Is regional diversity of premium Australian Shiraz significant?

Thesis Magister Vini

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Thesis report for the Magister Vini final exam

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Preamble

As a conclusion of my Magister Vini study, I have been able to conduct a research and write a report based on a thesis topic of my preference. Such navigating within the qualitative boundaries and further examination requirements connected to the conclusion of this study.

When starting the Magister Vini study, I knew my thesis would be on Australian Shiraz, as I am a great fan of Australia, Australian wine, and Shiraz. Shiraz both Australian as in general. My passion for wine was ignited in 2007 and 2008 when travelling and working in Australia. Working in fine dining, tasting great Australian wines with my colleagues. Up to then I liked wine, but it was basically limited to a variety of entry to mid-level wines. As said, the core topic of my thesis was clear, but it took till the spring of 2018 to shape to the topic, which came to be my focus area, diversity of Australian Shiraz.

Shiraz is not only one of my favorite grapes, but it is also a grape which shows incredible diversity based on the environment, the terroir where it is grown. In the Northern Rhône varying from lean styles with strong savory and spice notes in Côte-Rôtie, to richer and more rich examples in for example Cornas. Looking at this in a setting as you find in Australia, with the vast distances and climatic differences, I was triggered to dive into the question. The question on how significant diversity of Shiraz could be in Australia.

For the research I travelled through Australia, driving from Sydney to Adelaide and between Perth, the Great Southern and Margaret River regions, visiting 17 different wine regions spread all over the south of Australia, only missing Tasmania. Experiencing the regions in real life has opened my eyes to what Australia has to offer, and how the individual regions and vineyards within a region differ from the other.

In my research I have had the invaluable help of many wine experts and lovers, to whom I owe great gratitude. Wine Australia, especially Mark Davidson helping with preparations of my thesis topic and getting started. Back in the Netherlands received valuable support from Ronald de Groot (Chief Editor of Perswijn) in mentoring me and hosting my tasting, and especially from Mirjam van de Veen in reviewing my thesis, being as sparring partner, constantly pushing me forward. There have been times that this was needed.

I am very grateful for all the winemakers who invested their time in answering my survey and follow-up questions and hosting me at their wineries so close to harvest. The visits are unforgettable, and their inputs helped me putting the picture together. The support of Wes Pearson from AWRI was also of a great value, to get more insights on the academic research being conducted and outcomes of already performed researches. Lastly my special gratitude goes out to Michael Hill Smith MW. Without his continuous help, I would not have been able to conduct my research in the way I have done it now.

The thesis research has been an unimaginable journey for me, going back to the country I love, researching a grape I love. I hope that, in writing this thesis report, I can transfer this experience to you as a reader. Australian Shiraz in all its lean or luscious styles. Australian Shiraz has the world to offer, enjoy!

Anne Greveling
September 2020

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Summary

Shiraz over the years has become synonymous with Australia when addressing Australia as a wine country. In 2015 it accounted for 29.5% of total vineyard acreage in Australia. Australian Shiraz generally provides quite ripe styles and until around 10-15 years ago the emphasis also seemed to be more on 'Australian Shiraz' and less on specific regions within Australia. In recent years winemakers, the Australian Wine Research Institute and Wine Australia have put more emphasis on, and research in regions and regionality of wines. Winemakers interviewed, as well as wine writers in Australia and abroad are quite outspoken on the regionality of premium Australian Shiraz. But is this regionality of Australian Shiraz significant? That question is the main thesis for this research and is covered from various angles in the report.

For this research a total of 26 wineries have participated in the survey and around 35 wineries were visited, covering 17 regions in 4 states with 3,300 kilometers of distance -as the crow flies- between the most western and eastern wine regions included.

Shiraz can grow successfully and deliver exciting, expressive wines in both cool and warm climates. The grape itself is very sensitive to the climate and soil in which it is grown and shows its terroir in the resulting wine, if not overly irrigated and planted on poor soil or overpowered by the winemaker. The wines range from reasonably light to medium bodied wines with herbaceous, earthy, savory, and fresh red fruit to heavy dark wines with dark fruits -even stewed to dead fruit when overripe-, chocolate, coffee, and mint and anywhere in between.

Terroir proofs to be a key influencer, also as such understood and used by interviewed winemakers. Especially the meso climate with for example cooling winds, large diurnal differences, and sun exposure due to altitude and topography have a great impact on the resulting style. The soil, its composition and water holding capacity for the vines also have a notable influence. The terroir will determine whether Shiraz can grow and what styles of Shiraz can be made, where most interviewed winemakers feel that the climate has the biggest influence.

Over the year's viticultural practices in Australia for premium Shiraz have changed to create fresher, more digestible wines which reflect their origin. Planting vineyards in different aspect to the sun, higher altitudes, better canopy management and focus on the health of the vineyard and its soil, to get healthier fruit, with fresher characters. Winemakers try to delay the build-up of sugar to be more in line with phenolic ripeness, delivering better balanced wines, this for example by regulated deficit irrigation or dry farming. In general winemakers harvest earlier in the ripening process, preventing overripe shriveled fruit, which results in high alcohol volumes. The practices in the vineyard also proof to have a significant effect on the resulting wine and with that, its ability to show regionality.

With the changing focus on more digestible Shiraz wines, there is a shift to less interventional, more artisanal winemaking for premium Shiraz. Less technical prowess, less extraction, and more balance in the winemaking, to translate the grapes into a wine, reflecting the region or vineyard. Use of new oak has significantly decreased, French oak overtaking American oak as preferred type and barrel sizes increasing to hogsheads, puncheons, and far larger formats. Whole-bunch fermentation is increasingly used,

supporting fresher styles and by limiting alcohol levels, wines are better able to express aromas. Winemaking for premium Shiraz is becoming more contributing to and guiding of the wine, than 'making' or 'factoring' the wine. With this perspective on winemaking, there is a positive influence of winemaking on the ability to show regionality in premium Shiraz wines.

Australian Shiraz from a stylistic perspective generally shows distinct ripeness and generosity, but over a far wider spectrum more balanced and with some restrained on the ripeness, oak, and alcohol. Australian Shiraz is no longer mainly the ripe blockbuster, but covers a wide variety of styles, ranging from the well-known Barossa Valley Shiraz blockbusters to lean and sometimes Northern Rhône like styles from the cooler climates, showing balance structure, complexity and are often more digestible due to restricted alcohol volumes and less use of new oak. There are significant differences between Shiraz from various regions in Australia, which is primarily notable on a climatic scale and for experts also on a regional, and even vineyard and winemaker level. Following this research, a 4-tier scale is created in general styles of premium Australian Shiraz, aiming to give some structure in plotting Australian Shiraz.

This research shows that there is a great diversity in premium Australian Shiraz and that this differs per region, and even within a region and vineyard. As premium Australian Shiraz is mostly not a mass-market product and more often relatively high priced, there is though limited tasting experience providing detailed insights in differences between individual regions. Also, there are stylistic changes over recent decades. This makes it difficult to identify a specific region, have this common understanding on a more detailed level. The climatic influences are far more notable and create a basis on which premium Shiraz wines from specific regions can be classified, categorized.

Answering the core thesis question, yes regional diversity of premium Australian Shiraz is significant, but it is not a black and white answer. When regularly tasting premium Australian Shiraz from various regions over various vintages the differences are clear -sometimes subtle, sometimes very obvious-. For the wider public, which tastes premium Australian Shiraz less frequently and often not in comparative line-ups, it is difficult at this moment to pinpoint exact regions. This research forms a first step in the journey to this common understanding by providing a climatic classification of styles for premium Australian Shiraz.

1 Introduction

1.1 Background

Shiraz[1] is one of the most renowned quality grape varieties in the world. The Shiraz grape is very responsive to the terroir in which it is grown and shows great complexity in both cool and warm climates on a variety of soils, with varying styles. Also, the winemaking techniques have a great impact, but only with the potential the terroir has to offer.

In the Northern Rhône and basically the Old World in general, there is a large focus on diversity between and within regions. The soil composition, aspect towards the sun, specific vineyard meso climate all contribute to the wine and can result in markedly different wines, also when winemaking techniques are similar. In the New World, this focus on regionality, the notice of terroir is growing, both for the quality of the wine as well as marketing. New World winemakers have realized that regionality is the way forward (Goode, 2014, p. 25).

For Australia, following the high scores of Robert Parker for blockbuster wines, extraction and power became the new standard for many. This does not support showcasing regionality. As Parker stated on Australian Shiraz *"The greatest examples emerge from only two regions, Barossa and McLaren Vale. Elsewhere, Shiraz usually produces one-dimensional, heavy wines."* (Parker, 2008).

According to winemakers, writers and own experience, this statement does not seem correct, perhaps not then, but certainly not now and especially not for premium Shiraz. Given the sheer size of the country and the locations of wine regions scattered along the mostly coastal regions (3,300 kilometers west to east, 600 kilometers north to south), with different macro and meso climates, soils, altitudes and topographies, it does not seem unreasonable to expect quality Shiraz with a level of diversity.

1.2 Research thesis

For this thesis research the following research topic has been defined, to get a better understanding on the (non-) existence of diversity of Australian Shiraz.

"Is regional diversity of premium Australian Shiraz significant?"

In answering the thesis question, 5 main research areas have been defined to get a clear perspective and provide a realistic as possible answer to the overall thesis.

1) Main characteristics of the Shiraz grape
2) Terroir and its impact on regionality of Shiraz
3) Viticulture and its impact on regionality of Shiraz
4) Winemaking and its impact on regionality of Shiraz
5) What defines Australian Shiraz

Those research areas form the backbone of this report and are covered in chapters 3 through to 7, answering their impact on the thesis of this research: "Is regional diversity of premium Australian Shiraz significant?

[1] Only where referred specifically to Northern Rhône wines or styles, Syrah is used.

To review the research in a clear context, the key words in the thesis topic need some further clarification, as to what they mean in the scope of this research.

- **'Diversity':** In this research 'diversity' is defined as the level to which the Shiraz wines can be distinguished from each other, both in technical depicters such as alcohol and acidity, as well as tasting experiences (i.e. mouthfeel, aromas, flavor).
- **'Premium Australian Shiraz':** the scope for 'Australian Shiraz' is limited to premium Shiraz produced in New South Wales, Victoria, Southern Australia, and Western Australia. 'Premium' is defined as wine which is (i) not produced and sold in bulk, (ii) based on price and (iii) aimed to represent a certain region and/or provide greater aesthetic outcomes rather than sustenance and lubrication, showing social status and capital (Hall & Mitchell, 2008, pp. 3-4).
- **'Regional' or 'Regionality'**: In this research regionality is determined as the level to which there are commonalities in wines made in a region. Making it in distinct from wines from other regions, climates, providing a sense of place.
- **'Significant':** For this research 'significant' means sufficiently great or important to be worthy of attention; noteworthy; notable (Oxford dictionary). Thus, to what level regionality is actually notable.

1.3 Goal of the research and research questions

The goal of this research is to get a further insight in the main Australian Shiraz producing regions, the winemaker practices -both in the vineyard and the winery- and the specific local terroir and how this is reflected in the ultimate wines and the potential a region offers. To get clear to what extent the region is reflected in the resulting wine and how significant this regional diversity is for premium Shiraz, if at all.

Next to answering this core thesis question, with this thesis report aims to provide an insight in the background, styles, and production of Australian Shiraz in the major and some smaller Shiraz producing areas in Australia in 2019. An insight which can complement the various research projects being conducted by the Australian Wine Research Institute (AWRI) and Charles Sturt University Research Centre and show Australian Shiraz to wine lovers, wine students and experts alike.

1.4 Setup of the report

The report firstly starts with the research methodology in Chapter 2, focusing on the setup of the research and providing more background information on types of research techniques used. Also, further background is provided on using those methodologies and the selection of wine regions and wineries. In chapters 3 to 7 the key topics are addressed and answered

- Chapter 3 → Shiraz grape
- Chapter 4 → Terroir
- Chapter 5 → Viticulture
- Chapter 6 → Winemaking
- Chapter 7 → Australian Shiraz and its styles

Following those 5 chapters findings are combined in the conclusions in Chapter 8. Supporting documentation as referenced to throughout the report and the bibliography are added as appendices in the order as set out in the table of content.

2 Research methodology

2.1 Type of research

The thesis research has been set up and conducted as a combination of descriptive and comparative research. Descriptive as providing insights in Shiraz in general and more specifically in Australia and providing insights in the terroir, viticultural and winemaking conditions. Comparative as researching the potential differences between regions and perhaps even within regions, in the end also answering the thesis core question, "Is regional diversity of premium Australian Shiraz significant?

The research is qualitative with supporting outcome of literature study as well as interviews and sensory trials. The research and resulting report are meant to give a realistic insight in diversity of premium Australian Shiraz in the scope of this research but is not academic.

2.2 Research approach

2.2.1 Desk research

The research has been approached from a variety of directions. A substantial part has been conducted as desk research, including a variety of books, articles, and websites to get a better insight in the topic of this thesis research. This desk research formed the basis for the field research, but also followed later based on new insights.

2.2.2 Field research

The field research has been most of the research, as -as they say- the proof of the pudding is in the eating. What is the opinion of Australian wine experts and winemakers? What are the local conditions like? How are recent vintages shaping up? Those are questions which can only be answered by going out into the field. The selection of wine regions and wineries included in this research has been compiled based on discussions with Michael Hill Smith MW[2], meetings with winemakers and Wine Australia staff during Prowein and desk research. All regions are either well established or considered to be upcoming and promising to produce quality Shiraz.

The following field research has been conducted in the cause of this thesis research:

Prowein

Visits Prowein 2017, 2018 and 2019 including meetings with winemakers, experts from Wine Australia and tasting a variety of Australian Shiraz. The visits to Prowein shaped the base set up of the research thesis, whereas the 2019 edition was used for final checks and insights.

Australian wine regions and producers

To get a clear perspective on local specifics for Australian Shiraz -especially when it comes to climate and terroir, viticulture, and winemaking- intensive contact with producers and visiting the wine regions was needed. This local research was split in three main parts:

1) **Online survey** > a detailed questionnaire comprising 25 questions focusing on 4 key sections (climate and terroir; viticulture; winemaking; philosophy and history)

[2] Michael Hill Smith MW is Managing Director at Shaw+Smith winery (Adelaide Hills), Joint Chair for Decanter World Wine Awards, Vice Chair for the Decanter Asia Wine Awards, and the first Australian ever to pass the Master of Wine Exam.

supporting the answering of the thesis, sent out in November 2018. Follow-up questions have been asked in April and December 2019.

2) **Visits to wine regions** > to get an actual understanding of the local conditions, I visited a wide selection of regions which together formed a representative perspective on Australia and Australian Shiraz.
3) **Visits to wineries and AWRI** > a visit has been made to all wineries included in the online survey as well as some wineries added during my journey based on recommendations received from other winemakers visited. In all cases the wines have been tasted and in all but a few also interviews and tastings with the winemaker or general manager were conducted. Also, a visit to the Australian Wine Research Institute was conducted.

In total 25 producers spread over 15 wine regions in New South Wales, Victoria, South Australia, and Western Australia were willing to participate in the survey and were visited in January 2019, plus some wineries recommended by winemakers. Additionally, several contacts with Australian wine experts, including Michael Hill Smith MW and Wes Pearson at the Australian Wine Research Institute contributed to completing the thesis research. In the appendix an overview is provided of the wineries included in the thesis research.

Tasting panel

Together with the tasting panel of the Dutch leading wine magazine 'Perswijn' a selection of 17 Australian Shiraz and 1 Crozes Hermitage -majority between 2015-2017 vintages- have been tasted blind and assessed using a structured tasting form. The wines were selected based on experiences during the journey through Australia's Shiraz growing regions and to what extent the wines represent their region. The wines vary in retail price between €14 and €70, with the majority selling in the Netherlands between €20 and €40. The process followed and list of wines tasted are an appendix to this report.

3 Shiraz – the grape

3.1 Pedigree of Shiraz

3.1.1 History

Shiraz is a grape with a great and much discussed history. Stories ranging from its origin being in the ancient city of Shiraz in former Persia or coming from Sicily, being brought to France by Syracuse. First references to the Syrah grape date back to 1781, then referred to as la *Sira de l 'Hermitage* and other names such as *Serine*. This name related to the Latin word *serus* meaning 'late ripening' (Jancis Robinson et al, 2012, pp. 1023-1028).

After conclusive DNA research by UC Davis and INRA (Institut National de la Recherche Agronomique) in Montpellier (France), it was found in 1998 that the parents of Syrah were mondeuse blanche (mother) and dureza (father) via a natural crossing in the Rhône-Alps (Jancis Robinson et al, 2012, p. 1023).

3.1.2 Characteristics

The Shiraz vine is very versatile, and the vines show a vigorous growth. Proper soil, water- and canopy management are required to limit this vigor. The vine is susceptible to chlorosis and not suitable for soils with a high active lime content. The grape bunches are susceptible to botrytis bunch rot in case of rain around harvest time (Jancis Robinson et al, 2012, p. 1028).

Shiraz grapes are medium late budding and ripening, generally harvested between mid-September and late October or mid-February and late March (respectively northern- and southern hemisphere). The start of harvest for Shiraz in the northern hemisphere is generally later in the season than in the southern hemisphere, as most quality Shiraz regions in the northern hemisphere are at a higher latitude than those in the southern hemisphere.

The bunches are medium sized, long cylindrical, loose to well-filled, very long peduncles causing the clusters to hang free from the canes. The berries are small and at ripening they shrivel quickly when turning overripe (Jancis Robinson et al, 2012, pp. 1023-1031) (ANR Publication, 2003, pp. 147-149).

Figure 3.1: Shiraz grapes at Brokenwood (© Anne Greveling, 2019)

The typical dark color and aromas are decreasing swiftly if crop size is too big and the grape tend to lose acidity and depth of aromas swiftly when left on the vines too long after phenolic ripeness (Robinson, 2006, p. 433).

George Taylor (vineyard manager at Penfolds) explained that in maintaining a healthy condition, the Shiraz vine responds to excessive heat by turning its leaves upside down, thus closing the stomata and stopping evaporation at the warmest moments of the day. This limits water loss, but ripening is also somewhat delayed as photosynthesis is blocked. This process is also described by Jamie Goode (Goode, 2014, p. 77).

Wines made from Shiraz grape are very suitable for oak maturation -both old and new, American, French, and other origins- adding complexity and longevity to the wine. The better wines can age for decades (Robinson, 2006, pp. 432-433), as shown in both the Old World with Hermitage wines (Ivens, 2019) and Australian wines such as the wines from Maurice O'Shea (Mount Pleasant, Hunter Valley) and Seppelt Great Western, wines showed great finesse even after 40 to 60 years (Halliday, 2015, p. 211).

The Shiraz grape shines as a single varietal, as it shows great variations based on the soil, topography and meso climate in which it is grown. As mentioned in Wine Grapes (Jancis Robinson et al, 2012) even within the Hermitage itself, the style of the wine differs depending on the precise soil type and aspect. It is logical to expect that such differences occur wherever Shiraz is grown in the world, thus also Australia.

3.1.3 Terroir suitability

To ripen properly, Shiraz requires a sufficiently warm climate, which has restricted its geographic spread. In his climate index, Huglin (1978) positioned Shiraz at around 2,100 – 2,200, which fits in the 'temperate' viticultural climate description. It requires an average growing season temperature (GST) of 16 to 20° Celsius (Jones G. V., 2007, p. 2). Based on specific local conditions, high quality wines can also be produced in somewhat cooler or warmer regions, but the range is very limited. Ripening Shiraz below 15° Celsius GST is practically impossible, as phenolic ripeness is not reached. According to Van Leeuwen, the zone best suitable for high-quality grapes is within respectively the 35th and 50th and 32nd and 45th parallel latitudes in Northern and Southern Hemisphere. The best wines are produced where the cultivar just achieves ripeness over the season (Leeuwen, 2009).

Within the climatic boundaries and assuming soils don't have a high active lime content, the Shiraz grape will grow and produce interesting wines almost everywhere, as long as growth vigor is limited, and the vine has access to some water at flowering and during veraison. Proper canopy management and water management techniques (i.e. either cover crops or deficit irrigation) are essential influences in realizing the best quality and quantity of the crop (Smart & Robinson, 1991) (Goode, 2014, pp. 39-40). Lay-out of the vineyard and aspect towards the sun are also of great influence, determining the sun exposure of the leaves and bunches and heat accumulation during the day.

Given the growth vigor of the vine and also looking at where the most premium Shiraz wines are made (Northern Rhône, Barossa Valley, Hunter Valley, Grampians (Australia), Swartland (South Africa)) there seems to be a preference for soils which are poor in nutrients, well-draining and have water holding capacity in the subsoil. The best soils in general have a thin top layer and are sandy, rocky (granite, schist, basalt) with some level of clay. In Australia there is a variety of terroirs where specific local climatic conditions, soils and topography are likely to show in the resulting wine.

3.1.4 Flavor profiles

The grapes with their abundant anthocyanins and tannins provide good structure resulting in wines with medium plus acidity, firm but generally silky tannins and deep color.

The flavor of Shiraz tends to be in the leather, licorice and tar spectrum with marked black pepper when at the low side of ripeness, showing red fruit characters (strawberry, raspberry, cherry), moving to sweeter black fruit flavors (blackberry, black cherry,

blueberry) in properly ripened fruit in warmer climates. When the fruit is very ripe when harvested, flavors as dark chocolate, prunes, eucalypt, spices and even porty overtones can show (Jancis Robinson et al, 2012). With the variety of terroirs in Australia, you can find Shiraz wines from either side of the spectrum and everywhere in between.

Shiraz grapes which have not obtained proper phenolic ripeness can be harsh, green and astringent, providing flavors of burned rubber and black pepper (Robinson, 2006, p. 433). When left too long on the vine and harvested shriveled, the resulting wines are perceived as more alcoholic and aromas often associated with stewed fruit characters (Chou, 2018).

3.2 Leading growing regions and styles

3.2.1 Geographical spread

After the initial start, the first new plantings outside of Europe were in Australia and South Africa. With the surge in export of Australian Shiraz in the late 20th century, a boom in new plantings has been taking place in both the South of France as well as in many other countries such as Chile, Argentina and the western part of the USA.

Figure 3.2: Countries with Syrah plantings (OIV 2017 ©, p. 17)

Country	Ha. Shiraz	% of total plantings
France	64,000 ha	7.4%
Australia	40,000 ha	26.8%
Spain	20,000 ha	2.1%
Argentina	13,000 ha	5.8%
South Africa	11,000 ha	8.5%
USA	9,000 ha	2.0%
Chile	8,000 ha	3.8%

Table 3.1: Top Syrah producing countries in the world (OIV 2017 ©, p. 18 - 39)

Total Syrah plantings in 2015 account for approximately 190,000 ha spread over thirty-one countries according to the 2017 International Organization of Vine and Wine report (OIV, 2017, p. 13). The top 7 countries account for 165,000 ha, over 85% of Syrah plantings worldwide.

3.2.2 Main international stylistics

When looking at the great regions in the world producing Shiraz, one aspect really pops out when focusing on the latitudes. Syrah production in France all happens within a range of approximately 2 degrees of latitude, equaling around 200-230 kilometers north to south. In Australia, Shiraz is grown in a range of 6 degrees latitude (±660 kilometers) and the USA covers 11 degrees of latitude (± 1,200 kilometers), made possible by amongst others the respective cooling influence of the Pacific (California) and cool seas and altitude in Australia. It is logical that those regions should be capable of delivering a wide array in Shiraz styles, from the bold end of the spectrum to others at the limits of being ripened properly. An exciting but often overlooked aspect!

Depending on the terroir and especially climatic conditions, there is a wide variety of styles of Shiraz found in the world. Ranging from tightknit, peppery red fruit wines with a bit of earthiness, to deep, dark, and broody styles, showing opulent fruit, vanilla, and oak aromas. All major countries where Shiraz is grown have Shiraz wines in styles spread over the flavor and structure spectrum.

3.3 History of Shiraz in Australia

3.3.1 Arrival and settlement

Shiraz came to Australia in 1832, together with 453 varieties collected by James Busby in Montpellier which survived the journey. James Busby called the grape Scyras, what ultimately resulted in its current name, Shiraz. First vines where planted near Sydney and in the Hunter Valley (Halliday, 2015). Hunter Valley being a subtropical climate was not per se the most logical choice but made sense as it was close to the city of Sydney (Goode, 2014). Today it remains one of the leading wine regions for premium Shiraz.

