Smoke blanketing Hunter Valley vineyards in November 2019

Smoke analysis at the AWRI: a testing year

Eric Wilkes, group manager – commercial services, outlines the feedback that followed last summer's bushfires, the lessons learnt and the changes being implemented to prepare for future smoke and fire events.

Vintage 2020, at the beginning of an undeniably challenging year for the wine industry, was marked by widespread bushfires across eastern and southern Australia. These fires saw a high percentage of Australian vineyards experience smoke exposure (and in some cases actual fire damage). AWRI Commercial Services is one of two commercial laboratories in Australia to routinely offer analysis of smoke exposure markers in grapes and wine. It played a significant role in the industry response to the 2020 bushfire and smoke events. In this article, AWRI group manager – commercial services, Dr Eric Wilkes outlines the scale of the task set for the Commercial Services laboratory, some of the customer feedback received after the fires, as well as lessons learned and

changes being put in place to prepare for future smoke and fire events.

Smoke testing – what's involved?

Testing for smoke exposure in grapes is a complex process. There is no single compound that can be used as an absolute marker for smoke exposure. In addition, some of the volatile compounds present in smoke are transformed by grapes to a range of additional bound compounds (glycosides) that have potential to release smoke characters during winemaking and bottle ageing, and can have significant negative sensory impacts themselves. The relative amounts of the original volatile and bound smoke compounds can vary with individual

situation, variety and fire event. This range of compounds and the incredibly low concentrations at which they can have a sensory impact mean that the testing requires relatively complex (and expensive) instrumentation. At the AWRI, testing for smoke involves both gas chromatography mass spectrometry (GCMS) and liquid chromatography mass spectrometry (LCMS). The combination of instruments involved, and the specialist techniques required, are not generally available in Australian wine laboratories, which is why only a few analytical providers offer the service. It takes around 45 minutes for a sample to run on each instrument, so only a little over 30 samples a day can be processed by each instrument pair.

The time on the instruments, however, is only a fraction of the process. Grapes need to be sourced from the vineyard and appropriate biosecurity controls undertaken to prevent the spread of unwanted pests and diseases (usually freezing). The samples then need to be shipped to the laboratory, sorted and logged. Once thawed, they need to be homogenised, weighed and then put through various chemical extraction techniques (Figure 1) to isolate the compounds of interest into a liquid that can be injected onto the instruments. The labour-intensive processes involved mean that it can take one to two days to prepare a sample to be ready to join the queues for the GCMS and LCMS instruments. Once a sample has been run through the instruments, each set of results has to be checked by a technical expert before they can be reported. If there is no queue for samples and all the instruments work perfectly the process can take at least three to four days from sample receipt to reporting of the result (Figure 2). Following reporting, the AWRI helpdesk team provides an interpretation for each set of results.

Samples received in 2019/2020

The first grape samples for smoke analysis for the 2019/2020 vintage were received at the AWRI on 20 December 2019 from the Hunter Valley. From this point onwards, as for most of the industry, AWRI Commercial Services moved to working 7-day weeks with breaks only for Christmas and New Year's Day. Well over 4,800 samples were analysed between late December and the end of April. This compares to an annual average of 600 samples for the last five years. The biggest week in 2020 saw 793 samples logged and a record of 613 samples tested in a seven-day period. This was only achieved by using five GCMS instruments and three LCMS instruments (essentially every suitable instrument available at the AWRI, worth around $2 million) and 71 AWRI staff. It represented almost double the original theoretical sample processing and analysis capacity of the laboratory.

