Methane release from South African coal mines

Philip Lloyd [i] and Alan Cook [ii]

Abstract

The widely employed IPCC models for the release of methane from underground coal mining operations are reviewed, and put in the context of the South African National Communication on greenhouse gas emissions. Then attempts to calibrate the model via measurements on South African coalmines are described.

These attempts failed, because it rapidly became clear that the IPCC model, involving methane adsorbed by the coal and released a) by the depressurization of the strata caused by mining, b) from the broken coal and c) from coal remaining in roof, floor, pillars or goaf after mining, was not valid. Instead, measurements showed that the methane release was very variable, sporadically falling to zero. Carbon dioxide concentrations were monitored at the same time as methane, and followed methane concentrations.

An alternative model was developed, in which methane was largely displaced from the coal and held in fissures, cleats and pores, which, when intersected by mining, released methane into the ventilation stream. In a key test of this hypothesis, methane concentrations around a continuous miner were monitored both during operation and after shutdown. Even during operation, methane became undetectable. It is hypothesized that heating of the South African coal seams during the emplacement of the igneous dykes that cut so many of the seams caused displacement of the methane from the coal into the pores. This fissure-held methane, or free methane, is released rapidly once a pathway through the coal into the mine atmosphere is established. In contrast, methane adsorbed in the coal, and measured as the seam gas, desorbs relatively slowly. Measurements suggest that on average about 50% of the adsorbed methane is lost one day after mining. By that time, the coal will have left the mine, so that the remaining seam gas will be released to the atmosphere outside the mine.

Attempts to measure methane emissions from surface coal mining operations showed very little detectable methane. Coal from surface operations, which was milled and exposed to atmosphere, adsorbed gas from the air. It is concluded that methane release from surface operations is probably less than 3Gg/a.

It is estimated that the total methane release from the coalmining industry amounts to about 72 Gg/a, as opposed to the National Communication estimates of 323Gg/a in 1990 and 317Gg/a in 1994.

However, there are large errors associated with these estimates, and it is recommended that the methodology outlined in this report be extended to as many mines as possible to reduce the errors which are inherent in the physical processes underlying the release of methane from South African coal mines.

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[i] Honorary Research Fellow, Energy Research Centre, UCT, plloyd@ebe.uct.ac.za

[ii] Director, Itasca Africa, PO Box 38425, Booysens 2016, alancook@itasca.co.za

1 Introduction

In the National Communication [1] the inventories were generally prepared in accordance with to the 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines [2]. However, there were clear indications that the IPCC default factors for methane emissions from coal mining overstated the South African situation, and it was necessary to modify the IPCC approach to take account of far lower methane concentrations in the coal than anticipated.

The IPCC default factors are based upon a model involving:

- Fairly even distribution of the methane throughout the seam
- Retention of the methane within the coal measures due to hydrostatic pressure
- Release of the pressure and thus of the retained methane because of mining
  - Firstly from the broken surface of the newly mined coal
  - Secondly, and more slowly, from deeper in the newly mined coal, and
  - Finally, more slowly still, from pillars, roof and floor created by mining.

Thus as long as mining continued, there would be a general and reasonably constant release of methane, which would reduce shortly after the rate of mining was reduced, and more slowly once mining ceased, when the only methane sources were the floor, roof and pillars.

The revised model [3] was based on:

- An estimate of the potential methane content of the coal *in situ* from the depth of mining and the fixed carbon content of the coal
- The application of a factor of 20% to estimate the actual methane content (where the factor had limited experimental backing)
- The application of the IPCC default factors for mining method, namely:
  - 1.98 in respect of coal won by room-and-pillar methods,
  - 1.23 in respect of coal won by stooping or longwalling, and
  - 1.01 in respect of coal won by opencast methods.

These factors were derived from international studies which showed that, while much of the methane content of the coal was released soon after the coal was mined, coal remaining in the roof, floors and pillars (in the case of pillar-support mining methods) continued to degas long after the coal had been mined.

The modified method gave an estimate of the methane released by coal mining in SA of 323 Gg of methane in 1990 and 317 Gg in 1994, which represented about 15% of the total South African methane emissions. Of the coal mining fugitive emissions, 88% were directly from underground mines, and much of the balance arose from releases from recently-mined coal after leaving the mine.

As noted, one problem with the model was that it had limited experimental backing. The *in situ* methane content of a wide range of South African coals had been determined with relatively high precision, but seven measurements on mines having coals for which the methane content was well known showed that the actual release of the methane during and after mining was far lower than would have been expected for coals of the known gas content.

The average release was 20 ± 15% of the expected release, indicating severe under-pressurization of the coal [i].