Shiraz proved to be a successful grape, being reasonably easy to cultivate and make wine from. As new cities were founded, new wine regions around those cities emerged and in all, Shiraz found its home. For example, Barossa Valley, Eden Valley, Clare Valley and McLaren Vale around Adelaide and Heathcote, Sunbury, and Yarra Valley around Melbourne. The oldest producing Shiraz vineyard in Australia can be found in Barossa Valley at Langmeil, dating back to 1843.

3.3.2 Evolution

The wine business in Australia had a major downturn, following in part the introduction of Phylloxera in Victoria in the 1870's (then the biggest wine producing state), but mostly due to a focus on making fortified wines. As Shiraz was perfectly equipped to make port style wines -it is still often a reference in overripe Shiraz wines- it survived this downturn gracefully (Halliday, 2015). For a few regions Shiraz kept its status as a table wine, for example with Seppelt Great Western and in Hunter Valley with Mount Pleasant, where Colin Preece and Maurice O'Shea respectively made wine which proved to age for almost a century.

Around the early 1950's there was a turn again towards table wines, for example Henschke starting to make their own wines at Mount Edelstone and Max Schubert at Penfolds, pioneering in recreating Bordeaux style wines in Australia, following a visit to France. The result of his venture with Cabernet Sauvignon delivered great results, but as Cabernet Sauvignon was very limited available and Shiraz was in abundance, the Grange -as it became to be known- was to be created from Shiraz and still is (Halliday, 2015).

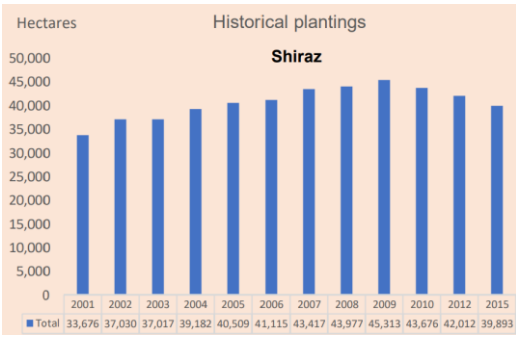
In the 2nd half of the 20th century more and more dry wines were made in Australia. Shiraz showed well as a variety for table wines and Henschke for example started making their own table wines from the Mount Edelstone vineyards which by then were already half a century old. Based on good knowledge of local conditions, winemakers planted more and more Shiraz at sites which are in general very suitable for the grape.

In the last decades, more and more focus is being placed on the heritage of the vineyards and determining specific sub climates and terroirs in wine regions. Since a few years, the AWRI and Charles Sturt University are conducting in-depth research into organoleptic and scientific differences between the Shiraz wines from the leading regions. This is expected to provide further academic basis for the regional terroir expression.

3.3.3 Australian Shiraz in numbers

In 1956 when first Australian statistics on varietal plantings came available, Shiraz accounted for 12,410 ton, only topped by Grenache with 21,200 ton. In 2018 Shiraz accounted for a crush of 429,106 ton, 23.9% of the total Australian crush and 46% of the reds. In hectares Shiraz accounted for 39,893 down from 45,313 at its top in 2009 (see

figure below). When asking Michael Hill Smith MW on possible reasons for this decline, he suggests it is possibly due to changing consumer tastes, also exploring other varieties. There are also trends for new varieties being planted, for example varieties normally planted in the south of Italy.



Top five regions % of total crush	Shiraz	All varieties
- Murray Darling - Swan Hill	22%	22%
- Riverland	13%	30%
- Riverina	12%	19%
- King Valley	10%	1%
- McLaren Vale	10%	2%
- Other	34%	25%

Top: Table 3.2: Top five Australian regions of total crush

Left: Figure 3.3 Historical plantings of Shiraz

(Source: Wine Australia Variety snapshot 2019 - Shiraz)

The top producing areas for Shiraz in numbers are Riverland, Murray Darling – Swan Hill and Riverina. Those grapes produce wines which show the characteristics of the Shiraz grape, but do not transfer terroir characters, opposed to lower production premium Shiraz which is the focus of this research

3.3.4 Heritage and terroir diversity

In recent decades, a significant focus has evolved in Australia on the heritage and terroir diversity of wine regions. Some wineries spread over Australia have done this for over a century, but the idea has now gained momentum in Australia. Examples are the Old Vine Charter in Barossa and the Scarce Earth Project in McLaren Vale.

Heritage

In the Barossa Old Vine Charter, all old vineyards in the Barossa region have been categorized in four age groups to represent the specific background and importance of such vines and vineyards to the regions and winemaking in general. The age categories are:

- 'Old Vine' ≥ 35 years,
- 'Survivor Vine' ≥ 70 years,
- 'Centenarian Vine' ≥ 100 years,
- 'Ancestor Vine' ≥ 125 years.

The oldest producing Shiraz vines in Australia are at Langmeil planted in 1843, making them a staggering 176 years of age. They are amongst the oldest continuously productive Shiraz vines in the world (Wine Australia, 2016).

Terroir diversity

As for terroir diversity, the McLaren Vale region is made up of a large variety of meso climates, soil types, and topography. 10 McLaren Vale producers set up the Scarce Earth project, in which they each produce a single vineyard Shiraz showcasing the terroir diversity of McLaren Vale.

3.4 Does the Shiraz grape influence regionality?

Research and experience have shown that Shiraz as a grape can strongly reflect its heritage, where and the conditions in which it is grown. The grapes characteristics will contribute to showcasing regionality when handled properly.

4 Terroir

The Shiraz grape itself provides the foundation for what wine can be made, but other aspects play a vital role. In this chapter the influence of terroir on the resulting wine is discussed, aiming to provide insight in the impact of terroir on the ability to showcase regionality and whether this is significant yes or no.

4.1 General

Terroir in wine is the possession of a 'sense of place'. That is, the wine expresses flavor and stylistic characteristics influenced by the properties of the vineyard or region it hails from (Goode, 2014, p. 23). Terroir is primarily defined by climate, topography and aspect, soil, and geography (subsoils) from an environment perspective and the traditions and winemaking technique used in a certain region. The below figure shows the core elements of terroir.

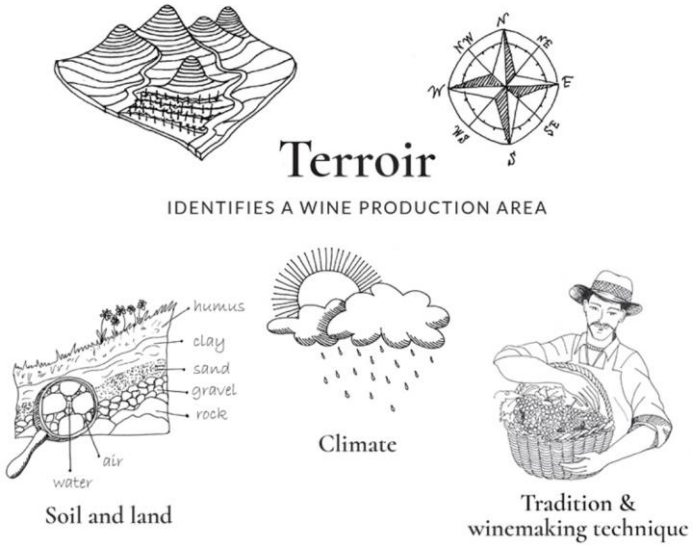


Figure 4.1 © https://www.terredeibuth.it/

Terroirs differ over regions, but also within a region and vineyards. One patch can be totally different from another, due to a different exposure to the afternoon sun or differences in the soil composition and water holding. New World winemakers have come to realize this according to Jamie Goode. Where grapes in one part of the vineyard maybe ripe, other parts may not have reached phenolic ripeness. A good example of such a vineyard is found at Mount Langhi Ghiran in the Grampians VIC, where one of the most important vineyards lies on a hill with various aspects to the sun, resulting in grapes on the less sun exposed side ripening around 2 weeks later then the sun exposed side.

In respect to the definition of terroir in the Old and New World, there is a subtle but important difference. Speaking generally, in the Old World terroirists aim to make wines that express the typicity of the specific vineyard site, whereas in the more pragmatic New World, understanding terroir is often seen as a route to improved quality. Exceptions exist to this generalization (Goode, 2014, p. 25). Based on the various interviews held in this research, the top Shiraz producers do not only aim for the improved quality, but also showcase their sense of place.

Based on feedback from the winemakers interviewed and literature the below table can be set out with the main climatic and terroir influencers for grapes grown and style of wines produced.

Climatic conditions	- Diurnal temperature difference. // Sunlight and average day temperatures during veraison and ripening. // Cooling influence from cool mountain or ocean winds // Rainfall
Topography	- Exposure and gradient of the vineyard to or away from the sun // Altitude // Vicinity of mountains providing i) early shading or ii) delayed morning sun
Soil	- Composition of the soil and subsoils // Amount of rocks in the soil // Water holding capacity for root system //Organic matter in the soil
Winemaker (vineyard)	- Canopy management // Dry farming vs irrigation // Ground cover // Moment of harvest
Winemaker (Winery)	- Whole-bunch vs destemmed fruit // Open tank fermentation // Oak usage

Table 4.1: Main terroir influencers on wine styles

4.2 Australian terroirs for Shiraz

4.2.1 Generic Australia

Australia is categorized as a New World wine country. It may miss the long track record as seen in areas such as Burgundy and Piedmont, but wines have been produced in Australia for almost 3 centuries. Wines produced in a country with a wide array of geological constructs of millions of years of age, far older than in most if not all other leading wine regions in the world. Often multiple soil types can be found in a single Australian wine region, for example 11 soil types in Clare Valley alone.

In this paragraph a more in-depth perspective is taken on the terroirs encountered in the assessed regions.

4.2.2 Climate

Climate is **the** predominant factor in the terroir according to the winemakers interviewed. The climatic conditions, especially the meso climate, determines what grape can be cultivated. When looking at the climate from a macro level, it is almost impossible to give a sufficiently detailed view on Australia as a wine producing country.

Looking at Australia as a whole, the generic view will be that the climate is hot and dry. But if you look at the Huglin Index map for Australia based on data over the period 1971-2000 (Hall & Jones, 2010), it becomes visible that especially in the coastal areas growing season temperatures and HI scores are showing a wide variety in climatic conditions at a macro climate level[3]. Each wine region at itself is again a macro climate, construed of a variety of meso climates for each vineyard, group of vineyards or even parts of a vineyard.

Australia is the 6th largest country in the world, measuring 3,300 kilometers from west to east. Climates ranging from equatorial up to temperate and relatively cool areas, such as Tasmania, southern parts of Victoria, South Australia, and Western Australia. The macro and meso climates in a wine region are determined by varying exposures to the cooling ocean winds and mountain ridges, and different altitudes on which grapes are grown. In Orange Shiraz is produced at altitudes up to 900 meters.

[3] Larger sized pictures as well as a Huglin index table with regions and grape varieties are included in appendix 6.

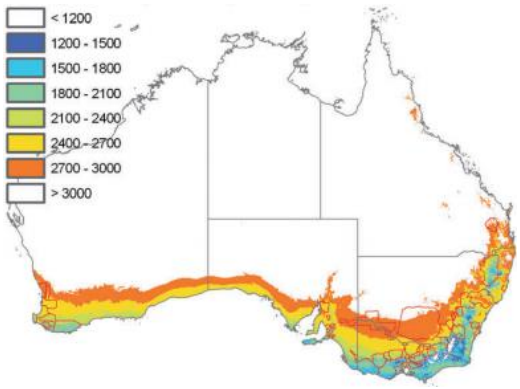


Figure 4.2: Huglin Index (Base 10°C, Oct-Mar)

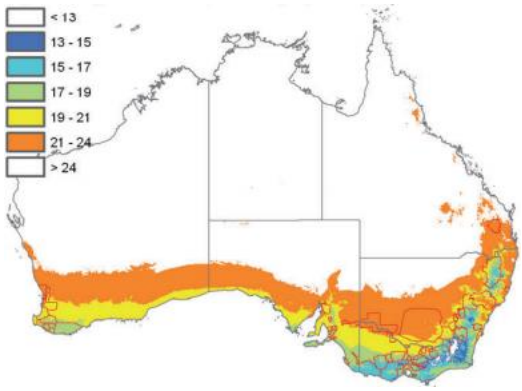


Figure 4.3: Growing Season Temperature (°C, Oct-Apr)

A good example of the climatic differences is seen in Hunter Valley versus the rest of Australia. When visiting the region early January 2019, the Shiraz grapes showed visible progress of veraison and were expected to be harvested mid-February (Mark Richardson - Tyrrell's, Adrian Sparks – Mount Pleasant). In no other wine region such early ripening was visible and harvest dates go as far as early to mid-April 6 to 8 weeks after harvest in Hunter Valley. Climate being the predominant reason for this.

Another example on a smaller scale is Heathcote, which is similar in size and shape to Alsace in France (100km North-South). The northern part is warmer, resulting in harvest dates which often are around 2 weeks earlier than in the southern part (Ron Laughton, Emil McNally – Jasper Hill). Opposed to Heathcote where Shiraz can ripen almost everywhere, in areas such as Adelaide Hills Shiraz can only ripen where the meso climate provides enough sun exposure and heat (Adam Wadewitz – Shaw+Smith). It is a region predominantly known for Chardonnay, Sauvignon Blanc, and Pinot Noir, but also delivers high quality Shiraz.

In determining the local climate, altitude, and exposure to cooling influences such as mountain or ocean winds are a great influence. McLaren Vale for example receives cooling winds from St. Vincent's Gulf and with increasing altitudes towards Adelaide Hills temperatures drop. Diurnal differences are limited in the valley but increase when moving up on the hillside (Sam Temme – Wirra Wirra, Chester Osborne – D'Arenberg). In Barossa altitude is also a distinct influence when looking at climatic conditions as shown in the table below.

	Barossa Valley	Eden Valley
Altitude	112 – 597 meters (278 median)	217 – 630 meters (409 median)
Climate	• Warmer, drier climate • Heat degree days Oct-Apr – 1,710 • Rainfall Oct – Apr 160mm • Mean January temperature – 21.4°C • Relative humidity Oct – Apr, 3pm 39%	• Wetter, cooler climate • Heat degree days Oct-Apr – 1,390 • Rainfall Oct – Apr 280mm • Mean January temperature – 19.4°C • Relative humidity Oct – Apr, 3pm 39%
Temperature	Warm, dry days, cool nights	Daytime 2-3°C cooler than Barossa, night temperatures 5-7°C cooler.
Harvest	Mid-February – late April.	Mid-March – April/early May.

Table 4.2 Climatic comparison Barossa Valley and Eden Valley (© BWGA)

As shown in table 4.1, the impact of the different altitudes on the heat degree days, average temperature and diurnal differences is significant. This also shows in the harvest period, which starts almost 4 weeks later. The impact on diurnal differences is perhaps the single most pronounced difference. With 3-4 degrees Celsius more in the diurnal

difference, this has a major impact on the ripening process, which stops when temperatures drop below 15 °C. Acidity will be better retained and ripening is delayed, which results in the ripening of the grapes in late summer, early autumn. This ensures a better build-up of flavonoids and flavor complexity together with the sugar levels in the ripe grapes. The higher acids and tannin structure provide long lived wines with generally more freshness compared to Shiraz wines from the warmer areas.

For Tony Brady at Wendouree the terroir and local climate are all. As a winemaker you are merely the process coordinator, ensuring that the grapes turn into wine. Vine age, soil type, dry farming, good genetic diversity, and local climate conditions are for him the main influencers. Sarah Crowe at Yarra Yering reasons in the same direction, with the site being ultimately responsible for what can be made, especially with their diurnal differences of up to 20 degrees Celsius in Yarra Valley. In the Grampians, such diurnal differences also occur in February and March, which is the actual ripening period of the Shiraz grapes there.

It can be concluded that climate has a significant impact on the wine style which can be produced and supports diversity in the wines made from various regions.

4.2.2.1 Detailed regional climatic data

In the report "Spatial analysis of climate in winegrape-growing regions of Australia" (Hall & Jones, 2010) a detailed overview is given on climatic data over the period 1971-2000. The table below presents this data to provide a clear overview for the leading Shiraz regions reviewed in this thesis research. The scores between 25 and 75% show a comprehensive picture of the general conditions within the viticultural regions, based on the Huglin index. The table is arranged from cool to warm and climate types are defined as described in the Huglin index setup, using the median HI score stated in the table. Regions such as Barossa Valley, McLaren Vale and Heathcote touch on the 'warm' category, but based on the median score, are considered 'warm temperate' in this report.

State	Region	Climate type (Huglin)	Altitude (median)	Rainfall[4] (mm)	Mean Jan day temp	GST	HI score (25%)	HI score (median)	HI Score (75%)
VIC	Mornington Peninsula	Cool	60-120	371	19.3	17.5	1689	1791	1854
VIC	Yarra Valley	Cool/Temperate	120	559	18.9	16.6	1615	1810	1945
VIC	Grampians	Temperate	270	258	19.8	16.9	1875	1943	2131
SA	Adelaide Hills	Temperate	500	268	20.4	17.5	1945	1994	2027
VIC	Sunbury	Temperate	220	324	19.3	17.6	1935	2014	2036
WA	Great Southern	Temperate	220	310	19.0	18.4	1955	2019	2120
NSW	Orange	Temperate	670-950	429	19.6	17.6	1914	2084	2285
WA	Margaret River	Temperate	50-100	202	20.9	19.2	2052	2092	2139
NSW	Canberra District	Warm temperate	650	406	21.3	17.7	1966	2115	2217
SA	Eden Valley	Warm temperate	420	229	19.4	17.9	2047	2141	2189
VIC	Beechworth	Warm temperate	550	445	21.2	17.7	1860	2155	2269
SA	McLaren Vale	Warm temperate	130	226	21.3	19.1	2146	2197	2210
VIC	Heathcote	Warm temperate	140	279	21.6	18.4	2171	2254	2337
SA	Barossa Valley	Warm temperate	270	220	21.9	19.0	2275	2342	2411
SA	Clare Valley	Warm temperate	450	232	22.3	19.0	2322	2388	2423
NSW	Hunter Valley	Warm	110	527	23.1	20.7	2403	2592	2743

Table 4.3: Climate details on Australian GI's part of this research

[4] The information on growing season rainfall and the mean January average temperature is collected from the wine region specific parts of the Wine Australia website, Varietal Wines (Halliday, 2015) and www.greatsouthern.asn.au for Great Southern. Altitude is taken from Varietal Wines (Halliday, 2015)

There is a variety of climates and regions in Australia which are suitable for production of quality Shiraz, each in its own way. Most HI Median of the regions assessed are within 100 degrees from the preferred 2100-2200 HI score. When including the 25% and 75% scores for the wine regions, it also shows that each wine region has vineyards which are to a larger or lesser extent suitable for Shiraz.

4.2.2.2 Climate change

Climate change is not specifically in scope for this research, but also not a topic which can be ignored. It is briefly touched upon in this paragraph, in the appendix 7 a more detailed view is given.

In the discussions with winemakers, climate change has been discussed and winemakers are very much aware of the impact on the potential of their fruit and resulting wines. Climate change already has an impact with increasing temperatures, earlier harvest dates and shorter ripening period of the fruit, and more erratic weather conditions overall.

Although Shiraz wines are in general not increasing in alcohol and seem to be more balanced than ever, with climate change, in time there will be a shift between the regions and specific sites, as to where Shiraz is best grown and where others may be better suited. Also, styles produced per region will change and blends with varieties better suited to the warmer and drier climate may become more common, for example Grenache and Mourvedre/Mataro. Drew Tuckwell (Printhie) for example would not be surprised if Shiraz wines from Orange in the future will move towards the current modern style of Barossa, with more oak usage and riper fruit, while maintaining the balance with freshness.

In their response in this research the winemakers feel and wines show that the winemakers and viticulturists have sufficient options to cope with the challenges and create exiting, digestible Shiraz wines for years to come, from the coolest to the warmest quality Shiraz regions

4.2.3 Soil

Soils are important factors in the production of quality wine. If you look at the different types of soil, both the diversity and age of the top- and subsoils are incredible. Looking for example at the soil in Heathcote with a majority of its volcanic basalt soil from the Cambrian age, aeolian soils with parna (red clay loam layer) and loess in Canberra district, volcanic soils in Orange resulting from eruptions of Mount Canobolas and the decomposed granitic soils in the Grampians, all soils are millions if not hundreds of millions of years of age. Within regions as Barossa Valley and McLaren Vale there is also significant diversity, where soils can differ from one patch to the other and local programs have started to research and document this (Scarce Earth project McLaren Vale; Barossa Grounds Project – example on Barossa topography in appendix 9).

The pictures below give a first insight in the variety of soils which are available in Australian wine growing regions.

Figure 4.4: from left to right aeolian soils from Canberra District (© Richard Green), Loam over red clay "Urrbrae Loam" and sandy loam over brown clay, both McLaren Vale (© DJS Growers) and Central Grounds Barossa soil – sand over clay over ironstone (© BGWA)

With the generally dry climates in Australia, the water holding capacity of especially the subsoil is a critical element for successfully growing Shiraz. When not irrigated, the limited water in the soil limits vigor of the vine, which is good when resulting in a healthy water stress, still providing enough water during flowering and at veraison to maintain photosynthesis and mature the grapes. Loam and gravelly subsoils as well as clay can help the vines survive and excel during the often very dry growing seasons, whereas gleied soils are not desirable as they log too much water, thus negatively affecting the root system.

The water holding capacity together with microbial life in the soil and the limited availability of nutrients are the key influencers of the soil. There is no scientific proof of uptake of actual minerals from the soil (e.g. granite, etc.) in the vine and grapes. Most minerals used by the vine are obtained from the decomposing process of organic matter in the soil (Goode, 2014, pp. 34-37). As mentioned by Jamie Goode in Science of Wine, it cannot be ignored that a large majority of the world's best wines are made by winemakers who emphasize the importance and reflectance of the soil in the wine. Also, all winemakers interviewed for this research stipulate the importance of the soil. There just is no scientific proof.

Based on the survey and interviews with the winemakers in all regions included in this research, the below high-level overview of soils planted with Shiraz is created.

State	Region	Predominant soil types for Shiraz vineyards
NSW	Hunter Valley	Red soils over volcanic soil, heavy red clay over limestone, sandy loam
NSW	Orange	Volcanic basalt and basalt derived soils, deep brown/red free draining soils.
NSW	Canberra District	Volcanic soils, decomposed dacite often covered with a red clay loam layer (Parna layer) [explained and deemed best for Shiraz by Tim Kirk - Clonakilla]
VIC	Beechworth	Shallow soils of ancient, decomposed granite with some clay
VIC	Heathcote	Decomposed volcanic basalt, deep Cambrian gravely basalt soil mixed with small rocks, 'greenstones', quartz and rubble
VIC	Yarra Valley	Bleached clay loam, sedimentary sandstone, and siltstone
VIC	Mornington Peninsula	Red volcanic (Ferrasol) soil, Sandy loam over Callabonna clay
VIC	Sunbury	Sandy loams
VIC	Grampians	Red clay loams dispersed with small to medium sized quartz pebbles and differing levels of granitic sand (most common), granitic sand, granite bedrock and pebbles (preferred by Justin Pierce, Tim Kirk, and other winemakers),
SA	McLaren Vale	Very diverse, i.e. sands and loamy sands, clay, mix of sandstone and limestone, red clay over limestone, shallow loam over shale and Maslin sands over ironstone and clay
SA	Adelaide Hills	Iron stone mixed with grey-brown and brown topsoils

State	Region	Predominant soil types for Shiraz vineyards
SA	Barossa Valley	Very diverse, i.e. sand over clay over ironstone, red brown earth over clay over ironstone, red brown earth over clay over calcrete (calcareous soil), sand over granite and quartz over clay, clay loam over limestone rock
SA	Eden Valley	Alluvial with sandy loam over clay, seep sandy loam over gravely medium red clay overlaying laminated siltstone, red brown clays
SA	Clare Valley	Red loam on sandstone, clay loam, scaly soils, and deeper alluvial soils
WA	Frankland River	Ironstone gravel and loam over red clay
WA	Mount Barker	Granitic gravelly loams and sandy loams over clay sub soil
WA	Margaret River	Ironstone gravel soils, shallow sandy gravel loam over clay, deep sandy soils over clay or rock

Table 4.4 Predominant soil types for Shiraz vineyards in researched regions in Australia

Looking at the table above, no regions have similar soils, perhaps Orange and Canberra District a little. All soils have different characteristics in for example, nutrition, water holding capacity, ability for roots to grow deep or not, which will all influence the vines in a different way. This will influence the chemical setup of the grapes and thus the resulting wine, supporting subtle differences and diversity.

