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Application of Quantitative Mineralogy to Determine Sources of Airborne Particles at Copper Producing Operations

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Activities performed at metal processing operations can produce significant quantities of airborne particles, which potentially contain hazardous metals. Determining the quantity and type of airborne particles permits the operation to identify the sources of dust, implement proper dust suppressant strategies, and ultimately, limit worker exposure and the risk to public health. Risks associated to airborne particles relates not only to their elemental composition, but also to their size and other physical characteristics. Conventional methods of analysis, such as chemical assay, are unable to rigorously differentiate between phases containing the same elements and may result in ambiguity related to the source identification of the airborne dust. In this study, we have characterized airborne dust generated at three separate Cu producing facilities (a Cu smelter/refinery and two Cu powder producers). The study was initiated as part of a sampling campaign to understand differences in total Cu in respirable versus inhalable dust fractions within the copper industry. A combination of automated mineralogy, electron probe microanalysis, and chemical characterization has been used to evaluate aerosol and settled/deposited dust samples collected at key locations throughout the three operations. This approach provides statistically robust data on particle-by-particle level.

Overall, the Cu phases present in the workplace air samples vary between operation and activity. At locations where the feed material is treated, the airborne dust is representative of the original feed composition, which are unique to each operation (Cu sulfides, metallic Cu and its alloys, and Cu hydroxides). In areas where furnace activities are conducted, the majority of Cu in the airborne dust is carried in metals or oxides. Particle size analysis (<100 μm) of the surface samples indicates that the oxidic and sulfidic Cu minerals are more likely to become airborne over Cu metal. It is expected that the data produced from this study will help determine if specific species of copper are dominant in health-related particle size fractions and determine how they differ amongst various activities that are conducted at an operation. Understanding these relationships can help guide mitigation strategies required to reduce emissions and to develop more informed occupational exposure limit values.