To improve the confidence level of the estimate, additional work was proposed to the Coaltech 2020 Supervisory Committee. Coaltech 2020 is a South African coal-industry co-operative research programme which funds research of this nature. The programme proposed to:

- Develop an empirical model of methane emissions from underground mining operations.
- Validate the underground emission model for a range of circumstances using independent sampling.
- Develop an empirical model of methane emissions from surface mining operations.
- Develop a model of methane emission from coal post-mining, including during milling, stockpiling and transport.
- Validate the post-mining emission model using chamber methods.
- Perform a sensitivity and error analysis on the estimates of coal gas characteristics, desorption curves, emission factors in relation to mining practices, etc required by the various emission models (underground, surface, smouldering and handling).

It is the purpose of this paper to provide a summary of this work, which started in the first quarter of 2002 and was completed in mid-2004. The original programme was extended because the initial findings showed that the release of methane from recently mined coal did not follow any expected pattern, and additional tests had to be developed to prove or otherwise hypotheses put forward to explain the observations.

2 Preliminary experiments

The intent was to measure the methane content of coal on the face of operating underground mines; to determine the methane content of the return air from the mine; and to determine the methane remaining in the coal after it had left the mine. It was hoped in this way to quantify the various contributions to the total methane release in terms of the IPCC model.

Six underground collieries were selected to cover a range of *in situ* methane contents from 1.27 to 0.01 m^3 methane per ton, which is typical of underground mines at a depth of 80 to 120 m below surface. The mines were selected on the grounds of:

- Covering a range of *in situ* methane concentrations in coal typical of the industry as a whole [ii], and
- Having a main fan serving an identifiable number of production sections (on some mines return air is drawn by several fans from several different sections).

High-precision measurements of methane in the return air from the main fan ducts were made approximately weekly for 2 months, and both hourly over 24h and every 5 minutes over one hour on a typical colliery. Samples were pumped into evacuated 5l spheres that were then sealed and sent for methane analysis at the high-precision gas unit at the Pelindaba analytical

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[i] That is, the apparent methane content of the coal was 20% of what would have been expected for a coal of the given quality and at the depth at which it occurred.

[ii] The *in situ* methane content of the coal was determined using a rapid method involving sealing the sample until it could be milled in a closed container, then measuring the methane emitted from the finely milled particles.

laboratories of the Nuclear Energy Council of SA [NECSA]. The return air contained from approximately 50 to 450 ppm methane by volume, and ventilation volumes were such that emission rates varied from 9 to 250 litres methane/s.

The mining method was generally mechanised bord-and-pillar, although on one mine (New Denmark) some of the production came from a longwall, and on some of the other mines considerable amounts of stooping (recovery of coal from oversized pillars) was practised. The mines and their shafts are listed in Table 1.

Table 1: Characteristics of shafts chosen for test work

Mine	**Koornfontein**	**Twistdraai**	**Matla**	**Douglas**	**New Denmark**	**Boschmans**
Shaft	**Gloria**	**Central**	**No.1**	**North**	**Okhozini**	**Main**
Coal, t/day	14000	8850	11880	18000	4000	8500
Seam gas content, m^3/t	1.3	1.2	0.4	0.1	1.3	0.01
Average depth, m	110	120	100	90	140	60
Vent volume, m^3/s	590	590	361	460	200	187

The Ventilation and Occupational Hygiene departments of the individual collieries measured ventilation volumes.

Coal samples of approximately 20 kg mass were collected from the belt leaving the shaft and analysed for residual gas content.

The results from the weekly sampling of all mines are given in Table 2; those for the hourly sampling of Koornfontein in Table 3; and those for every 5 minutes at Koornfontein inTable 4. The results of the analysis of coal samples for residual methane after mining are given in Table 5.

Table 2: The results of weekly sampling of the six mines, methane ppm by volume

Mine	**Koornfontein**	**Twistdraai**	**Matla**	**Douglas**	**New Denmark**	**Boschmans**
Shaft	**Gloria**	**Central**	**No.1**	**North**	**Okhozini**	**Main**
20-Jun-02	688					
3-Jul-02		200	208		56	
4-Jul-02	210			75		1
10-Jul-02		231	262		1[a]	
11-Jul-02	825			66		49
24-Jul-02		27	78		50	
26-Jul-02	263			31		21
1-Aug-02	1			12.5		1
2-Aug-02		68.5	1		88.5	
7-Aug-02		203	171		1	
8-Aug-02	418			34		31
14-Aug-02		100			215	
15-Aug-02	584			51		
Average	427	138	144	45	69	21
Standard deviation	291	84	104	23	79	21

[a] Nil production at time of sampling

Table 3: Results of hourly sampling at Koornfontein

Time	Methane, ppm	Time	Methane, ppm	Time	Methane, ppm
06:00	732	15:00	793	00:00	680
07:00	732	16:00	758	01:00	655
08:00	764	17:00	743	02:00	669
09:00	686	18:00	743	03:00	702
10:00	674	19:00	682	04:00	693
11:00	660	20:00	738	05:00	673
12:00	696	21:00	668	06:00	681
13:00	738	22:00	723	**Average**	701.6
14:00	716	23:00	541	**Std Deviation**	49.6

