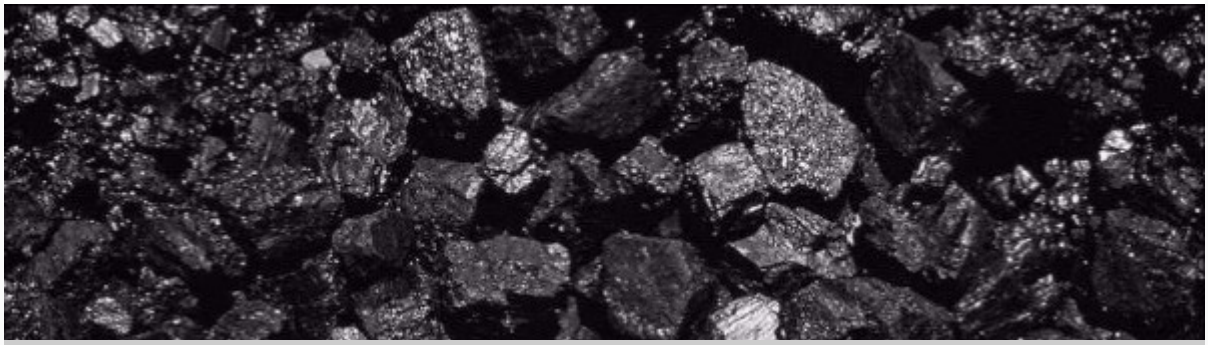
ACARP Matters



Quantifying the Percentage of Coal Dust in Airborne Particulates

The percentage of coal dust in airborne particulates can now be quantified and the results communicated visually using technology developed by CSIRO.

This breakthrough is the result of a collaborative research project, led by CSIRO Energy and the Queensland Department of Science, Information Technology and Innovation, with contributions from the New South Wales Office of Environment and Heritage, New South Wales Office EPA, Coalbridge Operations, Steel River Testing, CSIRO Oceans and Atmosphere,

Gauge Industrial and Environmental, and the Australian Synchrotron.

At the heart of this work is the modification of CSIRO's Coal Grain Analysis (CGA) software so that it can be used to identify and provide size details for the individual coal and non-coal particles present in dust samples. CGA is an optical reflected light microscopy technique that identifies particles using their reflectance signature. Knowing the particle size enables the samples to be categorised as nuisance, inhalable or respirable dust.

In addition to these modifications to CGA, researchers developed image viewing software so that analysis results can be presented to community members and other stakeholders in a format that is meaningful. A raw photomicrograph of the dust sample – comprised of a large number of individual images each collected at 500x magnification – is processed and characterised by the software to provide size details and dust category for each particle greater than one micron. The software is cloud based, so interested parties can open particular dust sample images once they have been emailed the link. Permissions can be assigned to an image so they can be accessed by the public or password protected to maintain client confidentiality when required. Researchers also developed a procedure for analysing and reporting results for community supplied dust samples.

The project includes three case studies based on dust samples from Hay Point Coal Terminal, West Mackay and the Port of Newcastle. The case studies, undertaken in collaboration with government scientists, provided data on the quantity and composition of the dust samples, which were categorised according to three size fractions: greater than 10 microns (nuisance dust), less than 10 microns (inhalable dust) and less than 2.5 microns (respirable dust). The characterisation of the Queensland samples was successfully validated by a skilled petrographer.

Graham O'Brien, project leader and Principal Coal Technologist with CSIRO's Coal Mining Research Program, said CGA was selected in preference to scanning electron microscopy because it was a technique known to work well with coal. "Scanning electron microscopy is very good at getting compositional information on metallic and other inorganic particles. However, it fails to get information on coal or organic particulates because they are very similar in chemical composition to the mounting resins we use to prepare dust samples," he said.

CSIRO postdoctoral fellow Silvie Koval, who was part of the research team, said CGA was the only technique in the world that could reliably distinguish coal from other carbon based particles. “The other technique used in these types of analyses is called source apportionment, but it will only give you a chemical fingerprint for carbon based particles as a whole. This means that coal cannot be distinguished from soot and diesel particles. Using our technique, we can clearly identify coal from the other particles,” she said.

Silvie said it was for this reason that CGA had the potential to be also used to analyse air samples collected in underground mines. These analyses could provide quantitative abundance and particle size information for the coal, rock and other particulates which may be present in the samples.

The impetus for undertaking the research was community concerns about air quality in proximity to coal mines and infrastructure. Dust in these environments can contain a wide range of particulates other than coal, such as soot, dirt, metal particles, paint aerosol droplets and insect and plant detritus. The coal industry wanted to be able to provide accurate and understandable data about the composition of these airborne particulates.

Industry monitor Stuart Ritchie said the project was attractive to the coal industry because it promised greater accuracy and offered a visual means of conveying technical air quality results so that individuals and community groups could view the results themselves. “The value of this research is that, in response to a complaint, we could commission analyses and be able to provide the results of the analyses to community members. This is the perfect tool for determining the composition of dust falling in a particular area and, over time, it has the potential to become a standardised monitoring tool,” he said. “To me, this is a great example of a project that has completed the transition from blue sky research into a commercial product.”

