5 The Growing Environment

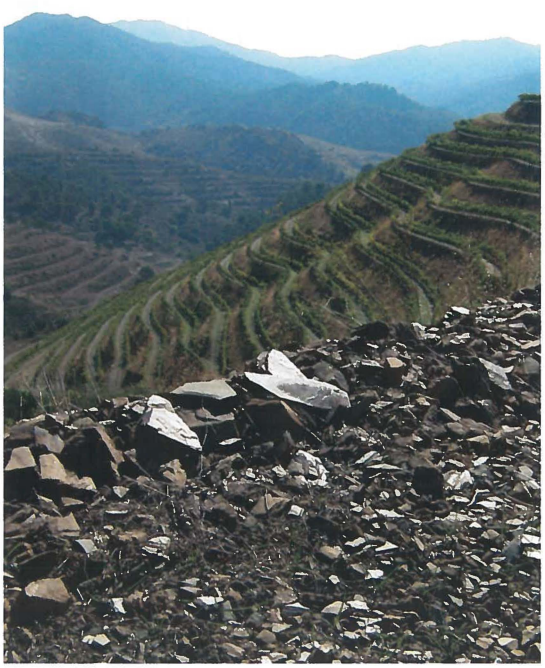
In order to survive, the vine must be able to take all it needs from its surroundings. The vine needs five things: heat, sunlight, water, nutrients and carbon dioxide. They can all have an impact on how well a vine grows and the quality and quantity of grapes it can produce. In this chapter we will look at all of these factors in turn and how they come together to create the vine's growing environment.

WHAT A VINE NEEDS

In the principal wine-producing regions of the world the vine has an annual growth cycle. In the winter it is dormant and there are no green parts on the plant. Budburst marks the start of the growing season in spring, as the new shoots begin to grow. During late spring and early summer the vine flowers and small grapes form, a process known as fruit set. As the summer progresses the grapes grow but are still hard in texture, green in colour, with high levels of acidity and no sugar. In late summer or early autumn the grapes start to ripen. They become swollen with water, sugar levels rise, acid levels drop and flavours develop. The first sign of this ripening process is a change of colour in the grape from green to blue/black, pink or golden depending on the variety. This change of colour is often known by the French term *véraison*. After the grapes are harvested in autumn the growing season comes to an end. The vine drops its leaves and as autumn turns to winter the vine becomes dormant again.

In order to complete its annual cycle a vine needs five things. **Heat** is of fundamental importance: if it is too cold the vine will either not grow or it will struggle to survive. Once the growing season has started the vine uses **sunlight** to combine **carbon dioxide** (CO_2) and **water** to produce glucose and oxygen, a process known as photosynthesis. The vine combines the glucose with the **nutrients** it extracts from the soil to support its growth and, most importantly, to ripen its grapes. The oxygen is lost through the leaves.

CO_2 is always in plentiful supply; however, the temperature and sunlight in a vineyard, as well as the amount of water and nutrients that are available, are factors that are constantly changing. These variations influence all aspects of the vine's annual growth cycle, and directly affect the quantity and quality of fruit a vine is able to produce.



A vineyard in Priorat, Spain. In the foreground, the stony soil is capable of reradiating heat. In the background, a vineyard is planted on a steep terraced slope.

HEAT

What a Vine Needs

If the temperature is below 10°C it is too cold for the vine to grow. This is why vines are dormant in winter and budburst happens in spring. The vine also needs a sufficient amount of heat for successful flowering, fruit set, and ripening. The amount of heat in the growing season is the defining factor that determines which grape varieties can be grown where. Not all varieties need the same amount of warmth during the growing season. This is why Riesling can thrive in cool locations where Grenache would not be able to ripen its grapes.

Factors Affecting Heat

Latitude – In order to meet the vine's temperature needs and its preference for a dormant period, most vineyards lie between the latitudes of 30° and 50° north and south of the Equator. Closer to the Equator it is too hot and closer to the Poles it is too cold. However, factors other than latitude can make an area outside these limits suitable for viticulture.

Altitude – As altitude increases, temperatures drop. This means that regions at high altitude, such as Cafayate in northern Argentina, can successfully grow vines even though they are close to the Equator.

