

ACARP GAS AND OUTBURST WORKSHOP MACKAY 28TH AUGUST, 2004

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Introduction

With an attendance of over 60 people, the workshop was a success. I would like to thank all the presenters for their excellent efforts in preparing and presenting such stimulating papers. The notes and slides contained in this document only represent what was shown on the screen at the workshop and what I was able to capture of the discussions. The details given by the presenters could not be captured and had to be heard to be appreciated.

An underlying message in many of the presentations was that, although surface to in-seam drainage has advanced considerably in the last few years, as more knowledge is gained, it is more obvious that there is much more to be learned. Each area is unique and has to be understood to get the best productivity from SIS. Just because the technique works for one mine or area, does not mean it will work in an adjacent area.

The workshop was very well attended by surface to in-seam drainage and CBM personnel whose contributions in the presentations and in the in-depth discussions provided a wealth of experience which can only help to better understand the problems of applying SIS techniques to coal mining gas management.

The relative paucity of attendance by coal mining personnel is regrettable and emphasises opportunities lost. Sharing of knowledge and experience is surely one of the most cost-effective methods of training personnel in gas management and prevention of costly mistakes and tragedies. These notes, even though widely distributed to mining personnel, can only convey a fraction of the information shared at the workshop.

I tried to record discussions and answers to questions as accurately as I could, but I apologise for any errors or mis-quotations.

John Hanes
Workshop Convenor

Tony Field

Questions, Comments and Answers

Roger Wischusen, ACARP - Could you use the drill rig monitoring to detect structures while drilling in- seam?

Tony - Yes, as long as there is sufficient throw. If there is a fault of greater than half seam thickness, it would be easily detected but less easily if say half seam thickness.

Andrew Clough, Queensland Department of Mines – What do you do when you abandon a hole? What do you do to prevent water ingress during mining? Do you cement the holes as is done for coal exploration?

Tony - Perhaps the question should be answered by the companies we drill for. The liners we use in the holes can be over-mined safely. We have not really come across this as a problem to date.

John Weissmann

Questions, Comments and Answers

David Mathew, CH4 – You spoke of the ideal length as being around 800 metres. Could you explain why you feel that to be the ideal length.

John - I do not think that. A few years ago when your first holes were being drilled, I was told 800 metres was ideal. I have been mainly involved with underground drilling where longer holes are drilled if time and circumstances permit. I am happy to drill a longer hole but I want to be sure it will be effective.

David - The issue for you to look at is what drilling rigs we have and how long we can push these holes. There is a whole issue out there that we have to understand what are the hydraulics of what is happening underground in that hole which I think might be telling you something about what the ideal hole length is. I would like to see some more work done on that because I feel that there lies the secret of the ideal length.

John - Another area we need to consider is that some seams do not have consistent gas content or pressure through the hole. In these holes there will be fluid transport between the areas of different gas content. The fluid will flow from the high pressure areas to the low pressure areas.

Richard Grigg, CH4 - With longer holes does gas production increase proportionally with length?

John - Every hole is an unknown identity. Every hole is different. Some longer holes produce a lot of gas for a long time, but a similar length hole adjacent might produce much less gas. It is hard to generalise. The original Oaky project had good gas production in a short period of time with rapid draw-down. At another site with holes of 1100-1200 metres, some holes produced phenomenal amounts of gas and some produced similarly to the tight coal at Dartbrook. A 2000 metres hole has just come on line and it is too early to comment on it.

Ray Williams, GeoGas - You mentioned putting all your eggs in one basket with surface to in-seam holes. You mentioned a series of 20 wells. I expect that before you drilled each hole you would have had some expectation of what would happen in it. What is your feeling now of how many holes lived up to your expectations? We are all on a learning curve with regards to surface to in-seam and we all learn as we go.

John - Where shallower, we have had more success. Deeper than 200 metres, things change, whether underground or from the surface. My great concern is that we have a hole which we must make sure produces. We currently use PVC conduit in holes to keep the holes open. But there are sites where it appears the conduit does not keep the holes open. I want to see a different form of casing used. Preferably one which might allow you to pass over it with a rod string to clean the hole. I want something that will make sure the hole stays open. When you do multiple branches, how can you make sure a branch stays open? With multiple branching, there is much more drilling and a bigger production of fines, so we need a bigger sump. I am really skeptical of multiple branched holes. At one site we are discussing multiple branches as well as multiple intersections.

Ray - Are you now more confident with medium radius drilling?

John - It is the same story. Some go very well and some not. The best producers are the shallower holes which are kept open. Care needs to be exercised during draw-down and

the pump must be matched to the water make. Stop-starts will kill a well. Reliability of equipment is important.

Don McMillan, Origin Energy - With the surface to in-seam project, do you produce gas from the lateral end?

John - Only if there are problems with the vertical hole.

