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RESPIRABLE QUARTZ IN COAL MINES IN THE MPUMALANGA REGION OF SOUTH AFRICA OVER THE PERIOD 2002 TO 2006

- **SAIOH Conference 2011**
- **BA Doyle**
- **Anglo American Platinum**

CONTENTS

Background

Background

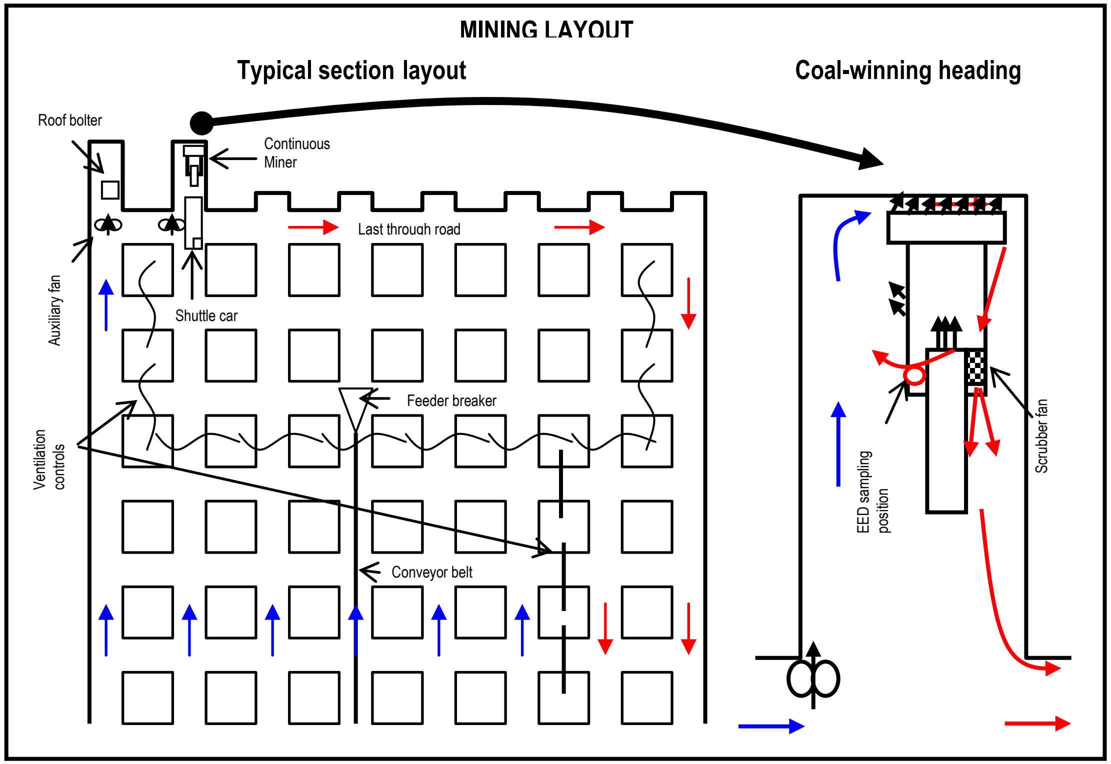
South Africa is the third biggest coal producer in the world. Collieries range in size from small operations with output limited to a few thousand tons of coal per year to Secunda, the world's largest underground coal mining complex, which has an annual production of about 35 million tons.

Almost 90 per cent of the country's saleable coal is mined in the Mpumalanga region.

The bord and pillar method is the most common mining method used, which accounts for just under half of total production. Seams are mined leaving “in situ” coal pillars, which are big enough to support the roof indefinitely, and a chequer-board pattern of mined-out 'rooms'. This method permits approximately 65 per cent of the available coal to be extracted.