Ocean currents – The major currents transport large volumes of warm or cold water across the surface of the ocean, leading to localised warming or cooling in certain wine regions. The Humboldt Current off Chile and the Benguela Current off South Africa cool regions that

might otherwise be too hot for grape growing whereas the Gulf Stream warms the north-west of Europe that might otherwise be too cold.

Fog – Fog can help cool an area that may otherwise struggle to produce high-quality grapes. This is a particularly important feature in many top vineyard areas in California, as well as Casablanca Valley in Chile.

Soil – Soils that are either dark in colour or that have a high stone and rock content absorb and reradiate more of the sun's heat than lighter coloured soils. This reradiated warmth can be critical for ripening fruit in cool climates. On the other hand, soils with high water content require more energy to warm up, and conduct heat from the vine more quickly than dry soils. This can delay budburst.

Aspect – The direction in which a slope faces is known as its aspect. The vineyards with an aspect facing the Equator receive the most heat. In the Northern Hemisphere south facing slopes get the most warmth whereas in the Southern Hemisphere it is the north facing slopes. This phenomenon is especially important in cool climates where the extra warmth can make the difference between a vine being able to ripen a crop or not. Steeper slopes benefit even more from this effect. This can be seen very clearly in the vineyards producing the best wines in Mosel, Germany, that not only have the most favourable aspect but are also very steep.

Continentality and Diurnal Range

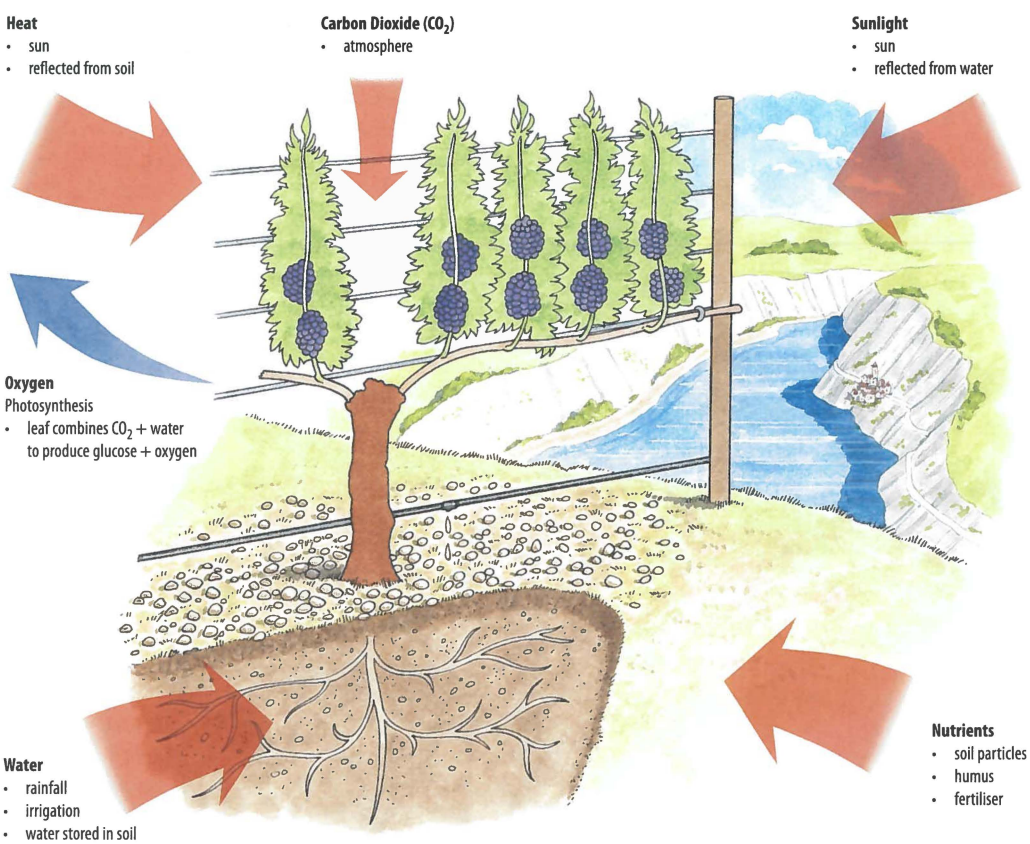
Although the overall amount of heat in the growing season is the primary concern of a grape grower, it is also important to know how much variation there is between the temperature in the height of summer and the depths of winter, as well as the variations between daytime and night-time temperatures. Both of these factors can have an impact on how well a vine performs in a region.

