UNIVERSITY OF CAPE TOWN
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MINE DUST WORKSHOP- Minutes

Friday 10th June 2016

CHE Engineering Boardroom, 5th Floor

The inaugural dust workshop was held at Minerals at Metals on the 10th of June, 2016. The workshop, attended by researchers from various research groupings both within and beyond UCT, was designed to establish a preliminary protocol and a plan of action in order to tackle the role of mine dust- its detection, implications and mitigation. Further, the meeting provided a starting platform upon which trans-disciplinary research in this area can be facilitated.

Opening Statement

Jenny Broadhurst

Welcome and Contextualisation

The issue of mine dust arose in 2010 under Prof. Don McKee and subsequently at a recent AAUN workshop held by Helen McDonald. Importantly, the prevailing thought from these meetings was that the inter-connected challenges and issues of relevance to mine dust can only be addressed through trans-disciplinary research and active collaboration between multiple stakeholders.

The primary purpose of the inaugural mine dust meeting was to develop awareness of current expertise, capabilities and activities; to highlight the key issues; to identify current gaps and deficiencies in terms of dealing with these issues; and to explore opportunities for developing trans-disciplinary and multi-stakeholder approaches and activities going forward.

The inter-disciplinary and collaborative Minerals to Metals (MtM) Signature Research theme can provide a suitable platform for this research to occur.

Key Note

Harold Annegarn

Regulatory and practical aspects of dust monitoring, health and environmental effects of mine dust emissions

Prof Harold Annegarn attempted to contextualise his nearly 40 years working on the various issues pertaining to anthropogenic dust.

The key issues were categorised into four specific sub-sections: (a) Management- relating to the monitoring and mitigation; (b) Regulation- relating to standards and their enforcement (c) Impacts- on health and environment; and (d) Community- and the perceptions and communication surrounding dust.

One of the key points raised from all of the research conducted showed that up to 80% of previous hard rock miners are suffering from lung impairment through mine dust and its subsequent effects. It was postulated that determining the health effects of quartz dust inhalation on the general population is not a trivial task. Monitoring respirable quartz in the ambient atmosphere is problematic in the absence of properly legislated standards and agreement on procedures. A pragmatic approach for protection of public health is to focus on the monitoring and control of mine dust fallout, which can be considered as a proxy for respirable dust.

Further, it was suggested that new monitoring methods provide a pragmatic, low cost means for legislating dust fallout from mine tailings. However, the levels at which standards have been set are too low and within range of normal background levels. This would therefore imply that almost all locations would be deemed "not in compliance" causing improper environmental governance. A brief comment on the standards based on the 1970 ASTM D1739 Version also suggested that a sampling time of months would be ideal, with sampling periods of shorter than one month providing no benefits in terms of dust management.

Reviews

Rahul Ram

Mine dust implications, detection and management

A brief literature review on the previous work conducted on mine dust- its detection, implications and management practices-was provided. Atmospheric dust and aerosols occur in three main size ranges: the ultrafine, accumulative and coarse modes. All three modes are of relevance to mining-related emissions. A large fraction of particles in air (>90%) has these ultrafine particulates of ≤ 2.5 μm. Although there are numerous natural and anthropogenic sources of atmospheric particulates, mining operations pose the greatest potential risk to human health and the environment. A major problem, especially in the arid and semi-arid areas of Africa, appears to be the contamination by dust fallout from mining operations, from flotation tailing ponds and from smelters. The changing nature of dust prevalence due to increased mining mechanisation, artisanal mining, urban mining and recycling of scrap has led to increased amounts of ultrafine atmospheric particulates with varying elemental compositions. Their subsequent toxicity and value recovery is also subject to modification.