4.2.4 Topography

Next to the soil, the actual topography of the region has a major impact on the resulting wine. Is the surface flat, steep, or undulating? What direction are the vineyards facing? Are there any physical objects, such as mountains or water bodies influencing the local climatic conditions?

Figure 4.5: Great Dividing Range at the Western limits of Hunter Valley, NSW (left © Cam Wheeler, right © Anne Greveling)

As visible in the picture above, a mountain range such as the Great Dividing Range, can have significant impact on viticulture. For Hunter Valley, the mountain ridges being on the west side result in some vineyards experiencing earlier relieve from the scorching afternoon sun as the sun descends behind the mountain ridge. The Brokenwood Graveyard Vineyard (right picture) and Mount Pleasant's Old Hill Shiraz Vineyards are perfect examples of this impact. The Great Dividing Range has a far greater influence in Australian viticulture, as it stretches from Queensland down the coast and then west all the way to Melbourne, where it ends approximately 100 kilometers northwest of the city. All along the mountain ranges the influence can be felt with for example early shading, later exposure to the sun, cooling winds and rainfall. More to the west the Grampians and Mount Lofty Ranges have similar effects on local climates.

Within the vineyards the topography also has impact, especially the aspect of the vineyard and exposure to the sun. For example, at Mount Langhi Ghiran, the top Shiraz vineyard on the winery gentle sloping hills is facing different directions. The slopes away from the afternoon sun ripen approximately 2 weeks later than the ones facing the sun. And this can be experienced in a stretch of just 50 meters. This is only in 1 vineyard, looking at it over wine regions, states, and the whole country, this will present massive options for diversity.

4.2.5 Altitude

When moving to warmer climates, altitude is mostly a factor creating exciting possibilities for quality wines, Mendoza in Argentina is a great example for this. In Australia Orange is exemplary with vineyards ranging from 600 – 950 meters and HI scores ranging between 1,698 (cool) to 2,551 (warm), thus encompassing 4 climatic zones in the Huglin index! (Hall & Jones, 2010)

Increased altitude results in bigger diurnal differences, as higher altitudes generally have cooler nights. In McLaren Vale this shows on the eastern slopes towards Adelaide Hills, and in the comparison Barossa Valley vs Eden Valley (4.2.2) a few hundred meters difference in altitude results in 3-5 degrees Celsius higher diurnal difference. For Clare Valley it is one of the reasons why such structured and balanced Shiraz can be produced. Diurnal differences are critical in providing balance in the grapes, delaying ripening, and maintaining proper acidity. Altitude is a great enabler for diversity in Shiraz, providing the conditions for the grapes to ripen slower and in a cooler part of the season, resulting in wines that show more balance, freshness, complexity, and sense of place.

4.2.6 Winemaker

Without the winemaker there is no terroir. The winemaker cultivates the vineyard and makes decisions based on the site, on tradition and experience. A winemaker can follow a minimalist approach, but in all cases his/her actions/omissions shape the potential of the fruit of the vineyard. In the chapters on viticulture and winemaking, this is further elaborated.

4.3 Impact of terroir on regionality

Terroir is predominantly determined by climate, soil, topography, and altitude. Climate is the main factor in determining regionality, as well as the most significant notable difference in tasting Shiraz wines. There can be significant differences of meso climates in one region, providing relatively warmer or cooler growing conditions and for example better or more restricted availability of naturally available water table for the vines. The soil, topography, altitude, and climates provide a complex and diverse basis for the Shiraz grown in Australia. Traditional winemaking techniques and styles for a region also form part of terroir. This complex and diverse basis is a foundation for regional diversity.

The climate determines whether Shiraz can grow in a region and in what manner it will ripen. And thus, what styles of wine can be made. The winemakers influence in the end is only limited. Shiraz grapes grown in a cool climate cannot make a rich and ripe warm climate style wine and vice versa. The winemaker can adjust by way of viticultural and winemaking practices, but they will be more on a subtle level when practiced correctly. Of course, a terroir can be overshadowed by winemaking techniques, for example excessive use of new oak. In an interview with Jamie Goode for this thesis (February 2020), he stated that the most important stylistic differences are between cooler and warmer climates providing significant differences. In addition, to a certain extent the style of winemaking is also part of terroir, especially if it fits in the local tradition and/or is practiced more widely in a region.

The terroir will give the wine a sense of place, at minimum in a significant climatic sense but also for specific regions and vineyards, mostly more subtle. For people experienced in tasting Australian Shiraz from various regions, for example show judges, the regional characters are familiar and profound, and thus recognizable.

5 Viticulture

The Shiraz grape itself provides the foundation for what wine can be made, but other aspects play a vital role. In this chapter the influence of viticultural practices on the resulting wine is discussed, aiming to provide insight in the impact of such viticultural practices on the ability to showcase regionality and whether this is significant yes or no.

5.1 Viticultural influencers

5.1.1 Soil

The soil is principally a given for any region. The winemaker works with what is available. In selection of the cultivars to be planted, soil is an important element. As mentioned by Adam Wadewitz (Shaw+Smith) and others, it is critical that the soil is not too rich and preferably quite poor and rocky. Tim Kirk prefers granite bedrock and pebbles, which in his opinion add spice and complexity to Shiraz. For Ron Laughton (Jasper Hill) the Cambrian soils of decomposed volcanic basalt and rocks brings out the best in Shiraz. The overall opinion of winemakers interviewed show a preference for granite-based soils, which can be found in Canberra District and the Grampians.

In 5.1.6 soil is further discussed in relation to vineyard health and impact on the quality and potential of the fruit.

5.1.2 Vineyard exposition and density

Vineyards are mostly planted on north and northwest facing hills and if climate permits also on partially or fully south facing slopes. The vine rows are mostly planted north-south direction, due to past practices when sun exposure was desirable to get the required ripeness. In the current perspective this is less desirable, as the grapes can get too much afternoon sun and west east facing rows would work better, having the afternoon sun along the vine rows instead of directly on them. This statement is not fully undebated, as several winemakers and experts interviewed feel that in this case the first vines in a row will get more sun than others, creating different levels of ripeness along the vine rows. The impact of this 'uneven' ripening is something which can be investigated further. Clear is that north-south facing vine rows catch both morning and the often-scorching afternoon sun. Especially the afternoon sun must be managed, as this can heavily affect the grapes. For example, by sunburn, but more importantly the significant impact on grape temperature when the sun is directly hitting the grapes. The grape temperature can easily become 15° Celsius higher than the actual air temperature, effectively boiling the fruit if canopy management is insufficient.

The density of planting in the vineyards over Australia varies, with the majority in this research at a density of 2,000 and 4,000 vines per hectare. The least dense planted vineyard was Henschke' s Mount Edelstone vineyard, a mere 783 vines per hectare. The most densely planted vineyards were at Shaw+Smith and Best's with up to 5,500 and 5,000 depending on the vineyard. The conclusion can be drawn, that the vineyards for quality Australian Shiraz are planted in reasonably low densities. This also makes sense with the limited natural water supplies available.

5.1.3 Clonal diversity

An item mentioned by several producers and wine writers -including Huon Hooke, Tim Kirk, Justin Purser and Daniel Shaw- as an important quality and style influencer, is the

clonal diversity in the vineyard as well as the quality of the clones. Some of the best and oldest vineyards are either original vines from the Busby clones brought to Australia or later cuttings of those original vineyards. Propagation is often done from very old clones via massal selection or layering. Since the 1950's 'clonal selection' has also become in use.

For the diversity in the vineyard and resulting wines it is considered best to use massal selection to prevent so-called 'mono-clonal' viticulture, as each vine than contributes its own traits. According to amongst others Daniel Shaw, Drew Tucker and George Taylor, having a selection of various high-quality clones in the vineyard -thus vines from totally different mother vines - adds to the complexity. Each vine propagates a different characteristic in a distinct way, affecting the resulting wine and has different traits regarding diseases and such. It is thus also safer. As Nick Dry stated "*Diversity exists amongst the population of Australian clones. Having diversity in our vineyards is important as a risk management strategy but also allows us to make distinctive wines*" (Dry, 2014).

The clones most referenced by the winemakers in this research are set out below, all of them to a more or lesser extent contributing positive traits to the resulting wines. Additional information retrieved from presentations from Nick Dry (Dry, 2014) and the Western Australian Vine Improvement Association (Fennessy & Fisher, 2018). Rootstocks have not been taken into consideration.

Clone	
PT23	Selected from a pruning trial in Griffith, NSW in the 1960's. Suggestions that these selections can be traced back to the Busby Shiraz.
Best's Old Block	Origin from vines planted by Henry Best in 1866. Supplied generally as a 'mass selection'. Known better as Concongella (CSIRO) Good fit for cool climate Shiraz (low yield, early ripening, loose bunch structure)
1654	Barossa clone selected from trial vines planted in 1944. Moderate yields, sensory comments from Yalumba evaluation - Chocolate, fruit cake aromas with medium bodied but complete palate.
BVOVS5	Yalumba selection Spicy, eucalyptus aromas, powerful tannins. Cooler climate palate, Central Victorian style.
EVOVS3	Yalumba selection Dry spice, fresh, perfumed aroma, tighter, fresh, more defined, and linear palate. Cooler climate wine style.
Original Busby cuttings	Original brought to Australia in 1832 by James Busby. No specific traits found.
R6WV28	Originating from Tahbilk (VIC) mid-1970's. Widely planted and appreciated due to low yields, earlier ripening and loose bunches. Lively palate, soft plush tannins. A touch of peppermint and cedar. Elegant wine. Good fit for cool climate Shiraz (low yield, early ripening, loose bunch structure)
Yalumba cuttings 1 & 2	Origination from Côte-Rôtie (registered 2001), no specific traits found.

Table 5.1 Predominant quality Shiraz clones used

The old vines are in most cases still on original rootstocks, although there are regions in Australia which are affected by Phylloxera and where vines are now crafted on resistant rootstocks. For new plantings in genera more often specific rootstocks are used, to ensure the vine will fit with the soil and climatic conditions. At Tyrells, the new vines are

planted at their original roots, as in their perspective they seem to produce the best result and the local situation allows them to do so. Where the vines in the vineyard still have good roots, but for example the vines are not that productive anymore or due to disease have to be replaced, it is mostly preferred to cut off the vine at trunk level or just above (depending on the health of the plant tissue) and then graft cuttings of healthy vines on top of the trunk (George Taylor - Penfolds, Mark Richardson - Tyrells).

5.1.4 Vine age

The age of the vines varies. In general, somewhat older vines are preferred as they are more balanced in vegetative growth versus grape ripening and have a sufficiently deep root system, giving good quality fruit. Some regions such as Orange and Canberra District are relatively young, resulting in a vine age between 20-30 years, while other regions such as Hunter Valley, Grampians, Barossa Valley and Clare Valley have vineyards which often exceed 50 years and even 100+. Having the older vines is not the goal, the quality must be there. As mentioned by the director of Yalumba in a film for Wine Australia (Barossa Wines, 2010), the older vines give the winemaker more consistent fruit and with that a better chance to make a good and interesting wine. In the end quality is the prevailing factor, though with keeping a close eye on the heritage of Australian wine.

5.1.5 Canopy management

In the past decades canopy management has proven to be critical in good vineyard management and getting high-quality fruit, even with higher yields (Smart & Robinson, 1991). Canopy-management techniques are aimed at achieving optimal leave and fruit exposure to sun, while reducing the risk of disease and pushing the quality-to-yield ratio as far as possible. Also, more nutrients will be available and less fruit will be fully shaded, improving overall quality (Goode, 2014, pp. 81-87).

Canopy management is critical in creating a healthy grape growing environment and prevent overheating of the grapes. A practice commonly encountered in the research, is ensuring enough leaf growth and trellising which allows for dappled light, limiting extended sun exposure of the grapes, preventing the grapes from sunburn or overheating. Most winemakers use bilateral cordon training. The main pruning and trellising method encountered is the ‘vertical shoot position’ combined with 2 wires and a lifting wire to guide the vine branches and bring the canopy in a good position to ensure this dappled light.

Aside from the desired leaf-fruit to sun ratio, having an open canopy enables open airflow, limiting the risk for fungal diseases. With Shiraz being sensitive to grey rot, this is an important measure.

As mentioned by Richard Smart, higher yields with high-quality fruit can also be realized with improved canopy management, but in most regions for premium Shiraz the limited availability of water is a limiting factor in the number of bunches which can be sustained by the vine. Winemakers need to find a balance for this and most wineries in this research limit the number of bunches to ensure the available fruit will attain optimum ripeness.

5.1.6 Managing vineyard health

All interviewed winemakers agree that keeping the vineyard healthy is essential in making fine wine and perform various activities in the vineyard to achieve just that.

Fertilization

The use of organic fertilizers is limited to specific moments – with restraint to limit vegetative growth. Jasper Hill, Vasse Felix and Wendouree make their own compost, which is added to the soil after harvest, to replenish the soil. Other than that, use of fertilizers is limited, unless there are deficiencies affecting the vine.

Spraying

All the producers have a spray program to support the vines. Most of them use copper sulphate when needed. Some spray natural foliage fertilizers (i.e. seaweed extract), strengthening the leaf cell structure and enhancing photosynthesis, and clay mixtures to prevent sunburn on grapes and leaves, to maintain the vine health. The winemakers generally spray when needed.

Cover crops

In between the rows many of the winemakers keep cover crops as competing vegetation, such as selected grasses and flowers, especially in the period until veraison. When veraison kicks in, the flowers and grasses are cut down to only a soil cover limiting water uptake. The topsoil is generally not ploughed at that time, as most winemakers state they want to keep the soil covered. This has multiple benefits, limiting heating and drying out of the soil, and restricting heat reflection to the grapes, keeping them cooler. From a practical perspective, the soil remains more accessible for the vineyard employees in case of rain and there is less evaporation of soil water. Pre-selected competing vegetation (i.e. grasses) also enhances the biodiversity both in the soil and above ground, by attracting other insects and birds which do no harm to the vines and fruit and in addition may keep other harmful insects and birds away from affecting the vines and fruit.

Microbial activity

A part where soil is really part of viticulture and influenceable by the winemaker, is the health of the soil and microbial activity. Microbial activity affects the speed and ability of the soil to break down organic matter into mineral ions that can be used by the vines. It is a critical part of the health of the soil and terroir expression. (Goode, 2014, p. 35). The vines will be better equipped to take up nutrients and grow healthy fruit.

Microbial activity is influenced by water, organic matter, and oxygen. Soils that are compressed and/or waterlogged have very limited oxygen and thus limited microbial activity. It also needs microflora (bacteria) and -fauna (soil organisms), where research has shown that spraying with herbicides and pesticides kill a large proportion of this (Goode, 2014, p. 35).

It is fair to conclude that vineyards which are cultivated in a biological or biodynamic manner and even 'lutte raisonée' will provide healthier, more balanced fruit which potentially can result in better wines showing its heritage. All winemakers interviewed work in one of the aforementioned methods.

5.1.7 Irrigation

With the ever-drying climate in Australia, some sort of irrigation is often needed to ripen grapes properly. A significant number of the winemakers interviewed, practice dry farming, some for all vineyards but especially older vineyards. Vineyards for premium Shiraz get limited to no irrigation. Medium-, and entry-level quality wines get irrigation on a more regular basis. This also explains the large production numbers for bulk Shiraz from inland regions as Riverina and Murray Darling, which otherwise would be too dry and hot

for wine production (Wine Australia, 2019). It also limits representation of vintage differences and terroir effects.

Dry farming

Dry farming is restricted to vineyards where the vine root system has access to the water table at critical moments in the vegetative cycle (budding, flowering, veraison). This depends mostly on type of subsoil (i.e. rocks or form of clay) and rain conditions to supplement the water table. Old vines in for example Barossa proof to be very capable for dry farming, aided by their balance in vegetative growth and fruit setting. Canopy management is also critical here, as this has a major impact on the need for water and availability of water for the grapes. For young vines it is now close to impossible to survive the first years without irrigation. According to Kim Farley (Kaesler Wines) and George Taylor (Penfolds) winemakers in Barossa are investigating options to help young vines through their infant stages by irrigation, but still growing deep roots and limiting the dependency on irrigation when maturing, eventually transferring to dry farming.

Partial Root Drying and Regulated Deficit Irrigation

With irrigation it is important to give the vine just enough water to survive and go through the critical phases, but create enough stress to limit vegetative growth after fruit set and later on promote veraison, the ripening of the fruit. Both Partial Root Drying (PRD) and Regulated Deficit Irrigation (RDI) are very useful methods, giving right levels of stress but also providing enough water to get high quality fruit in the end. Both methods have as a benefit that required level of water for irrigation is limited, where research on tomatoes has shown that with PRD water-use efficiency during ripening is improved by 93% (Goode, 2014, pp. 77-80). Further test on vines must be conducted, but the prospect is very interesting for growing Shiraz and other vines in the increasing drought of Australia.

In a study on the response of Shiraz grapes to PRD and drip irrigation compared at 0.9 and 0.45 ETc[5], it showed that the major determinant of vine performance was irrigation amount rather than irrigation method. The lower irrigation amount caused a significant reduction in yield and berry number. Berry soluble solids, pH and color and thus quality were not significantly affected (Collins, Barlow, Wood, Kelley, & Fuentes, 2004, pp. 367-368).

5.2 Practices to influence the style

In the perception of the winemakers interviewed most of the actual winemaking is done in the vineyard. Of course, with oak, extended or shorter maceration, whole-bunch and other winemaking techniques, the style can be influenced, but the size, phenolic ripeness, acidity, and health of the grapes are the key factors. If those factors are not optimal, the resulting wine will be of less quality. All winemakers interviewed to a certain extent perform style influencing activities. Influencing activities are also determined based on the climatic conditions. Some of the most predominant practices mentioned in 5.1. and specific style influencing practices are briefly explained in 5.2.1. Harvest as a major style influencing factor is described in 5.2.2.

[5] ETc = estimated crop evapotranspiration, this representing the total amount of water provided with irrigation

5.2.1 Practices prior to harvest

The following practices prior to harvest were identified in the research:

Clonal diversity	Different clones will provide subtle differences in aromatics, berry size and sensitivity to diseases. Use of a mix of clones in the vineyards adds to complexity of the wine.
Shoot thinning	Practiced early in vegetative growth to limit number of shoots, thus limiting potential number of bunches.
Crop thinning	Cutting of bunches, generally at start of veraison and sometimes a 2nd cycle. Goal is to split nutrition over less bunches, resulting in better grapes
Irrigation	Irrigation is mostly limited to when needed, thus RDI. This is practiced in over 50% of vineyards in Australia (Goode, 2014, p. 79). Dry grown vines seem to achieve better phenolic ripeness at lower Baume, retaining higher natural acidity (Justin Purser – Best's).
Mulching	Mulch is added under vines to prevent evaporation and heating of the soil, slowing down ripening and improve acid retainment.
Ground cover	Done to limit vine vigor, creating diverse ecosystem and too limit soil heating, heat reflection and soil water evaporation. This somewhat slows the ripening process.
Ploughing	Some winemakers plough gently under the cover crop to restrict further growth and competition, but keeping the soil covered and aerated.
Canopy management	Canopy management is especially focused on limiting direct sunlight from the afternoon sun but keeping it sufficiently open to have good airflow and limit source-sink by unnecessary vegetative growth.
Yield management	Yields for premium Shiraz are significantly lower than for bulk and entry-level wines. This is mostly due to limited irrigation and fertilizing, lower planting density, style of pruning and crop thinning. Yields differ significantly over the winemakers in this research, which is resulting from mostly planting density (Shaw+Smith 5,500 vs 783 vines/ha at Henschke for Mount Edelstone). In addition to vine density also canopy management has a significant effect on ability of the vine to support and properly ripen a larger quality crop (Smart & Robinson, 1991, p. 15). In this research average yield/ha is between 1.2 and 12.5 tons per hectare (t/ha) with most between 4 – 7 t/ha. For comparison, the average crop for Shiraz in Riverland in 2014 was 20.8 t/ha (Simon Berry, ASVO, 2015).

Table 5.2 Viticultural influencing practices (Anne Greveling, 2020)

5.2.2 Harvesting

Harvesting and determining when to harvest touch on both viticulture and winemaking. The winemaker determines when to harvest, in line with the desired style of the wine. For this research, the actual harvesting is addressed as part of viticulture but understood to have a deep connection with winemaking.

The moment for harvesting is fundamental in the making of wine. In recent years, more and more winemakers have started harvesting earlier in the ripening process, to prevent shriveled grapes. Shriveled grapes lead to stewed fruit and overripe porty characters and higher alcohol, which is no longer a desired trait, especially not for premium Shiraz. Several winemakers harvest all or a part of the grapes earlier in the ripening process to retain freshness. As adequate phenolic ripeness is needed, the winemaker must be careful not to harvest too early. For Shiraz, the harvesting window when ripe is not very long, so important to start at the right moment. When the Shiraz grape is ripe it does not

really ripen further, it dries out, intensifying the already existing ripe flavor resulting in overripe flavors such as stewed fruit, and lack of acidity.

The participating winemakers mentioned the following harvest period range:

State	Region	Harvest start	Harvest end
NSW	Canberra District	Mid-March	End of March, April
NSW	Orange	Late February to mid-March	Early March, to early April
NSW	Hunter Valley	Early to mid-February	Mid to end of February
SA	McLaren Vale	Mid-February to mid-March	End of March
SA	Adelaide Hills	March	March
SA	Eden Valley	Mid-March to early April	Early April to late April
SA	Barossa Valley	Mid-February to mid-March	Early to mid of April
SA	Clare Valley	Late February to mid-March	Early to mid-March
VIC	Sunbury	Mid-April	End of April
VIC	Yarra Valley	March	March
VIC	Beechworth	March	March
VIC	Grampians	Mid-March to early April	End of March, April
VIC	Heathcote	Early to mid-March	End of March, April
WA	Great Southern	Mid-March to early April	Mid to late April
WA	Margaret River	Mid-March to early April	Early to mid-April

Table 5.3: Harvest dates for premium Australian Shiraz

The table shows significant differences, with harvest starting as early as the first half of February, up to early and even mid-April. Most regions seem to start harvest in the first weeks of March complete harvest late March, early April. Hunter Valley is by far the earliest region for harvest. For Barossa it depends on the site. Barossa but also other regions show a wider harvest period, which is due to the variety in sites, topographies and meso climates, and whether vineyards are irrigated and if so to what extent. For example, according to Sam Temme (WirraWirra) within McLaren Vale, there can be 4 weeks between two vineyards with Shiraz, as one is situated on a higher altitude and/or more exposed to cooling sea winds, than the other. All local climatic and topographic specifics are of great influence, but for this research it stretches too far to fully split and detail the regions in the various climatic set-ups.

Harvest of grapes for premium wines is always done manually at the wineries involved in this research, where at other levels this differs per winemaker, depending on size of the winery and vineyards, and beliefs. At Best's, several harvest machines are in use for most wines. One of the newest machines can dispose unripe grapes, taking over the first quality selection normally done by the grape pickers, already easing the second selection at the winery.

With generally high temperatures during harvest, most wineries harvest either early morning (manual, machine) or at night (machine). In exceptional cases, harvesting is done all day, for example when ripeness of the fruit requires this. An important factor influencing this decision, is the availability of means to chill the fruit prior to processing. If no cooling facilities are available -as at Rockford-, the fruit needs to get in cool. Otherwise the fruit will be processed at a temperature at which the yeast becomes active, kicking off fermentation. With cooling facilities available -giant blast chiller at Brokenwood or chilled transport to winery as at Clonakilla- this is less of an issue. Aside from the impact on the fruit, harvesting in the heat of the day is also not preferable from a humane and environmental standpoint (required cooling capacity).

5.3 Impact of viticulture on regionality

Viticultural practices are critical in both making a good wine and in showcasing regionality. Or at least in growing fruit which can show its heritage. As Tony Brady (Wendouree) stated, 'a winemaker is merely the process coordinator for turning grapes in to wine'. This does not mean that a winemaker should do nothing but should ensure a healthy environment for the vine to grow and to a certain extent managing the vines and soil.