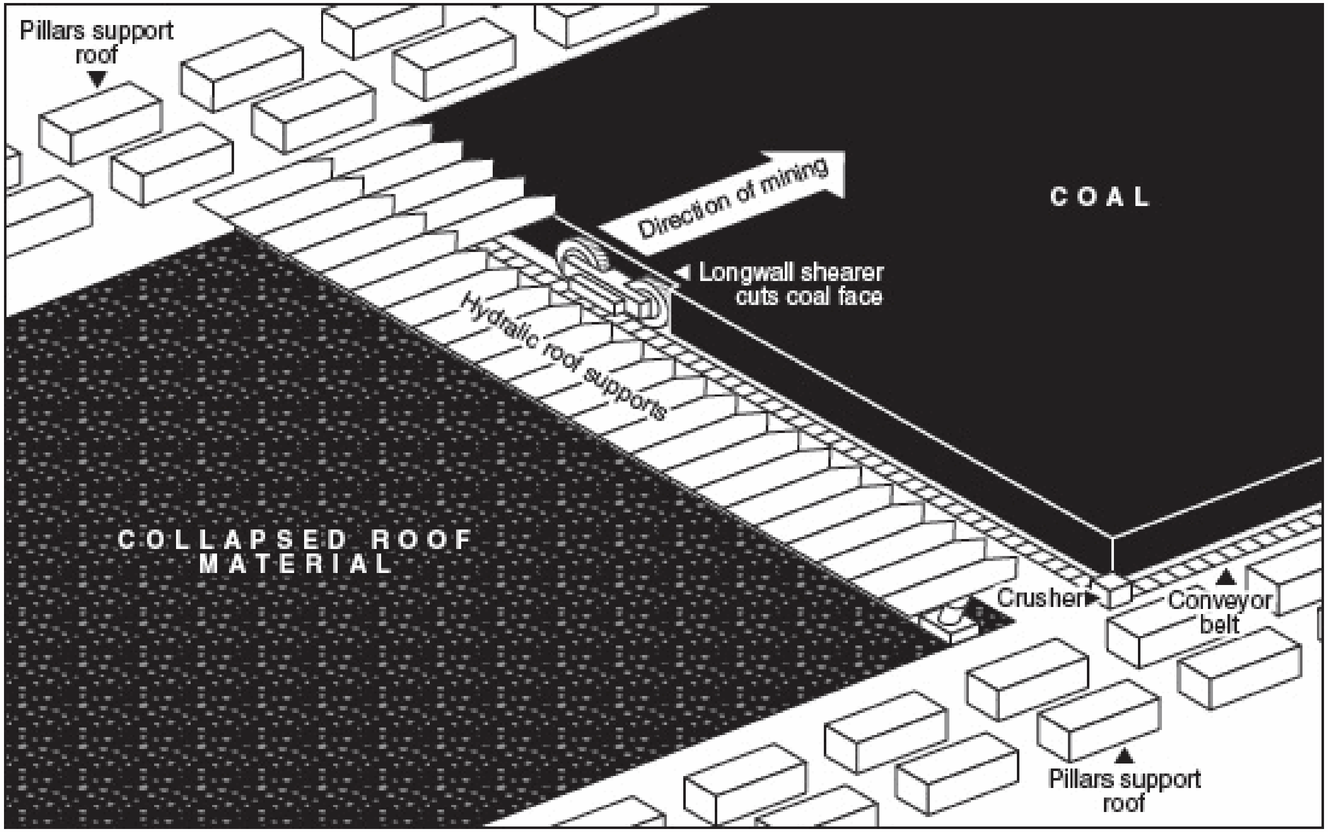
When the overlying strata impose no restrictions, total-extraction mining can take place. In reality however, on average somewhat less than 90 per cent of the coal reserve is recovered, when using this method.

Background



Bord and Pillar Mining

Background



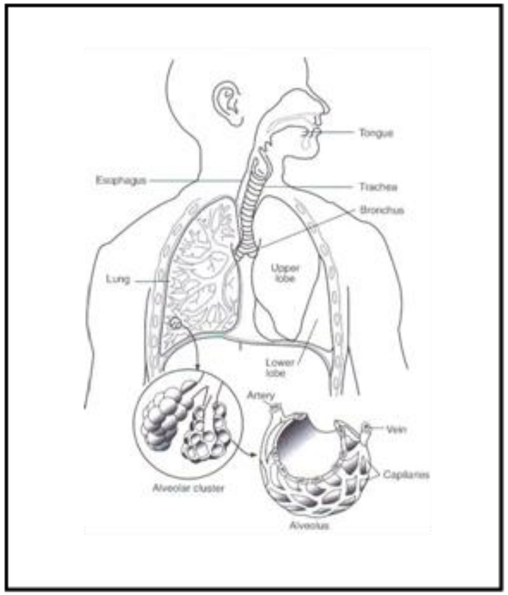
Longwall Mining

Dust Exposure – Health Impacts

Coal Dust Exposure - Health Impacts

Crystalline silica dust, is inherent in coal mine dust, which, during mining operations, is released into the working areas of a coal mine. Quartz is the primary form of crystalline silica found.