The project, however, was not without its challenges, including being able to provide dust sample information in a way that would be acceptable to community groups, managing the infiltration of fibreglass fibres from the filter paper into the dust samples, and accounting for water soluble particulates (salt) in the samples. These challenges have been resolved or are in the process of being resolved:

- the image viewing software received positive feedback when presented at a series of community meetings;

- the research team has recommended that a non-fibreglass type of filter paper be used in air samplers (a specific brand has been specified); and

- the team has also recommended that further work be undertaken to establish a sampling and analysis method that deals with water soluble particles.

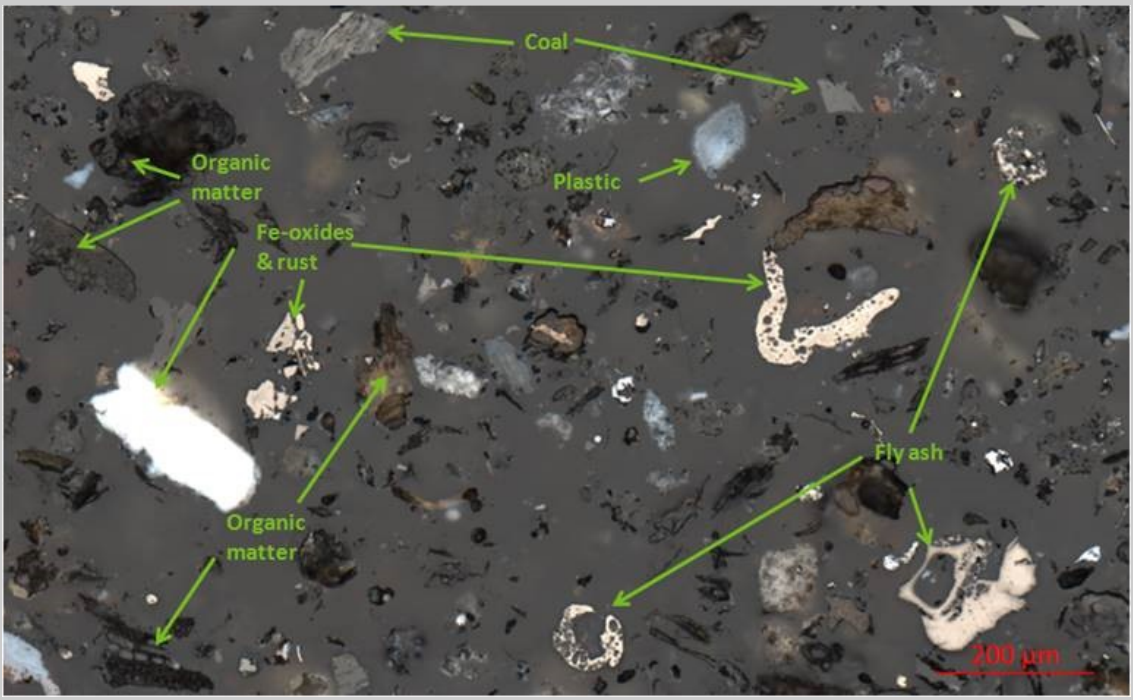
Graham said that not only had CGA received positive feedback from community representatives, it had also achieved a good level of industry acceptance. The research team had received ACARP funding for a follow-on project and there was a possibility that the sampling and analysis method could be developed into an Australian Standard.

Findings from the research have been published in academic journals, and presented at domestic and international conferences. In 2017, Graham presented a paper to the 40th Sydney Basin Symposium, and Silvie presented papers at the International Conference on Coal Science and Technology and the Australia-China Symposium on Energy in Beijing, the Clean Air Society of Australian and New Zealand's Biennial Conference in Brisbane, and the 12th Conference on Sustainable Development of Energy, Water, and Environment Systems in Dubrovnik. Silvie has been invited to address the Wynnum Clean Air Society, a community group in Brisbane.

Graham acknowledged the contributions of the research team at CSIRO Energy – Silvie Koval, Karryn Warren and Gregoire Krahenbuhl – and of David Wainwright (Qld DSITI), Yvonne Scorgie (NSW OEH), Hamish Rutherford (NSW EPA), Nick Stanning (Coalbridge Operations), Michael Campbell (Steel River Testing), Mark Hibberd (CSIRO Oceans and Atmosphere), Matt Newland (Gauge Industrial and Environmental) and Keith Bambery (Australian Synchrotron) to the project.

Use the following link to access CSIRO's image viewing software to view a dust sample:

https://cloudimaging.csiro.au/Sample/Viewer/8f7bf706-ce65-4474-8ef8-bf96cae8d992



Photomicrograph

Placing samples on the microscope stage

For further information:

The final report is available from the ACARP website. Report number C24038

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