The base set-up of the vineyard is the start of it all with topics such as: site selection, altitude, topography, sun exposition and angle on the vines, planting density, trellising, type of soil, type of Shiraz clones to use, irrigation yes or no. Here viticulture already has a major influence on the ability to show regionality

Moving into the year on year viticultural practices, management of the canopy and soil health and a healthy dose of water stress are essential in producing healthy and phenolic ripe fruit. Proper canopy management, with dappled light will prevent sunburn and limit temperature of the grape bunches and somewhat delay ripening of the grapes, as well as provide an optimal ratio for photosynthesis, water usage and build-up of carbohydrates for the ripening grapes. As stated by Justin Purser (Best's) dry grown vines seem to provide grapes with the best balance between phenolic ripeness and sugar ripeness, whilst maintaining acidity. Thus, giving more potential to show the regionality. Healthy water stress is key here. With restricted irrigation regimes such as RDI and PRD, vines can be guided and supported in producing high quality fruit which reflects the region. Too much irrigation or fertilizers will lead to increased vegetative growth, larger crops, and loss of regional characters.

Timing of harvest is a fundamental part in viticulture and affects the potential of the wine, which can be made. Harvesting has moved earlier in the season, in part due to the fruit ripening earlier, but more importantly, harvest is earlier in ripening cycle at lower sugar levels, with more acidity. As higher alcohol negatively influences the potential of a wine to express aromas, this earlier harvesting has great value in supporting the presentation of regionality in the resulting wine.

In the end, as stated in 4.1 and as mentioned by Jamie Goode, human intervention -and thus viticulture- is an essential part in terroir, in regionality. Without the winemaker there is no viticulture, no wine. Regional styles will evolve over time, also affecting choices made in the vineyard and when setting one up. With the changes in desired wine styles, making them more digestible and with a sense of place other choices are made in the vineyard. For some wineries this always was the way to do it, but others evolved over time.

Viticulture and choices and actions -or lack of actions- in the vineyard have a strong influence on the resulting Shiraz wine and add to or limit the wines capability to show its regional characters. When practiced with a focus to create a Shiraz which reflects its origin, viticultural practices will add to regionality, making it more pronounced, expressive.

6 Winemaking

The Shiraz grape itself provides the foundation for what wine can be made, but other aspects play a vital role. In this chapter the influence of winemaking practices on the resulting wine is discussed, aiming to provide insight in the impact of such winemaking practices on the ability to showcase regionality and whether this is significant yes or no.

6.1 Winemaking in Australia

6.1.1 Brief history of making Shiraz in Australia

The winemaking in Australia has evolved over centuries, with winemaking dating back to the 1830's. Over time Australia stylistically has moved from table wines to mainly fortified wines and then again focusing on dry table wines. According to Damien Sheehan (Mount Langhi Ghiran) it was common to see Shiraz wines at 12.5% alcohol in the 1970's and 80's, increasing to 13.5% in the 90's and between 13.5 – 15% in the current setting for medium bodied wines. This is also shown in AWRI research by Petri and Sadras (Goode, 2014, p. 118). Following the rave reviews from Robert Parker, the 1990's onwards showed a great boom in big and extracted, new oak aged power house Shiraz wines (Halliday, 2015).

6.1.2 Style change

In recent years there is a significant move away from those power-house wines, towards more drinkable, elegant and digestible styles. This is seen worldwide but is especially strong in Australia. The biggest changes are in limiting alcohol levels and use of new oak. Both are elaborated upon below.

With this move towards more drinkable wines a positive side effect is, that the Shiraz wines will be better able to show the quality of its fruit and with that potentially showing characteristics of its origins.

Restricting alcohol

The restriction of alcohol is an important element in making a wine more drinkable and elegant -although there are wines at 15% and higher which are very well drinkable and balanced-. The impact of lower alcohol is not only on the actual alcoholic experience -hot taste-, but it also has a major influence on the aromas experienced. High alcohol levels mask aromas by increasing solubility of aromas, making them reluctant to leave solution to the detriment of flavor (Goode, 2014, p. 118). It is safe to say that with lowering alcohol of the wine, the potential for regional expression is increased.

There are several options for the winemaker to limit the alcohol in the resulting wine:

- Earlier harvest
- Open fermentation
- Selected yeast strain
- Biodynamic viticulture
- Reverse osmosis
- Spinning cones
- Addition of water to the must

The last one is not allowed by law for this specific purpose, but within for example Australian regulations the winemaker can add up to 70ml water per liter of wine. This for addition of processing agents or where that addition of water is *incidental* to the

winemaking process and in conformance with good manufacturing practices (Australian Grape and Wine Authority, 2016, p. 7).

Use of oak

Oak is an important element in wine making, especially in red wine. It adds complexity and flavor but more importantly the micro oxygenation helps stabilize the wine, its color and soften tannins. With Shiraz the winemaker has the choice for all common types of oak, where American, French, and Slavonian are most common. The selected type already influences, as new American oak adds more flavors to the wine than French and Slavonian.

With the use of new oak and especially heavily toasted oak, powerful flavors are added such as vanilla, coconut, oak, char and spices (Goode, 2014, p. 116). Those can overpower the wine and depending on the style of wine desired by the winemaker, the type of oak, level of toasting, size and age of the barrel must be selected. Seasoned oak is as much capable of ensuring micro oxygenation for the wine as new but does not add the flavors of new oak.

Artisanal winemaking

In Australia there has been a real shift away from pride in technical prowess towards more artisanal methods. Producers are now more interested in expressing geography than technique (Johnson & Robinson, 2019, p. 345). This is expected to provide wines with more regional characters, less polished to 'perfection' or standardization as may be.

6.1.3 Regulations

An important difference in Australia's Geographic regions (GI's) opposed to what is seen in Old World wine regions, is that there are no standards for GI's which winemakers must comply with. The winemaker is only obliged to work in line with the Wine Australia Regulations and the Food Standards Australia-New Zealand, of which Wine Australia has created a compliance guide summarizing the specific regulation (Australian Grape and Wine Authority, 2016). Such regulations focus amongst others on percentage of the grape variety which must be in the wine, to give it the name of the grape. A Shiraz labeled wine should be made of at least 85% Shiraz grapes, which can have some impact on the flavor profile and structure of the wine if other grapes are included.

Within the GI the winemaker is free to choose whatever grape and winemaking technique he or she desires. This obviously can have an impact on the extent in which a resulting wine shows regional character, as the winemaking technique used -such as use of new oak - can override this.

6.2 Winemaking practices

6.2.1 Preparation for fermentation

Several winemakers make first selections in the vineyard, only bringing in the best fruit. When the fruit gets to the winery, most wineries sort and then destem the fruit gently to get whole berries. At Jasper Hill, Giaconda and De Bortoli a very subtle destemmer is used to get the berries destemmed in the most pristine possible condition.

Most respondents do not crush the grapes prior to fermentation, either destemming in full or retaining 10-35% of whole bunches for fermentation. Whole bunch is both used in a mixed batch with destemmed grapes as in separate batches. The whole bunch is used to add additional tannin structure, freshness, and floral notes to the resulting wine. Some

separate batches tasted showed significant tannins, requiring blending, but some showcased a ripeness and generosity which gives the batch potential for bottling on its own.

The pre-ferment maceration is mostly limited to a few days to prevent over extracting the skins, resulting in less balanced wines. In one case (Frankland Estate) the whole berries undergo a partial carbonic maceration prior to the full fermentation. The overall maceration (pre-ferment, fermentation, and post-ferment) for the participating wineries is generally two to three weeks. The shortest was 10 days and longest 30 days.

In some cases, acids are added to the must to improve balance, as the hot conditions can lead to too much loss of acidity before phenolic ripeness. Most winemakers interviewed do not add acids and feel that especially dry farming, cooler overall climates and having the right vineyard sites result in not needing additional acids to balance the wines. In one case 'sacrificial tannins' where added when destemming, to support color fixation. Those added tannins are destroyed during fermentation, thus sacrificial. The grapes' own tannins are retained to combine with the anthocyans for stabilizing the color (The Beverage People - Tannins).

There is a great variety in sizes of the vessels and to some extent also material used by the winemakers for maceration and fermentation. The size ranges between 600- and 12,000-liter vessels, the majority using 3,000- to 5,000-liter vessels. This depends on the size of batches (vineyards or even specific plots) and materials used. The largest vessels where mostly stainless steel and waxed concrete. For the smaller batches both stainless steel and waxed concrete tanks are predominant but 600-liter stainless steel lined wooden crates and plastic crates are also used.

6.2.2 Fermentation

In managing the fermentation process there are more distinct differences between the various winemakers.

The majority uses open fermenters. Open fermenters positively affect alcohol levels as a result of evaporation of up to 1% of alcohol during fermentation due to the higher fermentation temperature for red. According to Andrew Jefford stated in his monthly column, you need 2 grams extra sugar per % of alcohol in the resulting wine (Decanter, Andrew Jefford, 2016), which is confirmed by several winemakers. This is an added benefit of open fermentation desired by most winemakers from especially warmer regions, to manage their alcohol levels.

At Printhie there is a mix of open fermenters and closed fermenters during the whole process. Wineries such as Philip Shaw, Vasse Felix, Forest Hill and Frankland Estate -who separately vinify the whole-bunch section- use a closed environment for the short carbonic maceration stage before proceeding in the open fermenting.

Most winemakers keep the skins on top and either break the cap by plunging it down in the juice or spraying the wine from the bottom of the tank over the cap. At Henschke, the cap remains submerged during the whole fermentation, increasing skin contact for extraction and limiting risk in creating volatile acids.

As mentioned earlier, several producers use whole-bunch fermentation to form a part of their wine (Vasse Felix, Domaine Naturaliste (up to 33%), Giaconda (up to 35%) Frankland Estate, Clonakilla, Tyrells (up to 20%). The percentage depends on the vintage, but some

continuously experiment, for example Vasse Felix with increasing whole-bunch in their Shiraz with a few percent per year. The ones who vinify the whole-bunch separately, determine the percentage of whole-bunch in the final wine during blending. Pat Carmody (Craiglee) states that it remains to be seen what the effect is of using the whole bunches on the longevity of the wine and how flavors and structure will evolve. During blending you only see the impact at that time and the short to mid-term future. The impact on the long run on Australian Shiraz will be experienced over time and is something which can be the topic of a separate research. In the Northern Rhône it has been an established process for many decades and in addition wine writers such as James Halliday assign great longevity to Australian Shiraz wines, both with whole-bunch and without.

The temperatures for fermentation are mostly controlled by machines, but also the cellar temperature. The fermenting must is mostly allowed to peak at 30°C after which temperatures are brought down to 25-27°C.

An interesting finding is, that some producers such as Wendouree already press the grapes prior to full conclusion of fermentation, leaving 2 Baume of residual sugar, which then ferments to dryness directly after pressing.

6.2.3 Pressing

All participating wineries use subtle presses. The most common used are the Vaslin and the basket press. Both are very gentle on the fruit and the pips, minimizing the risk of extraction of harsh tannins. The Vaslin is capable of processing larger batches of grapes at a time than most basket presses. For the basket press most commonly a pneumatic and sometimes an old (to ancient) manual press is used, the latter only for very small batches, for example at Rockford where they are impeccably maintained. With the basket press there is more contact with oxygen, but this is perceived as a desirable effect by the winemakers, helping the evolution of the must.

6.2.4 Preparation for aging and malolactic fermentation

The preparation of the Shiraz after fermentation for aging mostly follows the general principles of red wine making, giving the wine 24 to up to 48 hours to settle, then racked of its lees to the barrels, casks or tanks for aging. In most cases the free run juice and pressed juice of the same batch are combined directly after fermentation, but Ton Brady (Wendouree) ages the free run juice separately, blending the resulting wine with the wine made from the pressed parts of the batch.

An interesting fact is that all but one of the winemakers let the malolactic fermentation take place in the barrel or cask. Tony Brady feels this must be done in tank, as in his opinion, having the malolactic fermentation in the oak increases the risk of microbiological contamination in the oak, which may induce a Brett infection.

6.2.5 Aging

There is a strong tendency to puncheons (500 liter) as preferred barrels for aging Shiraz, due to larger ‘wine to surface’ ratio and thicker barrel staves. Also, larger barrels of 1,200-2,500 liter are favored, for example at Tyrells. Most wineries visited only use French oak, especially in cooler areas. Others use a mix of French and American oak. Burgundy barrels (228 liter) are predominantly used for barrique when using French oak, though some winemakers who prefer the more cigar shaped Bordelaise barrels (225 liter). Several wineries encountered had both (a.o. De Bortoli, Forest Hill). Hogshead barrels (300 liter) are also found at various wineries. The toasting is generally medium to medium/heavy,

where at Giaconda some barrels were progressively toasted from one end to the other (light to heavy)

New oak is mostly between 15 and 35%, for some wines -especially warmer regions- this percentage can go up to 70% and higher. For example, Barossa's Elderton Wines 'Command' Shiraz 2015 tasted at Prowein 2019, made from 125-year-old vines, has a 30-month oak maturation, 2/3 American and 1/3 French oak, 80% new. This without overpowering the wine and all together creating an impressive balance and complexity.

At the wineries in this research, the winemakers aspire balanced wines, where oak contributes to, but does not overpower the wine. The level of new oak a wine can handle depends on the acidity level and the ripeness and body of the fruit. The riper and bigger with good acidity structure the wine has, the larger proportion of new oak can be used. This is also seen in the input from the wineries in this research: most new oak used in Barossa Valley and McLaren Vale; significantly less new oak and larger barrel sizes in more moderate and cooler climates. This also adding to the ability to understand regionality in Shiraz from the various regions.

6.3 Impact of winemaking on regionality

Winemaking has a major impact on the resulting wine and with that, can also have an impact on the regional character of the wine, in a positive contributing factor, but also in a negative masking factor. This is an accepted phenomenon in the wine world, both Old and New. Take Meursault and Chablis for example, one of the key markers of a Meursault is the opulent use of oak, providing richness and body to the beautiful complex fruit. For Chablis, the use of stainless steel and perhaps some old barrels -the odd new barrels left out- are marking for the fresh zingy style. Rioja also is recognizable as a region due to its winemaking techniques. Why would this be any different in Australia for Shiraz?

All over the world winemakers are reinventing themselves, young winemakers often leading the way, breaking with the 'old' way of work. Producing wines out of appellation because they want to showcase the wine in a different way. In Rioja winemakers as Telmo Rodriguez and Sandra Bravo (Sierra de Toloño) are now focusing on single vineyard wines, showcasing different altitudes, topographies, meso climates and soils.

Back to Australian Shiraz, the macro and meso climates determine to a large extent, what a winemaker can do with the wine. A winemaker cannot create something, which is not there in the basis. Next to that there is a strong direction with premium Shiraz winemakers in showcasing the heritage of the wine, a sense which is also experienced in a broader sense, communicated by wine experts and magazines such as James Halliday, Oz Clarke and Decanter.

All winemakers interviewed in this research aim to make wines which represent the region they are from. For some regions this includes some more pronounced new oak - Barossa Valley, McLaren Vale, Heathcote- while others focus on older and larger oak - Hunter Valley, Great Southern, Yarra Valley, Margaret River-. As mentioned in 6.1.2, artisanal winemaking is gaining terrain and quality winemakers are letting go of their technical prowess. Not per se letting it all go but limiting and using the best of both worlds in making the best possible wine, reflecting where it came from. Winemakers such as Tony Brady (Wendouree) and Pat Carmody (Craiglee) see the winemaking only as a

guiding the grape into eventual wine. So minimum intervention and keep the wine as pure as possible.

Another aspect is making less alcoholic and fresher wines, a tendency to make wines more digestible. Earlier harvesting contributes to both, with lower alcohol showing more aromas. The addition of whole bunch increases structure, floral characters, and freshness, which for Jamie Goode adds to the regionality. It can just make a wine just that bot more balance, more brightness in fruit and more elegant, but still showing the climate it came from, as Tony Jordan stated (Goode, 2014, p. 110).

In the end -as Jamie Goode stated in our interview- the winemaker will interpret the vineyard and translate that into a wine, which the winemaker feels represents that vineyard. And in time -as mentioned before- with changing climates and viticultural practices, the regional character of a wine region will shift. Winemaking thus will have an influence on the resulting wine and regionality, but for premium Shiraz, where the winemaker seeks to represent the region, this impact is expected be less notable, if only more in showcasing the wines' heritage. Just like with changes in viticulture, this may in time alter the understanding of a regions character -however subtle-, finding a new understanding of what for example a typical Barossa Valley, Heathcote or Canberra District Shiraz is.

7 Australian Shiraz and its styles

In the previous chapters the focus was on the impact of terroir, viticultural- and winemaking practices on the ability of the Shiraz wines to showcase regionality and whether this was significant yes or no. Based on the research it shows, that all three in their own way and weight have an influence on showing regionality, a sense of origin in the resulting wine. In this chapter the focus lies on Australian geographic regions (GI's), what is understood with regionality, what styles can be found and to what extent they can be correlated to a region -thus to what extent there are significant differences-.

7.1 Styles of Australian Shiraz

7.1.1 Australian GI's

In the Old World the AOP's with their regulations and boundaries have developed over a long time, some for centuries. This AOP set-up is based on both qualitative and commercial grounds. In Australia wine regions originally were initiated near larger cities as this is where their market was. You see this with for example Sydney (Hunter Valley), Melbourne (Yarra Valley, Heathcote) and Adelaide (Barossa Valley, McLaren Vale). Until not too long ago the GI's as we know them now did not even exist in their current form. They were created in 1993 as part of a trade deal with the European Union and as Damien Sheehan (Mount Langhi Ghiran) shared it, more a legal and marketing process than an organic process. For him, a region covering Heathcote, Bendigo, Avoca through to the Grampians would be more logical, as all of them have Shiraz as main variety. This area would in styles as a comparison equate to Northern (Grampians) and Southern Rhône (Heathcote).

7.1.2 Evolution in styles

Styles of Australian Shiraz have evolved over time and are likely to keep evolving. As mentioned, the Shiraz grape has lent itself perfectly for the production of fortified wines in Australia, having the potential to produce luscious fruit and big ripe flavors. At the same time, Shiraz has also shown potential as a dry table wine from the start, both with higher levels of alcohol (McLaren Vale, Barossa Valley) and for example Hunter Valley with lower alcohol.

In the era led by Robert Parkers high scores for power-house wines, Australian Shiraz followed suit. Times have changed and there is an increased focus on the heritage of the wine. Techniques in the vineyard and winery have evolved, helping to bring out the freshness, fruit, and perfume of Shiraz. Closer vine spacing, hand harvesting, earlier picking, grape sorting, more gentle use of oak and the move to old French oak, and small-batch open-top fermentation are some of the practices that are reshaping the face of Shiraz (Decanter, Olivia Mason, 2019). This reflection shared by Olivia Mason supports the findings in this research.

Late Tony Jordan mentioned: "*Everyone seemed to think bigger was better and wines seemed to be getting bigger in every way. Now there is a big step back from that. And yet if you are in a warm climate, the wines are going to be robust. That's the terroir speaking. But you still can aim for freshness, a bit of brightness of fruit, more elegance on the palate*." (Goode, 2014, p. 110). Terroir and winemaking techniques go hand in hand in defining the style of Shiraz made and winemaking does not need to overrule its heritage.

7.1.3 Common understanding of regionality

Within the scene of Australian Shiraz there is a large diversity in styles, often with significant differences related to terroir -especially macro- and meso climate, altitude and topography-, viticultural practices, winemaking techniques, and more subtle differences for example regarding to the soil and clonal material.

Expert tasters, who are experienced in tasting Australian Shiraz from various regions over many vintages have built up a tasting memory on what are specifics for a region. They can taste regional differences and pinpoint specific regions based on sensory characteristics, considering vintage influences. For them, the regional differences are significant enough. It is all about building this signature and creating a consensus that such is a representation of a region. This for example happened In Bordeaux, Burgundy and Piedmont over decades and centuries, resulting in the general understanding wine experts and wine lovers now have.

There is not just 1 defined Australian Shiraz, Drew Tucker (Printhie) states. It is like saying Chablis, Côte de Beaune and Macon are all just French Chardonnay or to stick to Shiraz, there is only one Northern Rhône and Côte Rôtie, Hermitage and Cornas are thus 'the same'. This seems to be a very good comparison, as when referring to those regions - which are well known to the European wine business and consumers- there immediately a stylistic memory for especially Chardonnay from all 3 regions comes to mind, and for experts and experienced wine lovers also the Northern Rhône.

For premium Australian Shiraz, this knowledge and experience is very limited, in that the premium wines are a bit more of a niche, resulting in a limited number of people tasting Shiraz wines from a variety of regions and creating this understanding. Some regions are well known, such as Barossa Valley, and are more easily identified, but comparing Yarra Valley and Canberra District, is more complex. For this, we heavily rely on wine experts and writers (i.e. Hugh Johnson, James Halliday, Huon Hooke) to provide this notion on an anecdotal basis. On an academic level, AWRI and the Charles Sturt University are adding evidence for this understanding by performing detailed sensory analysis where the results of several multi-year studies are expected to be presented in the coming years.

7.1.4 General style classification

Gregory Jones created an overview on climate's role on expression of terroir in resulting wines, shown over 3 general climate structures (Jones G. , 2015).

Wine Characteristic	Cool Climate	Intermediate to Warm Climate	Warm to Hot Climate
Fruit Style	Lean, Tart	Ripe, Juicy	Overripe, Lush
Red Flavors	Cranberry, Cherry	Berry, Plum	Fig, Prune
Body	Light	Medium	Full
Acidity	Crisp, Tangy	Integrated	Soft, Smooth
Alcohol	Low to Moderate	Moderate to High	High to Very High
Overall Style	Supple, Elegant	Medium Intensity	Bold

Table 7.1 Climate's role in the expression of terroir in wine characteristics (© Gregory Jones, 2015)

According to Jones, the climate has by far the biggest impact on the resulting wine style. Climate shows for example in the alcohol level, freshness, and flavor intensity. The climate in this explanation is not just the overall weather but the full meso climate, thus also including topography, exposure to the sun, winds, etcetera. This view is supported by Jamie Goode and all winemakers interviewed. Soil also influences the resulting wine, but those are relatively more subtle influences which you find when analyzing the wine in-

depth on its aromas, flavor, and structure. This supports the idea of Australian Shiraz showing significant differences over the various climates and thus regions.

Following the statement of Jones and the findings from the field research and panel tasting, the climatic differences have a significant impact on the resulting wine. In general, Australian wines will be richer in style simply due to the overall warmer climatic conditions following the lower latitude degrees, higher average temperatures, and sun intensity. This is in line with the distinct differences which are found between wines from warmer and cooler regions, as also presented in high level in the above table.

7.1.5 Style classification of Australian Shiraz

How then to create an understanding and classification in styles of Australian Shiraz? There are significant differences between Shiraz from various regions, but mostly difficult to pinpoint at a specific region. It is easier aggregated and defined on a climate-based definition. Is it for example a cool climate style or warm? And if it is warm, is that in the more classic way (obvious oak, high alcohol) or modern (less oak, bit fresher but still big and ripe)? Using such gradings, it is possible to assess wines and position them in 'classes', call it a classification. With the Huglin Index for climate sections as basis, 4 classes have been defined based on this research:

1) Classic warm
2) Modern warm
3) Intermediate / temperate
4) Classic-cool

Where Australian Shiraz generally will show the generosity and ripeness connected to the warmer climate, wines in all 4 classes can be found and even in styles which can be deemed 'ultra-cool' due to structure, alcohol and flavor, which are a rarity and therefore not included in the report. In the table below, the classes are defined based on *structure* and *aromas and flavor* which are the most striking differences. The table is based on structure provided by Gregory Jones (7.1.4), including some of the terms used.