Coal miners inhaling this dust are at risk of contracting respirable quartz diseases, such as silicosis. Silicosis is one of the oldest occupational diseases, which still kills thousands of people every year, everywhere in the world. It is an incurable lung disease that is irreversible and, moreover, the disease progresses even when exposure stops. Extremely high exposures are associated with much shorter latency and more rapid disease progression. It is rated by the International Agency for Research of Cancer (IARC) as being carcinogenic to humans (Group 1).

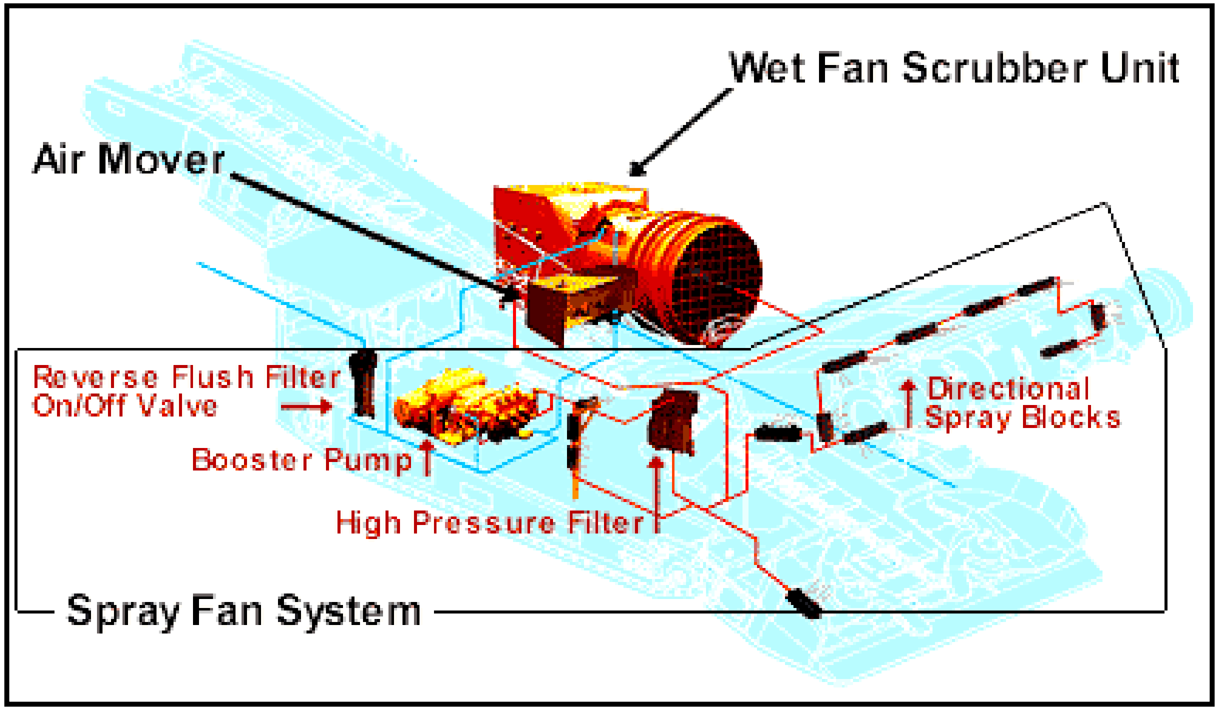


Inhalation diagram of the human body

Dust Control Measures

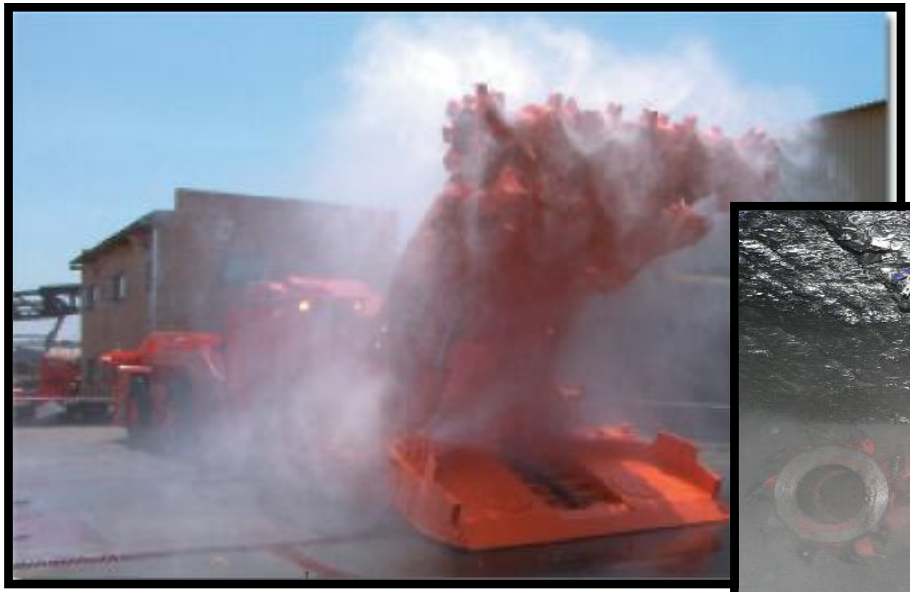
Controls – Continuous Miners

The most commonly used ventilation and dust control systems for CMs are on-board scrubbers, water sprays, water powered air movers and auxiliary ventilation systems such as brattices, jet fans and force ventilation systems. In addition, remote control has enabled an operator to be positioned in the fresh air intake, which significantly reduces worker exposure levels.



On Board Scrubber system

Controls – Continuous Miners



Spray system

Controls – Continuous Miners

Shuttle Cars

Controls – Longwalls

A shearer-spray-system design with adequate pressure, water quality and water delivery system is paramount in effective dust control. Ventilation in the same direction as the coal been transported is the most effective means to remove the dust from the workings. Workers downstream of the operations are issued with appropriate respiratory protective equipment.

Longwall Controls

Controls – Conveyors

A conveyor belt can generate dust from various sources:

- At transfer points
- Can be shaken from the belt as the belt moves over the idlers.
- Spillage of material from the belt can also be a big contributor.
- Further high air velocities of ventilating air (>4 m/s), will assist the release of dust by drying the material and entraining settled dust.

Typical dust control methodologies include:

- Enclosing transfer points, which are equipped with a spray system and/or exhausting the air to a dust filtration system.
- Automatically activated spray systems
- Ensuring that the coal being transported is kept adequately wet.

Controls – Conveyors

Conveyor Belt

Study Design and Population

Study Design and Population

The research conducted consisted of a study of retrospective respirable quartz concentration results. A total of 2346 respirable quartz exposure results were obtained from 9735 samples taken in 41 coal mines located in nine magisterial districts of the Mpumalanga region, over the period 2002 to 2006.

The data used for this research was provided by the company Colliery Environmental Control Services (CECS) who provided a service to the coal mines within the sample population used.

Objective 1

Objective 1

To describe respirable quartz concentrations in the 41 coal mines in the Mpumalanga region of South Africa over the period 2002 to 2006