Claire Fitzgerald

Mine dust and society

Anthropogenic dust resulting from mining has severe impacts on people both within the mine and in the areas surrounding the mines. Dust has far more pervasive effects on human health due to its high probability of transport to various sources within communities. It also marks other boundaries with mine workers in the mine, as well as their families living near the mine, negatively affected by mine dust. Historically, the mining industry is one of the biggest air polluters with a long history of health effects. The first reported harmful effects focused on asbestosis and coal pneumonicosis due to exposure of asbestos and coal. While the effects are now well known now, at the time, limited knowledge meant enhanced repeated exposure within several generations of mining and native communities. Recently, the severe influence of tuberculosis among mine workers has led to increased emphasis on the correlation between TB and mine dust. To simplify further, Claire associated the phrase "mine dust" to "my dust" referencing the significant social stigma around native workers within these communities.

Origin and Source

Aubrey Mainza

Implications of dry processing

The key role of communition (including crushing and milling) on the production of large quantities of dust was highlighted. Currently there is little focus on the development of techniques to minimise dust resulting from the crushing of rocks. Current trends are in fact towards dry processing, which although advantageous in terms of water use, leads to greater dust liberation. Most ore processing circuits install suppression systems in flowsheets to deal with dust, however these systems are not well developed and mainly involve wetting the material by means of water jets. In this way, material containing significant amounts of fine dust particles is fed through the circuit in a wet form, effectively shifting the dust problem down the processing chain to the final residues or waste streams (furnace dusts, tailings etc). This problem could be prevented, at least partly, by generating coarser material in the comminution circuit. However, despite data indicating that a fine particle size often has no significant benefits in terms of product output, mining companies are resistant to changing current practices. This is exasperated by the fact that current classification systems, designed to regulate size, only focus on the top size, and not on the large amount of fines generated, which ultimately contribute to dust formation.

Effects and Implications

Helen McDonald/Mutsawashe Mutenda

Community perceptions and experiences of mine dust

The delegates at the conference were introduced to the concept of "matter out of place" which was extended to include both inanimate waste and humans, i.e. if humans lose their value and become sick, they are "matter out of place" and subsequently removed and sent home to die. These kind of perceptions permeate through the mining community due to inefficacy and inaction from the mining companies. South Africa is a TB endemic area with a high co-association of HIV within mining workers. There was also a strong correlation between TB and silicosis within these mining communities.

Data from fieldwork demonstrated that miners associate TB with their occupation and specifically mine dust, rather than attributing it to a bacterial infection. When research participants were asked where they thought TB came from, all shared the same view; "TB comes from mine dust". One interviewee stated: "Well, the soldiers in my body had been probably fighting the disease four years but my soldiers got tired and only when they got tired did I begin showing the symptoms of TB. I started coughing a lot and sweating at night".

Muazzam Jacobs

Investigating the interaction between silica and mycobacterium tuberculosis in the laboratory

Prof Muazaam Jacobs is hosted at the Department of Immunology at UCT. His primary work involves the investigation and understanding of host immune mechanisms in response to tuberculosis infection and the evaluation of drug leads/medicinal phytotherapies/drug delivery systems for efficacy in experimental therapeutic studies in vivo. Various platforms and imaging/analytical tools are used in these investigations.

South Africa has the highest prevalence of tuberculosis in the world, and is often associated with silicosis. It was postulated that, in order to effectively understand the impact of silicosis on immune responses against TB, we need to first understand what a "normal immune response against TB" is i.e. the parameters that defines the immune response in an immune competent host without the influence of a secondary external agent needs to be investigated. For example, a Type 1 pneumocyte- a cell that takes up dust particles that is not designed for effective response may cause occlusion of the lung that could enhance host susceptibility.

Several key knowledge gaps were identified, including the Innate Immunity, Adaptive immunity against TB and silicosis (Dendritic cell function/phenotype, T cell function/phenotype. B cell function), the key drivers of immune associated pathology (Cytokines/Chemokines?); therapeutic outcomes with existing drug regimens (+/- silicosis and TB. i.e pathology may affect drug delivery to sites of infection) and clinical immune functional studies. In order to provide solutions through appropriate interventions, the mechanistic relationship between TB, silicosis and mine dust needs to be understood. This in turn requires an understanding of the characteristics of the critical dust particles that make a host susceptible to TB. A trans-disciplinary approach is required to address this complex challenge.

