $cmol^+/kg$ | 0.29 | 0.47 | 0.30 | 0.27 |
| $Mg^{2+}$ $cmol^+/kg$ | 0.56 | 1.20 | 1.51 | 2.77 |
| $Ca^{2+}$ $cmol^+/kg$ | ++ | 5.71 | 6.36 | 8.68 |
| S (sum of cations) | ++ | 7.4 | 8.2 | 11.7 |
| V (saturation rate) | Sat. | 90% | 89% | 89% |
| **C.E.C cmol$^+$/kg** | 4.9 | 8.2 | 9.2 | 13.1 |
| **Total Ca (%)** | - | - | - | - |
| **Active Ca (%)** | - | - | - | - |
| **IPC** | - | - | - | - |
| **$P_2O_5$ g/kg Joret-Hébert** | 0.359 | 0.03 | 0.03 | 0.03 |

## Interpretation of the analytical results

The profile from Château de la Grenière was dug from ancient fluvial deposits at an altitude of 53m. The texture of the soil is predominantly silty. A horizon with 40% large particles is located at a depth of 70-90cm. Mottling appears at shallow depths on the profile and indicates the presence of a free water table in winter. It is likely that this water table disappears quite early in the season, and that it has little impact on the vines' water supply in summer. The soil and subsoil are compact. As such, there are no roots visible beyond a depth of 110 cm. The silt has an excellent water-retention capability. The compaction of the subsoil is an asset here, as it restricts the depth of the root system and thereby restricts the available water somehow.

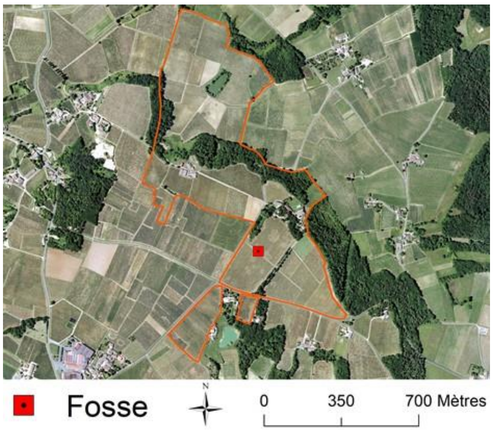
The soil has very low levels of organic matter and total nitrogen. It is likely that the vines have very moderate levels of available nitrogen. For the production of quality red wines, moderate nitrogen availability is a quality factor as it stimulates the synthesis of phenolic compounds in grape berries (tannins and anthocyanins).

The catione exchange capacity (CEC) of the soil is quite low, but the distribution of the cations on the adsorbent complex is balanced ($Ca^{++} > Mg^{++} > K^{+}$). The potassium available to the vines will need to be monitored using periodic petiole analysis (every 5 years), and by looking out for the appearance of any deficiencies. On the other hand, there is no risk of any magnesium deficiency. The pH is near 7 on the surface, but the soil is clearly acidic further down. The soil is high is phosphorous, probably due to fertilisation.

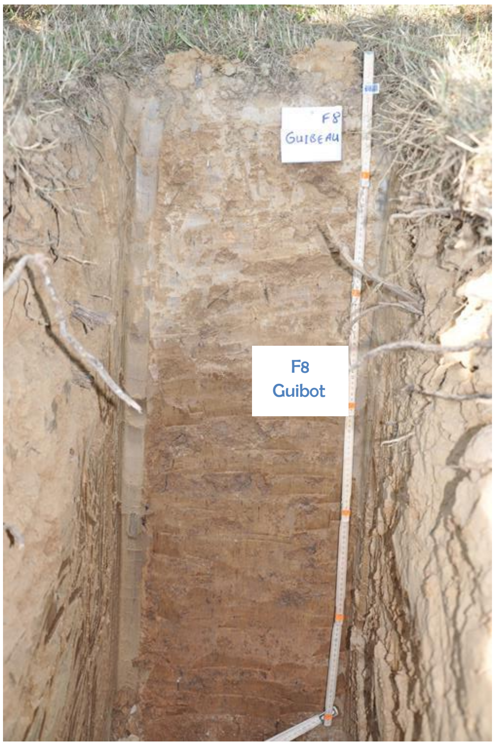
This soil would be suitable for Merlot, Cabernet Franc or Cabernet-Sauvignon. These last two are late-developing varieties and require high quality growing practices to bring them to maturity, in particular with a leaf/grape ratio above 1.5m²/kg at harvest. The soil does not contain any limestone, allowing for the use of a wide variety of rootstock. It is preferable however to choose a rootstock inducing moderately low vigour, such as the 101-14MGt, in particular if used with Cabernet Franc or Cabernet-Sauvignon.

The low-redox BRUNISOL on the ancient fluvial deposits at Château de la Grenière is highly unusual. The texture is predominantly silty, but has a layer of gravel deep down. This soil provides a very moderate level of available nitrogen. Because it is not calcareous, it allows for the use of low vigour inducing rootstocks. These quality rootstocks will in turn allow for the use of late-developing varieties such as Cabernet Franc or even Cabernet-Sauvignon. This somewhat atypical plant material (for Saint-Emilion) will produce very unusual wines, with lots of freshness, a great tannin structure and an expressive aromatic profile dominated by fresh fruit.