Continentality – The temperature difference between the coldest and the hottest months is referred to as continentality. Regions with high continentality have large differences in seasonal temperatures. Regions with low continentality see less variation in temperatures throughout the year.

Large bodies of water, such as seas or lakes, heat up and cool down more slowly than landmasses. Therefore

WHAT A VINE NEEDS

In order to survive the vine needs access to five key things:



in winter they have a warming effect on the surrounding air and in summer they have a cooling effect. Areas close to large bodies of water therefore generally have low continentality whereas wine regions that are far inland usually see more temperature extremes and have high continentality.

A region's continentality will determine the length of the growing season and this has an impact on the total amount of heat available to a vine. This in turn will influence what grape varieties can be successfully grown there.

Diurnal range – Diurnal range is the difference between daytime and night-time temperatures. Cool nights help slow the loss of aromas and acidity in the grapes during ripening. Warm nights accelerate ripening. For example, in a region with a warm or hot climate, a vineyard with a large diurnal range can produce wines that are fresher and more aromatic compared with a vineyard that has a smaller diurnal range.

A vineyard's proximity to seas and lakes can reduce its diurnal range. Even relatively small bodies of water, such as rivers, can hold enough warmth to keep adjacent vineyards warm overnight and provide cooling breezes during the day.

The level of cloud cover (generally greater nearer seas and lakes) also influences diurnal range. This is because temperatures drop more quickly on clear nights, when there is no insulating blanket of cloud (increasing diurnal range), and rise more slowly on cloudy days, when sunlight cannot heat the ground directly (reducing diurnal range).

Temperature Hazards

Winter – If temperatures fall below -20°C the vine can be seriously damaged or even killed by winter freeze. The part of the vine most at risk is the graft. In areas at risk from winter freeze, earth can be used to cover up and protect the graft, a process called 'earthing up'.

Heaters in Napa County, California. The heat creates air movement, which helps to prevent frosts.

If the winter is mild, or there is no winter at all (as is the case in subtropical climates), the vine will not have a dormant period and may produce more than one crop each year. Its life will be shortened, and the quality of the grapes will suffer. Mild winters also mean larger populations of insect pests survive to attack the vine the following summer.

Spring frosts – These occur when cold air below 0°C collects at ground level, freezing any water vapour that has settled on the ground or the vine. If this happens to newly burst buds or young shoots it kills them. The damage done and the impact on yields can be enormous, and in frost-prone regions growers go to great lengths to minimise this risk. There are four main forms of protection:

- **Heaters** may be placed throughout the vineyard and lit if frost is forecast. The heat they generate creates movement in the air preventing the cold air from settling and causing the frost.
- **Wind machines** are widely deployed in vineyards at risk from frosts. The most commonly used looks like a large fan that draws warm air from above to keep the temperature at ground level above freezing. Some wind machines incorporate heaters.
- **Sprinklers** may be used to spray water onto the vines. As the water freezes, it releases some heat into the plant tissue protecting the buds and shoots.
- **Thoughtful vineyard design** can also minimise the risk of frosts. Because cold air sinks to the lowest point it can find, it is best to plant vineyards on slopes and avoid depressions in which cold air can collect. Vineyards planted on the middle of the slope are noticeably less at risk from frost damage than those in lower lying areas. Vines can also be trained high to avoid the worst of the cold air.

The growing season – Cold temperatures in the spring may delay budburst. This shortens the growing season and could mean that there is not enough time for the grapes to ripen fully in the autumn before it becomes too cold. Flowering and fruit set can also be disrupted by cold temperatures, resulting in a smaller than average crop of grapes.

During the summer, very hot temperatures can be harmful, and in prolonged periods of extreme heat all vine activity will slow and eventually stop, even when there is sufficient water. This prevents the grapes from ripening properly. In extreme cases the vine will die.

SUNLIGHT

What a Vine Needs

Without light, photosynthesis cannot happen and plants die. Broadly speaking, the more light there is the more a vine will photosynthesise and the greater the amount of glucose produced for growth and ripening grapes. Flowering and fruit set also benefit greatly from plenty of sunlight.

Factors Affecting Sunlight

Many of the factors that affect temperature also affect the amount of sunlight in a vineyard.