Style	Structure		Aromas & flavor	
Classic warm	*Overall style*	Rich, bold, intense, ripe, lot of everything, notable oak usage. Can lack balance	*Intensity*	Very expressive and intense, can be heavy
			Fruit style	Overripe, lush., sometimes too ripe, stewed and sometimes 'dead fruit'
	Body	Full bodied	*Fruit*	Dried black fruit, jammy, Dark fruit like blackberry, plum, black currant, black cherry. Red fruit like very ripe strawberry;
	Alcohol	Generally, 15% and higher		
	Acidity	Soft, smooth	*Other*	Often strong -overpowering- vanilla & coconut; spices (clove, bay leaf, nutmeg, pepper); licorice, floral (violets); leather; eucalypt; chocolate (milk/dark), coffee, caramel, mocha; cedar wood
	Tannins	Big ripe tannins		
Modern warm	*Overall style*	Rich, big bodied. Connecting ripeness and flavor with balance and freshness. Notable but balanced oak	*Intensity*	Expressive to very expressive, lively, ripe
			Fruit style	Ripe, juicy, lush but fresh
	Body	Full bodied with freshness	*Fruit*	Dried black fruit, jammy Dark fruit like blackberry, plum, black currant, black cherry. Strawberry, ripe raspberry
	Alcohol	Generally, 14 - 15%		

Style	Structure		Aromas & flavor	
	Acidity	Soft, smooth, integrated	*Other*	Some to more notable vanilla & coconut; Spices (clove, bay leaf, nutmeg, pepper); licorice, floral (violets); leather; tobacco; eucalypt; chocolate (milk/dark), coffee, caramel, mocha; cedar wood, black olives, smokey, meat extract
	Tannins	Ripe, integrated tannins		
Intermediate / Temperate	*Overall style*	Elegant, medium to medium+ intensity, ripe and fresh. Notable but balanced oak	*Intensity*	Expressive, lively, fresh to ripe
			Fruit style	Ripe, juicy, fresh, lively
	Body	Supple, medium to medium+ bodied	*Fruit*	Dark and forest fruit, blackberry, blueberry, plum, red, and black cherry, strawberry, raspberry
	Alcohol	Generally, 13,5 - 14,5%		
	Acidity	Integrated, can be crisp	*Other*	Some vanilla; Dried herbs, spices (clove, bay leaf, pepper, aniseed), licorice, meat extract, smoky, black olives. Some can show mineral, earthy, and savory characters
	Tannins	Notable, ripe, fine grained, integrated		
Cool / cool temperate	*Overall style*	Supple, elegant, lean, and fresh, with good fruit ripeness. Limited oak usage can be some new oak but some full stainless. With cooler versions savory notes can be more dominating.	*Intensity*	Somewhat restrained to expressive, fresh lively
			Fruit style	Lean, fresh, bright
	Body	Supple, fresh medium bodied	*Fruit*	Fresh red fruit (cranberry, raspberry, strawberry, cherry, sour cherry, plum)
	Alcohol	Generally, 12.5 - 14%		
	Acidity	Crisp, integrated, can be tangy	*Other*	Fresh and dried herbs, spices (black & white pepper, bay leaf), mineral, green bell pepper, licorice, meaty, earthy, savory.
	Tannins	Notable, mostly ripe, fine grained, integrated		

Table 7.2 Climate classification for premium Australian Shiraz (Anne Greveling, 2020, based on G.V. Jones)

7.1.6 Positioning of Australian Shiraz regions

Based on the climate classification as described above, the wine regions can be plotted on where the wines *generally* can be placed, which is presented in table 7.3 below. It is not possible though to just make the simple demarcation, that a wine region showcases one style only. Barossa Valley can show classic warm, but the majority is in the modern warm class, while Hunter Valley is by far the warmest climate, but presents wines which can be positioned in the temperate and even cool styles (alcohol) -the 2017 Tyrell's Johnno's and Brokenwood Tallawanta Vineyard Shiraz's have only 13%-. It is thus not possible to judge merely on temperature, Huglin Index, or heat degree days what type of wine can be produced. This creates a challenge in pinpointing specific origins if you lack experience with tasting wines from the various regions.

Where a region is present in multiple style classes, the region name is written in *(Italic)* in the style where it also occurs, but which is not the main style.

Climate style classification	General
Classic Warm	*(Barossa Valley, McLaren Vale)*
Modern Warm	Barossa Valley, McLaren Vale, Heathcote *(Hunter Valley)*
Temperate / intermediate	Eden Valley, Hunter Valley, Clare Valley, Beechworth, Margaret River *(Adelaide Hills, Orange, Grampians, Yarra Valley)*
Cool / cool-temperate	Sunbury, Mornington Peninsula, Yarra Valley, Orange, Grampians, Canberra District, Great Southern, Adelaide Hills *(Margaret River)*

Table 7.3 Premium Australian Shiraz regions plotted on climate style

7.2 Shiraz vs Syrah on the label – a producer's view

When choosing Shiraz vs Syrah in labeling a wine, there are multiple elements to consider. Firstly, most winemakers that use the name 'Syrah' do this, as they feel their wine is a representation of cool climate 'Syrah', resembling Northern Rhône stylistics and wine making techniques, but within Australian climates. Some of those Syrah wines are difficult to distinguish from Old World versions when tasted blind. There are also many winemakers which create a more 'cool climate' style, for example Frankland Estate and Clonakilla, but prefer to use the traditional Shiraz name. Secondly, whilst it may be a principal choice of the winemaker, it is also a commercially driven choice. It is a way of positioning your wine and differentiating from others. This can be a successful method -especially if you get the message properly communicated to your markets-, but there are some risks to it, as consumers may be confused and not select your wine as they don't know what to expect.

The labeling option is a way to further emphasize the diversity in Shiraz wines from Australia, already imprinting the style to be expected in the mind of the consumer. This understanding of various styles and origin can be created and embedded with proper informing of consumers, both on the bottle, tasting notes on websites via expert sellers as well as with targeted marketing campaigns. A leading role needs to be taken by both winemakers, importers, and representative bodies such as Wine Australia.

7.3 Sensory trial

During this research wines have been tasted at various occasions, at Prowein (2018 & 2019), the wineries (January 2019) as well as a blind tasting back in the Netherlands (March 2019). The tastings at Prowein and the wineries are my own anecdotal references, but the blind tasting was done with a panel of 11 experienced tasters, used to analyze and decipher wines for competitions, magazines, articles or selection for quality wine lists.

7.3.1 Own tasting

In my memory before embarking on this research, tasting Australian Shiraz for me generally showed generosity and richness on the palate, showing its distinct warmer heritage. In my tastings for this research, I was genuinely surprised with the variety of styles, with wines from different regions, as well as from within regions and even same winemakers. Most wines are above the 13.5% alcohol mark, but I have encountered distinct cooler climate wines -red fruit, herbaceous, pepper, floral-, as well as warm climate wines -jammy, ripe dark fruit, eucalypt and oak- and anything in between, but almost no unbalanced overripe and overly oaked wines.

The biggest differences experienced are in fruit flavors, spices, chocolate, alcohol, oak usage, body and combination of acidity and tannins. For example, when tasting Barossa's Elderton Wines 'Command' Shiraz 2015, boasting dark ripe fruit, chocolate, spices, leather, cedar, distinct use of oak, and big bodied, I get what I expect from a high-quality Australian Shiraz. When I for example put the Shiraz wines from Craiglee (Sunbury. VIC), Chapoutier (Mount Benson, SA), Frankland Estate, Forest Hill (both Great Southern, WA) Domaine Naturaliste and Vasse Felix (both Margaret River, WA) against that, it is a completely different set of wines. The palate far more on the fresh red fruit, peppery notes, herbaceous even, with distinct acidity and freshness. The alcohol dropping as low as 12%, providing a wholly different sensory experience.

The two examples above are extremes, but in between there are countless differences between each region and within regions, showing the diversity of Australian Shiraz. During ProWein 2019 Thomas Curtius MW hosted a tasting of Barossa Shiraz for Wine Australia and Barossa Wines, presenting four sub-regions within Barossa- and Eden Valley. From each different sub-region 2 wines were tasted showing distinct differences, from the fresher red fruit dominated wine from cooler Eden Valley to the bigger and bolder wines from the warmer Central Grounds. Also, within the 3 subregions of Barossa Valley itself, differences were markedly. This tasting gave a real insight in what differences can already be found in just one region.

In appendix 4 more detailed information is provided on all regions which are part of the research. This includes information on overall climate, soils, topography, plantings, and a description of the general regional styles.

7.3.2 Panel tasting

For the collection of more representable and less anecdotal data, a blind tasting was organized with 11 experienced tasters and 18 Shiraz wines of which 1 from Crozes Hermitage, poured in different orders. Unfortunately, it was not possible to create a line-up from 1 vintage, having a majority between 2015 and 2017, some older. Given those differences in vintages the outcome is less academic. Although not being able to show conclusive data on the differences between regions within a single vintage, the results of the panel tasting did show perceived sensory differences, especially on the climatic score, body, tannins, alcohol, and aromas. It also showed that some wines showed resemblance with the Crozes Hermitage, as not all tasters pinpointed that one as the Rhône comparison, showing that Australian Shiraz can resemble Northern Rhône.

The data is presented on regional level to align with the regional difference topic of this thesis. Where 2 wines for a region were tasted, the score was averaged for all 1-5 score items and for aroma and flavors the output was combined. The number of wines tasted for a region is stated behind the region's name as either (1) or (2).

7.3.2.1 Perceived sensory differences

The panel perceived clearly notable differences for the wines tasted. In appendix 5 all results are included, but 4 examples are elaborated here: climate scores, structure, aromas, and flavors.

Apart from the aromas, flavors and the climate score, all items assessed during the tasting are scored on a 1-5 scale from low to high. For the aromas and flavors only, the characteristics referenced multiple times were included in the overview to maintain a readable table.

Climate scores

However no region was unanimously scored in one climate based on the tasted wines and sometimes on the extremes-this is still up to the perception of the taster- the tasting showed significant differences in climatic scores between the wines. For example, both Heathcote and Barossa Valley clearly show the warm characters for all tasters, while Margaret River, New South Wales, Grampians, and Orange score high on cool climate characters. Canberra District and Great Southern also score high on cool and temperate climates.

As mentioned earlier this quite possibly is the most practical depicter for the wines, the climate in which they are made.

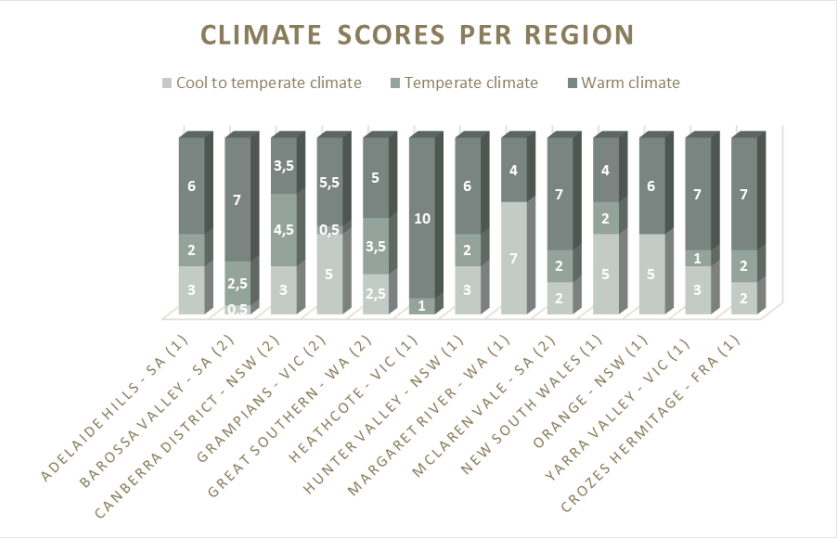
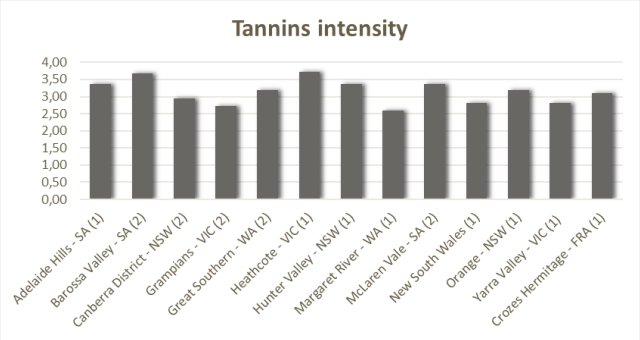


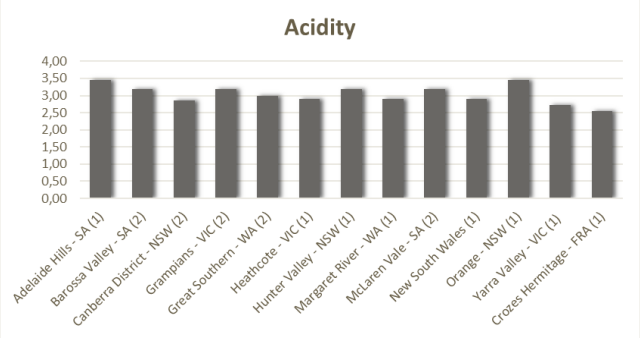
Figure 7.1 Climate score – output sensory panel tasting

Structure

In addition to the climatic score, the structure of the wines gives an indication on the heritage of the wine. Some of the most dominant structure characteristics are tannins, acidity, body, and alcohol.

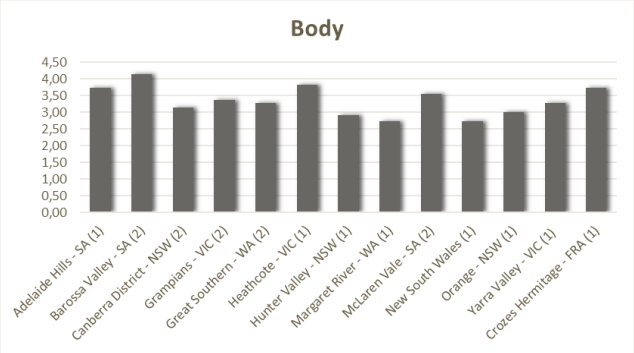


The panel has perceived notable differences in tannin levels between wines from the various regions. Barossa Valley and Heathcote scored highest, which aligns with more full-bodied wines, matured on a larger percentage of new oak. Cooler areas as Canberra District, Grampians and Margaret river scored notably lower, which aligns with the lighter cooler climate style with less new oak.

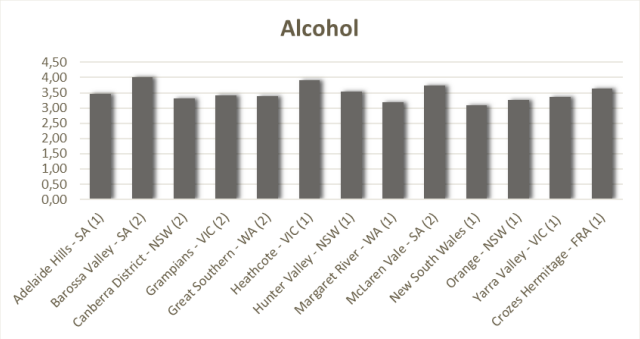


On the topic of acidity there are some differences perceived, where Adelaide Hills and Orange - both cooler climates- score highest and Barossa, Grampians, Hunter Valley and McLaren Vale have similar scores. The distinction between regions on acidity is thus quite limited based on the scores in this tasting. The ability of Australian winemakers to acidify their wines for more balance may play a role here, as well as the overall balance of the wine, which may

reflect more or less acidity. The actual pH of the wines tasted varied between 3.33 and 3.7 and TA (total acidity) between 5.6 and 7.6 grams per liter.



For the body of the wines, the wines from Barossa Valley clearly stand out as richer and more full-bodied followed by Heathcote and McLaren Vale. This is logical given the warmer climate, higher alcohol levels and use of larger percentage of new barrique. Surprisingly, Adelaide Hills with the Shaw+Smith Shiraz and the Crozes Hermitages also scored high. This shows that cooler climates can also make more full-bodied wines under the right terroir conditions.



The panel has perceived all wines to have a medium+ or higher alcohol levels, including the Crozes Hermitage. Barossa Valley, Heathcote, and McLaren Vale top the list, which is also in line with their warmer climate. None of the wines was perceived as lower in alcohol. As the wines tasted vary in alcohol between 13 to 15% according to available data, with the majority around 13.5 – 14%, it is fair to say that all wines are at least medium+ in alcohol, also the wines from cooler regions.

Overall, on the structure, the panel tasting showed most distinct differences in the body and tannins of the wines and to a lesser extent alcohol, although the top 3 warmest regions do stand out. Acidity was not a differentiating factor in this tasting. Overall, the outcomes align with the characteristics related to the various regions.

Aromas

For the aromas as shown in figure 7.2 the most eye-catching outcome is the level of red fruit and pepper perceived. The cooler climates showing higher ratings for those, while black and dark fruit and for example plum in Barossa Valley are more pronounced in the warmer climate wines, with only the Grampians as odd one out also showing more dark fruit. Pepper characteristics were most notable in the cooler regions, especially Margaret River, Canberra District and Adelaide Hills and to a lesser extent also Hunter Valley, New South Wales, and the warmer regions such as Barossa Valley. Surprisingly, the wines from the Grampians, Orange and Yarra Valley were not perceived to show real peppery notes, while those are relatively cooler regions.

All wines tasted, consistently gave different aroma character combinations, which supports the concept of regionality.

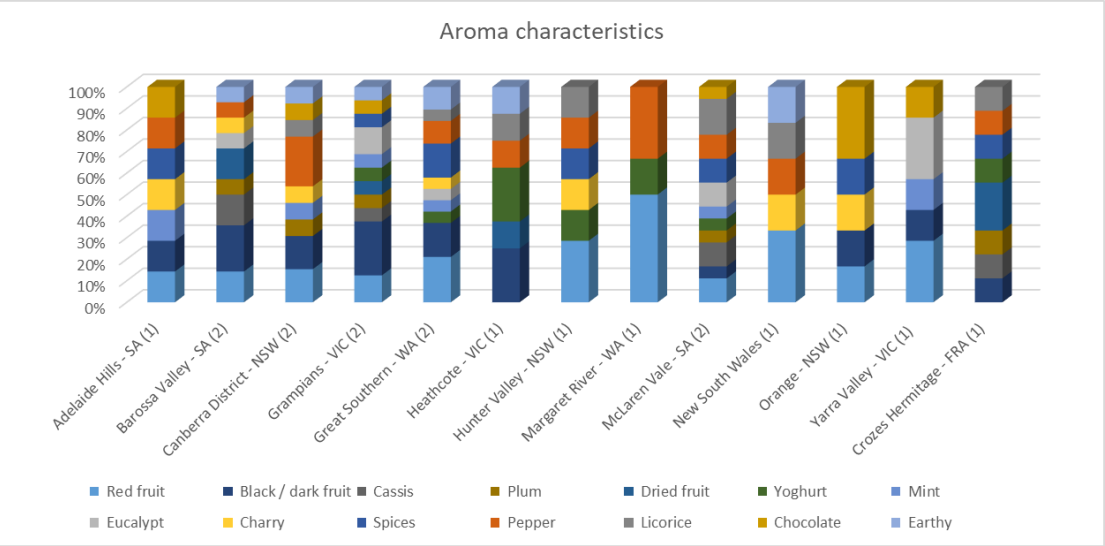


Figure 7.2 Aromas characteristics – output sensory panel tasting

Flavor

On the flavor side, red fruit again shows more distinctively with the cooler areas, while Heathcote shows none and Barossa only very little. Pepper was most distinct in Hunter Valley and Margaret River. Plum, dark fruit and dried fruit on the other hand show more intensely in the wines from classic warmer areas such as Barossa Valley, McLaren Vale and Heathcote. The wine from Heathcote mostly reflected the impression of a premium Australian Shiraz from a warmer climate, showcasing the dark and dried fruit, plum, spices, chocolate complemented with a touch of cedar. The Yarra Valley wine was surprisingly rich and ripe in perceived flavors, as it is a cooler region, but still showcased aromas like plum, dried fruit, chocolate, coffee, and mint.

All regions showcase different characteristics and compilations of characteristics, where the key characteristics mostly align with the climatic setting of the regions supporting the concept on regionality. However, based on this panel tasting the distinction for specific regions presents itself less clear in the flavors than with the aromas.

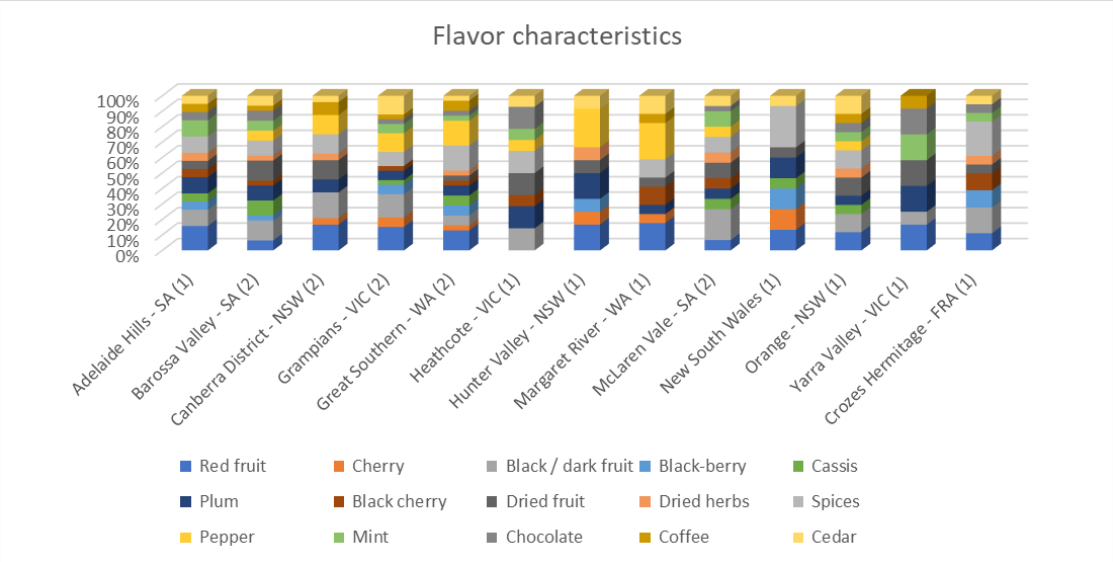


Figure 7.3 Flavor aromas – output sensory panel tasting

Overall

The tasting shows diversity between the regions in both aroma and flavor profiles as well as other sensory experiences, one more significant than another. The topic of climatic heritage also gave clear outcomes for determining the origin of the wine, especially for Barossa Valley and Heathcote on the warmer side and Margaret River, Canberra District and Great Southern on the cooler side.

The tasting -however limited to 17 Australian Shiraz wines over various vintages and thus mainly giving a first insight- overall supports the thesis that there are significant differences between Shiraz from various regions, albeit that the most notable differences are climate driven.

7.4 Does regionality show in Australian Shiraz?

The key question for this thesis research is: *"Is regional diversity of premium Australian Shiraz significant?*". It has proven to be a tricky question, which does not lend itself to one conclusive answer, a black and white demarcation between yes and no.

The theoretical research and interviews provided the insight that wine critics, writers and winemakers agree on the existence and significance of regional diversity of Australian Shiraz. They feel it exists and based on tasting notes, anecdotal evidence can also be provided. Given the academic research in soils and climates, there is also a solid foundation to support this assumption. However, academic research on detailed sensory aspects of the Shiraz wines has only started in recent years and the various research projects have not yet provided data which can be published. Until now, the evidence for this diversity remains mainly based on tastings, and especially relying on the experts who work with wine on a day to day basis and regularly taste a variety of Australian Shiraz wines over various vintages.

When remembering the tastings at the wineries, a wide variety of flavors and styles comes to mind, as also described in the climate style table. From bold and rich in the warmer areas as McLaren Vale, Barossa Valley and Heathcote, to powerful but balanced Shiraz from Clare Valley, Hunter Valley and Beechworth to tight and savory Shiraz tasted in Great Southern, Orange and Margaret River. All regions showing a wide variety of stylistics, which the Shiraz grape can deliver. This also showed from the panel tasting. For some regions, such as Barossa Valley and Heathcote it proved possible to pinpoint the region without knowing what was tasted. But when putting other regions against each other, it becomes more complicated. Pinpointing the subtle differences based on soil, the topography of the vineyard and region remains difficult. Most of the panel and own tasting showed that making a dissection at a climatic style level was feasible.

8 Conclusions

The main thesis question for this report was “Is regional diversity of premium Australian Shiraz significant?” 5 main topics were identified for the research and are answered in this thesis report. Each paragraph in this chapter is dedicated to a main topic and whether this has an influence on the answer to the main thesis.

8.1 Shiraz the grape

The Shiraz grape has a history dating back many centuries in the Rhône valley in France, where it produces distinctively different styles in for example Côte-Rôtie, Hermitage and Cornas, which are all within a region measuring less than 100 kilometers from north to south. Shiraz is a very versatile variety which can grow in a wide range of growing conditions cool and warm, but with a preference for poor soils and a healthy level of water stress if quality and regional reflection are the aim.

The Shiraz grape provides distinctively different wines depending on the terroir where it is grown, how it is cultivated and what winemaking techniques are used. From delicate, red fruit, red cherries, savory and pepper notes, with moderate to low alcohol and tangy and sometimes grippy structure in the cooler climates to big bold (over)ripe dark fruit, eucalypt, chocolate, mocha, leather and high alcohol in the warm to hot climates (see table 7.2). The winemaker has a big impact in managing the vineyard, as over production will lead to diluted wines and too much or too little shade will also affect the ripeness of the grape.

