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Characterization of respirable mine dust and diesel particulate matter

By

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PRESENTATION OUTLINE

- Introduction
- Objectives
- Experimental
- Results and Discussion
- Conclusion
- Acknowledgements

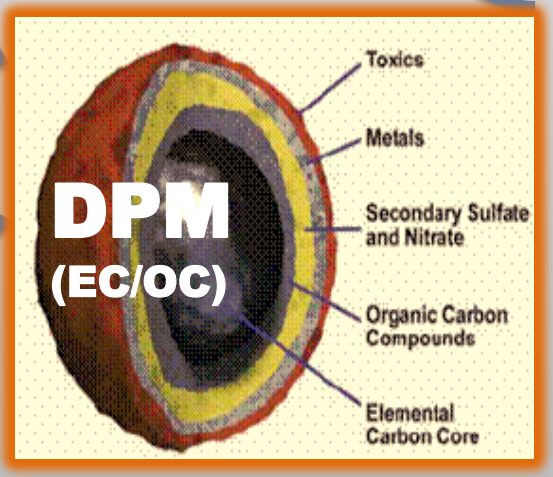
INTRODUCTION

- Underground mining is often associated with the release of:

Mine Dust → Respirable dust { Diameter ≤10 (µm) } → SiO2 (α-quartz) → Affects mine employees

Focus of this presentation

Diesel Exhaust → Gas Phase & Particulate Phase → DPM (EC/OC)



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MAIN OBJECTIVES

The ultimate goal of the entire project is to:

- To determine eco-toxicity and radioactivity markers in DPM and respirable dust.
- Develop advanced analytical methods.
- Contribute to better engineering and occupational health monitoring system.

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SECONDARY OBJECTIVES

Develop/optimize methods to characterize DPM and respirable dust samples for the following:

- Crystalline compounds
- Common mineral analytes
- Particle size distribution
- Elemental Carbon (EC) and Organic Carbon (OC)
- Alpha-quartz concentration

EXPERIMENTAL

DPM SAMPLES:
12 gold mine
12 chrome mine

DPM ANALYSIS(EC & OC)
(NIOSH 5040)
Destructive analysis on 1.5 cm2 specimen

PSD ANALYSIS
(Laser scattering)
Non-destructive on remainder of sample

QUALITATIVE ANALYSIS USING X-RAY POWDER DIFFRACTION

EXPERIMENTAL

DUST SAMPLES:
12 chrome mine only

PSD ANALYSIS

(Laser scattering)

Non-destructive on remainder of sample

- QUALITATIVE ANALYSIS USING X-RAY POWDER DIFFRACTION (XRD)
- Direct-on-filter (non-destructive)

EXPERIMENTAL

Techniques used for analysis:

Fig 1: An LA950V2 Laser Light Scattering Particle Size Analyzer used for PSD analysis

EXPERIMENTAL

Fig 2: D8-Bruker X-ray Powder Diffraction instrument fitted with a Lynxeye detector (used for XRD analysis)

EXPERIMENTAL

Fig 3: A Thermo-Optical Analyzer (DPM) instrument with an FID detector used for DPM analysis