## Château Guibot,
## “Le Haut du Bassin” plot (F8)
## NEOLUVISOL on *molasses de l’Agenais*




**Description of the profile on the 29 July 2020**
Plot located on the Puisseguin plateau, at 100 m above sea level




**Horizon 1: 0 - 45 cm**
Texture: Silt clay
Large particles: none
Colour: Pale brown (dry)
Structure: Angular blocky
Very compact horizon (dry)
Humidity: Dry
Reaction with hydrochloric acid: absent
Rooting: Many fine, medium and thick roots, horizontal and oblique, in good health

**Horizon 2: 45 - 80 cm**
Texture: Clay and silt
Large particles: none
Colour: Brown
Structure: Angular blocky
Compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: Many fine roots, vertical and oblique, mostly necrotised

**Horizon 3: 80 - 130 cm**
Texture: Clay
Large particles: none
Colour: Brown
Structure: Angular blocky
Very compact horizon
Humidity: Fresh
Reaction with hydrochloric acid: absent
Rooting: Many fine roots, vertical and oblique, mostly necrotised, but with living roots down to the bottom of the pit

## Analytical results

| Parcel "Le Haut du Bassin" | Horizon 1 | Horizon 2 | Horizon 3 |
|---|---|---|---|
| **DEPTH (cm)** | 0-45 | 45-80 | 80-130 |
| **COURSE ELEMENTS (>2 mm) (%)** | 0% | 0% | 0% |
| **FINE EARTH (%)** | 100% | 100% | 100% |
| Coarse sand | 3% | 3% | 5% |
| Fine sand | 6% | 5% | 5% |
| Coarse silt | 39% | 26% | 24% |
| Fine silt | 25% | 28% | 25% |
| Clay | 27% | 38% | 41% |
| **TEXTURE** | Silty-clay | Silty-clay | Clay |
| **ORGANIC MATTER (%)** | 0.7 | <0.6 | - |
| **ORGANIC CARBON (%)** | 0.4 | - | - |
| **TOTAL NITROGEN (%)** | 0.07 | 0.052 | - |
| **C/N ratio** | 5.8 | - | - |
| **pH (water)** | 6.8 | 6.8 | 6.8 |
| **pH (KCl)** | 5.9 | 5.8 | 5.9 |
| **ADSORBANT COMPLEX** | | | |
| $K^+$ $cmol^+/kg$ | 0.52 | 0.35 | 0.36 |
| $Mg^{2+}$ $cmol^+/kg$ | 1.18 | 1.31 | 1.28 |
| $Ca^{2+}$ $cmol^+/kg$ | 8.61 | 12.43 | ++ |
| S (sum of cations) | ++ | ++ | ++ |
| V (saturation rate) | Sat. | Sat. | Sat. |
| **C.E.C cmol$^+$/kg** | 9.2 | 13.8 | 13.5 |
| **Total Ca (%)** | <0.1 | <0.1 | <0.1 |
| **Active Ca (%)** | - | - | - |
| **IPC** | - | - | - |
| **$P_2O_5$ g/kg Joret-Hébert** | 0.043 | 0.03 | 0.03 |

## Interpretation of the analytical results

The profile from Château Guibot la Fourvieille was dug from the *molasses de l'Agenais* which covers the *calcaire à Astéries*, at a height of 100m. The *calcaire à Astéries* does not appear at the base of the pit. The soil contains a large proportion of silt, but becomes more clay at depth. This clay gradient is most likely caused by clay washing, justifying the label of NEOLUVISOL on *molasses de l'Agenais* for this soil. The profile does not show signs of hydromorphism, probably due to its elevated topographical location. Living roots are visible throughout the profile and probably go down even lower. The high silt content and significant root depth provide a high soil water holding capaity. The vines' water supply should almost never be a limiting factor.

The soil has low levels of organic matter and total nitrogen. The available nitrogen should be very low. This availability is limited further by the presence of moderately competitive grass seeded between the rows. The low available nitrogen is undeniably an asset for the quality of the wine, as it stimulates the synthesis of phenolic compounds in grape berries (tannins and anthocyanins). It may, on the other hand, penalise yield. It is necessary to find a balance between quality and yield. This could be achieved by modulating the seeding, either by installing species which compete less, by limiting seeding to every other row, or by including legumes in the seeding (clover, for example).

The catione exchange capacity (CEC) is moderately high, and the distribution of the cations on the adsorbent complex is balanced ($Ca^{++} > Mg^{++} > K^{+}$). There is no risk of a magnesium deficiency, but the potassium must be monitored using periodic petiole analysis (once every 5 years, approximately) and by looking out for any deficiencies. The soil has an acceptable level of phosphorous. The pH is near 7 and there is no active limestone, which allows for the use of a wide range of rootstock.

This soil is suitable for Merlot, but with temperatures increasing, Cabernet Franc will also be possible. Various rootstock options are available, but the 101-14MGt seems a good choice for reasons of quality. The estate is run organically, which generally implies fairly high competition from cover crop. Under these conditions, it is also possible to choose 3309C or 420A (only with Merlot) to ensure a higher yield.

On Château Guibot la Fourvieille's NEOLUVISOL on *molasses de l'Agenais*, the wines are rich with plenty of freshness. They can be blended with wines produced on CALCOSOLS on *calcaire à Astéries*, which are less powerful but finer. This blend produces wines which combine power, finesse and a good potential for ageing.