Conclusion 1:

If properly managed in the vineyard, grown on a relatively poor soil with restricted availability of water and not overpowered by winemaker influences, Shiraz as a grape is very capable of providing a sense of place to the resulting wine, based on the terroir characteristics of a region.

8.2 Terroir

It is shown that Shiraz as a grape is very sensitive to the terroir in which the grape is grown. The grape is especially sensitive to differences in the meso climate, altitude and topography in the region, and the soil including availability of water. There is some debate between winemakers on ranking soil first or after climate. Local traditions and winemaking techniques also play a role in representing terroir.

The grape responds strongly to the meso climate. Within one vineyard with different aspects to the afternoon sun, harvest dates can be two weeks and more apart, resulting in different sugar/acid balance, setup in flavor compounds, and phenolic ripeness. This effect is seen in several of the wine regions and wineries assessed. Altitude also clearly influences the climatic conditions as shown in the comparison between Barossa Valley and Eden Valley (see table 4.2), significantly affecting diurnal differences and overall ripening conditions. Hunter Valley lastly is a good example where the hottest wine region for premium Shiraz can produce perfectly ripe and intense Shiraz at 13% alcohol due to local conditions such as cloud cover and shade from mountain ranges. With climatic conditions favorable for the Shiraz grape, the terroir components such as soil composition

play a distinctive role in the aroma profile of the wine according to the winemakers interviewed, showcasing more subtle structural and flavor elements.

Australia provides a wide diversity of terroirs in which the grapes for premium Shiraz are grown, providing a huge potential for diversity. When viticultural and winemaking practices are supportive, aimed on quality and regionality, the terroir is a real differentiating factor for showcasing regional diversity of Australian Shiraz.

Conclusion 2:

Shiraz as a grape is very sensitive to and reflects the climate and terroir in which it is grown, as well as the viticultural and winemaking practices used. When viticultural and winemaking practices are supportive, aimed on quality and regionality, the terroir is a real differentiating factor for showcasing regional diversity of Australian Shiraz.

8.3 Viticulture

Viticultural practices have a major influence on the resulting style of premium Australian Shiraz, which can contribute to the terroir, but also block terroir characteristics.

It is in viticulture that the winemakers interviewed are perhaps taking the most measures influencing the resulting wine. With the climatic changes and the often-scorching afternoon sun, and a desire to make more digestible wines, winemakers are actively managing the vineyard and especially focusing on the canopy, soil, and a healthy dose of water stress for the vines. This works on a higher level with planting better clones or create different sun aspects, but foremost in the year on year management of the existing vineyards.

The most important actions taken by the winemakers interviewed, which are critical in ensuring healthy and balanced fruit, which can show regionality, a sense of place in the resulting wine are:

- Canopy management (leaf to fruit ratio, dappled light, limit vigor)
- Soil management (cover crop, gentle ploughing, promote microbial life)
- Vineyard health management (lute raisonee, biological and biodynamic practices all too balance and strengthen the vines, soil, and biodiversity, promoting better flavor and chemical setup of the fruit)
- Limit spraying with non-natural material to bare minimum
- Dry farming or limited irrigation (restrict growth vigor, but support vital stages in flowering, fruit set and ripening, ensuring good flavor intensity and chemical setup)
- Yield management (proper fruit to canopy ratio, adjusted number of bunches to potential of the vine for optimum ripening of high-quality grapes)
- Harvesting (earlier harvesting for more balanced and fresh characters, lower alcohol to better present aromas and regionality)

With all the above viticultural practices the winemakers contribute to the grapes' ability to showcase regionality.

Conclusion 3:

With proper measures in the vineyard, high quality Shiraz grapes can be grown and harvested, grapes which are balanced in sugar, acidity, and phenolic ripeness. Viticulture can significantly support the grapes ability to show regional characters, by providing healthy and balanced vineyards and canopy, and preventing the fruit to become overripe.

8.4 Winemaking

Where in viticulture winemakers generally seem to intervene more than in the past - though less intrusive, more supporting-, in winemaking a tendency is seen, that the winemakers are moving towards a setup, in which less measures are taken in the winemaking process to showcase the Shiraz grape and its regional characters. Less technical prowess, more artisanal methods, finding a balance.

With the earlier harvesting they get fresher fruit in the cellar, providing a base for fresher wines. The research shows that this happens in all wine regions covered, from cooler to the warmest climates.

Winemakers are looking for balanced wines which reflect the region and vineyard they come from, not a wine which could have come from anywhere. Key practices found are:

- Medium length maceration (prevent over-extraction)
- Inclusion of whole bunches in the maceration and fermentation (increase freshness, tannins, leanness, and spice, balancing the wine and adding complexity)
- Open top fermentation (evaporation of up to 1% alcohol)
- Limited use of new oak and use lighter toasting (limit oak flavor influences, increase presentation of the fruit and use oak as supporting element)
- Move from American to French and Slavonian oak (more subtle flavor impact, more supporting element)

With all the practices from the winemakers there is an aim to make digestible wines, which reflect the region and vintage, the potential there is. In the end all actions of a winemaker influence the resulting wine, also the lack of action, but such (lack of) actions more and more support the wine in showcasing regionality.

Conclusion 4:

All actions of a winemaker influence the wine, but with techniques and practices more and more focusing on letting the Shiraz grape speak out, aligning the winemaking influences on what Shiraz from that region can handle, the winemaking process is able to add to showcasing regionality.

8.5 Australian Shiraz and its styles

Premium Australian Shiraz is a wine with a great heritage, with premium wines dating back to the early 1900's. While vineyards were often planted over a century ago, the current GI's where only set up in 1993, following trade agreements with the European Union, and was in the end more a legal and marketing process instead of organic as

Damien Sheehan stated. This impacts regionality, as we now have a different perspective on GI's and regionality, then might be the most correct one.

Power-house Shiraz can still be found, also in the premium segment, but the research shows that producers of premium Shiraz have been moving towards a style of Shiraz which is digestible, balanced and representing its origin. Thus, not overpowered by merely one or two aromas, but showing a balanced set of aromas, contributing to each other. Most prominently in this research is the lack of the overpowering new -often American- oak, while some of the wines tasted still have up to 70% new oak. It is basically a more holistic approach, where the sum of elements is bigger than in case one or two elements would have dominated.

The research shows a variety of styles of quality Australian Shiraz, covering the spectrum of the lean and sometimes even Northern Rhône like styles all the way to the classical big bodied, high alcohol wines. There is not just one definition for Australian Shiraz anymore.

In chapter 4 on Climate, climate change was briefly touched upon. The increasing heat and drought will affect winemakers in what style of Shiraz they can produce in the future, and whether Shiraz will then be the grape of choice, given new conditions. Some regions are exploring Shiraz, their climates becoming suitable for properly ripening the grape. It is a challenging future, but one which is not per definition negative if winemakers are willing to take the necessary measures. Stylistics of premium Shiraz from individual regions will change as will the understanding of those wines.

This climate change, together with changing viticultural and winemaking practices, have an impact on the wines made and what represents a wine region. It has done in the past decades and will lead to new understandings of regional styles moving forward.

It has proven to be complex to define detailed sensory differences on a per region basis, really defining what each region is and how this then differs opposed to other regions. Further extensive in-depth research on this is being conducted by Charles Sturt University and Australian Wine Research Institute. The panel tasting showed that the most distinct difference is found in the climate driven characters of the wine, its richness, body and type of fruit, oak, and other aromas. As output of this research a climate style classification has been created and the assessed wine regions are plotted over the scales (paragraph 7.1.5 and 7.1.6).

Conclusion 5:

Stylistics of premium Australian Shiraz have changed in favor of creating digestible wines, showing regional characteristics. More and more winemakers aim to make a wine with a sense of place, adding to regional diversity.

8.6 Conclusion to the thesis

The research started with the question "*Is regional diversity of premium Australian Shiraz significant?*" The answer is yes, but not in a black and white sense.

There is a wide array of Shiraz styles found in Australia. From Margaret River with the leaner styles of Vasse Felix and Domain Naturaliste, Frankland Estate in the Great Southern in at the west coast, to the rich, big bodied but still balanced styles (not overly

oaked) in McLaren Vale (Wirra Wirra, d'Arenberg, Chalk Hill), Barossa Valley (Rockford, Kaesler). In Clare Valley (Wendouree) and Eden Valley (Henschke) you find rich and ripe but leaner styles. This all the way through Victoria with both cooler (Sunbury, Mornington Peninsula) and warmer regions (Heathcote, Beechworth) showing their own distinct styles, to the east coast where eventually Hunter Valley is producing ripe but medium body, elegant Shiraz wines, with alcohol levels as low as 13%.

So, **YES** diversity is there, but to what extent is this then significant and recognizable for a wider public? Is there a widespread common understanding of how a Shiraz from a region would taste, to such a detail that 2 climatically similar regions can be set apart when tasted? For experts who regularly taste premium Australian Shiraz from a variety of regions, over different vintages in comparison, yes, this regional diversity is clear. But most wine experts and especially consumers outside of Australia generally do not get to taste premium Australian Shiraz from a wider variety of regions and vintages and thus do not built up this tasting memory, which has over time been created for regions such as the Northern Rhône, Burgundy but also Barossa Valley, which better known to a wider public. The generally accepted understanding and tasting memory is something which is being built, an ongoing organic process, which can be supported by further academic research from AWRI and Charles Sturt University -as is ongoing- and adequate marketing and overall information provision by Wine Australia, producers and importers. With the development of this understanding, the significance of regional diversity will continuously grow, quite possibly to the level as seen in the understanding of the wider public on classic regions in the Old World.

Final conclusion to the thesis:

There certainly is a significant diversity in premium Australian Shiraz and this is also notable on a regional level. When regularly tasting premium Australian Shiraz from various regions over various vintages the differences are clear -sometimes subtle, sometimes very obvious-. The main limitation for a wider understanding of each regions specific characteristics is, that the wider public mostly does not regularly taste premium Australian Shiraz from a variety of regions in comparison, let alone multiple vintages. This requires further research such as the ones which are being conducted by AWRI and Charles Sturt University.

The potential is there, but a common understanding needs to be formed. This research forms a first step by providing a climatic classification of styles for premium Australian Shiraz.

In time a broader understanding of premium Shiraz from individual regions will grow. It is my hope that many people will experience the exciting diversity premium Australian Shiraz has to offer. I wish it to you all, enjoy!

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Appendices

Appendix 1 Regions and wineries assessed

For this research, a wide selection of wineries has been asked to participate from the most important Shiraz producing regions in New South Wales, Victoria, South Australia, and Western Australia. All wineries below have participated in the survey and I have visited all except for Torbreck. During the visit's additional interviews, cellar and vineyard visits, and barrel sample tastings took place, to get a better understanding of the actual situation, setting in which the Shiraz wines are produced. In addition to the line-up of wineries below also other wineries were visited after reference by winemakers, but other than a short interviews and tastings, those have not participated in the survey.

State	Region	Winery
NSW	Canberra District	Clonakilla
NSW	Orange	Printhie Wines
NSW	Hunter Valley	Mount Pleasant Wines
NSW	Orange	Philip Shaw wines
NSW	Hunter Valley	Brokenwood
NSW	Hunter Valley	Tyrells
SA	McLaren Vale	d'Arenberg
SA	Adelaide Hills	Shaw and Smith
SA	Eden Valley	Henschke Cellars
SA	Barossa Valley	Kaesler Wines
SA	Barossa Valley	Rockford Wines
SA	Barossa Valley	Torbreck
SA	McLaren Vale	Wirra Wirra
SA	Clare Valley	Wendouree
VIC	Sunbury	Craiglee
VIC	Yarra Valley	Yarra Yering
VIC	Mornington Peninsula	Paringa Estate
VIC	Grampians	Best's Wines
VIC	Beechworth	Giaconda Vineyard
VIC	Yarra Valley	De Bortoli
VIC	Grampians	Mount Langi Ghiran
VIC	Heathcote	Jasper Hill
WA	Great Southern	Frankland Estate Wines
WA	Great Southern	Plantagenet Wines
WA	Margaret River	Domaine Naturaliste
WA	Margaret River	Vasse Felix

Appendix 2 Survey questions

The following questions have been asked to the winemakers in the initial survey for this thesis research:

1. SITE AND CLIMATE

1.1. How would you rank the importance of terroir or site on the wines you produce and specifically Shiraz? What are the main impact factors for your style of Shiraz?
1.2. What is for you in your region the preferred orientation of your vineyards to get your preferred style of Shiraz?
1.3. What are the predominant soil types in your vineyards? Are there significant differences between vineyards and is there a soil type you specifically prefer?
1.4. In describing your vineyards terroir, how can this be described in matter of rainfall, wind exposure, terrain style and sunlight hours?
1.5. How would you describe the general vintage conditions if you take the last 5 years? Are the conditions improving for the growing of your preferred style of Shiraz or do you feel otherwise? Please briefly elaborate.

2. VINES AND VITICULTURE

2.1. What clone(s) of Shiraz do you use in your vineyards? If multiple closes are used, for what purpose? Please briefly explain the reason for selecting the specific clone(s).
2.2. What is the average vine age? If this differs for various vineyards, please state the oldest vineyard, average age and youngest you use in production.
2.3. How have you arranged the vineyard lay-out and what is the planting density?
2.4. What type of trellising, pruning methods and canopy management do you apply? Why have you made this choice?
2.5. What is the average yield you get from your vineyards? Are there significant differences between vineyards and do you actively influence the size of the yield?
2.6. In how far do you apply irrigation? If you do use irrigation, what type or irrigation do you apply and why did you select to use this method or not to apply irrigation?
2.7. What measures do you take in the vineyard to ensure healthy vines and perfectly ripe fruit?

3. WINE MAKING PROCESS

3.1. With regards to harvesting:
- which period (month) do you preferably harvest?
- During what period of the day do you harvest?
- Is harvesting done manually or with machines?

3.2. In preparing the grapes for the must, please give a short description of your process and choices made. (e.g. (manual) sorting, pre-ferment maceration, whole-bunch, whole berry, or traditional de-stemming and crushing, etc.)
3.3. For the fermentation, please describe the type of yeast used (indigenous or selected), type and size of the fermentation vessel, length of fermentation and post fermentation maceration prior to pressing if any.
3.4. For the maturation, what type and shape of vessel is used, e.g. oak, concrete, inox. In case oak is used, what type of oak and what is the percentage of new oak?
3.5. Are there any specific conditions in your cellar or practices which have a significant impact on your wine, other than the topics discussed in the previous questions?
3.6. In how far do you apply racking, fining, filtering and/or stabilization? Does this differ per wine? Please briefly elaborate.

3.7. What type of closure do you use for your wines, is this the same for all wines and what is your reason for choosing this closure? Please briefly elaborate on your choice. (natural cork, conglomerate cork, extracted plastic cork, screw cap, or vino lock)

4. PHILOSOPHY AND HISTORY

4.1. What style of Shiraz do you aim to produce and why?

4.2. In the vineyard management and winemaking, do you follow a philosophy such as organic, biodynamic or lute raisonee or do you use other practices? Please briefly elaborate on your choice and way of working.

4.3. How would you describe the level of intervention you apply in the winemaking (from grape growing up to the bottled wine)? Please briefly elaborate how and why you chose to do this.
1) Low/Non interventional;
2) Modest;
3) High.

4.4. How would you describe your style of winemaking? Modern or traditional? Please briefly elaborate your answer.

4.5. In making your wines, do you make the wines with grapes from single sites or blends of multiple sites or multiple regions? Why have you made this choice?

4.6. If you had to describe what makes Australian Shiraz, Australian Shiraz, what would that be?

Appendix 3 Average yields

In this research all winemakers shared their yields in tons per hectare, either as one number or a high and low ranges. In the below overview those numbers are provided and converted into HL per hectare using the conversion numbers based on an article by Andrew Jefford and the metric used at Tyrells (see table below). Where wineries mentioned both a low and high number of yields, those are minimum and maximum numbers for a normal vintage.

HL per ton	Low	High
Andrew Jefford	7.69	-
Tyrrell's	7.14	8.57

Where data on planting density is available, this is added. For several wineries only gross data is available on approximate distances between vines and rows.

				Lower yield				Higher yield			
State	Region	Winery	Vines/ha	T/ha	Jefford HL/ha	Tyrells Low HL/ha	Tyrells High HL/ha	T/ha	Jefford HL/ha	Tyrells Low HL/ha	Tyrells High HL/ha
NSW	Canberra District	Clonakilla	n/a	7	53.8	50.0	60.0	9	69.2	64.3	77.1
NSW	Orange	Printhie Wines	1,660	6	46.1	42.9	51.4	8	61.5	57.1	68.6
NSW	Hunter Valley	Mount Pleasant Wines	2,000	2.5	19.2	17.9	21.4	10	76.9	71.4	85.7
NSW	Orange	Philip Shaw wines	n/a	5	38.5	35.7	42.9	8	61.5	57.1	68.6
NSW	Hunter Valley	Brokenwood	n/a	-	-	-	-	-	-	-	-
NSW	Hunter Valley	Tyrells	2,500	3.5	26.9	25.0	30.0	-	-	-	-
SA	McLaren Vale	d'Arenberg	n/a	2.5	19.2	17.9	21.4	5	38.5	35.7	42.9
SA	Adelaide Hills	Shaw and Smith	5,500	6	46.1	42.9	51.4	0	0.0	0.0	0.0
SA	Eden Valley	Henschke Cellars	n/a	2.5	19.2	17.9	21.4	3	23.1	21.4	25.7
SA	Barossa Valley	Kaesler Wines	n/a	8.1	62.3	57.9	69.4	-	-	-	-
SA	Barossa Valley	Rockford Wines	n/a	2.5	19.2	17.9	21.4	12.5	96.1	89.3	107.1
SA	McLaren Vale	Wirra Wirra	n/a	5	38.5	35.7	42.9	8.75	67.3	62.5	75.0
SA	Clare Valley	Wendouree	1,200	3.75	28.8	26.8	32.1	5	38.5	35.7	42.9
SA	Barossa Valley	Torbreck	1,500	1.2	9.2	8.6	10.3	7	53.8	50.0	60.0
VIC	Sunbury	Craiglee	n/a	2	15.4	14.3	17.1	3	23.1	21.4	25.7
VIC	Yarra Valley	Yarra Yering	2,200	5	38.5	35.7	42.9	-	-	-	-
VIC	Mornington Peninsula	Paringa Estate	2,125	6.20	47.7	44.3	53.1	7.40	56.9	52.9	63.4
VIC	Grampians	Best's Wines	2,500	4	30.8	28.6	34.3	8	61.5	57.1	68.6
VIC	Beechworth	Giaconda Vineyard	2,500	5	38.5	35.7	42.9	-	-	-	-
VIC	Yarra Valley	De Bortoli	1,757	6	46.1	42.9	51.4	8	61.5	57.1	68.6
VIC	Grampians	Mount Langi Ghiran	2,469	5	38.5	35.7	42.9	-	-	-	-
VIC	Heathcote	Jasper Hill	n/a	1.95	15.0	13.9	16.7	2.60	20.0	18.6	22.3
WA	Great Southern	Frankland Estate Wines	2,200	7	53.8	50.0	60.0	8	61.5	57.1	68.6
WA	Margaret River	Domaine Naturaliste	1,666	6	46.1	42.9	51.4	-	-	-	-
WA	Margaret River	Vasse Felix	n/a	4	30.8	28.6	34.3	9	69.2	64.3	77.1
WA	Great Southern	Plantagenet Wines	1,850	4.5	34.6	32.1	38.6	-	-	-	-

Appendix 4 Regional characteristics

In this appendix the various regions are individually described with key data on the terroir and regional stylistics.

New South Wales

Canberra District					
Latitude	35° 03'S	Climate	Temperate / warm temperate	HI 25%	1,966
MJT[6]	21.3	Sun hours/day	8.5	HI Median	2,115
Rain (mm)	406	GST	17.7	HI 75%	2,217
Shiraz ha.		122			
Altitude (avg.)		650 (264-1419m)			
Topography		Generally undulating, but quite some variety in altitudes over the region, affecting meso climates.			
Soil		Volcanic soils, decomposed dacite often covered with a red clay loam layer (Parna layer) [explained and deemed best for Shiraz by Tim Kirk - Clonakilla]			
Climate style		Extreme continental climate. Very warm, dry days but cold nights during summer. Cool autumn temperatures with rain at harvest are not uncommon			
Regional style		Cool climate wine styles, particularly medium body and weight, savory Shiraz with red fruit, black cherry, anise, floral and spice characters, with occasional herbal inflection. Blends with viognier are common.			

Hunter Valley					
Latitude	32°33'S	Climate	Warm	HI 25%	2,403
MJT	23.6	Sun hours/day	7.3	HI Median	2,592
Rain (mm)	527	GST	20.7	HI 75%	2,743
Shiraz ha.		1,024			
Altitude (avg.)		110 (0-1597m))			
Topography		Undulating with on the edges the start of the Great Dividing Range, with vineyards in early shade from afternoon sun. Vineyard exposition differs significantly.			
Soil		Red soils over volcanic soil, heavy red clay over limestone, sandy loam			
Climate style		The Hunter Valley has a warm and humid climate, almost sub-tropical, there can be rain during harvest. Rain, humidity, cloud cover and gentle sea breezes mitigate the warmth.			
Regional style		Mostly medium bodied, dark, and blue berry fruit, strawberry, cherry freshness, spices, licorice, subtle but notable tannins, structure. Medium alcohol.			

Orange					
Latitude	33°39'S	Climate	Temperate / Warm temperate	HI 25%	1,914
MJT	22.9	Sun hours/day	8.9	HI Median	2,084
Rain (mm)	429	GST	17.6	HI 75%	2,285
Shiraz ha.		439			
Altitude (avg.)		670 (376-1390m)			

[6] MJT is Mean January Temperature

Orange	
Topography	Distinctly high altitude, generally undulating with variety of sun exposures and quite significant altitude differences over the region. Mount Canobolas is a marker in the region with great effect.
Soil	Volcanic basalt and basalt derived soils, deep brown/red free draining soils.
Climate indication	The climate is strongly influenced by, and largely dependent on, elevation. Overall, mild to warm midsummer mean temperatures, seldom rising above 32°C, are offset by cool to very cool nights during the growing season. The rainfall predominates in winter and spring, while the three driest months are February, March, and April, making supplementary irrigation highly desirable.
Regional style	Dark and blueberries, juicy red fruit, spices, dried herbs, elegant with good tannins and savory. Generally fresher styles due to higher altitude.

South Australia

Adelaide Hills					
Latitude	34°98'S	Climate	Temperate	HI 25%	1,945
MJT	20.4	Sun hours/day	8.4	HI Median	1,994
Rain (mm)	352	GST	17.5	HI 75%	2,027
Shiraz ha.		n/a			
Altitude (avg.)		500 (149-714m)			
Topography		The region is very hilly -mostly at elevation- with various valleys and sub-valleys providing distinct meso climates			
Soil		Iron stone mixed with grey-brown and brown topsoils			
Climate indication		Altitude with various aspects creates diverse meso-climates but overall, the climate is cool to temperate. Most of the region is best suited to early ripening varieties.			
Regional style		Elegant cool climate Shiraz - wines with modest alcohol, attractive pepper and spice aromas, fine tannins and acid structures which deliver palate length and ageability.			

Barossa Valley					
Latitude	34°51'S	Climate	Warm temperate / warm	HI 25%	2,275
MJT	21.9	Sun hours/day	8.6	HI Median	2,342
Rain (mm)	220	GST	19.0	HI 75%	2,411
Shiraz ha.		6,513			
Altitude (avg.)		270 (112-596m)			
Topography		The complex system of transverse sub valleys and twisting hills results in a variety of slopes, aspects, and sites.			
Soil		Very diverse, i.e. sand over clay over ironstone, red brown earth over clay over ironstone, red brown earth over clay over calcrete (calcareous soil), sand over granite and quartz over clay, clay loam over limestone rock			
Climate indication		The region has a Mediterranean climate ideal for full-bodied red wines. The climate ranges from warm on the valley floor to cool at the higher altitudes in the hills surrounding the Valley. Large diurnal temperature range, high maximum temperatures, high sunshine days and low humidity and rainfall.			

Barossa Valley	
Regional style	Full-bodied, richly textured and ripe, lush, velvety and mouth-filling, with flavors in the spectrum of black cherry to blackberry, ripe plum, chocolate, oak, spices, cedar wood, the tannins ripe and soft, medium+ towards high in alcohol. Often strong oak frame, but premium Shiraz is more balanced.

