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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "An explanation of large-scale coal and gas outbursts in underground coal mines: the effect of low-permeability zones on abnormally abundant gas" *by* F. H. An and Y. P. Cheng

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The authors would like to appreciate the anonymous Reviewer #1 for his helpful and useful comments. The authors will take into account the recommendations of the Reviewer and try to improve the overall redaction of the paper. This is a point-to-point response to the Reviewer.

Comment 1: I am not convinced that the paper is suited for this journal. Clearly, explosive outbursts of gas and coal in coalmines are a serious problem, in China and

in other areas of the World. However the paper does not explain how the research conducted in this study can reduce the risk posed by the outbursts.

Answer: The aim of this paper is to describe an aspect of the formation mechanism of large-scale coal and gas outbursts. Therefore the original paper was not focused on the technology and mechanism for reducing the outburst risk. Considering the Reviewer's comment, we added introduction about the approaches for outburst prevention.

Comment 2: Some of the findings described in the paper are (or at least appear to me) rather basic, and not particularly new or innovative. Indeed, it is well known that the local and the regional geological structures (e.g., the presence of folds and faults) condition the location and the abundance of coal, and of volumes of gas in the coal seams. It is also obvious that the presence / absence of sealing around a coal seam controls the presence of pockets of gas in the coal, that can produce destructive gas outbursts. The authors should explain better what is the innovative contribution of their work.

Answer: It is true that regional geological structures are widely regarded as one controlling factor of the coal gas distribution. However, to preserve the regional abundant coal gas the neccesary and affecting factors of the low-permeability zone in the coal seam is not analyzed in the previous study and its effect on the outbursts risk is not studied as well. Considering the recommendation, we emphasized this point in the revised paper.

Comment 3: The paper is reasonably well written, but there are a few typos that should be corrected [see below]. In places the language is a bit too technical, and difficult to understand for a reader not familiar with the coal mining literature. I will make a few examples of words that needs clarification: (i) page 4752, "coalification", "work face", page 4756, "Langmuir pressure", page 4757, "tectogenesis", page 4759 "Kronecker symbol". The authors should make an effort to simplify the language, as much as possible.

Answer: The typos were modified in the revised paper and the technical words were simplified or modified.

Specific comments There is a typo in the first line of the Abstract. “gas outbursts post a risk” should be “gas outbursts pose a risk”

Answer: It was corrected.

There is a typo in the line 4 of page 4753. “outburst” should be “outbursts”.

Answer: It was corrected.

page 4753, line 11, “has been”? Does it mean that now it is not lacking anymore?

Answer: It was modified.

Page 4753. Here and in other places the authors use the word “abnormal”, but they do not define what is “normal”. This should be clarified.

Answer: The explanation of “abnormal” was added in section 2.1.

Page 4753, line 20. Language of the first sentence of the paragraph does not make sense.

Answer: The amount of coal and coal gas ejected out in a large-scale outburst requres enough energy. The main energy source for outbursts is the coal gas stored in the coal mass releasing energy by expanding. So enough coal gas is requried to provide the energy released in the outburst. We modified the expression.

Page 4753, and Table 1. How the volumes of coal and gas given in the text and listed in Table 1 were measured, and with what level of accuracy?

Answer: The mass of coal can be weighed when the coal mass ejected into the working face was cleared after the outburst. The volume of coal gas is an estimate. When the outburst occur, the concentration increase of coal gas would be detected by the gas sensor in the roadway and air shaft. The quantity of coal gas emission during the

outburst can be estimated with the quantity of ventilation airflow and coal gas concentration. The volume of outburst coal gas is the difference between the quantity of coal gas emission during the outburst and the quantity in normal times. More explanation was added.

Page 4754, please explain what a “tectonic zone” is, in the context of the work. What is the geographical, geological, or geometrical scale of such zone?

Answer: The “tectonic zone” means the area affected by geological structures. The spatial scale of coal mines usually ranges from several kilometers to tens of kilometres and outburts occur in parts of the coal mine. So the paper put attention on the area affected by geological structures in the above range or smaller ones. To be clear, we modified the expression.

Page 4754, lines 26-28. It is not really new, or surprising that “in the past years, it was found that the distribution of gas is nonuniform due to tectogenesis, and certain tectonic structures promote certain patterns of gas distribution”. What are these “certain patterns”?

Answer: It is our mistake that this sentence was not clear. It has been found in the previous study that certan tectonic structures are beneficial to the storage of coal gas. And it has been modified.

Page 4755, line 13. Quantify “enormous”.

Answer: As listed in Table 1, the quantity of outburst gas is more than tens of thousands of cubic, and the average outburst gas per ton of outburst coal is much higher than the usual coal gas content.

Page 4756, various places. When explaining symbols in the equations there is no need of repeating the word “represents”.

Answer: It was modified.

Page 4757, lines 18 and 24. Delete “clearly”.

Answer: It was modified.

Page 4757, line 25. Why “more than a million years”? Clarify.

Answer: Without considering the effect of new geological structures, the gas migration through the coal seam would continue for a long time with constant boundaries, and the low-permeability zone could affect the gas distribution obviously in this process. In the numerical example we studied this process for one million years with the effect of low-permeability zone in the coal seam. And this sentence referred to the result of this numerical example that the concentration of coal gas in the low-permeability zone could maintain higher than outside the zone after more than a million years, When the permeability of the low-permeability zone is two or three orders of magnitude less than that of normal coal. We modified the expression to avoid referring in particular to “a million years”.

Page 4758, lines 15-20. This conclusion is not really surprising, or new.

Answer: The conclusion was modified and rewritten to take into account your recommendations.

Page 4759, lines 6 and 9. Explain “Kronecker symbol” and “DP”.

Answer: “Kronecker symbol” is 1 when i=j and is 0 when i$\neq$j. The Drucker-Prager (DP) criterion is the yield funtion shown by equation (6). We modified the expression.

Page 4760, line 6. Why 10E5 years, and not a different period? Explain.

Answer: The gas migration time is long, and maybe hundreds of thousands of years or more. To analyze the effect of various low-permeability zones on gas distribution and then on the outburst risk, we chose one case that the coal gas distribution is after gas migration for 10E5 years. The 10E5 years is not special actually and we added more details in the previous section.

Table 1, page 4764. How the quantities were measured, and with what level of accuracy? It would be better to list the events by date. Can you provide a map showing where the mining accidents occurred?

Answer: The mass of coal is weighed when the coal mass is cleared after the outburst. The volume of coal gas is estimated by the difference between the quantity of coal gas emission during the outburst and the usual quantity. When the outburst occur, the concentration increase of coal gas could be detected by the gas sensor in the roadway and air shaft. The quantity of coal gas emission during the outburst can be gotten with the quantity of ventilation airflow and coal gas concentration. The gas amount of an outburst is the difference between the quantity of coal gas emission during the outburst and the quantity in normal times.The relative gas emission rate of the entire is estimated through dividing the quantity of coal mass in the ventilation airflow by the coal production. The events was listed by date. The map showing where the mining accidents occurred was added.

Figure 1. I understand this is a sketch, but providing a scale for the sketch will help the reader understand the problem.

Answer: It is hard to confirm the scale of these geological structures. But the area affected by the geological structure is mine-scale, with a range from hundreds to thousands of meters. The description “mine-scale” was added.

Figure 2. Same comment as for Figure 1.

Answer: More details were added.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/1/C2828/2014/nhessd-1-C2828-2014-supplement.pdf

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