Table 4: Results of sampling every 5 minutes at Koornforntein

Time	Methane, ppm	Time	Methane, ppm	Time	Methane, ppm
19:00	682	19:25	704	19:50	691
19:05	660	19:30	719	19:55	676
19:10	646	19:35	606	20:00	738
19:15	681	19:40	694	Average	666.2
19:20	681	19:45	483	Std Deviation	64.0

Table 5: Results of analysis of coal samples for methane

Mine	Koornfontein	Twistdraai	Matla	Douglas	New Denmark	Boschmans
Residual Methane, m^3/t	0.6	0.22	0.01	0.01	1.00	0.00
In situ Methane, m^3/t	1.30	1.23	0.42	0.08	1.27	0.010
Methane released, m^3/t	0.7	1.01	0.41	0.07	0.27	0.01

Immediately a problem was apparent. For example, at Koornfontein, 14 000t coal/day was produced, which had lost 0.7m^3 methane/t (Table 5) into 590m^3 air/s. This means an average of 192ppm methane in air from freshly mined coal. Tables 2,3 and 4 show more of the order of 400 – 700ppm methane in the return air, so if the IPCC model were valid, and methane were being lost, then the methane released from residual coal in floor, roof and pillars would amount to 200 – 500 ppm methane. But the loss from the residual coal would continue night and day, yet Table 2 shows that at Koornfontein there was one occasion when it fell to nothing.

There were similar results from the other mines. Only at Douglas was there a reasonable correlation between the minimum level of methane observed in the return air and the methane calculated on the basis of the assumption that methane would be released from residual coal, as shown in Table 6. In three other cases the calculated residual was much higher than the minimum observed, and in the other two cases the calculated residual was negative.

Table 6 Calculation of residual contribution to methane in return air, and comparison with observations

	Koornfontein	Twistdraai	Matla	Douglas	New Denmark	Boschmans
t coal/d	14000	8850	11880	18000	4000	8500
m^3/t	0.7	1.01	0.41	0.07	0.27	0.01
m^3/d	9800	8939	4871	1260	1080	85
m^3 CH4/s	0.113	0.103	0.056	0.015	0.013	0.001
m^3 air/s	590	590	361	460	200	187
New coal CH_4 ppm	192	175	156	32	63	5
Return CH_4 ppm	427	138	144	45	69	21
Residual CH_4 ppm	235	-37	-12	13	7	16
Minimum CH_4 ppm	1	27	1	12.5	1	1

A check was made on the analytical methods, which failed to reveal any problems that might have led to the observations.

The statistical properties of the distributions of methane measured in the return air showed that, at Koornfontein, while there were no significant differences between the measurements made hourly and every five minutes (Tables 4 and 5), both were significantly different from the distribution of measurements taken weekly (Table 3). This was a further indication that it was invalid to assume that there would be a fairly constant release of methane from the residual coal, because if this were so, the weekly measurements should have had properties similar to those of the shorter-term measurements.

A further check was made on the seam gas content (SGC) by repeated sampling, with the results given in Table 7.

Table 7 Check on seam gas content by repeated sampling

Shaft	Koornfontein	Twistdraai	Matla	Douglas	New Denmark	Boschmans
Average SGC, m^3/t	1.21	1.27	0.423	0.109	1.47	0.023
Std. Dev., m^3/t	1.16	0.55	0.245	0.137	0.38	0.037
No. of samples	6	25	9	9	3	10
Minimum, m^3/t	0	0.29	0.13	0	1.13	0
No. samples with 0	1	0	0	3	0	7

While the average values were slightly different from the values used initially and recorded in Table 1, the differences were not significant statistically, and the conclusions reached earlier were unchanged. If anything, the observation of very low seam gas contents in samples taken from the same seam was confirmation of the low methane content of the return air.

3 Dynamic tests

It is a general rule that it is impossible to derive mechanisms from steady-state or equilibrium measurements. Accordingly it was decided to undertake measurements when conditions were changing, such as during a production shutdown, when the methane released from freshly mined coal would be absent and the methane released from residual coal should be the sole contributor.

Measurements were taken at Koornfontein during a production stoppage, with the results shown in Figure 1.

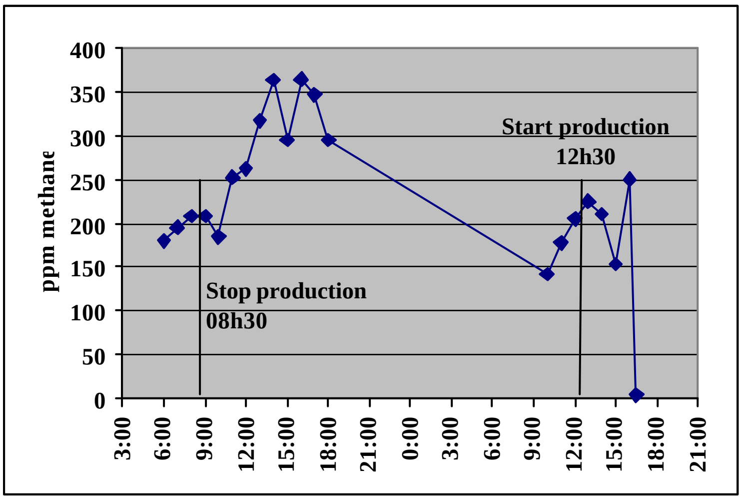

Figure 1 Methane in return air during a production stoppage at Koornfontein

The Figure shows an *increase* in the methane content of the return air after production ceased, and a drop to 4ppm soon after production restarted. What this clearly indicates is:

(i) The methane released from residual coal is an erratic and by no means even source of methane; and

(ii) The methane released from newly mined coal may not release any or all its methane content soon after mining.

The suggestion was made that atmospheric pressure changes might be responsible for the observations. Some results, over two different 36h periods, are shown in Figure 2.

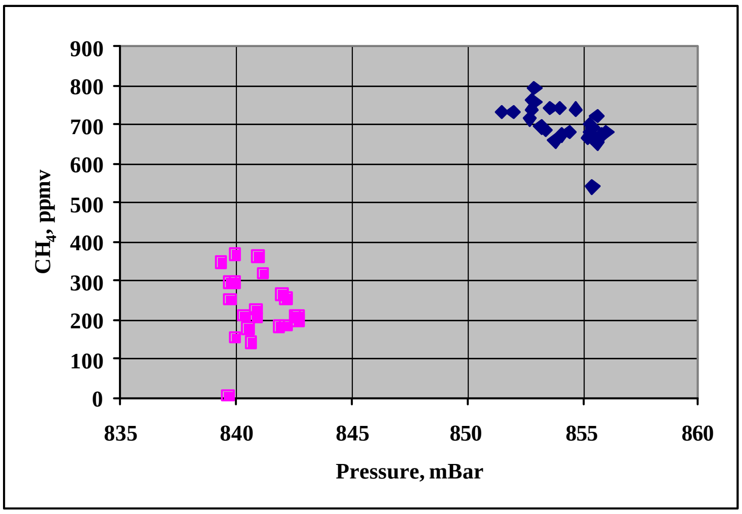

Figure 2 Methane in return air as a function of barometric pressure at Koornfontein

It is apparent that atmospheric pressure, if it is related to the release of methane from the coal seams, is related in a most peculiar manner, with increases of a few millibar causing massive increases in release. This seemed so unlikely that further studies were abandoned.

Confirmatory tests were undertaken on numerous occasions. For instance, at Matla, before going underground, the return air at the surface fan showed about 230 ppm CH_4. However, when sampling started at the section, no methane was present. Half an hour later, it was over 250 ppm, and stayed there until just before the change of shift, when it fell to 20ppm. During the shift change, it returned to normal levels and stayed there until the final sampling at 20h00. Check samples were taken from the return air from the continuous miner. When the miner was in operation, the results were similar to those in the return from the section as a whole, but a sample taken when the continuous miner was not working gave an even higher reading than when it was. This meant that release from freshly mined coal was not a significant factor. These results are shown in Figure 3.

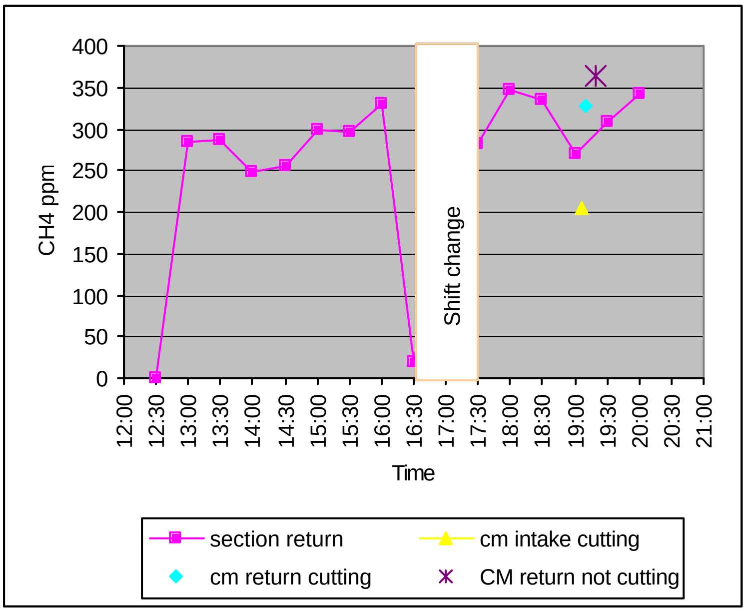

Figure 3 Results from repeated sampling in an operating section at Matla.