Clare Valley					
Latitude	33°89'S	Climate	Warm temperate / warm	HI 25%	2,322
MJT	22.3	Sun hours/day	8.9	HI Median	2,388
Rain (mm)	232	GST	19.0	HI 75%	2,423
Shiraz ha.		1,865			
Altitude (avg.)		450			
Topography		Very hilly with variety of exposures to the sun, high in the Mount Lofty Ranges.			
Soil		Red loam on sandstone, clay loam, scaly soils, and deeper alluvial soils			
Climate indication		The temperature data is often said to be very misleading due to the large diurnal variation. Drops of temperatures from 40°C during the day to 1°C at night are common during main ripening months. Altitude and aspect within the valley are important. Region grows some of the best Shiraz and Riesling of Australia.			
Regional style		Juicy plum, blackberry and black cherry within a framework of oak, masculine structure. Medium- to full-bodied styles with balance and richness.			

Eden Valley					
Latitude	34°61'S	Climate	Warm temperate // temperate	HI 25%	2,047
MJT	20.2	Sun hours/day	8.5	HI Median	2,141
Rain (mm)	229	GST	17.9	HI 75%	2,189
Shiraz ha.		710			
Altitude (avg.)		420 (219-632m)			
Topography		Rolling, exposed hills with moderately steep gradients are commonplace and the correct match of site and variety is critical.			
Soil		Alluvial with sandy loam over clay, seep sandy loam over gravely medium red clay overlaying laminated siltstone, red brown clays			
Climate indication		Altitude, aspect, and slope are all important in determining meso climate in this hilly region. Southern end is higher and cooler than northern part of Eden Valley. Overall growing season temperatures are significantly lower than those of the Barossa Valley, and the final stages of ripening and harvesting take place in much cooler conditions. Risk of spring frosts.			
Regional style		The wines rarely show the spicy and peppery characters of cool climate Shiraz from other parts of southern Australia. Tending to more luscious plum and blackberry fruit characters, with touches of licorice and more gamey, forest characters. Structurally smooth, with ripe integrated and balanced tannins. Often long lived.			

McLaren Vale					
Latitude	35°19'S	Climate	Warm temperate	HI 25%	2,146
MJT	21.3	Sun hours/day	8.4	HI Median	2,797
Rain (mm)	230	GST	19.1	HI 75%	2,210
Shiraz ha.		3,866			
Altitude (avg.)		130 (0-417m)			
Topography		Generally undulating with varying aspects, slopes, and altitudes, especially more towards the Adelaide Hills.			
Soil		Very diverse, i.e. sands and loamy sands, clay, mix of sandstone and limestone, red clay over limestone, shallow loam over shale and Maslin sands over ironstone and clay			
Climate indication		Generally, quite warm, but the cooling effect from the ocean creates substantial meso-climate variation. Exposure to or protection from ocean influence dictates success of varieties planted. Low summer rainfall			
Regional style		The styles produced are marked by red and blue fruit, spices, and a signature hint of chocolate. Approachable and generally rich full-bodied style with soft tannins.			

Victoria

Beechworth					
Latitude	36°35'S	Climate	Temperate / warm temperate	HI 25%	1,860
MJT	21.2	Sun hours/day	8.7	HI Median	2,155
Rain (mm)	467	GST	17.7	HI 75%	2,269
Shiraz ha.					
Altitude (avg.)		550 (204-1045m)			
Topography		Complex topography with a great variety of slopes in varies grades and aspects. The GI covers, especially the elevated terrain. Elevated on the continental side of the alps.			
Soil		Shallow soils of ancient, decomposed Devonian granite with some clay derived from volcanic deposits			
Climate indication		Wide range of altitudes make generalization difficult and strongly influence specific sites. Slopes often perform best. Lack of available water			
Regional style		Earthy, spicy wines with raspberry fruit and distinct savory notes.			

Grampians					
Latitude	37°30'S	Climate	Temperate	HI 25%	1,875
MJT	19.8	Sun hours/day	8.2	HI Median	1,943
Rain (mm)	261	GST	16.9	HI 75%	2,131
Shiraz ha.		323			
Altitude (avg.)		270 (142-1161m)			
Topography					
Soil		Red clay loams dispersed with small to medium sized quartz pebbles and differing levels of granitic sand (most common), granitic sand, granite bedrock and pebbles (preferred by Justin Pierce, Tim Kirk, and other winemakers),			

Grampians	
Climate indication	The climate is Mediterranean, the proximity to the Southern Ocean (100 -200 kilometers) provides a cooling influence during summer. Cooler climate grape growing region, the growing season in summer is characterized by warm to hot days and cool to cold nights.
Regional style	Style range from silky smooth wines with red cherry and plum flavors through to strikingly concentrated wines, redolent with spice, pepper, licorice, and game. There is a common thread to these wines in their elegance and fine tannins,

Heathcote					
Latitude	36°80'S	Climate	Warm temperate	HI 25%	2,171
MJT	21.6	Sun hours/day	8.2	HI Median	2,254
Rain (mm)	28	GST	18.4	HI 75%	2,337
Shiraz ha.		732			
Altitude (avg.)		140 (112-599m)			
Topography		Undulating with variety of slopes and exposures to or away from the sun.			
Soil		Decomposed volcanic basalt, deep Cambrian gravely basalt soil mixed with small rocks, 'Cambrian Greenstones', quartz and rubble			
Climate indication		Heathcote's climate and soils are strongly influenced by the Mt Camel Range, providing natural tunneling for the prevailing cool, south to south-east winds that blow throughout the growing period from October to March.			
Regional style		Deep, rich, and velvety, with cascades of blackberry, dark cherry plum and sweetly spicy fruit. The ripe but fine tannins give texture, sustaining length and a superb ability to age. Generally great length.			

Mornington Peninsula					
Latitude	38°34'S	Climate	Cool / temperate	HI 25%	1,689
MJT	19.3	Sun hours/day	7.1	HI Median	1,791
Rain (mm)	380	GST	17.5	HI 75%	1,854
Shiraz ha.		42			
Altitude (avg.)		60-120			
Topography		Mix of undulating with variety of slopes towards and away from the sun, combined with plains.			
Soil		Red volcanic (Ferrasol) soil, sandy loam over Callabonna clay			
Climate indication		Strongly maritime but site specific.			
Regional style		Relatively new variety in the region, top versions show black and purple fruit, licorice, savory and sometimes meaty characters, peppery spice, freshness, fine grained tannins and good concentration and length.			

Sunbury					
Latitude	37°45'S	Climate	Temperate	HI 25%	1,935
MJT	19.3	Sun hours/day	7.6	HI Median	2,014
Rain (mm)	420	GST	19.3	HI 75%	2,036
Shiraz ha.		44			
Altitude (avg.)		220 (0 – 494)			
Topography		Undulating, some quite steep hillsides away from the afternoon sun.			
Soil		Sandy loams, typically dark. Depth and structure varying from plains to hillsides.			

Sunbury	
Climate indication	Appears quite temperate, but the climate during the growing season is influenced by the cooling winds that blow over the plain. The nearby Macedon Ranges to the north and the sea to the south also have a cooling influence.
Regional style	Wines with a splendid array of black pepper, spice and black cherry aromas and flavors. As it is seldom more than medium bodied, the wine can be deceptively light, the alcohol level is rarely higher than 12.5° and the tannins are typically soft and fine.

Yarra Valley					
Latitude	37°49'S	Climate	Temperate / cool	HI 25%	1,615
MJT	18.9	Sun hours/day	7.4	HI Median	1,810
Rain (mm)	559	GST	16.6	HI 75%	1,945
Shiraz ha.		244			
Altitude (avg.)		120 (17-1338m)			
Topography		Undulating landscape with some larger hills in the lower Yarra. The upper Yarra is too cool and less fit for production of quality Shiraz.			
Soil		Bleached clay loam, sedimentary sandstone, and siltstone			
Climate indication		Difference in altitude and aspect leads to substantial variation in meso climate, even warmest sites are relatively cool. Limited rain during ripening.			
Regional style		Elegant, aromatic, often more medium-bodied, with an array of red and purple fruits, plus spicy complexity. Floral, savory vibrant, with silky to firm tannins. Can show earthy notes.			

Western Australia

Great Southern					
Latitude	34°58'S	Climate	Temperate	HI 25%	1,955
MJT	19.0	Sun hours/day	7.5	HI Median	2,019
Rain (mm)	310	GST	18.4	HI 75%	2,120
Shiraz ha.		618			
Altitude (avg.)		220 (180-250)			
Topography		Undulating landscape with vineyards scattered both planted on slopes towards and away from the sun.			
Soil		Diverse soils over sub regions. A.o. ironstone gravel and loam over red clay, and Granitic gravelly loams and sandy loams over clay sub soil.			
Climate indication		More inland from the strongly maritime-influenced climate of Denmark, the Continental influence and temperature variability increase significantly. Elevation, aspect, and sites vary widely, but slightly warmer. Heat summation and sunshine hours do not change greatly over sub regions, careful site selection allows the production of virtually every wine style.			
Regional style		Great Southern Shiraz exhibits a compelling combination of licorice, spice, pepper, black cherry and plum. Balanced oak treatment, allowing the fruit quality to express itself.			

Margaret River					
Latitude	33°57'S	Climate	Temperate	HI 25%	2,052
MJT	20.9	Sun hours/day	7.6	HI Median	2,092
Rain (mm)	221	GST	19.2	HI 75%	2,139
Shiraz ha.		700			
Altitude (avg.)		50-100			
Topography		Undulating landscape but limited larger hills. Quite open to ocean influences			
Soil		Ironstone gravel soils, shallow sandy gravel loam over clay, deep sandy soils over clay or granite rock and gneiss. Low water holding capacity			
Climate indication		Overall, Margaret River climate is similar to Bordeaux in a dry year Has the most marked maritime climate of any region in Australia in terms of rainfall Low diurnal temperature range leads to very even heat accumulation			
Regional style		The wines tend to be a medium to full-bodied style with perfumed, fruit driven aromas with ample forest fruits on the palate. Mulberry, blackberries, plum, raspberry, pepper, spice, violets with subtle to firm tannins. Use of whole bunch provides freshness.			

Appendix 5 Sensory tasting

5.1 Tasting set up

As part of the research also a blind tasting has been performed to find out, whether organoleptic differences could be experienced by the tasting panel. For the tasting a set of wines was selected, representing the various Shiraz growing regions of Australia, spread over the states included in the research. One test wine from the Northern Rhône (18) was added and tasters were informed upfront that there was one French wine in the line-up. Due to unavailability of all the same vintages, there is a bit larger vintage difference than preferred, some wines dating to 2014 and one even 2013. Most are 2015, 2016 and 2017 vintages.

The tasting panel existed of experienced wine tasters who normally taste for the Dutch wine magazine 'Perswijn' and other wine professionals. In the tasting, the wines were tasted over 3 flights, where the wine were mixed over 3 different tasting group line-ups (A, B and C). This based on advice of Wes Pearson from AWRI, to have as open a view on each wine as possible.

TASTING SELECTION AND LINE-UP

No.	State	Region	Winery	Wine	Vintage
1	NSW	Hunter Valley	Brokenwood	Shiraz	2016
2	NSW	Orange	Philip Shaw	The Idiot Shiraz	2015
3	NSW	NSW	McWilliams	Markview Shiraz	2017
4	NSW	Canberra District	Clonakilla	O'Riada Shiraz	2013
5	NSW	Canberra District	Brokenwood	Shiraz	2015
6	VIC	Heathcote	Jasper Hill	Georgia's Paddock	2017
7	VIC	Yarra Valley	Innocent Bystander	Syrah	2016
8	VIC	Grampians	Grampians Estate	Streeton Reserve Shiraz	2015
9	VIC	Grampians	Mount Langhi Ghiran	Hollows Shiraz	2015
10	SA	Barossa	Kaesler	Stonehorse Shiraz	2015
11	SA	Barossa	Langmeil	Orphan Bank Shiraz	2014
12	SA	McLaren Vale	Chalk Hill	Clarendon Syrah	2017
13	SA	McLaren Vale	WirraWirra	RSW Shiraz	2015
14	SA	Adelaide Hills	Shaw+Smith	Shiraz	2015
15	WA	Frankland River	Frankland Estate	Shiraz	2016
16	WA	Mount Barker	Forest Hill	Mount Barker Shiraz	2017
17	WA	Margaret River	Domaine Naturaliste	Rachis Syrah	2017
18	Rhône	Crozes Hermitage	Domaine Des Hauts Chassis	Les Galets	2017

For the tasting, the panel members received some basic instructions as to how they were expected to score and review. Not in what the outcome should be, but the methodology and terminology. On the next page the tasting form used in the panel tasting is added. For the scoring 1 to 5 the following instruction/definition was provided:

① Low or light / ② Average - / ③ Average / ④ Average + / ⑤ High or full

For determining the tannins ripeness and balance, the following options were provided, ideally to be chosen between:

a) Ripe/soft vs. unripe/green/stalky; and **b) Coarse vs. fine grained**

5.2 Tasting form

The form below was used in the tasting and filled by the panel members.

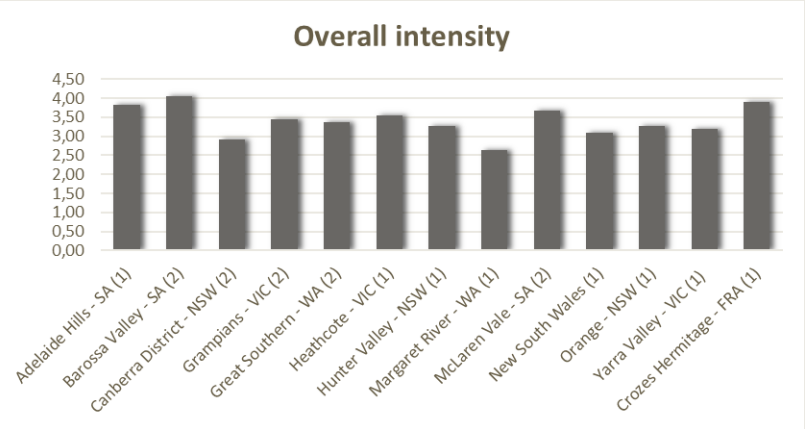
	Wine 1					Wine 2					Wine 3				
Visual															
Elements - Color - Intensity - Development															
Nose															
Elements - Aroma's - Complexity - Development															
Intensity overall	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Intensity of pepper aromas	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Flavor and mouthfeel															
Level of sweetness	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Level of acidity	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Alcohol %	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Body	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Fruit															
Other aromas such as Herbs and spices															
Intensity of pepper aromas	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Oak usage															
Oak notable	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Level of new oak	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Level of oak integration	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Tannins – intensity	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
Tannins – nature															
Ripening/age															
Overall - Balance - Complexity - Length															
Viticulture and winemaking															
Cool vs warm climate? Why?															

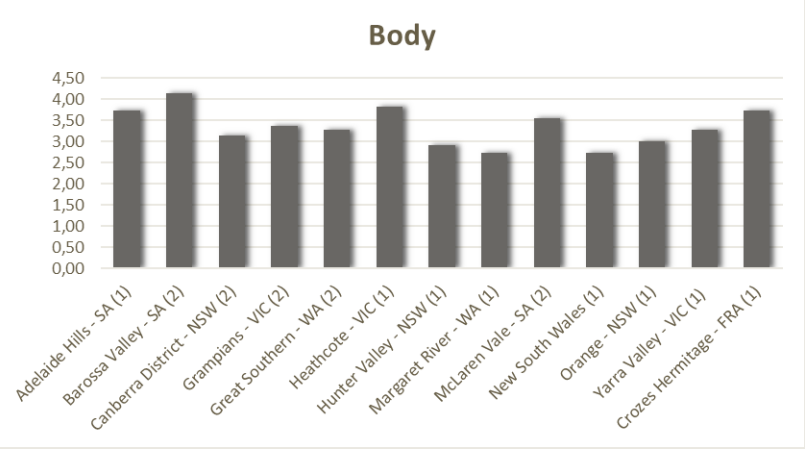
Vinification: - Style. - Classic or modern winemaking? Why?			
Origin			
Does this wine align with your expectations of Australian Shiraz? Why yes or no?			

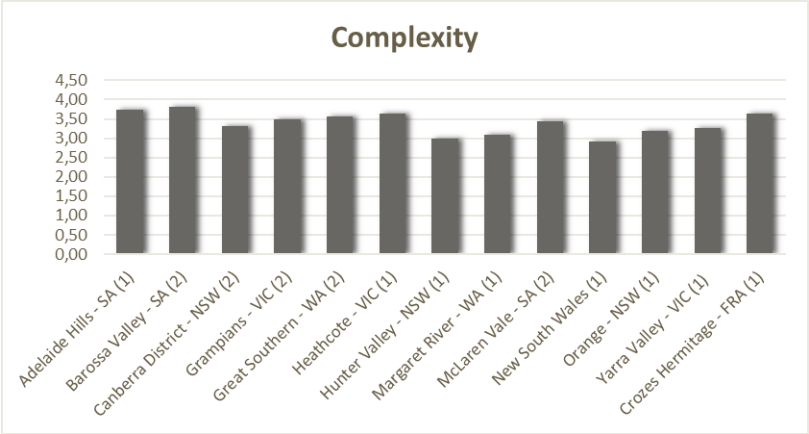
5.3 Output of the panel tasting

For the presentation of the output for the wines tasted, a decision was made to do this at a regional level and not individual wines. This creates better readable tables and provides some insights on regional characters in the comparison. Where 2 wines from a region were tasted, it takes away the individual differences between the wine, but that is inherent to the choice made.

For all tables below the answer options were on a scale of 1 to 5.



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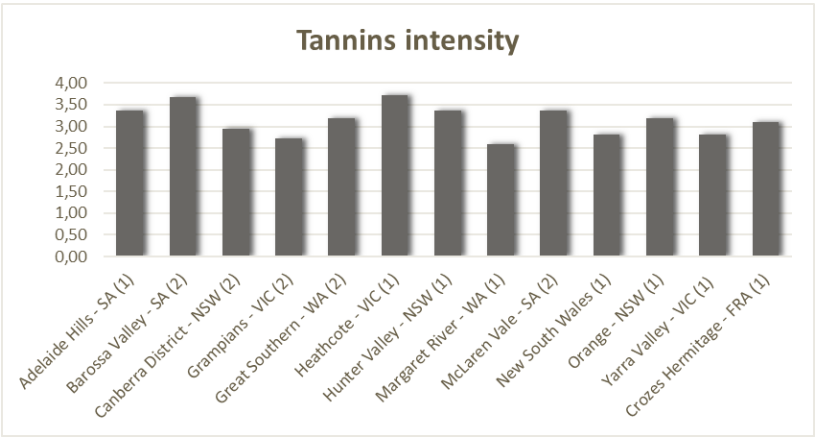
4,00
3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
McLaren Vale - SA (2)
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)


Tannins intensity
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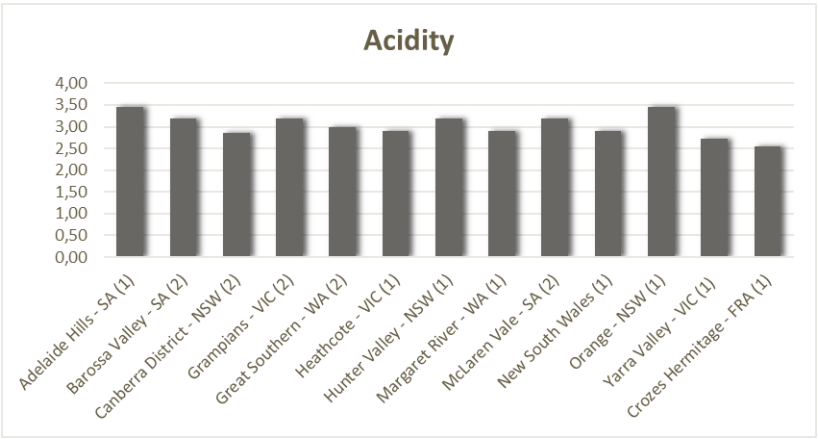
3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
McLaren Vale - SA (2)
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)


Acidity
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1,50
1,00
0,50
0,00
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
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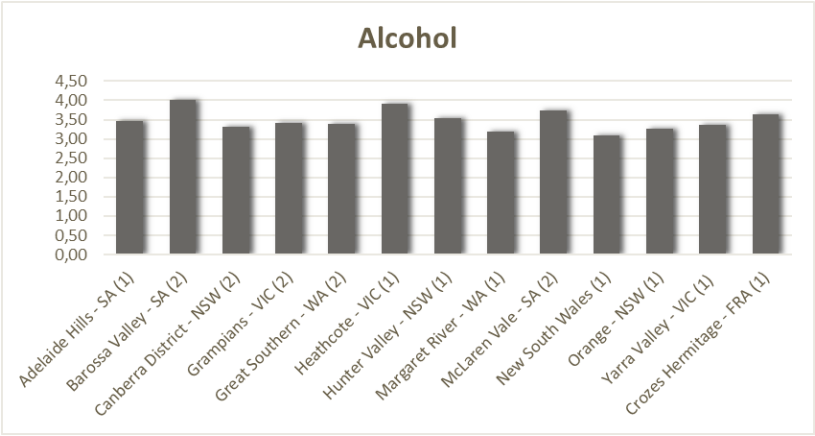
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)


Alcohol
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2,00
1,50
1,00
0,50
0,00
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
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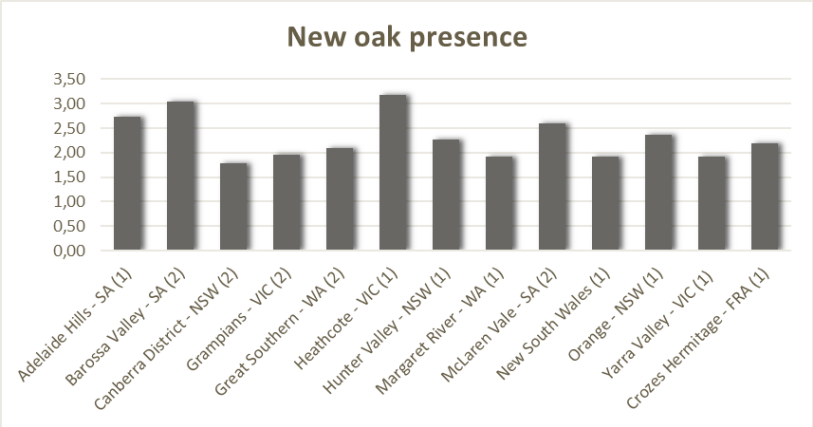
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)


New oak presence
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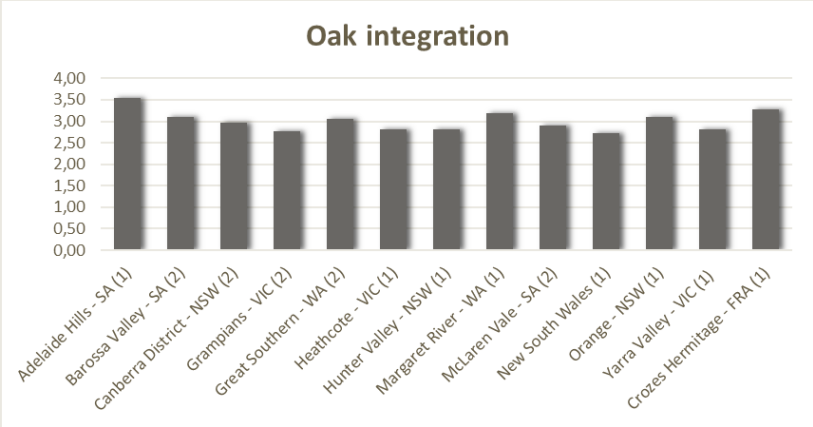
2,00
1,50
1,00
0,50
0,00
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
McLaren Vale - SA (2)
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)