Monitoring and Analysis

Megan Becker

Qemscan analysis of dusts

Quantitative Evaluation of Minerals by Scanning Electron Microscopy (QEMSCAN) is a potentially useful tools for mine dust characterization. The QEMSCAN provides several important pieces of information including particle images, bulk mineralogy, element deportment, particle properties, mineral liberation and mineral association. A relatively new and very modern instrument was acquired by the EBE Faculty in 2015, and has been successfully used to characterise base & precious metals, iron ore, heavy mineral sands, coal and coal ash, cement, dust and soils across several field of study (including minerals processing, extractive metallurgy, geology, oil and gas, archeo-metallurgy and environmental sciences). Given its success it could be a valuable tool to characterise dust effectively for a variety of applications. Further development of special sample preparation techniques would be essential in the case of dust.

Jorè von Holdt

How to characterise a dusty surface

Any dust cycle involves three primary factors- entrainment, transport and deposition. Entrainment or emission is the least understood of these processes. In particular, research is required to determine which surfaces emit dust, under what conditions they emit dust, and the key characteristics that make them dusty. This is important to further understand, measure, model, and control dust emissions and their impacts. Current research focused primarily on natural desert surfaces that produce dust. The study site in the Namib Desert is similar to surfaces found in deserts and arid regions globally and would undergo the same modifications and disturbances from various anthropogenic sources.

To date research has mainly identified three broad categories of controls:

- Components that affect the cohesion or binding such as crusting (whether physical or biological) or moisture
- Texture – need appropriately sized particles to undergo suspension and LEM for saltation – a very important mechanism for entrainment.

- Non-erodible roughness elements – vegetation (or lack thereof) and gravel. Increases threshold at which emission takes place or lowers the friction velocity of the wind.

Measuring dust emission potential involves identifying dust hot spots, determining influencing variables, and subsequently conducting dispersion modelling. Combining tools such as Pi-SWERL wind tunnel and QEMSCAN provides the opportunity to compare various surfaces in terms of their dust emissions. It also allows for the study of the evolution of dust particles during transport and deposition, which could have an important bearing on their impact.

Through this research it was established that modified and disturbed surfaces can act as potentially significant sources of dust. Disturbances include water abstraction/diversion, road construction, infrastructure development, mining and agriculture.

Frank Eckardt

South African mineral aerosol sources: What is the natural background?

The focus of this presentation was on mineral dust in South Africa from natural sources. The natural sources of dust include River Valleys, Pan Surfaces, Coastal Mudflats, Alluvial Fans and Bare Soils. Dust patterns between several natural and anthropogenic sources were successfully identified differentiated, by working backwards from the impacts to their sources. Through atmospheric and remote modelling, as well as data collected from fallout dust monitors over thirty years, an effective summation of the dust patterns through both natural and anthropogenic sources can be effectively modelled, providing a critical evaluation of the significant role of dust in society.

Chris Loans

Mine dust and dust monitoring in South Africa

A practical assessment of mine dust and dust monitoring in South Africa, on the basis of the activities of the company "Dustwatch", was provided. The issues of dust monitoring was promulgated in response to the requirements of the ASTM D1739 act, which specifies measures that need to be followed by any monitoring programmes. The regulations outline a standard that should be used in South Africa and describe conditions under which monitoring is required, as well as providing a reporting format. As the regulation makes no distinction between dust resulting from individual operations or activities, the company is liable for all the dust recorded by their dust monitoring device. Ambient dusts from external sources leading to high levels can be defended by using effective sample monitoring techniques with samplers placed at key locations within the surrounds of a site.

The MicroScan provides a cost effect method for dust monitoring and can also be used to determine qualitatively (estimate) the contents of the geology and makeup of the sample including organic materials; average D0.5 particle size of either the whole sample or constituents of the sample; and a sample image to indicate these contents. Further, unusual contents and organic insects can be logged for biodiversity purposes. As the various associated companies prepare their own reports, fixed format documents are provided that will incorporate MicroScan reports where these are required. It was suggested that these MicroScans are being carried out on samples from around the world at the rate of nearly 2000 per month and form an important characterisation tool for identifying dust.