Latitude – Day length during the summer growing season is longer the further the vineyard is from the Equator. This extra sunlight is an important factor that helps Riesling to ripen in Germany.

Seas and lakes – Vineyards near large bodies of water tend to experience more cloud cover. Regions at the centre of large land masses tend to be sunnier. In some cases, vineyards situated above rivers or lakes can benefit from sunlight reflected from the surface of the water.

Aspect – A slope's aspect affects the amount of sunlight it receives and steeper slopes benefit more from this effect. Vineyards that face the Equator receive the most sunlight. The greater the distance from the Equator the weaker the sun's energy, so for vineyards that are closest to the Poles maximising the sunlight with a favourable aspect is especially important.

Sunlight Hazards

There are a number of times in the year when low light levels can cause problems for the grape grower. Sunlight is needed for successful flowering and fruit set, and cloudy conditions during this period can result in a smaller crop of grapes. Also, the slowing in photosynthesis caused by heavy cloud cover can stop grapes ripening fully.

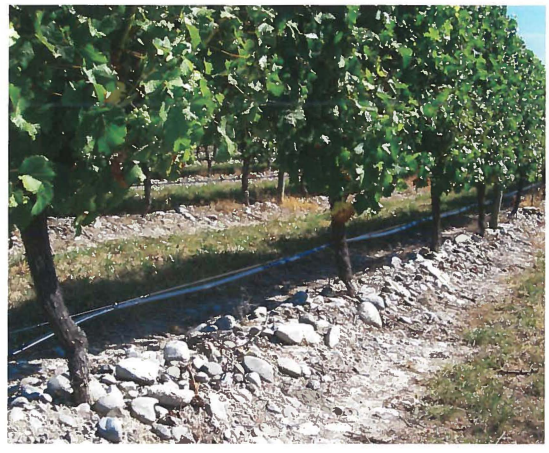
Although direct sunlight helps grapes to ripen, intensely sunny conditions can cause sunburn, leading to bitter flavours developing in the grape skins. The grape grower can arrange and manage the leaves of the vine, known as the vine canopy, to ensure that sunlight is maximised in very cloudy areas or that enough shade is provided in extremely sunny regions. This is covered in the section *Trellising and Canopy Management* in Chapter 6.

WATER

What a Vine Needs

The vine needs water for photosynthesis and to swell its grapes during ripening. The vine accesses water through its roots and, in a process known as transpiration, water is drawn up to the leaves. The amount of water a vine needs is determined by the temperature. As it gets warmer, water evaporates from the vine's leaves at a faster rate, meaning that the vine needs to take up more water from the soil to compensate.

Once a sufficient canopy of leaves has grown, limiting the supply of water can be beneficial for grape ripening. In these conditions the vine has enough water to keep photosynthesising but the shortage of water means that the vine concentrates on grape ripening rather than further shoot growth. This has the added advantage of reducing the impact of shading because the canopy does not grow too large.



A drip irrigation system in New Zealand.

Rainfall and Irrigation

Rainfall is the most important source of water but, if it is insufficient, then it can be supplemented with irrigation if local laws permit. There are three main irrigation techniques.

Drip irrigation – This is the most advanced and expensive. Each vine has its own dripper that can be computer controlled to ensure that each vine gets the optimum amount of water.

Sprinklers – These are still widely used and cheaper than drip irrigation but they waste a lot of water and, like rain, they create damp conditions in the vineyard increasing the risk of disease. If correctly designed, sprinklers can also be used for frost protection.

Flood irrigation – This is very cheap to use but is only possible in vineyards that are flat or very gently sloping and where there is access to large quantities of water.