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Objective 1 Results

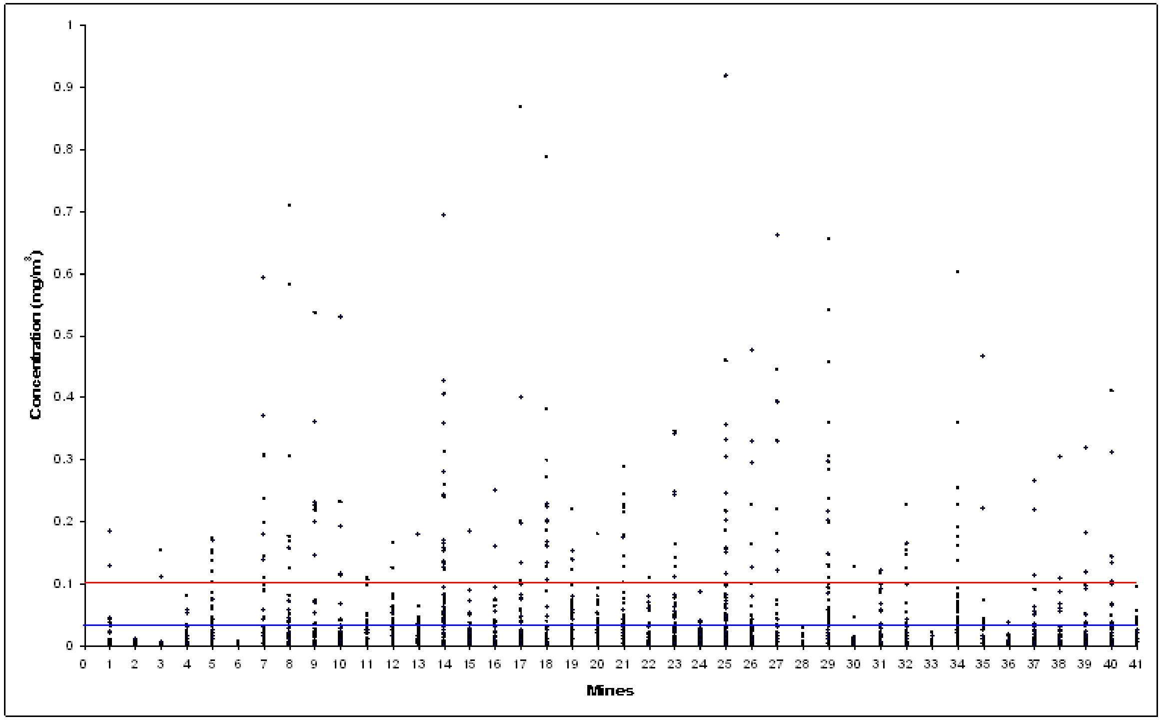
Mine No.	Rank	n	Median	Mean	Minimum	Maximum	Inter Quartile Range		No. >0.1 mg/m^3
28	41	16	0.003	0.006	0.000	0.029	0.002	0.006	0
36	40	62	0.003	0.005	0.000	0.038	0.001	0.006	0
6	39	4	0.003	0.003	0.000	0.007	0.001	0.006	0
27	38	73	0.004	0.085	0.000	1.706	0.002	0.020	9
35	37	54	0.004	0.022	0.000	0.466	0.002	0.013	2
37	36	83	0.004	0.016	0.000	0.265	0.002	0.009	3
24	35	40	0.005	0.011	0.000	0.086	0.002	0.013	0
2	34	10	0.005	0.095	0.001	0.012	0.003	0.006	0
15	33	42	0.005	0.019	0.000	0.185	0.003	0.022	1
38	32	45	0.005	0.021	0.000	0.305	0.003	0.016	2
20	31	97	0.005	0.017	0.000	0.179	0.003	0.022	1
22	30	53	0.006	0.015	0.000	0.110	0.002	0.018	1
3	29	10	0.006	0.030	0.000	0.155	0.003	0.006	0
11	28	64	0.006	0.016	0.000	0.110	0.003	0.021	2
31	27	52	0.006	0.025	0.000	0.121	0.003	0.035	2
1	26	45	0.006	0.038	0.000	0.184	0.002	0.020	2
26	25	76	0.006	0.035	0.001	0.476	0.004	0.026	7
13	24	56	0.007	0.015	0.000	0.180	0.002	0.018	1
30	23	28	0.007	0.013	0.001	0.128	0.004	0.011	1
4	22	54	0.007	0.012	0.000	0.081	0.004	0.013	0
18	21	86	0.007	0.056	0.001	0.787	0.003	0.038	16
33	20	9	0.007	0.010	0.001	0.023	0.006	0.015	0
19	19	96	0.008	0.024	0.000	0.219	0.003	0.029	4
39	18	42	0.010	0.032	0.001	0.320	0.005	0.034	3
41	17	40	0.010	0.016	0.000	0.095	0.003	0.022	0
10	16	55	0.011	0.033	0.000	0.529	0.003	0.023	5
5	15	78	0.011	0.030	0.001	0.174	0.004	0.038	7
21	14	100	0.011	0.037	0.000	0.288	0.005	0.032	11
17	13	70	0.011	0.045	0.000	0.868	0.004	0.039	6
23	12	86	0.012	0.039	0.000	0.345	0.004	0.046	9
34	11	153	0.012	0.032	0.000	0.602	0.005	0.031	8
32	10	50	0.014	0.035	0.001	0.227	0.004	0.036	6
12	9	77	0.014	0.023	0.000	0.165	0.005	0.035	2
16	8	35	0.015	0.034	0.000	0.252	0.004	0.038	2
9	7	52	0.016	0.086	0.001	1.354	0.003	0.069	10
7	6	48	0.020	0.072	0.001	0.593	0.006	0.088	10
40	5	51	0.021	0.043	0.000	0.411	0.006	0.036	6
8	4	36	0.025	0.089	0.000	0.710	0.011	0.092	9
25	3	79	0.029	0.091	0.000	1.284	0.008	0.077	5
29	2	72	0.033	0.136	0.000	2.197	0.007	0.113	19
14	1	67	0.052	0.096	0.000	0.693	0.010	0.134	19
Total	41	2346	0.007	0.038	0.000	2.197	0.001	0.134	191

Respirable quartz concentrations in mg/m^3

Objective 1 – Results

191 measurements (8 %) exceeded the South African OEL of 0.1 mg/m^3. Of the 41 mines eight did not report any results that exceeded this limit.