Similar results were obtained at Gloria, as shown in Figure 4. Surface sampling showed about 200 ppm CH_4 before going underground. The first sample taken underground showed no methane, but the level rapidly increased to over 800 ppm. This was followed by a quick drop to 600 ppm, followed by oscillations between 1200 and 0 ppm until the end of the testing period. On return to surface, the surface fan showed less than 100ppm methane. The intake to the continuous miner, when it was in operation, was similar to the section value, as it was in the miner return air when the miner was not working. However, when the miner was in operation, the return air from it climbed to over 1800 ppm. In this case, therefore, it appeared that release from freshly mined coal was significant, although the rise in the methane concentration during the shift change (when no production took place) suggest otherwise.

Anglo Coal made further results available, having sampled six of their mines. Some typical results are shown in Figures 5 and 6. In Figure 5, the sudden drop in methane concentration to very low values, which has been repeatedly observed, again occurs. In this case, CO_2 concentrations fell in sympathy. Much coalbed methane contains significant quantities of carbon dioxide, so this fall in concentration, in sympathy with the fall in methane concentration, is confirmation of the phenomenon.

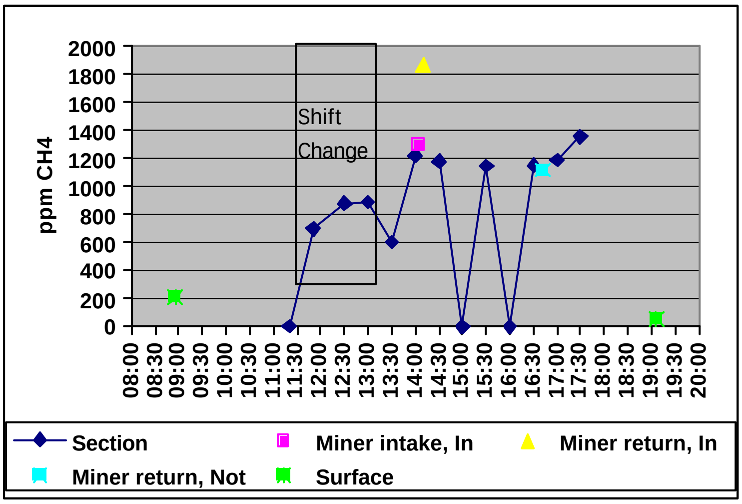

Figure 4 Results from repeated sampling in an operating section at Gloria.

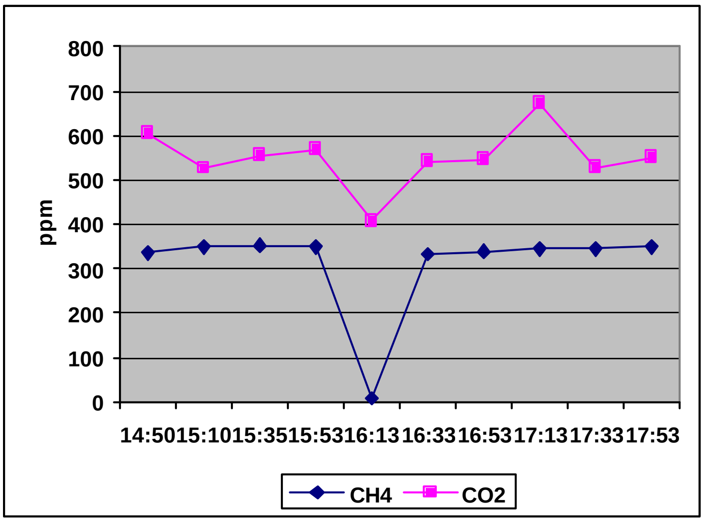

Figure 5 Repeated sampling of return air, S shaft, Bank Colliery

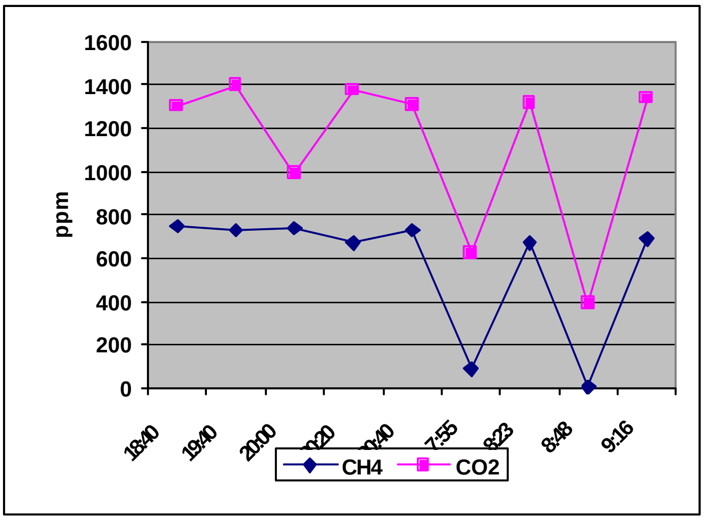

Figure 6 Repeated sampling of return air, Central E shaft, New Denmark.

Similarly, in Figure 6, there are repeated drops in the methane concentration to low levels, and simultaneous drops in the CO_2 concentration.