Water Hazards

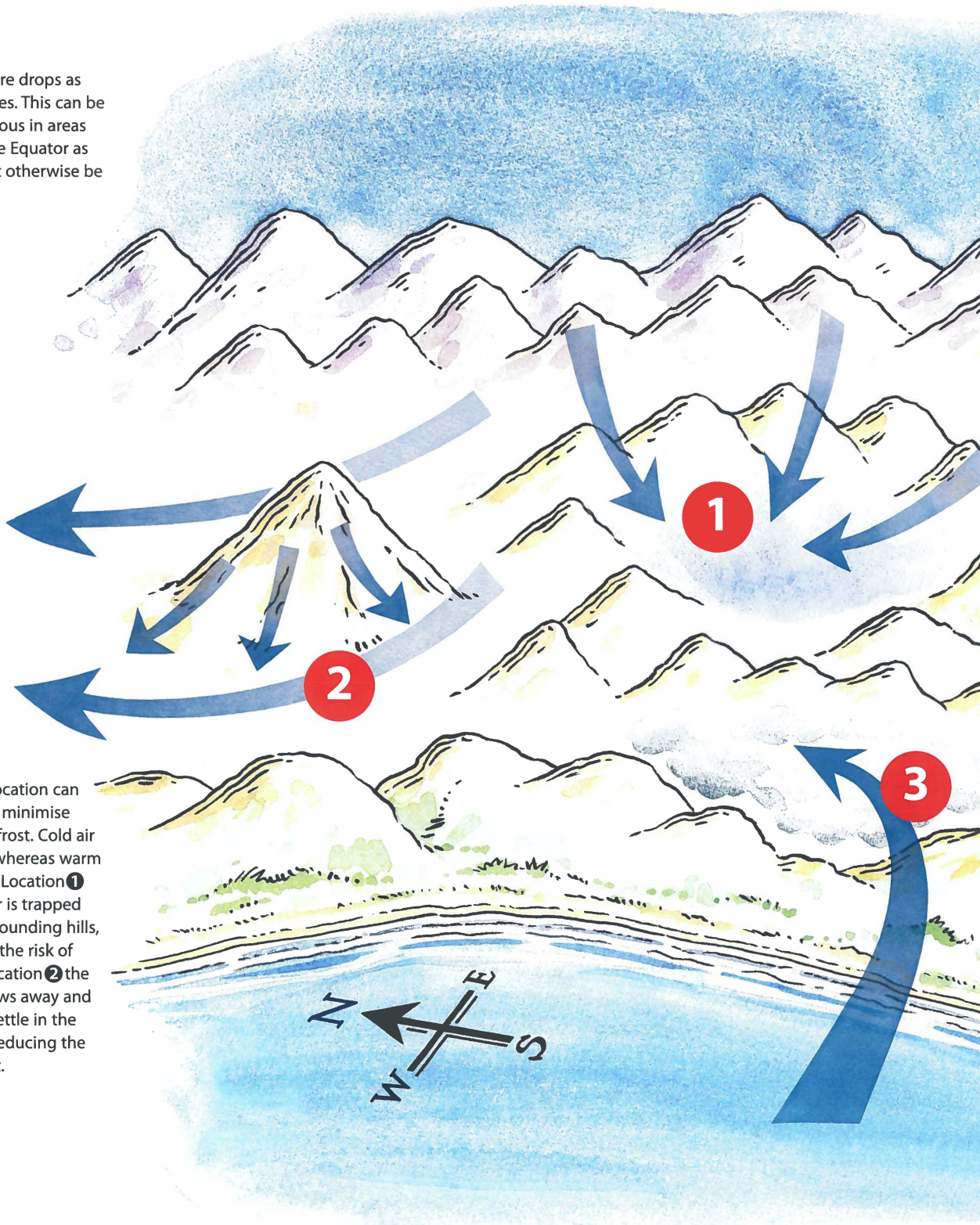
Drought – If there is a water shortage the vine can temporarily stop transpiration in order to preserve its resources. During prolonged shortages or drought, vines suffer from water stress; photosynthesis stops, leaves wilt and grapes fail to ripen. Ultimately this can weaken and kill a vine.

Too much water – If the vine has access to too much water during the growing season the vine will continue to grow shoots and leaves during the ripening season, leaving less sugar for ripening grapes. Furthermore, the extra shoots and leaves increase the amount of shading in the canopy, which restricts grape ripening. In extreme cases, a waterlogged soil can cause the roots to become saturated and die. Waterlogging can be avoided by planting vines on a slope or, on flat sites, installing drainage pipes to aid the flow of water away from the roots.