660 measurements (28 %) exceeded the ACGIH limit of 0.025 mg/m^3. Only 3 mines did not report any results that exceeded this limit.



Full range of measurements taken per mine

Objective 2

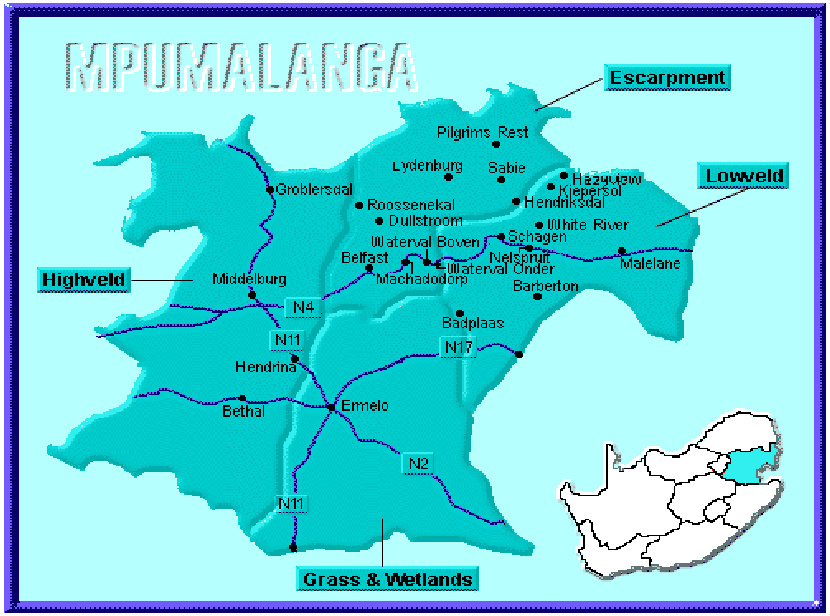
Objective 2

To compare respirable quartz concentrations in nine magisterial districts of the Mpumalanga region of South Africa over the period 2002 to 2006, to the South African OEL of 0.1 mg/m^3 and the ACGIH Threshold Limit value of 0.025 mg/m^3.

Objective 2

Mpumalanga Magisterial Districts

- Belfast
- Delmas
- Ermelo
- Kriel
- Middelburg
- Piet Retief
- Secunda
- Standerton
- Witbank



Objective 2 - Results

Magisterial District	No. Mines in District*	n	No. Results >0.1mg/m^3**	% Results >0.1mg/m^3	No. Results >0 025mg/m^3***	%. Results >0 025mg/m^3	No. Mines in District > OEL	No. Mines in District > TLV
Belfast	3	65	4	6	10	15	2	2
Delmas	1	54	0	0	6	11	0	1
Ermelo	4	166	26	15	66	40	3	3
Kriel	8	448	44	10	144	32	7	8
Middelburg	1	70	6	9	20	29	1	1
Piet Retief	1	86	0	0	29	34	1	1
Secunda	10	715	58	9	205	29	8	10
Standerton	1	72	20	28	38	53	1	1
Witbank	12	670	33	5	156	23	9	11
Total	41	2346	191	Ave 8%	674	Ave 29%	8(9)	9(9)

Note* No. of mines in the magisterial district that were sampled by CECS

Note** South African Occupational Exposure Limit (OEL)

Note*** American Congress of Governmental Industrial Hygienists Limit (TLV)

Objective 2 – Results

Districts ranked based on their risk, i.e. percentage of results exceeding the OEL and TLV values are:

- Delmas
- Piet Retief
- Witbank
- Belfast
- Secunda
- Middelburg
- Kriel
- Ermelo
- Standerton

Lower Risk

Higher Risk

Objective 3

Objective 3

To describe twenty four activity areas in 41 coal mines in the Mpumalanga region of South Africa, over the period 2002 to 2006, which exceed the action limit and OEL of the South African OEL of 0.1 mg/m^3, and the ACGIH TLV of 0.025mg/m^3.

