

**ESEF Cymru**  
**“Geology and Wine”**

4.30pm – 7.00pm 12 December 2006  
National Museum of Wales, Cardiff

Presentation by  
Professor John C W Cope  
(Department of Geology, National Museum of Wales)

ESEF Cymru met at the National Museum of Wales to hear about the relationship of wine to geology and to taste a few glasses. John ([john.cope@museumwales.ac.uk](mailto:john.cope@museumwales.ac.uk)) explained that the relationship is not simple; geology impinges directly and indirectly on the vines and factors other than the geology are also important in the production of wine. These include climate (water supply, insolation and temperature) and not least, the producer. The geology has an influence on water supply, indirectly on insolation (exposure to sunlight) by its influence on topography, and minerals and trace elements in the soil. Much of what the French call ‘terroir’ is a mystique that is a combination of several of these factors.

The grape vine *Vitis vitifera* has as many as 1,000 varieties, with a wide range of qualities. For example, cabernet franc is an old variety grown around the world. In the mid-Loire region of France it may be relatively austere, as in Saumur Champigny or Bourgueil, whereas the same grape grown in the Languedoc is sweeter, whilst in California a cabernet franc wine has been referred to as ‘the wine-drinkers Ribena™’ by the wine critic Malcolm Gluck.

Within a single area e.g. Burgundy, adjacent vineyards with the same grape variety can produce different tasting wines. These differences have been put down to differences in the ground — the concept of ‘terroir’ — but the concept of terroir actually embraces a variety of factors. In the 1940s it was established by Californian workers that there was an optimum temperature regime for each of the different varieties of grapes, to produce the best wines. The available heat is influenced by a number of factors including the:

- Position of the vineyard – elevation, latitude, shelter etc.
- Amount of sun
- Angle of the slope
- Amount of heat absorbed by the soil/ground
- Amount of heat reflected by the soil/ground
- Protection from frost

**The position of the vineyard**

Chablis from the north of the Bourgogne region of France is getting towards the northern limits of wine-growing in France. Here there is a distinct correlation between favourable slopes and the quality of the wine. The amount of shelter within the vineyard varies from the valley bottom, which is less sheltered than the slope above it. Shelter can be further improved should there be a wood at the top of the valley side.

The cool night air accumulates in the valley bottom and the movement of the air, or lack of it, affects the vines. There can be as much as 8° C difference in the air temperature between vines that are as little as 100m apart vertically and within a distance of 2-3 km because of variations in the degree of shelter afforded by local factors.

### **Amount of Sun and angle of slope**

A diagram produced by Jake Hancock shows the simple mathematical correlation between slope of the ground, elevation of the sun and the degree of insolation. Thus the greater the slope the greater the amount of sunlight (and therefore heat) received by the vines. The attitude of the slope is also important, with a south facing slope receiving more sun than a north facing slope etc. In January a 20° south facing slope, for example in Germany, receives twice as much heat as does level ground. In the Moselle and Rhine valleys steep south facing slopes produce the best wines. In the southern hemisphere, the northern facing slopes are preferentially insulated (exposed to more sunlight).

### **Amount of heat absorbed/reflected by the soil**

This is referred to as the 'albedo effect'. Sand and light-coloured soils are good reflectors of heat. Reflected light has a longer wavelength and thus has a more warming capacity than direct radiation. The intensity of the radiated heat is less, further away from the ground; the re-radiated heat's intensity is inversely proportional to the square of the distance above the ground. On the steep slopes of the Moselle vineyards, for example, the Devonian slates and phyllites provide black shiny surfaces around the bases of the vines. In the Châteauneuf du Pape vineyards cobbles of fluvial deposits crop out around the bases of the vines. These are heated by the sun during the day and serve to re-radiate heat as the air cools. To take advantage of the re-radiation some bunches of grapes are grown very low and close to the ground – some bunches are barely 20 cm above the ground in the Châteauneuf du Pape vineyards.

### **Protection from frost**

Vines shoot in spring once temperatures reach 5-7 ° C. However, this is at a time when late frosts may occur in some areas. If they do, they will kill the new growth, which can set back the whole grape production a month or so, having a knock-on effect on harvesting, etc. Covering vines with protective nets etc. is possible if frosts are forecast. A slope can also offer protection, as movement of air down slope keeps frost away. In California a 2.5° slope may offer protection, but in Chablis even a 5° slope may not afford protection from a severe frost.

### **Temperature and rainfall**

A comparison of temperature and rainfall in the Bordeaux region of France and Mendoza (Argentina) showed that there were some differences in temperature, with higher maxima in Mendoza, but that there was a far greater rainfall in the Bordeaux area. However, it is not the rainfall *per se*, but the availability of water that is important. The climate in the UK has recently become more conducive to wine making, with many vineyards over southern Britain, but historical records show that in the past, black grapes were grown in the monasteries as far north as Yorkshire. At present Denbies vineyard, near Dorking, south of London is the largest vineyard in the UK by far, with 285 acres of vines of many different grape varieties. The next largest vineyard in the UK is at Battle (60 acres).

