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ANALYSIS OF ETHANE EMISSION TRENDS FROM ACTIVE GOAF SEALS AT MANDALONG MINE

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ABSTRACT: Monitoring of active goaf seals at Mandalong Mine shows anomalous levels of ethane concentrations. Currently ethane concentrations exceeding 250 ppm have been experienced from 30 to 32 C/T seals of MG8 with the remainder of the panel averaging 50 - 100 ppm. Active goaf seals for MG7 and MG9 average 50 - 100 ppm and 80 - 100 ppm, respectively. For most mines these concentrations of ethane would be assumed to indicate a spontaneous combustion event; however no carbon monoxide is being recorded and a sympathetic relationship with methane indicates that the measured ethane is due to gas desorption. This paper presents the results from the mine showing trends in ethane emissions from the active goaf seals to date, and shows how this historical data can be used to predict expected ethane concentrations in the active goaf of MG10.

INTRODUCTION

Mandalong Mine is located 50 km south of Newcastle, New South Wales, Australia. The mine operates a 150 m wide retreat longwall system in the West Wallarah Seam of the Newcastle Coalfield. The seam varies in thickness from 3.5 to 6.5 m and has moderate gas content up to 6 m^3/t. The predominant seam gas constituent is methane, but ethane is also present as a subordinate component in appreciable amounts. In-seam gas drilling and drainage is applied to the seam to lower the gas content to sufficient levels to prevent statutory limits being exceeded in the mine general body gas make.

Anomalous concentrations of ethane experienced in recent active goaf areas has been a cause of concern to the operations as ethane is generally linked to a possible heating of coal (Beamish and Jabouri, 2005; Claassen and Beamish, 2010). This has prompted an investigation into the source and trends of ethane emissions within the active goaf. Data for the first three months of monitoring each cut-through seal has been analysed to determine localised trends and averaged to determine panel wide trends. This paper presents the results of this investigation including a model of the ethane emissions in the active goaf.

GAS SAMPLING AND RESULTS SUMMARY

Summary of gas data

Gas chromatographic results of gasbag samples from active seal samples at Mandalong Mine have been analysed to determine and interpret trends in ethane emission data. To standardise the results, data from the first three months of monitoring for each seal was analysed. The active goaf areas investigated were Maingate 7 (MG7), Maingate 8 (MG8) and Maingate 9 (MG9). The average ethane concentrations for the first three months of monitoring 32 C/T to 19 C/T of MG7, MG8 and MG9 are contained in Table 1. The corresponding values for 18 C/T to 3 C/T are contained in Table 2.

Active goaf trends

Maingate 7 active goaf trends

Average ethane concentrations for 32 C/T to 30 C/T are around 100 ppm and remain relatively stable in the first three months of monitoring (Figure 1). For the outbye cut-throughs the ethane concentrations decrease to values between 50 and 80 ppm (Figure 1). Methane and ethane concentrations along MG7 cut-through seals show a sympathetic relationship, as shown for 29 C/T to 24 C/T in Figure 2, while carbon monoxide is generally absent.

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Table 1 - Average ethane results for maingate cut through seals, 32 C/T - 19 C/T

Maingate seal	MG7 Ethane (ppm)	MG8 Ethane (ppm)	MG9 Ethane (ppm)
32 C/T	104 ± 3 (31/03/09 – 15/05/09)	173 ± 19 (28/07/09 – 27/10/09)	–
31 C/T	105 ± 7 (31/03/09 – 21/05/09)	163 ± 28 (4/08/09 – 3/11/09)	–
30 C/T	98 ± 8 (1/02/09 – 2/05/09)	195 ± 22 (28/07/09 – 27/10/09)	89 ± 10 (15/02/10 – 15/05/10)
29 C/T	63 ± 18 (31/03/09 – 22/05/09)	99 ± 10 (28/07/09 – 27/10/09)	81 ± 6 (15/02/10 – 15/05/10)
28 C/T	68 ± 12 (2/03/09 – 2/06/09)	90 ± 12 (28/07/09 – 14/10/09)	82 ± 14 (08/04/10 – 15/07/10)
27 C/T	67 ± 19 (31/03/09 – 22/06/09)	81 ± 3 (27/10/09 – 13/01/10)	95 ± 10 (15/04/10 – 8/07/10)
26 C/T	61 ± 19 (31/03/09 – 16/06/09)	–	105 ± 9 (08/04/10 – 04/05/10)
25 C/T	56 ± 12 (31/03/09 – 20/05/09)	64 ± 10 (29/07/09 – 27/10/09)	95 ± 19 (10/02/10 – 29/05/10)
24 C/T	54 ± 8 (31/03/09 – 16/06/09)	54 ± 3 (21/08/09 – 8/12/09)	–
23 C/T	56 ± 4 (31/03/09 – 22/06/09)	56 ± 12 (21/08/09 – 30/11/09)	77 ± 24 (27/10/09 – 10/02/10)
22 C/T	54 ± 12 (2/03/09 – 2/06/09)	51 ± 4 (25/08/09 – 25/11/09)	64 ± 6 (04/05/10 – 08/07/10)
21 C/T	47 ± 9 (31/03/09 – 22/06/09)	53 ± 5 (1/09/09-20/11/09)	–
20 C/T	55 ± 6 (31/03/09 – 16/06/09)	55 ± 4 (1/09/09 – 8/12/09)	80 ± 11 (18/02/10 – 30/03/10)
19 C/T	51 ± 19 (31/03/09 – 22/06/09)	54 ± 8 (15/09/09 – 20/12/09)	–