SAMOHP
South African Mines
Occupational Hygiene
Programme

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Objective 3 - Results

Activity Area	Rank	n	Minimum	Maximum	Median	Inter Quartile Range		Proportion of Results >50% of OEL (%)	Proportion of Results >100% of OEL (%)
Dumps/Dump Recycling	24	11	0.000	0.602	0.002	0.001	0.006	10	9
Rawmaterial	23	3	0.002	0.024	0.003	0.002	0.014	0	0
Surface Workshops	22	140	0.000	0.582	0.004	0.002	0.009	4	3
Shafts & Services	21	112	0.000	0.221	0.004	0.002	0.008	3	3
Roving Surface	20	248	0.000	0.305	0.004	0.002	0.008	4	2
Assay/Laboratory	19	20	0.001	0.058	0.004	0.003	0.010	10	5
U/g workshops	18	52	0.001	0.038	0.004	0.002	0.009	0	0
Roving Plant	17	196	0.000	2.197	0.005	0.002	0.013	5	3
Separation Processes	16	6	0.003	0.080	0.005	0.003	0.010	16	0
Crushing	15	6	0.003	0.080	0.007	0.004	0.020	16	0
Ground Handling	14	29	0.000	0.072	0.007	0.003	0.014	7	0
Opencast	13	91	0.000	0.466	0.007	0.003	0.016	10	5
Roving Underground	12	338	0.000	0.370	0.008	0.003	0.021	10	4
Unknown*	11	371	0.000	1.528	0.008	0.003	0.030	17	10
Screening/Grading	10	27	0.000	0.064	0.009	0.004	0.021	11	0
Development (Single shift)	9	12	0.003	0.050	0.013	0.009	0.029	0	0
Rock Mining Coal	8	21	0.001	0.134	0.015	0.004	0.062	29	10
Conventional Mining	7	127	0.000	1.354	0.023	0.009	0.043	25	9
Raise Boring/Dry Drilling	6	5	0.004	0.090	0.026	0.005	0.049	20	0
Stooping/Pillar Extraction	5	12	0.003	0.100	0.030	0.016	0.048	25	8
Development (Multiblast)	4	6	0.019	0.068	0.035	0.029	0.044	17	0
Continuous Miners	3	491	0.000	1.706	0.036	0.012	0.089	41	23
Handgot	2	1	0.036	0.036	0.036	0.036	0.036	0	0
Longwall Mining	1	21	0.001	0.259	0.044	0.009	0.134	47	38
All Activity Areas	24	2346	0.000	2.197	0.007	0.001	0.134	14	8

Lowest Rank

Highest Rank

Respirable quartz concentrations in activity areas exceeding the action limit and OEL of 0.1mg/m^3

Objective 3 - Results

The longwall activity area reported the most results exceeding the 50% and 100% OEL criteria; with the continuous miner activity area following.

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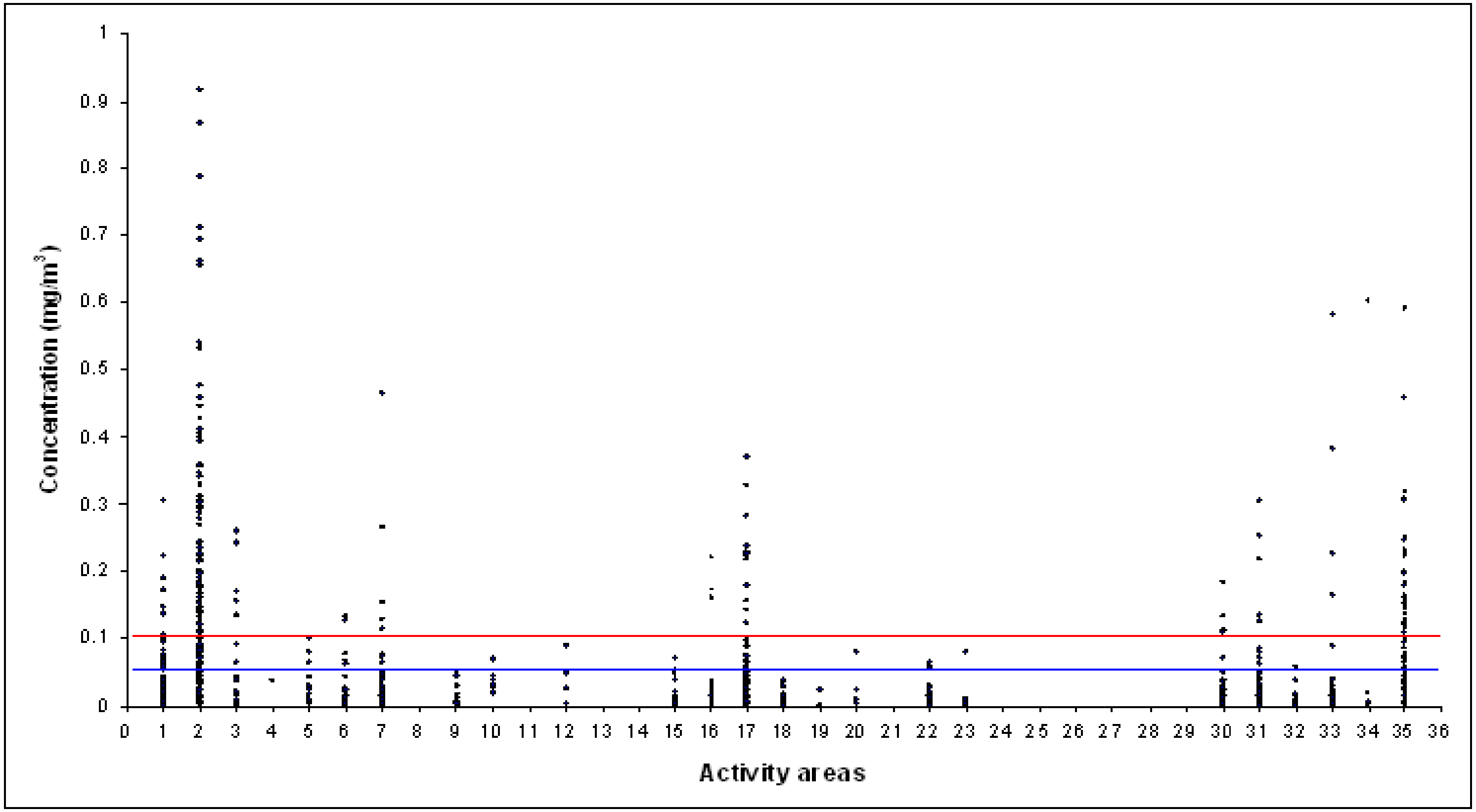
Objective 3 – Results cont