RESULTS AND DISCUSSION:PSD

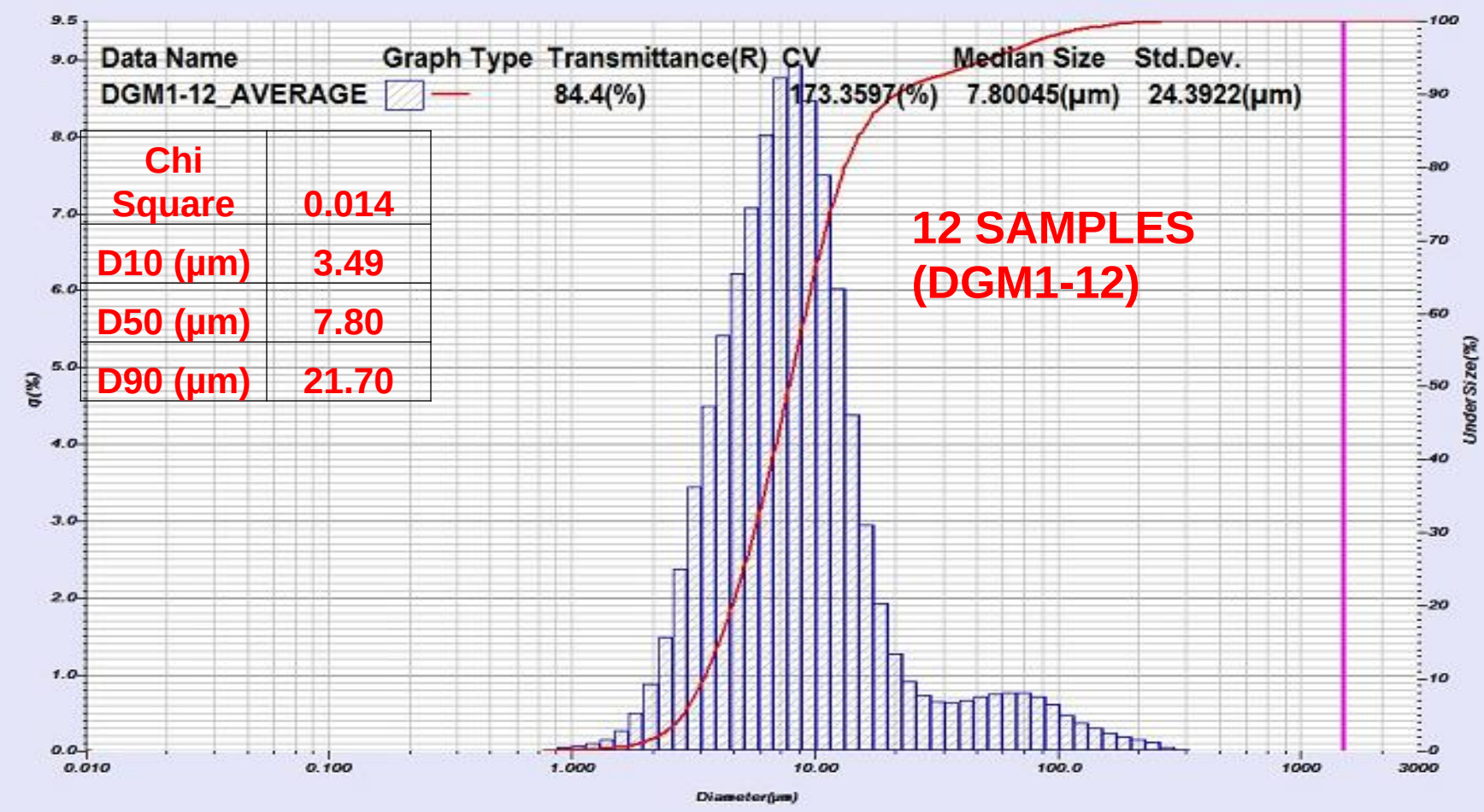

Fig. 4: Average of the distribution graphs for 12-gold mine DPM samples

RESULTS AND DISCUSSION:PSD

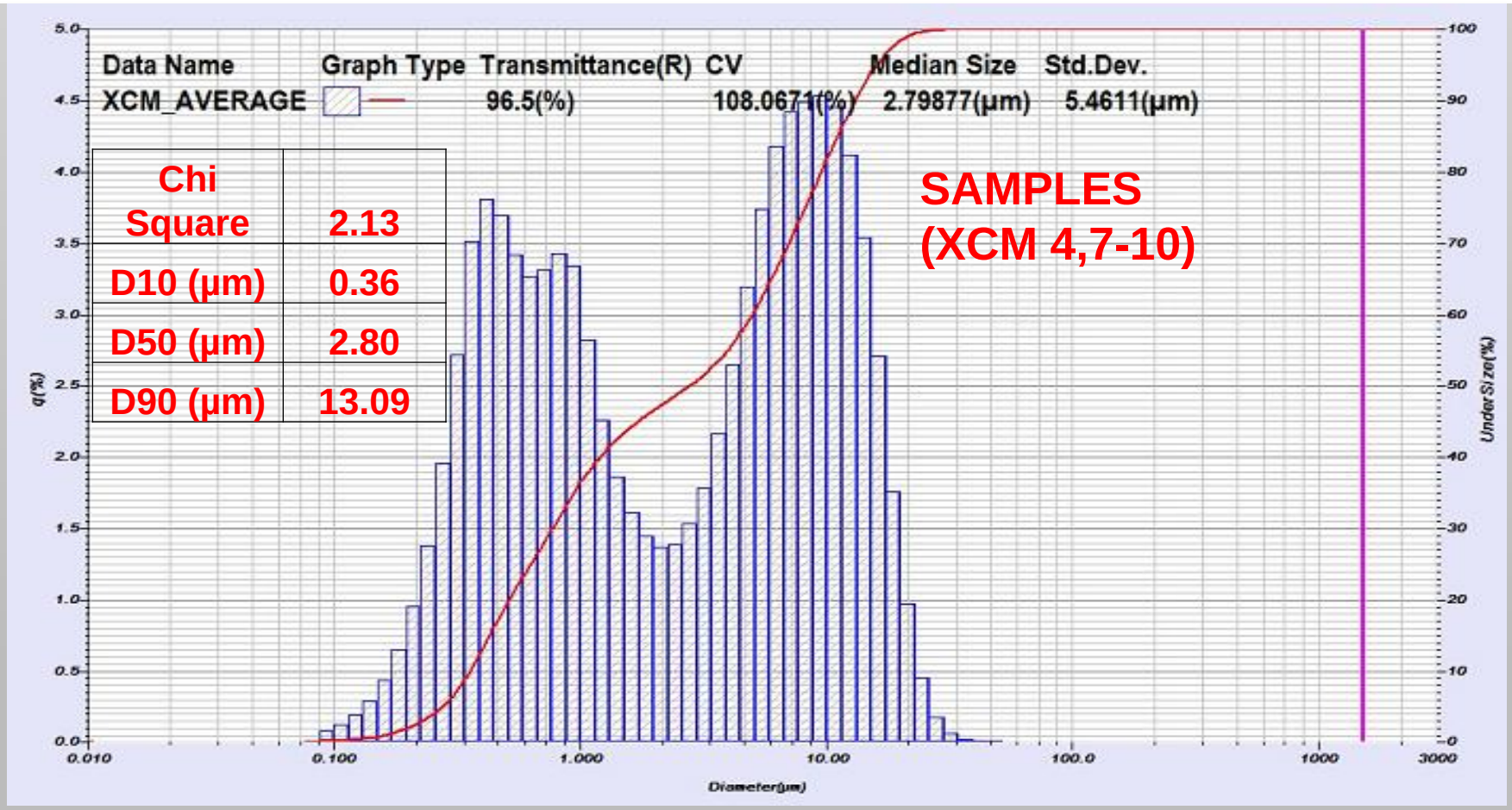

Fig. 5: Average of the distribution graphs for 5-chrome mine DPM samples

RESULTS AND DISCUSSION:PSA

SUMMARY OF THE PSD RESULTS

2-PSD graphs were summarized as follows:

Table 1:

File Name	Samples	Mine	Ave. %PM10	Ave. D90 (µm)
Fig 4	DPM	Gold	67	21.70
Fig 5	Dust	Chrome	83	13.09