Table 2 - Average ethane results for maingate cut through seals, 18 C/T - 3 C/T

Maingate seal	MG7 Ethane (ppm)	MG8 Ethane (ppm)	MG9 Ethane (ppm)
18 C/T	60 ± 7 (31/03/09 – 16/06/09)	57 ± 8 (30/09/09 – 17/12/09)	67 ± 8 (31/03/10 – 2/07/10)
17 C/T	57 ± 3 (31/03/09 – 3/05/09)	63 ± 10 (30/09/09 – 30/12/09)	76 ± 11 (11/02/10 – 26/03/10)
16 C/T	59 ± 12 (2/04/09 – 16/06/09)	56 ± 6 (14/10/09 – 12/01/10)	63 ± 16 (16/02/10 – 29/04/10)
15 C/T	63 ± 14 (2/04/09 – 22/06/09)	55 ± 3 (21/10/09 – 12/01/10)	77 ± 9 (02/02/10 – 26/03/10)
14 C/T	58 ± 7 (20/04/09 – 16/06/09)	59 ± 6 (3/11/09 – 12/01/10)	60 ± 10 (16/02/10 – 29/04/10)
13 C/T	–	57 ± 7 (11/10/09 – 12/01/10)	72 ± 11 (11/02/10 – 26/03/10)
12 C/T	67 ± 5 (25/04/09 – 2/06/09)	63 ± 7 (15/12/09 – 3/03/10)	55 ± 5 (16/03/10 – 29/04/10)
11 C/T	77 ± 16 (18/05/09 – 22/06/09)	53 ± 2 (12/01/10 – 20/04/10)	56 ± 9 (10/02/10 – 19/05/10)
10 C/T	69 ± 16 (25/04/09 – 17/06/09)	67 ± 3 (15/12/09 – 2/03/10)	69 ± 24 (02/02/10 – 29/04/10)
9 C/T	69 ± 26 (22/06/09 – 10/09/09)	57 ± 6 (12/01/10 – 20/04/10)	62 ± 19 (11/02/10 – 20/05/10)
8 C/T	77 ± 17 (18/05/09 – 16/06/09)	58 ± 4 (2/03/10 – 14/05/10)	64 ± 16 (16/02/10 – 29/05/10)
7 C/T	74 ± 24 (8/05/09 – 22/06/09)	60 ± 1 (12/01/10 – 20/04/10)	60 ± 5 (26/03/10 – 19/05/10)
6 C/T	69 ± 17 (20/05/09 – 16/06/09)	67 ± 6 (2/03/10 – 22/06/10)	71 ± 22 (17/02/10 – 29/05/10)
5 C/T	78 ± 17 (21/05/09 – 22/06/09)	68 ± 1 (12/01/10 – 20/04/10)	84 ± 23 (10/02/10 – 19/05/10)
4 C/T	60 ± 23 (16/06/09 – 20/10/09)	110 ± 10 (12/01/10 – 2/03/10)	86 ± 21 (17/02/10 – 29/05/10)
3 C/T	81 ± 15 (21/05/09 – 10/09/09)	81 ± 9 (12/01/10 – 20/04/10)	102 ± 22 (15/02/10 – 26/03/10)

Maingate 8 active goaf trends

Average ethane concentrations for 32 C/T to 30 C/T are significantly higher in MG8 seals compared with MG7 and it is not until 27 C/T before the ethane concentrations begin to decrease to the 50 – 80 ppm range of the outbye seals in MG7 (Figure 1). A second anomalous zone of high ethane also occurs at 4 C/T.