Because sample numbers rapidly outstripped capacity, waiting times quickly started to grow beyond the initial five days achieved in late December, with a few customers waiting up to 19 days to receive results at the peak of demand. ▶
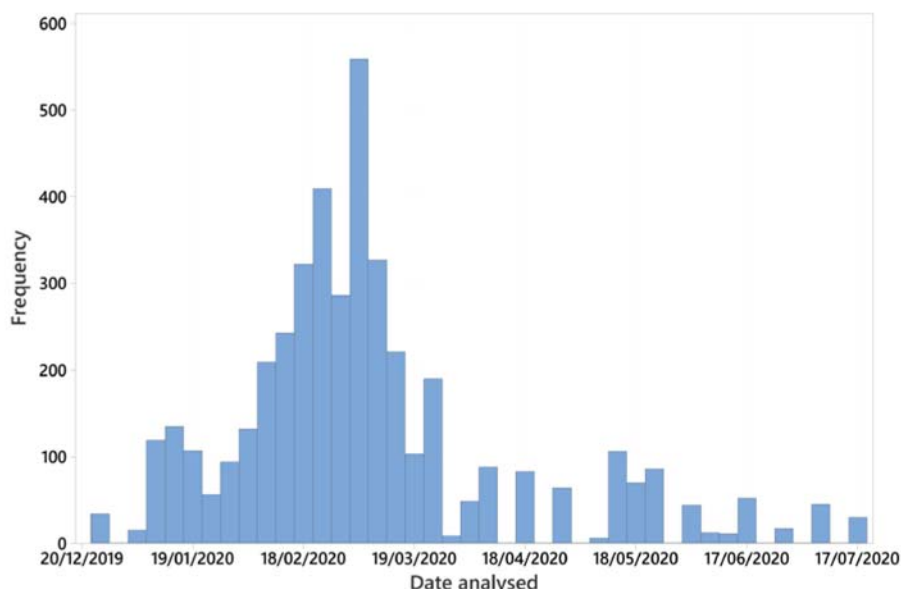
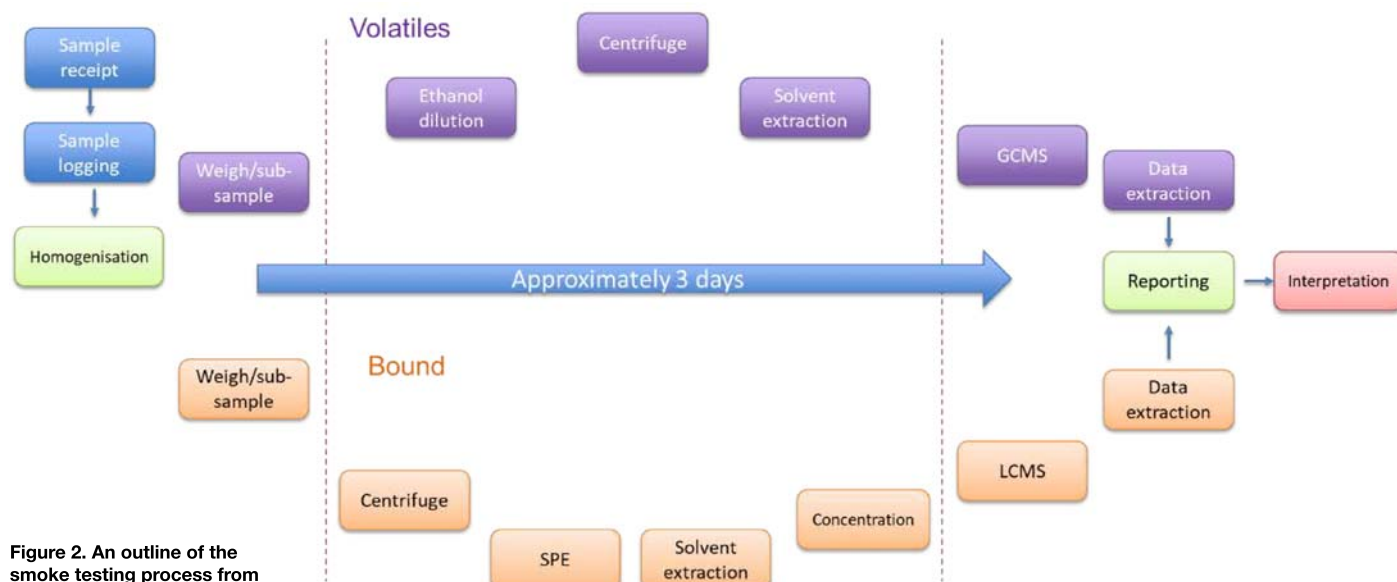Figure 1. Samples being extracted in preparation for smoke analysis