Taken in their totality, these results show very clearly that the concepts underlying the IPCC model were flawed in the case of South African mines, and it was necessary to develop an alternative model to explain the observations.

4 The release of methane from freshly mined coal.

A parameter that had not been checked after the initial observations was the release of methane from the coal. Table 5 gives calculations of the quantities, but it was felt to be desirable to determine them directly.

Coal samples were taken from the face belts, and the methane content determined in the normal way at various times after sampling. Figure 7 shows the rates of desorption from coal from four mines.

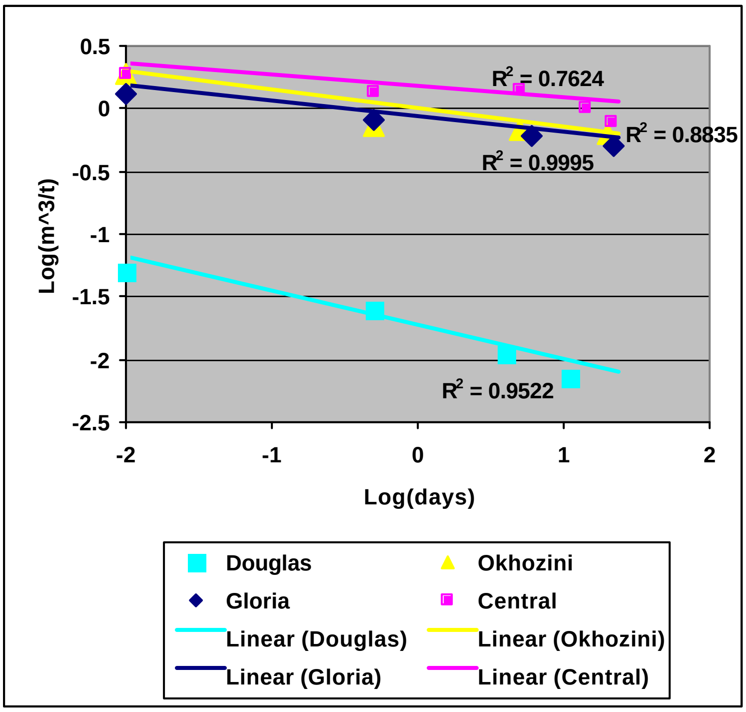

Figure 7 Rate of desorption of methane from coal samples exposed to the atmosphere.

All plot linearly on log-log plots with correlation coefficients varying from 0.762 (Central) to 0.999 (Gloria). Desorption was relatively slow in all cases. The more rapid rate at Douglas may have been due to a slightly finer run-of-mine coal than in the other cases – size distributions were unfortunately not recorded – but the relatively slow rate in all cases means that the contribution from freshly mined coal to the methane in the return air must have been relatively small. Even if it takes the coal as long as 1 day to leave the mine, on average only half the methane originally present in the coal will have been lost to the return air.

It has to be asked why the South African coals desorb methane so much more slowly than coals elsewhere. It has been reported previously [2] that South African coals are markedly undersaturated, in that they are able to hold at least five times as much methane under the hydrostatic conditions in which they are found than they actually do. That must in turn mean that they have a lot of free adsorption sites, which in turn means that methane desorbed from one site has as much of a chance of re-adsorbing as it does of escaping from the mass of the coal.

5 Synthesis of underground results

The results obtained above are best interpreted as follows:

1. Methane in South African coal occurs in the coal adsorbed on a small fraction of the available adsorption sites; and as free methane in faults, fissures and cleat structures associated with the coal. The methane is associated with significant quantities of carbon dioxide (Figures 5, 6), and its concentration in the coal is highly variable (Table 7). The free methane is probably **not** determined accurately in the usual method of estimating the seam gas content, although any free methane in a sample, held in microfractures, pores and cleats probably will be determined
2. When the coal is mined, its methane content is released relatively slowly from the mined coal (Figure 7), while the free methane is released relatively rapidly as long as there are pathways from the coal into the mine atmosphere. However, either the methane feeding such pathways can be exhausted, or the pathways themselves may become blocked by capillary forces or ground movement, so that the contribution from this source can drop rapidly to low levels. As mining proceeds, other pathways are then opened up and methane is again released, although not necessarily at the same rate as previously (Figures 1, 2, 3 & 4).
3. Coal that is not mined, but left in the floor, roof and pillars, makes only a small contribution to ventilation load because much of the free methane has already been released during mining. There is little driving force to desorb the residual adsorbed methane, although this may enter the mine atmosphere slowly over the years, particularly if there is any ground movement to re-open any pathways to release free methane and thus re-establish the driving force for desorption.

The slow release of methane from freshly mined coal, and the rapid release of methane from small sources of free methane within the coal seams, explains the discrepancies in the methane balances shown in Table 6, which were calculated on a basis of the IPCC model, which assumes rapid release from freshly mined coal and slow release from unmined coal.