FACTORS THAT AFFECT THE CLIMATE OF A VINEYARD

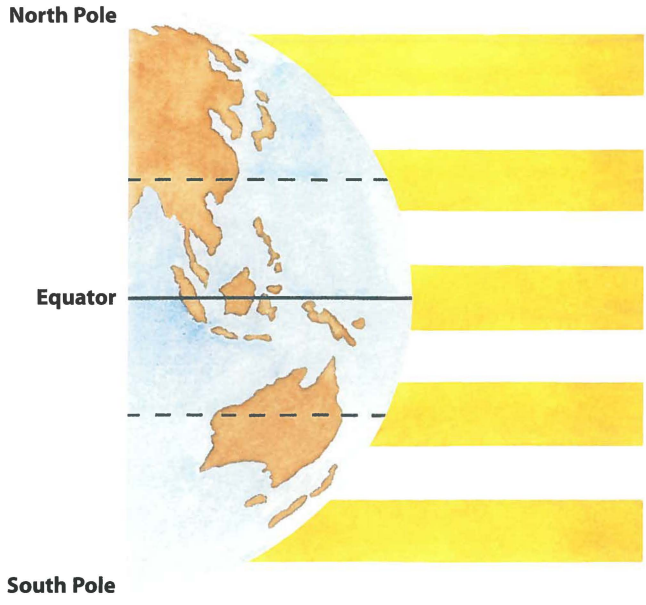
This is an imaginary landscape set in the Northern Hemisphere, which shows how the location of a vineyard can affect its climate.

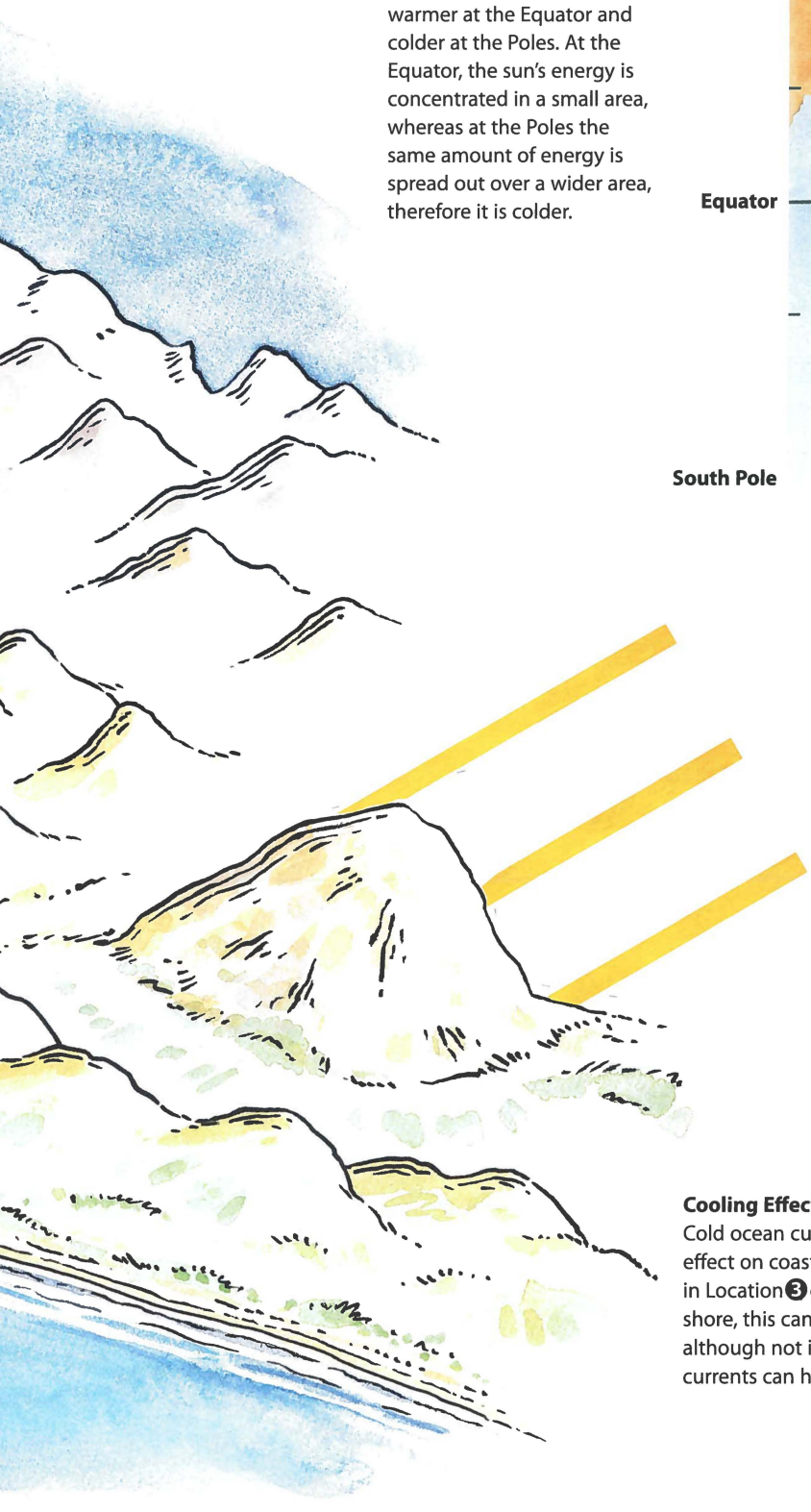
Altitude
Temperature drops as altitude rises. This can be advantageous in areas close to the Equator as they might otherwise be too hot.