Activity Area No.	Activity Area Description	n	No. Exceeding TLV ($0.025mg/m^3$)	No. Exceeding OEL ($0.1mg/m^3$)
1	Conventional Mining	127	63	10
2	Continuous Miner	491	287	103
3	Longwall Mining	21	13	8
4	Handgot	1	1	0
5	Stooping/Pillar Extraction	12	7	1
6	Rock Mining	21	8	2
7	Opencast	91	17	5
9	Development Single Shift	12	4	0
10	Development Multi blast	6	5	0
12	Raise Boring/Dry Drilling	5	3	0
15	Ground Handling	29	5	0
16	Shafts and Services	112	6	3
17	Roving Underground	338	74	12
18	Underground Workshops	52	6	0
19	Raw Material	3	0	0
20	Crushing	6	1	0
22	Screening and Grading	27	5	0
23	Separation Process	6	1	0
30	Roving Plant	196	21	5
31	Roving Surface	248	23	5
32	Assay/Laboratory	20	2	0
33	Surface Workshops	140	12	4
34	Dumps/Dumps recycling	11	1	1
35	Unknown	371	109	32
Totals		2346	674	191

Respirable quartz measurements exceeding the ACGIH TLV and the South African OEL of 0.025 mg/m^3 and 0.1 mg/m^3 respectively in 24 activity areas

Objective 3 – Results cont

The continuous miner, conventional mining and roving underground activity areas recorded the most measurements exceeding the TLV and OEL values of 0,025 mg/m³ and 0.1 mg/m³ respectively.



CONCLUSIONS / RECOMMENDATIONS

CONCLUSIONS / RECOMMENDATIONS

Persons working in the longwall and continuous miner activity areas are most at risk of contracting occupational diseases related to exposure to respirable quartz.

Individual samples taken should be individually analysed for their percentage respirable quartz content. This will allow for accurate and timeous determinations to be made of worker exposures to respirable quartz, allowing appropriate interventions to be implemented within an acceptable time period.

The effectiveness of present implemented interventions needs to be investigated. Investigation should include the following:

- Compliance with mine operational standards;
- Compliance with mine maintenance procedures and schedules; and
- Operator and supervisor knowledge on the use of current interventions and reporting of malfunctioning equipment.

Area monitoring should be considered to determine if current control systems and newly implemented control systems are operating effectively according to manufacturers specifications.

Awareness programmes should be initiated at all coal mines where the adverse health effects of exposure to respirable quartz are described to all levels of employees. The importance for control measures to operate effectively must also be explained and understood.

Acknowledgements

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THANK YOU