67% VOLUME RESPIRABLE

HIGHLY % OF RESPIRABLE DUST

RESULTS AND DISCUSSION:XRD

- Gold mine DPM samples analysed on XRD

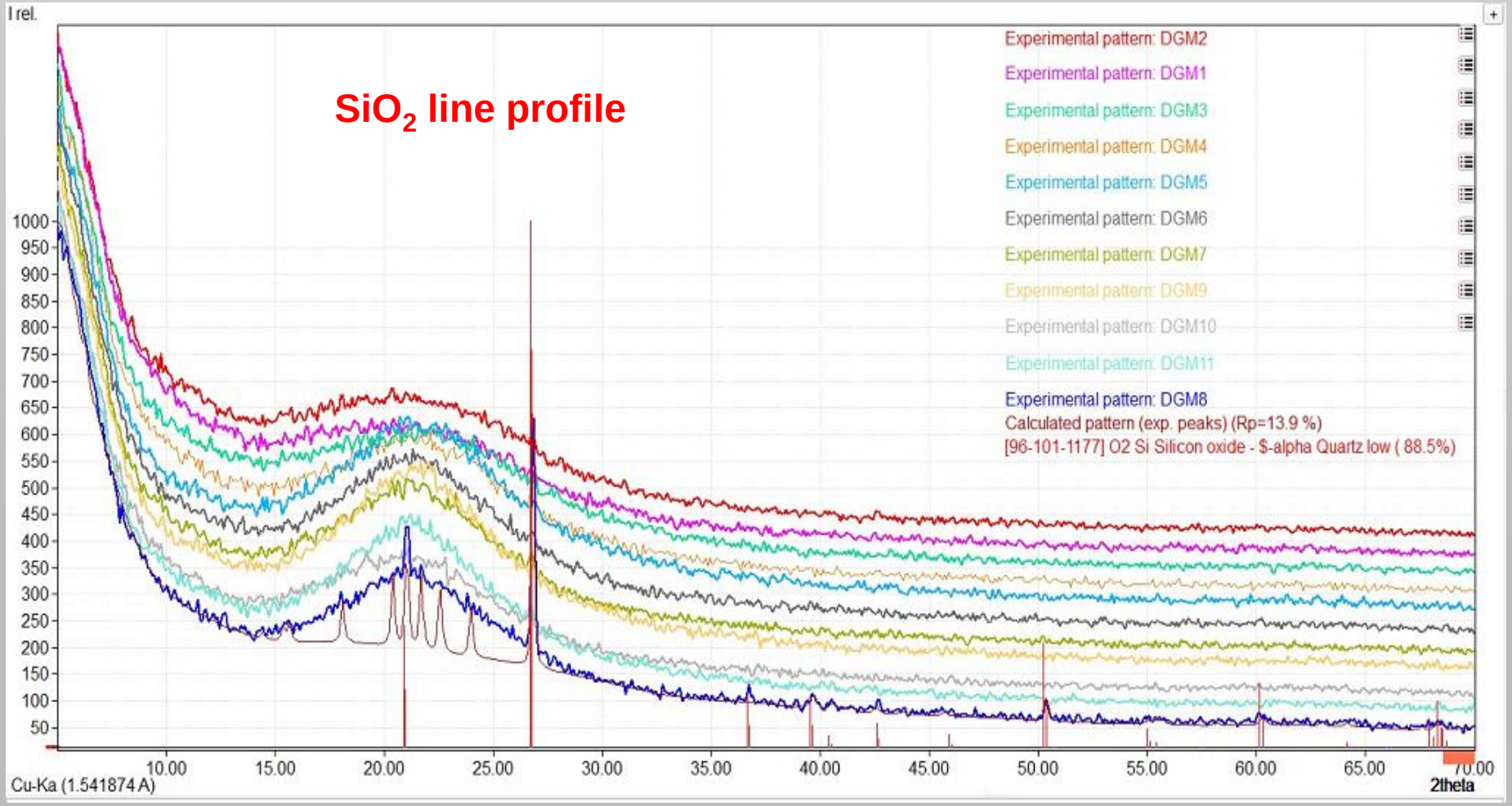

Fig. 6: XRD Scans of the 12 DPM samples (0-70)˚ 2θ

RESULTS AND DISCUSSION:XRD

- Chrome mine DPM samples analysed on XRD

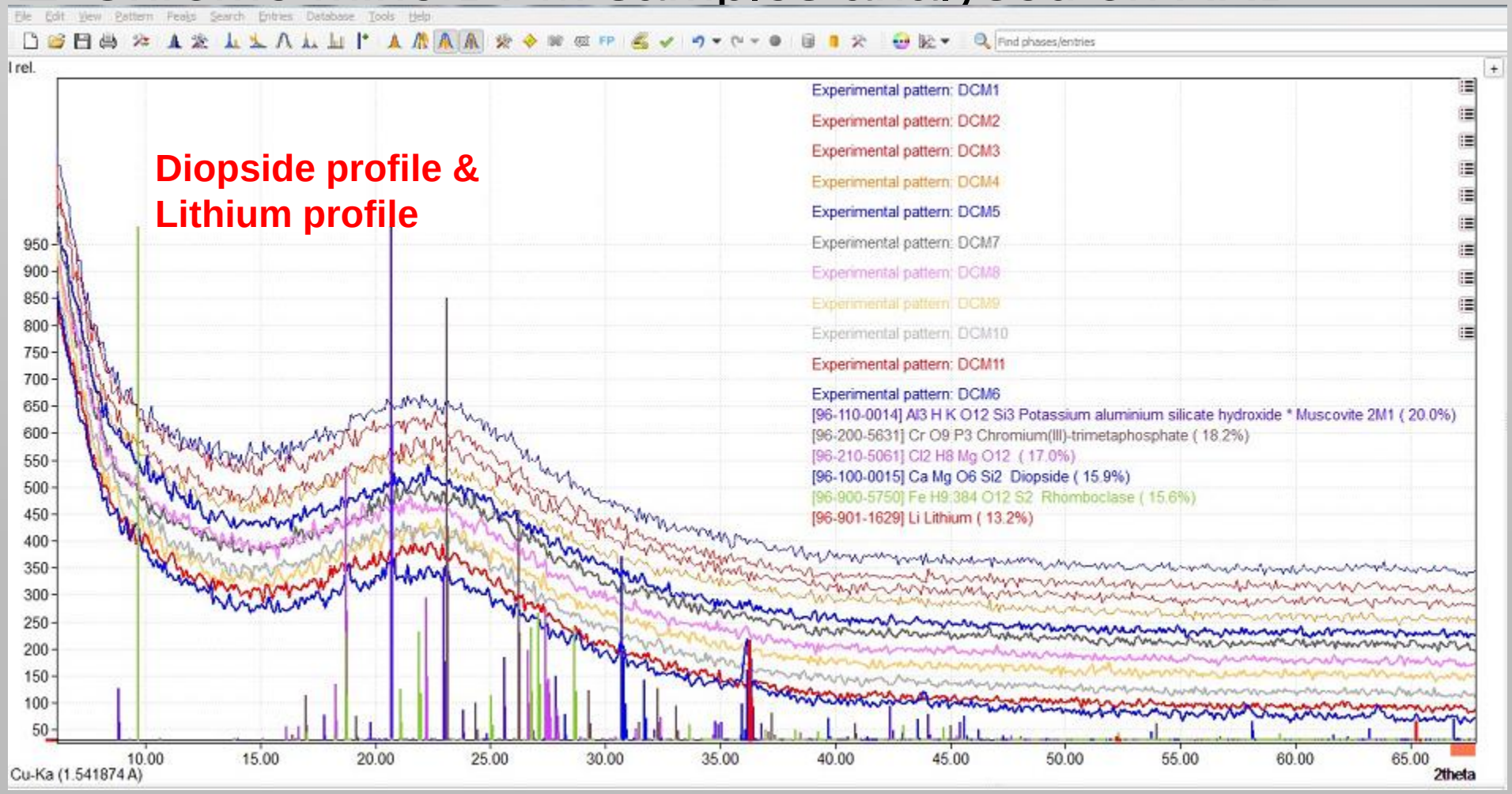

Fig. 7: XRD scans of the 11DPM samples (0-70)˚ 2θ

RESULTS AND DISCUSSION:XRD

- Chrome mine dust samples analysed on the XRD

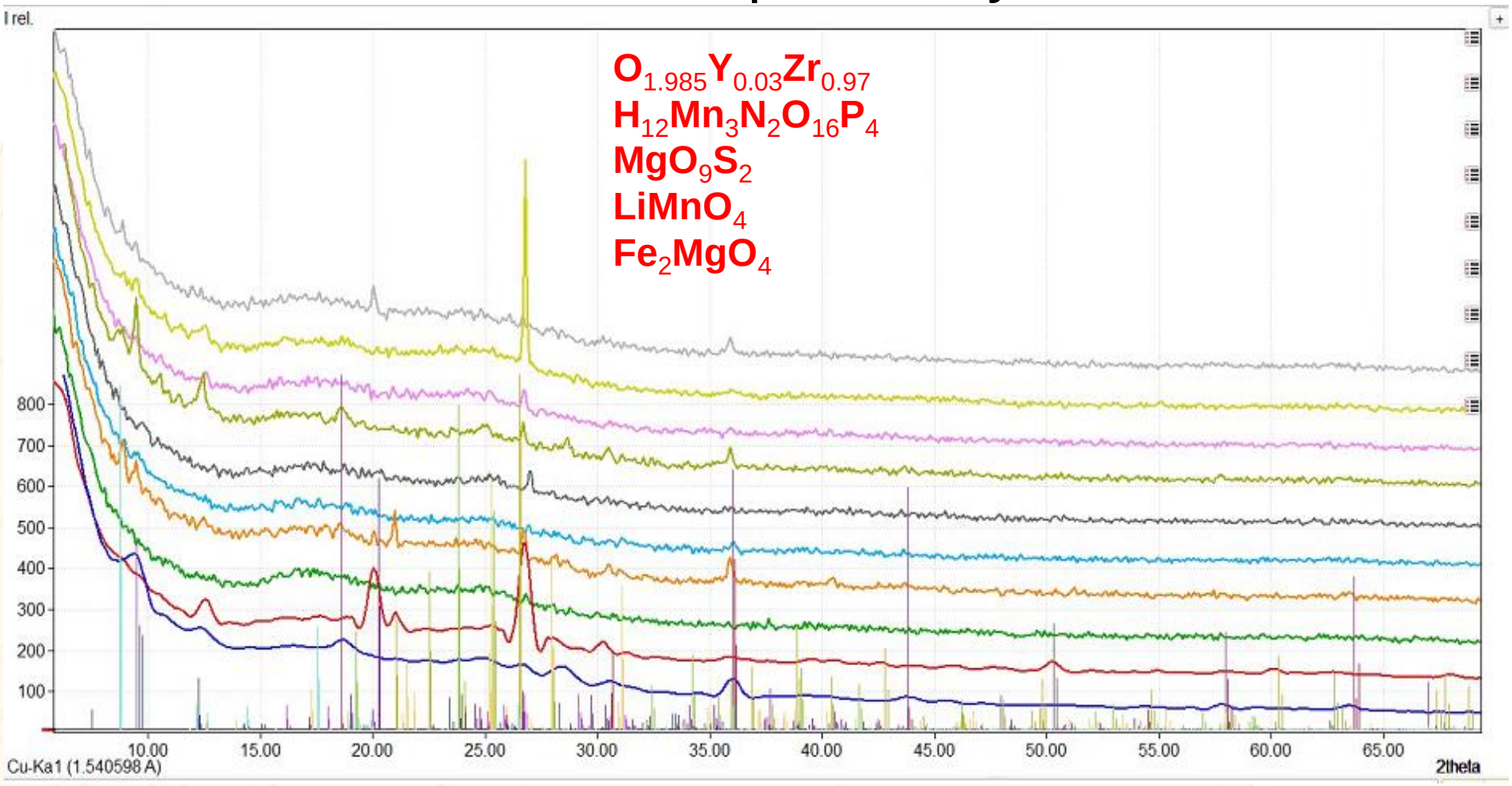

Fig. 8: XRD scans of 10 dust samples (0-70)˚ 2θ

RESULTS AND DISCUSSION:XRD

Table 2: SUMMARY OF THE QUALITATIVE XRD RESULTS

SUMMARY XRD DATA TABLE					
GOLD DPM SAMPLES		CHROME DPM SAMPLES		CHROME DUST SAMPLES	