Maingate 9 active goaf trends

Average ethane concentrations for 30 C/T to 25 C/T are elevated in the range of 80 – 100 ppm before returning to the 50 – 80 ppm range at the outbye seals, except for 3 C/T (Figure 1). Once again a sympathetic relationship is present between ethane and methane emissions.

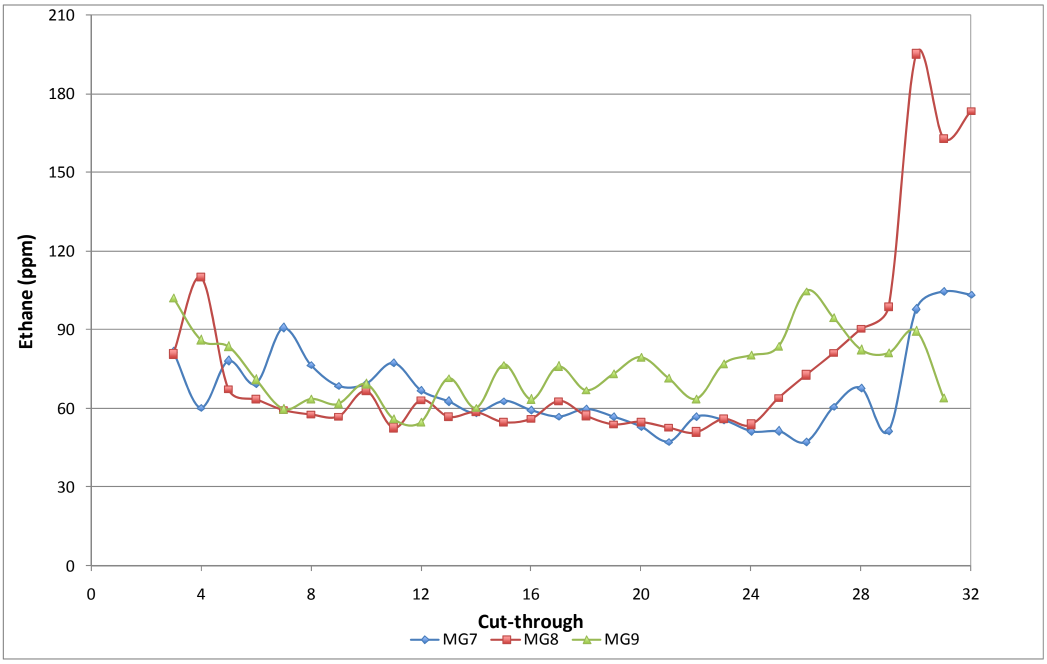

Figure 1 - Average ethane concentrations for MG7, MG8 and MG9

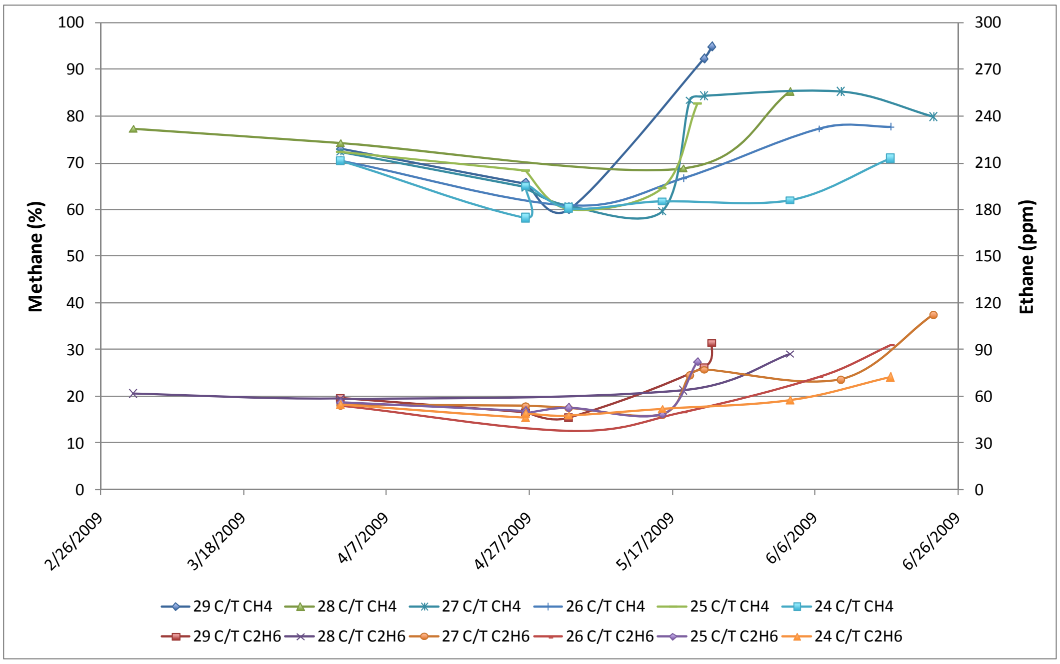

Figure 2 - Maingate 7 methane and ethane concentrations on air free basis (29 C/T – 24 C/T)