It has to be asked why South African coals differ from the coal beds that gave the data for the IPCC model. The answer may lie in the considerable igneous activity that took place after coal formation in South Africa, as shown by the extensive network of dolerite dykes through, and sills over, the coal seams, and the “burnt” coal associated with the intrusive dykes. The heat associated with these events may well have driven off much of the methane generated during the process of coalification, leaving the seams relatively underpressured as has repeatedly been observed. We know of no similar intrusive igneous activity in coal beds elsewhere in the world.

The problem of developing a model for the emissions may be illustrated by the data from the Koornfontein Gloria shaft. There are 65 data points representing data acquired on several occasions over a period of two years. Figure 8 shows the data, and illustrates that it is NOT normally distributed. If, nevertheless, we assume a normal distribution would be shown if more data were acquired over a longer period, then is would indicate an average of 510ppm CH_4 with a standard deviation of 237ppm.

Table 7 indicates that the coal has a seam gas content of 1.21 m^3/t with a standard deviation of 1.16 m^3/t, while Figure 7 indicates that the coal loses its methane at a rate such that 43% of the seam gas is lost in one day. For 14 000 t coal/d (Table 6) and 590m^3/s ventilation air, then the contribution of freshly mined coal to the observed methane in the return air must be 143ppm (with a standard deviation of 137ppm). This implies that the free methane contribution averages 367ppm (with a standard deviation of 194ppm).

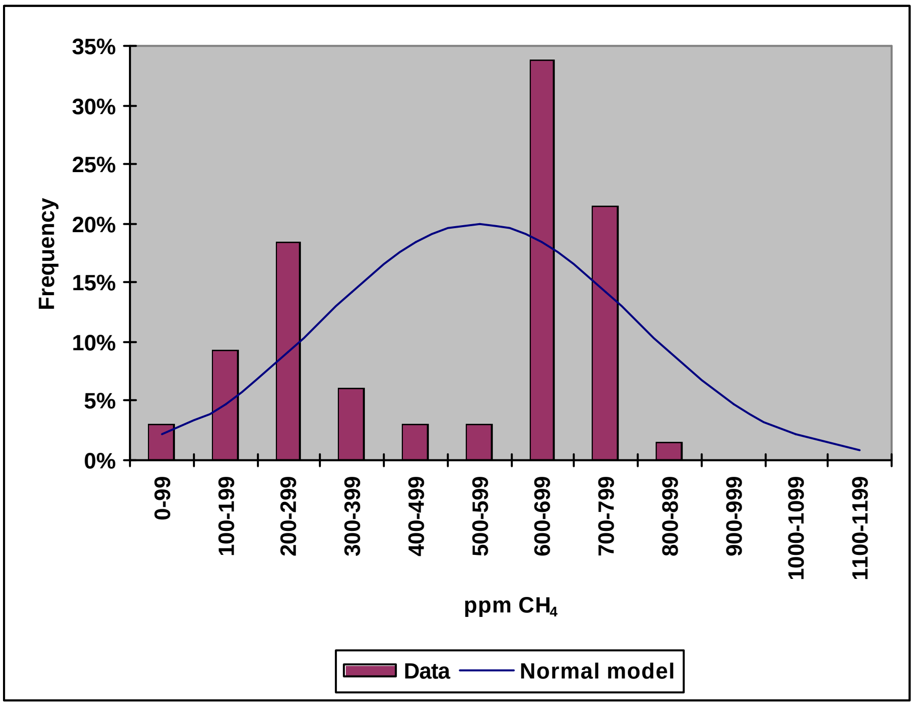

Figure 8 Distribution of data on methane in return air, Gloria Shaft, Koornfontein, 2001-3

The very large variances associated with each of these estimates mean that there are finite possibilities of observing very low methane concentrations, when both the free gas and the seam gas contributions to the ventilation load are low. Indeed, this is precisely what is observed.

Then, in attempting to estimate the methane bad imposed on the environment through coal mining, the underground contribution would be made up of two terms:

1. The methane content of the ventilation flow which, as we have seen, can be very variable. To estimate it with any degree of precision would require regular, possibly continuous, measurements of the methane content at each fan over extended periods. In the case of Gloria Shaft, Koornfontein, for instance, the 510ppm CH_4 at 590m^3/s translates into 7000t CH_4/a.
2. The methane lost from coal after it leaves the mine, which will amount to about 50% of the seam gas as normally determined. It can be estimated by sampling coal from the belts leaving the mine, and determining the residual methane by fine grinding in a controlled atmosphere. Again, because the seam gas content is so variable, it would require a significant number of measurements on each mine to make a reliable estimate of this contribution. In the case of Gloria Shaft, Koornfontein, for instance, we know that 57% of the seam gas is retained in the coal after 1 day, and that the seam gas amounts to 1.21 m^3 CH_4/t. At a mining rate of 14000t/d, this is 2500t CH_4/a.