## **Water and nutrients**

A paper by Jenny Hugget (2006) shows the porosity and permeability of various substrates (rocks and soils). Porosity is a measure of the amount of water a substrate can hold in pores (gaps between particles, fractures or cracks); permeability is a measure of the amount of water that can flow through a substrate between particles via connected pores, or along fractures and cracks. Chalk is the best substrate for vineyards as it drains well, is fractured and has high porosity and high mass permeability, but it has very low matrix permeability.

The mass permeability refers to the rock as a whole (including all the fractures and joints) whereas the matrix permeability refers to the rock excluding fractures and joints. Thus the mass permeability of the chalk is high (because of the many fractures), but the matrix permeability is low (as the pore dimension in the matrix of the chalk is very small, precluding most flow through it). This means that suction from the roots can extract the water held in blocks of chalk during drier periods and explains why vines can be found with their roots wound around chalk blocks. The roots probably receive their nutrients from the waters within the fractures, while water stored within the chalk blocks is called upon during drier periods.

Shale has poor matrix permeability. Sandstones do not retain water. Schist (a metamorphic rock) has very low matrix permeability and its mass permeability varies. The granites of Southwest England have very low matrix permeability but are generally well-jointed and act as aquifers, storing water in cracks and fractures.

The best Chablis, Grand Crus, is from grapes grown on the south-west facing slope on one side of the valley on marly limestones of the Kimmeridgian (Kimmeridgian describes rocks formed 154 to 145 million years ago (Ma), as part of the Late Jurassic Epoch). On the opposite side, Premier Crus grow on the north-east facing slope also on Kimmeridgian. Lesser Chablis are grown on the valley floor and on the overlying Portlandian limestones of the hill-tops. The Kimmeridgian here is generally well-draining and a good substrate for the vineyards. In the UK, however, the Kimmeridgian is unsuitable for vines as it is a clay rather than limestone and doesn't drain well.

The depth that the vine roots go to find water and nutrients can be many metres deep, for example in the Medoc region of France, roots have been found at depths of 15 metres. The roots penetrate layers of alluvial material from the Gironde River and the variety of Quaternary sediment of the Gironde is of importance in the different Bordeaux vineyards (Quaternary is a subdivision of geological time, the Quaternary Period covers the last two million years up to the present day). The ground is normally well-drained, but on the lower levels, near the present water-table, land drainage has had to be installed.

In some vineyards, the lack of nitrogen, absorbed through the roots, may cause problems, but most vines are able to obtain nitrogen from the association of their roots with soil bacteria and fungi. Phosphorus is also absorbed through the roots, but not directly. Phosphorus is derived mainly from the mineral apatite, which is found in most igneous and sedimentary rocks and is obtained, on the vines' behalf by fungi. These symbiotic relationships benefit both vines and fungi, for example mycorrhizal fungi get carbohydrates from vines, whilst the vine gets phosphorus from the fungi.

Potassium, a breakdown product of minerals such as muscovite and biotite micas, orthoclase feldspar, and clay minerals such as illite is needed by the vines. Illite has the capacity to grab hold of potassium ions in soil.

Vineyard design is now a high-technology business, using computers and computer modelling to identify the ideal match between geological and geographical parameters (including elevation, available water, amount of clay in the subsoil etc.) and the grape varieties. Models show that cabernet franc generally needs more available water than chardonnay or semillon, whilst shiraz not only needs less available water but can be grown at higher elevations in drier areas. This method has been put to good use by Australian growers.

John Cope summed up the presentation by repeating that the relationship of geology to wine is a complex one, and that many factors need to be taken into account, and finished by saying that the wine-maker or producer probably has as much effect as all the factors put together.

In response to one of the questions, we were told that the grape varieties grown in Wales tended to be those that are also grown in northern Germany.

We were then invited to taste a range of wines, arranged by Professor Mike Bassett, Head of Geology, National Museum of Wales.

Cally Oldershaw  
20 December 2006

p.s. While searching the web, I came across <http://server01.idr-ab.uclm.es/bacchusweb/Data/Bacchus%20PP%20brochure%20v0.pdf>

### **Methodical approach for vineyard inventory and management.**

BACCHUS is a Research and Technological Development (RTD) project co-funded by the European Community (EC) within the Energy, Environment and Sustainable Development (EESD) Programme and carried out by 14 companies, institutes, public agencies and regulating organisations belonging to some of the main wine producers regions in Europe.

BACCHUS main scientific aim is to provide vineyard management organisations with an integrated and comprehensive solution to meet their information requirements, based on the use of Very High Resolution (VHR), Remote Sensing data, Geographical Information Systems (GIS) and modern software programming languages, improving current methodologies for vine areas location, parcels identification and vine characteristics specifications. A methodology for vineyard inventory and management will be developed, which will be implemented and tested through a pilot system addressed to vineyard managers to be an instrument for:

- obtaining statistical information,
- improving the regulation and land management and
- making easy the planning and quality control regarding areas inscribed in the list of Controlled Origin Denomination.