Frost
Vineyard location can be used to minimise the risk of frost. Cold air descends whereas warm air rises. In Location ❶ the cold air is trapped by the surrounding hills, increasing the risk of frost. In Location ❷ the cold air flows away and does not settle in the vineyard, reducing the risk of frost.

Latitude
The illustration to the right shows why temperatures are warmer at the Equator and colder at the Poles. At the Equator, the sun's energy is concentrated in a small area, whereas at the Poles the same amount of energy is spread out over a wider area, therefore it is colder.





Aspect
Slopes facing the sun get the most heat and light. In the Northern Hemisphere, as shown here, these slopes are south facing. In the Southern Hemisphere they are north facing. In this illustration you can see that the sun's energy is most concentrated at the middle of the slope (compared with the top and bottom), meaning that this location receives the most heat and light.

Cooling Effects from the Ocean
Cold ocean currents can have a cooling effect on coastal wine regions. If, as shown in Location ❸ cold air and fog blow on shore, this can enhance the effect. Note, although not illustrated here, warm ocean currents can have the opposite effect.

Netting in Argentina designed to protect the vines from devastating damage caused by hail. The extent of the potential damage justifies the cost of installing the netting.

Rainfall is important both in its timing and the amount that falls. Flowering and fruit set can both be disrupted by heavy rainfall and this can significantly reduce the number of grapes that are formed. Damp conditions that follow rainfall also encourage the spread of fungal diseases. Heavy rain shortly before harvest time can cause the berries to swell excessively. This dilutes the flavours in the wine they produce and in extreme cases the berries swell so much that they split, which attracts fungal disease. This is discussed in more detail in the section *Managing Vineyard Pests and Diseases* in Chapter 6.

Hail – Hail can damage grapes and even the vine itself. In the worst cases it can destroy an entire crop. Some areas, such as Mendoza in Argentina, are particularly prone to hail. In certain vineyards netting is used to protect the vines, which is quite costly. Hail storms tend to be very localised and so ultimately the best protection may be to reduce the risk of losing the whole crop by owning several vineyard sites in different locations.

CLIMATE AND WEATHER

The temperature, sunlight and water availability can be combined to give an overall picture of the climate and weather in a region.

A region's climate is defined as the annual pattern of temperature, sunlight and rainfall averaged out over several years. The climate does not change from one year to the next, though it can alter over a period of decades.

A region's weather, on the other hand, is the annual variation that happens relative to the climatic average. Some regions experience greater variation in this pattern than others. For example, the amount and timing of rainfall in Bordeaux, France, can vary quite considerably: in 2007 the region was cool, cloudy and wet during most of August, whereas in 2003 high temperatures and near drought conditions were experienced. The weather in other regions, such as Central Valley in California, is far more predictable, with hot dry weather from one year to the next.

Climate Classification

For the purposes of consistency, in this book a region's temperature will be defined using the average temperature during the growing season, which is April to October in the Northern Hemisphere and October to April in the Southern Hemisphere. For simplicity, the following temperature terms will be used:

Cool climates: Regions with an average growing season temperature of 16.5°C or below.

Moderate climates: Regions with an average growing season temperature of 16.5°C to 18.5°C.

Warm climates: Regions with an average growing season temperature of 18.5°C to 21°C.

Hot climates: Regions with an average growing season temperature in excess of 21°C.