Oak integration
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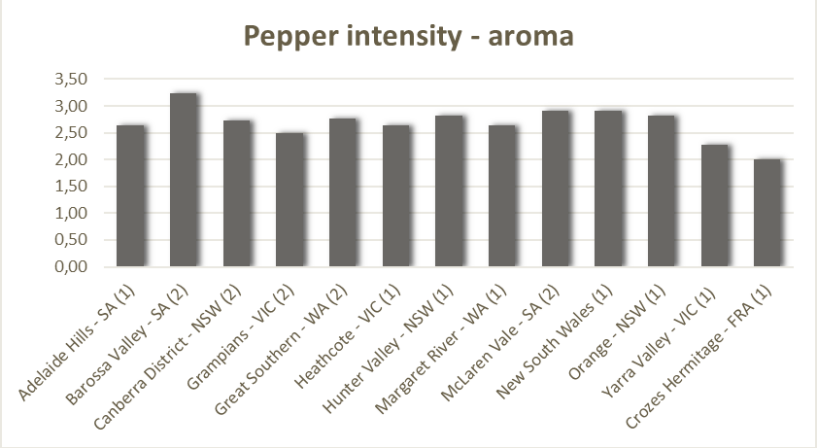
0,00
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
McLaren Vale - SA (2)
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)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2,00
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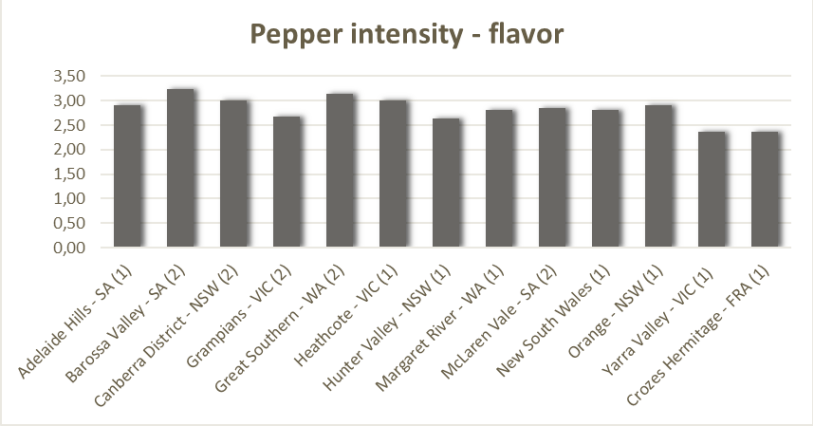
1,00
0,50
0,00
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
McLaren Vale - SA (2)
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)


Pepper intensity - flavor
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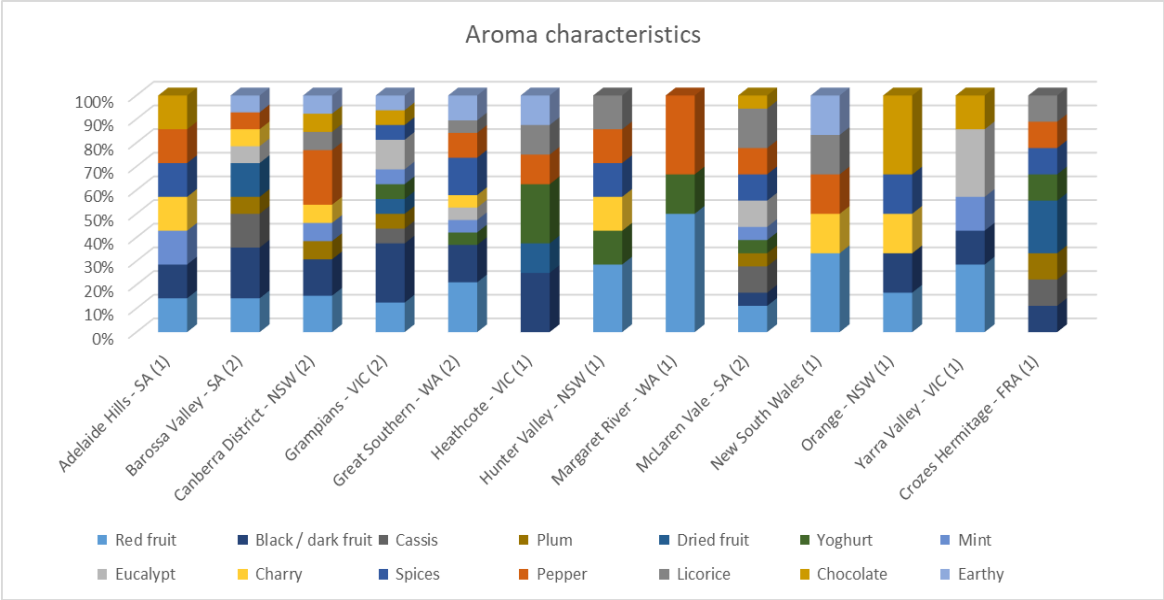
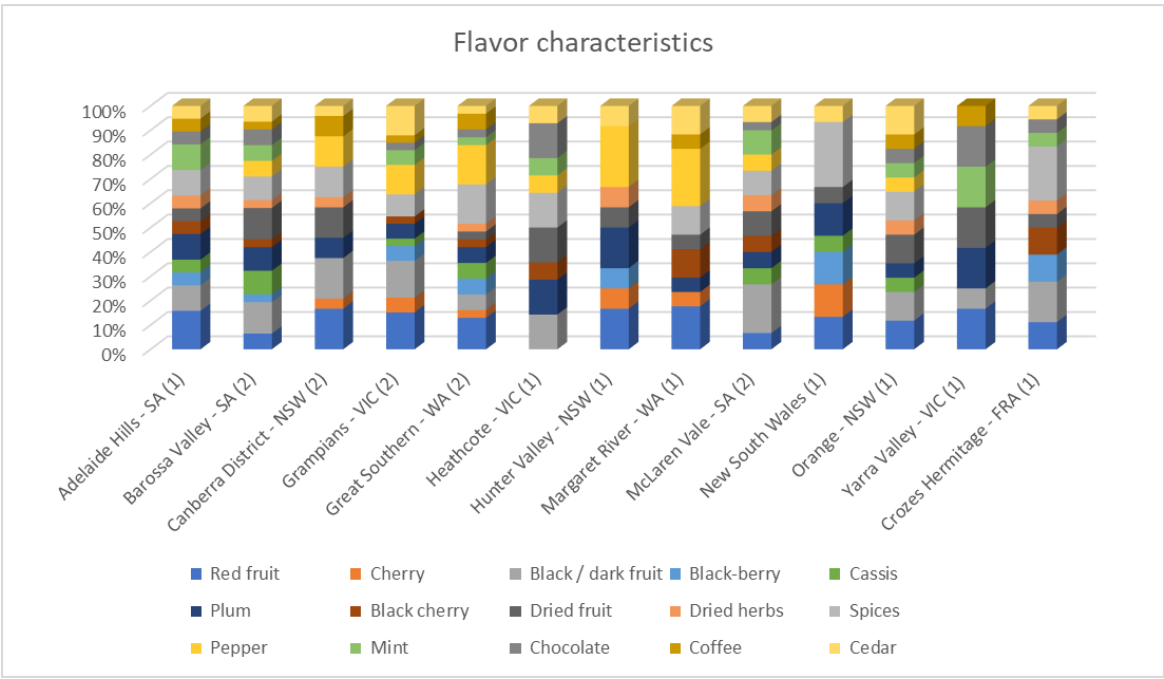
1,50
1,00
0,50
0,00
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
McLaren Vale - SA (2)
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)


Aroma characteristics
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
McLaren Vale - SA (2)
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)
Red fruit
Black / dark fruit
Cassis
Plum
Dried fruit
Yoghurt
Mint
Eucalypt
Charry
Spices
Pepper
Licorice
Chocolate
Earthy

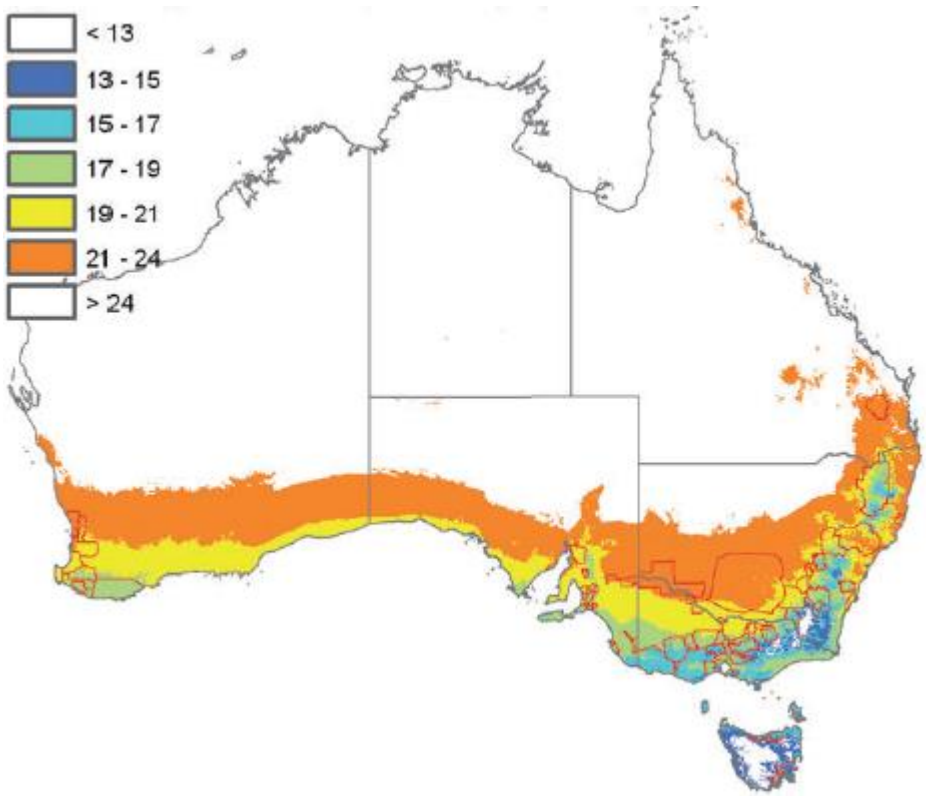

Flavor characteristics
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Adelaide Hills - SA (1)
Barossa Valley - SA (2)
Canberra District - NSW (2)
Grampians - VIC (2)
Great Southern - WA (2)
Heathcote - VIC (1)
Hunter Valley - NSW (1)
Margaret River - WA (1)
McLaren Vale - SA (2)
New South Wales (1)
Orange - NSW (1)
Yarra Valley - VIC (1)
Crozes Hermitage - FRA (1)
Red fruit
Cherry
Black / dark fruit
Black-berry
Cassis
Plum
Black cherry
Dried fruit
Dried herbs
Spices
Pepper
Mint
Chocolate
Coffee
Cedar

Appendix 6 Huglin Index Australian wine regions

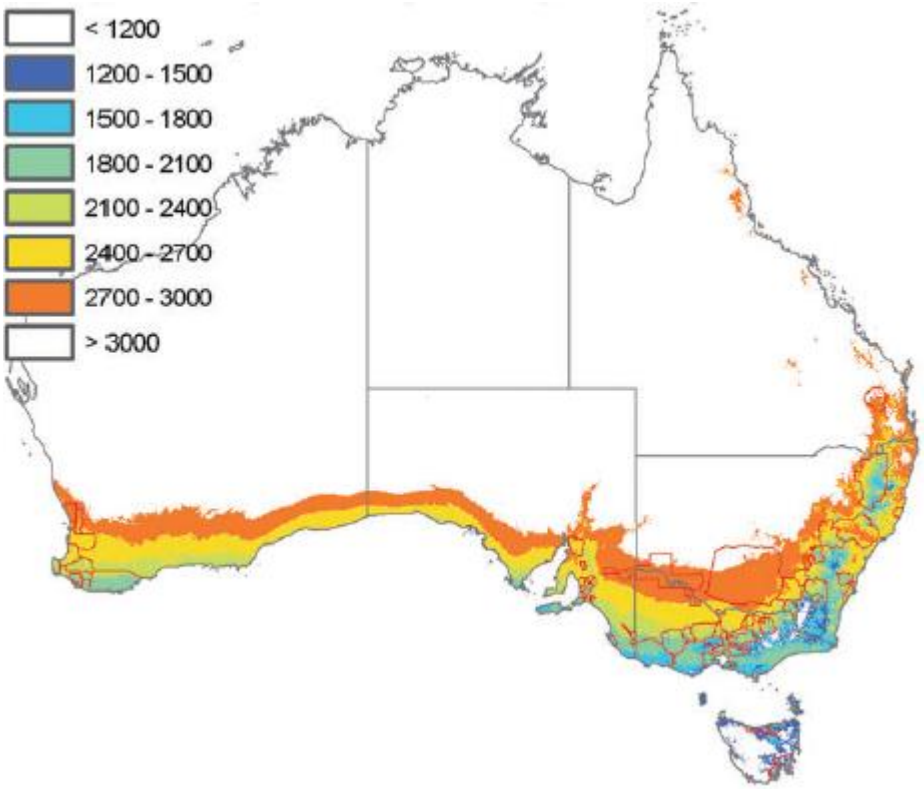
In this thesis research the Huglin index has been referenced various times. The table below gives a definition of each climate zone according to Huglin, what this zone means in HI index score, understanding on the grapes which are suitable for that climate and lastly, what regions can be thought of, representing such climate zones.

Zone	HI (°C)	Grape varieties	Wine regions
Very cool	1,200 – 1,500	Muller Thurgau	Tasmania, Champagne, Burgundy, Friuli, Chablis
Cool	1,500 – 1,800	Pinot blanc, gamay, pinot noir, chardonnay, riesling, sauvignon blanc	Yarra Valley, Great Southern, Alsace, Bordeaux, Napa
Temperate	1,800 – 2,100	Chenin blanc, semillon, cabernet franc, Cabernet Sauvignon, Merlot, Shiraz, barbera	Rioja, Piemonte, Clare Valley, Grampians, Stellenbosch, Constantia
Warm temperate	2,100 – 2,400	Shiraz, cinsault, ugni blanc, Grenache (rouge & blanc), carignan, Mourvedre	Montpellier, Florence, McLaren Vale, Walker Bay, Barossa valley, Hunter Valley, Napa Valley
Warm	2,400 – 2,700	Aramon	Sicily, Sardinia, Jerez, Swan Valley, Swartland, Stellenbosch,
Very warm	2,700 – 3,000	-	

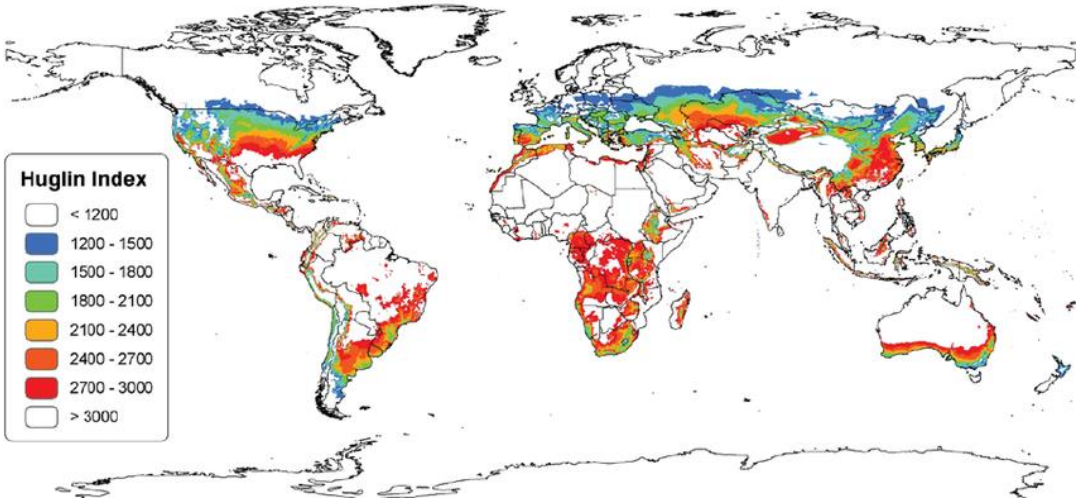
In chapter 4, 2 figures presenting important climatic conditions for Australian viticulture where included. Below those figures on 'Growing Season Temperature' and 'HI index score' (Hall & Jones, 2010) are included in a larger print, as well as a world map presenting the HI scores of wine regions worldwide.



Growing Season Temperature (°C, Oct-Apr)



Huglin Index (Base 10°C, Oct-Mar)



Huglin Index world map (Jones, Moriondo, Bois, Hall, & Duff, 2009)

Appendix 7 Effects of climate change

The impact seems to vary, based on the feedback of the various winemakers. For several regions (i.e. Grampians – Mount Langhi Ghiran, Orange - Printhie and Heathcote – Jasper Hill) harvest is now 2 to 3 weeks earlier than 10 years ago. Some regions still have harvest as late as April (i.e. Sunbury, Great Southern) as showed in the survey.

Climatic changes which impact the production and style of Shiraz are mainly increased drought and erratic weather conditions such as heat spikes as encountered in the summer of 2019 with weeks of 35 and even days of 40+ degrees Celsius, local heavy rains and frosts.

In the eye of climate change, based on answers to the survey and interviews, winters seem to become dryer in most regions and rain is generally down or at best equal in quantity over the whole year. According to the winemakers in many regions the rain which falls, is getting more and more erratic. This can be damaging to the vines and grapes and depending on the soil water lodging capacity, this can also have a negative impact on the naturally available water over the vegetative cycle of the vines, especially for the growing season and veraison. Not only in the current year but also for next year's harvest. The perception of the interviewed winemakers in Yarra Valley and Clare Valley is, that rain is moving more from winter to spring and early summer. However positive for the available water at that time in the vegetative cycle, it can also negatively affect flowering and fruit set. For Margaret River and the Great Southern the rainfall is quite high on an annual basis (up to 1,000mm), where the vast majority falls in winter and early spring and around 20% during the growing season.

Where rainfall is low during the growing season, the drought can have a negative influence on the vines ability to ripen the grapes and keep a healthy vegetative growth. In case of severe water shortage, the vine keeps the water at the roots, resulting in leaves potentially turning yellow and falling off, as also stated by George Taylor (Penfolds) during our visit to the vineyards. As a result, the photosynthesis will not be able to proceed, thus having no ability to properly ripen the fruit. This can destroy the harvest potential of those vines.

In 2017 and 2018 there was some severe frost in multiple regions along the south coast. Amongst others the Hill of Grace vineyard (2018) and Best's estate vineyards (2017) were affected by black frost[7], where for Best's the total estate production potential for that vintage was destroyed. When thinking of potential climate hazards for winemaking in Australia, frost is not the first thing which pops to mind but proves to be a serious risk. This especially with somewhat higher altitudes and lack of nearby water bodies.

The heat spikes hit the vines ability to perform the photosynthesis and thus delays ripening, while potentially burning the grapes in case they do not have enough shade. A lucky tweak in nature has made the Shiraz vine reasonably resistant to this hot weather. In the heat the leaves of the Shiraz vines turn and as a result the stomata are not in the sun, they close-down, and respiration is stopped (George Taylor [Penfolds] and Mark Richardson [Tyrells]). Thanks to this adaptation, the Shiraz vine can limit its loss of water and better resist the heat and water shortage. Unfortunately, it does not totally take

[7] Black frost is a radiation frost, which are generally more frequent and severe in inland sheltered areas. Black frost can occur if there is low humidity leading into a frost event and the dew point is below 0° C, frost will occur without the formation of ice on exposed surfaces" (Pocock and Lipman, 2002) (Hans Loder, Wingara Wine Group Pty. Ltd., 2008)

away the issue, but if the vine would not do this, the impact of such droughts and heat spikes would be far greater.

Aside from the above-mentioned heat spikes and drought, the increasing temperatures and shortening ripening periods, can lead to more overripe and unbalanced wines with overpowering dark fruit and alcohol. Given Shiraz's past in Australian winemaking for fortifieds, this would still offer some opportunities, but looking at production of high-quality dry wine, this is an undesired development. To cope with the changing climate and keep ripeness and alcohol at an acceptable level and ensure balance, producers take various actions in the vineyard and cellar, as described in Chapter 5 and 6.

Next to adjusting some practices and set-ups in the vineyards there are also two other developments found which were of interest in the discussion around climate change:

1) While Shiraz being the main and most important red grape variety in several regions, the warmer regions such as Barossa and McLaren Vale, but also Clare Valley and Eden Valley are exploring other grape varieties and some winemakers feel those other varieties will start to play a bigger role in the future. The two most named grapes are Grenache and Mataro (Mourvedre). They are already used in blends with Shiraz but also as 100% single variety. Both Grenache and Mataro are later ripening than Shiraz and have a better ability to cope with higher temperatures, although acidity in Grenache can drop very low when to hot.

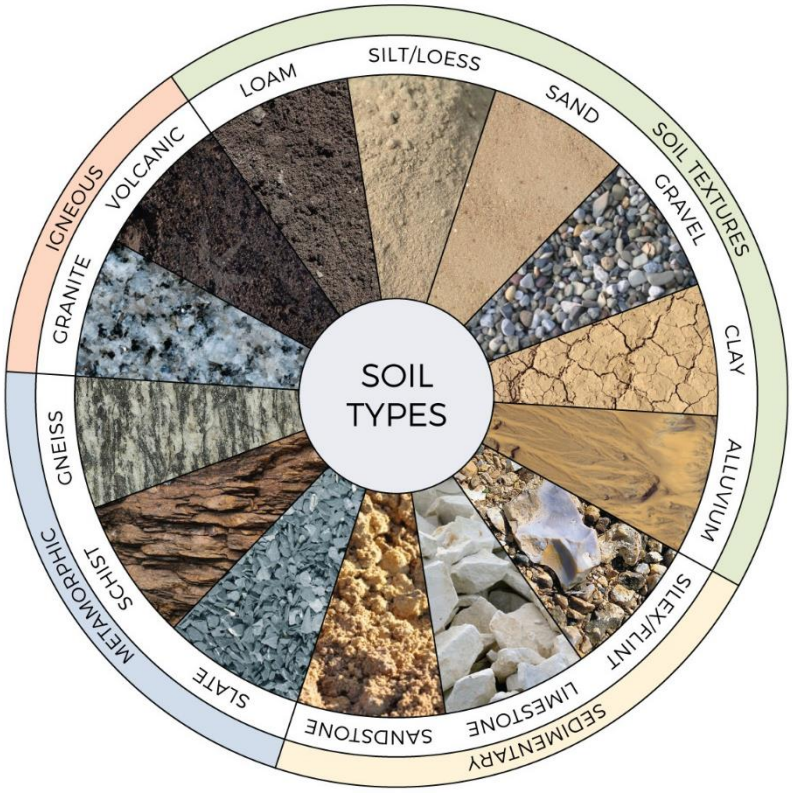
2) Improbable winemaking sites become the 'go to' area for producing cooler climate Shiraz. In Orange, where Shiraz was already grown at 600+ meters altitude, plantings are now also up at 900 meters (for example the vines for Philip Shaw's "The Idiot Shiraz") and the end is not yet in sight. Also, regions not known or even debated for Shiraz come into play. Mornington Peninsula is often deemed to be too cool and is renowned for its fresh and balanced Chardonnay and Pinot Noir wines, but with producers such as Paringa Estate, Yabby Lake and Moorooduc Estate the region is showing some great potential for production of high-quality Shiraz. Paringa Estate has already won several awards, with the 1990 Shiraz winning gold at the Yarra Valley Wine Show and the 2006 Estate Shiraz winning 'The Best Shiraz & Red Wine' in the 2009 Sydney Royal Wine show, where especially the latter shows the actual potential of Shiraz in Mornington. In the Sydney Royal Wine show of 2018 two of the highest scores for Australian Shiraz vintage 2017 came from Margaret River (Windance Estate and Credaro Family Estate) and another high-ranking wine from the Great Southern (Forest Hill). Other unknown regions which can be of great interest for Shiraz are Sunbury (i.e. Craiglee showing great wines for decades), Mount Benson (i.e. Chapoutier) and the coastal regions in the south of Western Australia. Those wines also have great aging potential, I recently tasted the Mount Benson Chapoutier Shiraz from 1998 and it showed great structure and freshness at only 12.5% alcohol.

All in all, climate change is having an impact, firstly showing in the earlier harvest dates, more erratic and scattered rains, and more erratic weather conditions overall. The wines are in general though not increasing in alcohol and seem to be more balanced than ever. Challenges lay ahead and in some cases may require the selection of other grape varieties or planting on different sites, but the winemakers feel and wines show, that the winemakers and viticulturists have sufficient options to cope with the challenges and create exiting, digestible Shiraz wines for years to come, from the coolest to the warmest quality Shiraz regions.

Appendix 8 Soil types

The graphic below gives a visual representation of 14 of the most encountered soil types for vine growing in the world. For production of quality Shiraz in Australia the following soils are most important, either by itself or in combinations:

- Volcanic.
- Granite.
- Clay.
- Loam.
- Sandstone
- Gneiss.



Source and ©: Vine Pair (www.vinepair.com)

Appendix 9 Barossa grounds

In Barossa extensive studies have been performed on soil composition and the topography. The below overviews give an 3D insight in the diversity of the topography in the region.