Figure 2. An outline of the smoke testing process from sample receipt to reporting
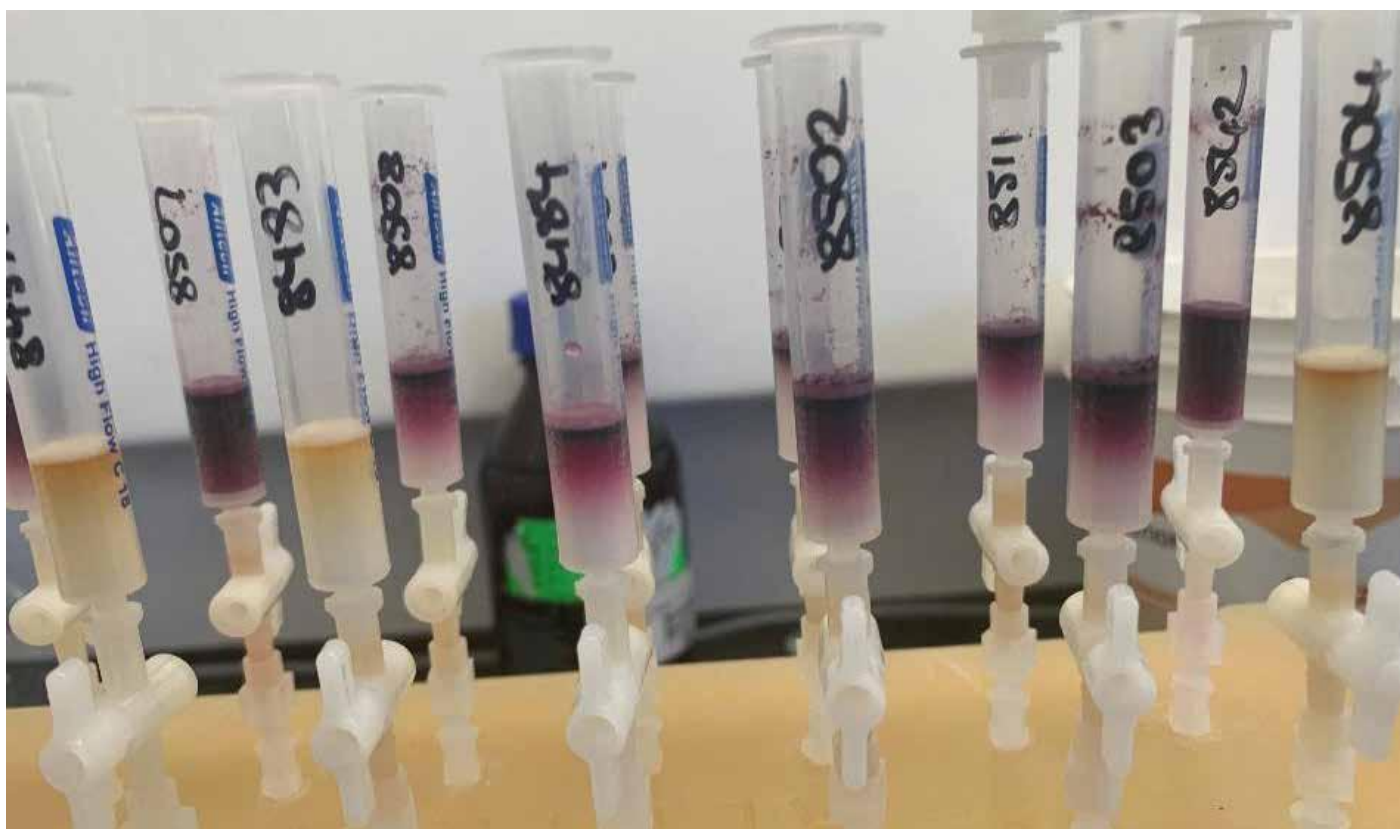
Figure 3. The number of grape samples analysed for smoke markers by AWRI Commercial Services from December 2019 to July 2020. In a typical year, the laboratory analyses a total of approximately 600 samples for smoke.