These give a good approximate guide to which grapes can be successfully ripened in any given region but, as noted above, climate classifications also need to incorporate how the temperature varies throughout the year (continentality) or during a typical day (diurnal range), and also the level and timing of rainfall and sunlight. For consistency the following three climate categories will be used taking into account the temperature categories of cool, moderate and warm as well as a region's continentality, sunlight and rainfall.

Continental climate – These climates have the greatest difference in temperature between the hottest and coldest months (high continentality) and are usually characterised by short summers with a large, rapid temperature drop in autumn. Cool continental climates such as Chablis and Champagne (both in France) are at risk from spring frost, and low temperatures throughout the growing season can affect flowering, fruit set and ripening. They are, therefore, better suited to varieties that bud late and ripen early. Continental climates are also noted for having dry summers and so if the temperature is high then irrigation can be necessary.

Maritime climate – Maritime climates are characterised by cool to moderate temperatures and a low annual difference between the hottest and coldest months (low continentality). Rainfall tends to be evenly spread throughout the year which helps to moderate the temperature. This means that temperatures are warm enough for grapes to continue ripening far into the autumn. Consequently, maritime Bordeaux can successfully ripen the thick-skinned grape variety Cabernet Sauvignon, which might otherwise struggle to ripen at this latitude. However, rainfall in the spring and summer can be harmful to the flowering, fruit set and health of the grapes at harvest.

Mediterranean climate – Mediterranean climates are also characterised by a low temperature difference between the hottest and coldest months but the summers tend to be warm and dry. These conditions are to be found throughout the Mediterranean, as well as much of coastal California, Chile, South Africa and South Eastern Australia. The extra warmth and sunlight, compared with maritime climates, leads to wines that are fuller bodied, with riper tannins, higher alcohol and lower levels of acidity. The lower rainfall can have a positive effect on the health of the grapes but can also lead to drought.

SOIL

Soil supplies the vine with water and nutrients and therefore plays a critical role in grape growing.

Soil Composition

Soil sits above the underlying bedrock, and may be anything from a few centimetres to several metres deep. It is made up of tiny particles of various sizes, as well as larger stones or rocks and humus (organic matter such as decomposing leaves). The composition of the soil and size of the particles within it are very important.

Stones, sand and clay – These come from the underlying rock or later deposits laid on top of the rock. Regardless of the source, it is the size of the soil particles that is crucial. Stones are the largest soil particles and are not always present in vineyard soils. As noted above, stones on the surface of a soil can help heat up a vineyard. The rest of the soil is made up of tiny particles, the most important of which are sand (the largest) and clay (the smallest).

Humus – This is made up of decomposing plant and animal materials that are rich in plant nutrients and have excellent water retaining properties.

Soil and Water

Grape quality is affected by the amount of water that is available in the soil. Ideally, the vine needs a good supply of water early in the season to support strong shoot and leaf growth, followed by mild water stress after *véraison*; this has been shown to promote grape ripening.

Water is stored in the soil by binding to clay particles or humus. If a soil contains too much clay it can easily become waterlogged, which in extreme cases can kill the vine's roots. Conversely, sand particles and stones do not hold water well and facilitate water drainage. Therefore, if there is too much sand and stone in a soil, insufficient water may be retained and irrigation may be needed, even in areas of high rainfall.

A vine in the Mâconnais, France, suffering from chlorosis.

Many of the best soils are made up of a mixture of sand and clay particles, known as loam. These soils have good drainage but retain enough water for vine growth. However, it is important to note that there is no one soil type that is always ideal, and a soil's suitability will depend on other climatic factors such as temperature and rainfall.

Soil and Nutrients

The most important nutrients for a vine are nitrogen, phosphorus and potassium. These elements are naturally occurring in the soil and are taken up by the vine roots. Vines do not need high levels of these nutrients in order to be able to thrive. In fact, if levels are too high the vine will grow too vigorously and produce a dense leafy canopy that shades the fruit too much. Nevertheless, over time the nutrients in the soil become depleted and the grape grower will need to replace them with natural or chemical fertilisers.

A common symptom linked to a lack of nutrients is chlorosis. The leaves turn yellow and the vine's ability to photosynthesise is restricted. Grapes struggle to ripen properly and their quality and quantity is reduced. The problem can be solved by using an appropriate fertiliser.

The overall impact of soil and vine nutrition on the quality of the grapes and the finished wine is very complex and beyond the scope of this book.