6 Release of methane from surface mining.

Coal samples were collected from exposed seams in opencast coal mines, from drill holes and from interburden strata. They were sealed in gas tight containers for transport and crushed in the laboratory to release the methane content. The results were analysed using the standard USBM graphical method to determine lost gas volumes.

Some of the samples were also left to desorb over a period of time to quantify the rates of gas desorption after mining.

Gas samples were taken from boreholes into coal, interburden, and from underground coal seams, and pumped into 400ml glass pipettes at 100kPa gauge. They were submitted to NECSA for laboratory analysis to determine what gases were being emitted.

The results from mines in the Witbank area are given in Tables 8 and 9, and those from Grootegeluk in Table 10.

Table 8 Seam gas content of surface mines, Witbank District.

Mine	Coal seam	Content (m^3/t)
Goedgevonden	5	0,04
Klienkopje	2	0.009
	2	0.002
	4	0
	4	0
	overburden	0.017
Optimum	2	0.011
	2a	0.002
	4	0.064

Table 9 Seam gas contents of borehole and pitface samples at Optimum Kwagga

Coal seam	Drill core (m^3/t)	Exposed pit coal (m^3/t)
2 upper, top of seam	0,058	0,006
2 upper, top of seam		0,028
2 upper, bottom of seam	0,023	

Table 10 Seam gas content of borehole and pitface samples, Grootegeluk

	Gas content (m^3/t)	
Sample depth, m	**Boreholes**	**Pit**
34	0.021	0.008
66	0.012	0.005
79 (shale)	0.003	
92	0.081	
97	0.035	
104	0.049	
109	0.038	
112	0.000	0.005
128	0.000	

The seam gas analysis showed significantly more carbon dioxide than methane. This was true even when there was quantifiable contamination of the sample by air and allowance was made for the 365ppm CO_2 background. In contrast, methane desorbed from coal samples collected underground proved to be essentially pure CH_4.

Comparison between borehole samples and pitface samples showed, statistically, that there was a slight loss of seam gas as the coal was exposed, as would be expected.

However, tests on the desorption of seam gas from some samples were inconclusive. If the sample initially had a very low seam-gas content (<0.01m^3/t), then it tended to adsorb gas (probably CO_2, although this was not checked) from the atmosphere, reaching contents as high as 0.05m^3/t after 80 days. In contrast, samples with initial seam-gas contents of the order of 0.1m^3/t degassed to less than 0.01m^3/t over a period of about 20 days.

The combination of low seam-gas contents in the coals mined from surface, and the low concentration of methane in the seam gases, mean that the contribution from surface mining of coal to greenhouse gas releases by the industry can effectively be ignored. Even if the seam-gas content were as high as 0.1m^3/t and the methane content were as high as 50% of the total seam gas, then the approximately 100Mt of coal plus intraburden mined annually would contribute <3000t (3Gg) CH_4/a.

7 Estimate of the industry's releases, conclusions and recommendations

During the course of this work most of the production shafts on underground mines have been sampled repeatedly. In total there were 243 measurements of methane in the return air from 27 different shafts. As we have seen, a wide scatter was observed, but taken as a whole the results give us some measure of the quantities involved. For each shaft the average methane concentration was multiplied by the known ventilation rate, which gave a contribution to the total methane emission of 40.8Gg CH_4/a (with an error of ±30.2 Gg).

Seam gas contents had been determined for about 72% of the coal production. Assuming 50% was lost underground, and contributed to the methane in the return air, and that the mines for which data were missing were represented by the mines for which there was data, then the total lost after leaving underground mines was about 28.6Gg CH_4/a (with an error of about 24Gg).

Thus the best present estimate of the release of methane from South African coalmines is:

- 40.8 Gg CH_4/a in ventilation air from underground mines;
- 28.6 Gg CH_4/a from coal after it has left the mine; and
- <3 Gg CH_4/a from surface mining operations,

or approximately 72Gg/a.

However, there are very large errors associated with these estimates. The source of these errors is largely the physical processes responsible for the release of much of the methane from South African coalmines, particularly the sporadic release of free methane. This causes huge fluctuations in the measurable concentrations of methane in the return air. To improve the estimates will require effectively continuous measurements over several weeks on each shaft. Further errors arise from the considerable variation in the seam gas content of the coal, and again it will require repeated measurements of the residual gas in coal coming from underground on each mine before these errors can be reduced significantly.

Fortunately the techniques for carrying out these measurements are not particularly onerous, time consuming or expensive, and it is recommended that consideration be given to requesting environmental officers on the mines to undertake this work and to collate the results nationally, to allow the Industry to demonstrate that it is not the polluter it is often portrayed as being.

8 Acknowledgements

The authors would like to express their thanks to many colleagues who have assisted them in this work in many different ways, not least of which has been undertaking sampling under trying conditions and over long periods. The Energy Research Centre and Itasca Africa are thanked for granting permission to prepare this paper. The CSIR is thanked for its administration of the contract on behalf of Coaltech 2020, the funders of this study.

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