SAMPLE	PEAKS OBSERVED	SAMPLE	PEAKS OBSERVED	SAMPLE	MOST PEAKS OBSERVED
DGM8	SiO_2	DCM6	Lithium & Diopside	XCM1,7,3 &4	$O_{1.985}Y_{0.03}Zr_{0.97}$ $H_{12}Mn_3N_2O_{16}P_4$ MgO_9S_2 $LiMnO_4$ Fe_2MgO_4
DGM1-7	No Peaks	DCM1-5	No Peaks	XCM (most samples)	$Li_{0.87}Mn_{1.98}O_4$, $AlAsO_4$, Cr_2NiO_4, MgO_9S_2, $O_{1.985}Y_{0.03}Zr_{0.97}$, $H_{12}Mn_3N_2O_{16}P_4$
DGM9-12	No Peaks	DCM7-10	No Peaks		

RESULTS AND DISCUSSION

Table 3: SUMMARY OF ALL THE OBTAINED RESULTS

Analysis	Result Item	Gold	Chrome
DPM	Average EC (mg)	0.140	0.463
	Average OC (mg)	0.186	0.278
PSA	Average %PM10	67	83
	Average D10 (µm)	3.5	0.4
	Average D90 (µm)	21.7	13.1
XRD	DPM samples (Samples with XRD line profiles)	1	1
	DPM samples with Crystalline structures	0	0
	Average Quantitative α-quartz analysis (mg)	N/A	0.007

Chrome Dust samples highly respirable

CONCLUSION

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- EC and OC were found in both DPM groups.
- Observed respirable particles (%PM10) for the gold mine DPM samples were lower than that of the chrome mine dust samples.
- A number of mineral compounds were detected from the respirable dust samples.
- Only three non-crystalline compounds were detected in both DPM groups.
- Sample pre-treatment prior to XRD & PSD analyses proved to be sensitive for the study.

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Thank You For Your Attention!