ETHANE PREDICTION MODEL

All of the average ethane values obtained from the active goaf seals in MG7, MG8 and MG9 have been used to create a grid model in the surface modelling package Surfer® 8 using the Kriging method. The gridded values have been contoured to generate a 3D surface model of the ethane concentrations (Figure 3). The anomalous ethane zone shows as a localised area in LW8, extending from 32 C/T to 28 C/T. The kriged values obtained using Surfer can also be used to predict the ethane concentrations for each of the active seals in MG10. These values are contained in Table 3 and they show that ethane concentrations range from 68 to 97 ppm.

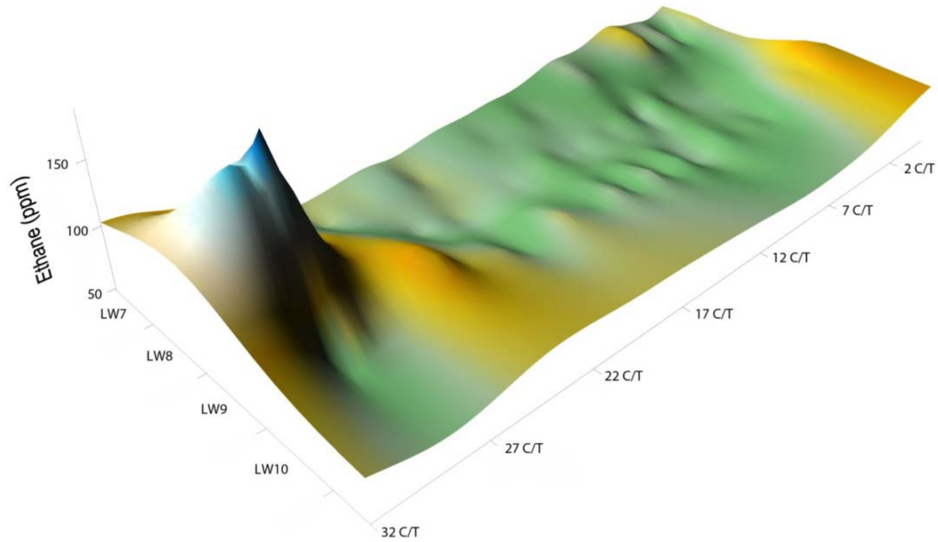

Figure 3 - 3D surface model of ethane concentrations for Mandalong Mine active goaf areas

Table 3 - Maingate 10 predicted ethane concentrations

Location	Ethane (ppm)	Location	Ethane (ppm)
3 C/T	97	18 C/T	78
4 C/T	93	19 C/T	79
5 C/T	86	20 C/T	80
6 C/T	80	21 C/T	79
7 C/T	74	22 C/T	80
8 C/T	71	23 C/T	82
9 C/T	70	24 C/T	85
10 C/T	69	25 C/T	87
11 C/T	68	26 C/T	88
12 C/T	68	27 C/T	85
13 C/T	70	28 C/T	79
14 C/T	72	29 C/T	73
15 C/T	74	30 C/T	70
16 C/T	75	31 C/T	71
17 C/T	77		

CONCLUSIONS

The presence of ethane in recent active goaf areas appears to be due to seam gas desorption and not coal oxidation due to the lack of consistent carbon monoxide readings, as well as the sympathetic relationship with methane. The 32 C/T to 28 C/T area of MG8 experienced a localised spike in ethane concentrations, possibly due to an increased level of desorbed ethane, or an increase in seam thickness resulting in a higher quantity of coal in the goaf. Based on ethane trends for the first three months of each cut through seal of MG7, MG8 and MG9, a gridded model has been developed using kriging to produce a 3D surface model of the ethane concentrations at each seal. This model has also been used to predict the expected ethane concentrations in the first three months for each cut-through seal of MG10. As these values become available they will be used to validate and refine the model.

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