This was obviously not ideal and incredibly stressful for those involved but could not be avoided given the extremely high numbers of samples arriving. Over 99% of samples were reported within 14 days and the average turnaround time for reporting once samples had been logged was seven days. One of the core features that allowed the AWRI to process so many samples was the cooperation and support of State Governments, state and regional associations and the large wine companies. Their help with consolidating and standardising processes for getting samples to the AWRI greatly improved overall efficiencies.

Opportunities for improvement

While acknowledging the amazing efforts of everyone involved in vintage 2020 smoke testing at the AWRI, once the peak analytical demand had passed it was important to review processes and explore opportunities for improvement . As a first step, a survey was distributed to all users of the smoke testing service to gain a better understanding of their experiences. The good news was that over 80% of users found the service valuable and a further 15% found it somewhat valuable. The biggest 'pain points' identified were wait times for results and results interpretation. Approximately 40% of respondents indicated that delays in receiving results affected their ability to make timely production decisions and nearly 40% of respondents nominated that understanding results was one of the biggest challenges encountered when using the service. In addition, 18% of respondents highlighted that getting samples to the AWRI was a challenge, with several respondents indicating a desire for testing to be available closer to their region. Another interesting result was that two-thirds of respondents valued all

three components of the results provided; that is, the analytical results, the graphs showing comparison to known background levels and the text-based interpretation and did not rely on just one component of the information provided.

Using the information from this survey and other feedback, the AWRI is implementing a range of enhancements to improve its smoke analysis service. While the most obvious target would be to increase capacity and therefore reduce turnaround times, this would involve a massive capital investment, with a doubling of capacity requiring around $2 million in instrumentation, plus the technicians to operate it. Efforts are therefore underway to improve efficiencies and to expand the range of equipment currently available to do the required testing. The AWRI is also working with other laboratories and organisations such as Charles Sturt University in NSW to assist them to set up smoke analysis. In addition, while it would not be feasible for the AWRI to move the equipment required for smoke analysis to a region in a time of need, there is an opportunity to perform the initial sample processing steps at a local facility. This would involve undertaking the logging, subsampling and homogenisation of grape samples within the relevant region and only shipping small frozen samples of homogenate rather than large bags of grapes to a central laboratory. This option would speed up turnaround times significantly, allowing samples to be quickly registered on arrival and move directly to the extraction stage. Investment has also been made in IT systems at the AWRI to allow automatic generation of graphs of results against known background levels for different varieties, allowing this information to go out at the same time as the analytical results rather than in a later interpretation report. This improvement will free up time for the helpdesk team to provide verbal interpretations of smoke analysis results and answer questions from affected producers.

Research on new analytical technologies

Research is also progressing at the AWRI and other institutions on ways to streamline the process of testing grapes and wines for smoke markers. Specifically, a number of technologies including Fourier transform infrared (FTIR) and nuclear magnetic resonance (NMR) spectroscopy are being investigated as possible screening methods. While these technologies will not provide the accuracy and precision of current methods, they show promise in being able to identify clean or extremely smoke-affected fruit quickly (within minutes), reducing the number of samples that require detailed analysis and thus reducing capacity constraints. Work is also continuing on improving current analytical methods to reduce run-times and developing further understanding of what the results mean.

While it is hoped that Australia will never again experiences bushfire and smoke events like those of 2020, changes in climate mean the requirement for smoke testing of grapes is unlikely to go away. The AWRI will continue to support close working partnerships between industry, research and analysis providers to ensure the best possible services and support for industry. **GW**