Andrew Clough, Queensland Department of Natural Resources, Mines and Energy - What measures do you take when abandoning the hole to protect mining?

John - At one site holes have been intercepted already. Part of the risk assessment for those holes was we had to be sure there was no water in the vertical systems and that the whole system was open. We had to be sure there were no blockages. There are a number of ways to check on this.

Ray Williams, GeoGas - There might be some confusion with Andrew's question. These holes are typically lined and cemented down to the coal seam.

Andrew - Under the Coal Mining Regulations, exploration holes must be cemented.

John - It is an issue which will have to be considered.

David Mathew, CH4 - It is a whole new world. One of the issues I think we are going to have will be with the legal profession. They have to understand that the coal seams have to be shared between the two industries. The questions of how you protect your investments and how you protect your stake holders and share holders. The lawyers want to make everything black and white. It is really all about co-operation with your neighbour.

Bill Koppe

Questions, Comments and Answers

Bill - the Coal Seam gas Council was formed to provide a forum for co-operation between gas and coal producers. We each have our own separate organisation to look after our separate interests. The Gas Council is different in that it is focused on both industries working together. We would like to see more coal companies join.

Scott Thomson, CoalBed Concepts – What is happening in NSW re sharing of gas?

Bill – NSW gas has been run by policy rather than by legislation. This might get difficult to manage down the track when there are legal challenges. They are currently allowing gas extraction over mineable coal seams. The new NSW Greenhouse policy has a working group which is looking very hard at mining issues. I understand that they are including consideration of regulating emissions from open-cuts – we should see later this year when they release a discussion paper on the subject

Brendan Galloway, Queensland Department of Natural Resources, Mines and

Energy – You should not worry about the size of the pages in an Act. Bill has given a very balanced view of the situation. This is a quite complex area and deals with things that have not been experienced before. The future is not clear. Representatives of both parties have done an excellent job in a very mature fashion in ensuring that the interests of both parties were actually dealt with. Anyone today who has a five year plan and does not believe it will need much change several times, doesn't understand the laws of change. We only have to look at the current oil price and how much it has changed in recent times. The Government wants the best outcome for the state. In other words, the interest of the two parties is met in a fair and equitable fashion. Because of the way the world is today, every organization is faced with changing its development plans in line with the market. The Government cannot control the market place. We too react just as you do. We want people to be up front to establish lines of communication. It is a brave new world. We are finding out what we need to know.

Trevor Stay Moura

Questions, Comments and Answers

David Mathew, CH4 – How long have the holes been in production?

Trevor – All wells were completed in 12/03 and 1/04. There has been fairly consistent production for 8 months to a year after the peak, then another +30 months to decline.

David – You could leave the holes open with no liner.

Trevor – If we could leave it unlined, then we could clean it out once per year. Perhaps using TRD could remove the double skin.

David - Re the new regulations, there was one regulation the miners insisted on and that was that SIS holes would have liners. They did not want the holes to collapse and cause pressurised sections of holes.

Scott Thomson, CoalBed Concepts – The hole could block, even with a liner.

Tim Meyer, CRC Mining - If you could run down your line in a simple cost-effective way, and clean out the hole, it could be budgeted in for every year say. With a rapid deployment tool we use for TRD, we could not only clear the hole, but re-excite it and remove a lot of the skin effect and re-activate the laterals. Liners will be required but they will not be steel. We should be able to use a water jet to clean the slots. With the current state of technology, we should be able to gear up a flexible hose system for cleaning holes soon.

Ray Williams, GeoGas – Could you tell us what changes you have made to get up to one million cf/d?

Trevor – It has mainly been due to orientation of the holes in relation to cleat and stress directions. We seem to have found a happy balance through trial and error. The holes seem to produce well and are related to the key features of cleat and stress and dewatering. For workovers, bigger sumps and dewatering seem to be working, but now, we dewater much more slowly than previously to reduce the skin effect.

Trevor – When you are trying to dewater a coal seam, out amongst the acres of cleated coal, there will be some fine coal. The hole is like a tub of muddy water. If you pull the plug and allow it to drain quickly, most of the mud will be drawn to the plug hole. With coal seam drainage, rapid drainage will draw the fines into the cleats. With regards to the skin effect, if you drain quickly, you increase the resistance to drainage. Therefore, the slower dewatering, and maintenance of pressure initially to slow the gas flow over the first few months can benefit longer term production. Controlled dewatering and controlled gas onset are the key.

Steve Taylor, Principal Geologist, CSM team, Santos.

Questions, Comments and Answers

Dave Mathew, CH4 - What will happen when you go off the anticline?

Steve - I imagine there will be fewer fractures and a more complex stress regime.

Roger Wischusen, ACARP - What differences are there in the approaches by Santos and the more recent coal seam methane producers?

Steve - Mainly the different depths. We would not use the fracture stimulation at shallower depths where vertical stress is less than horizontal stress.

Roger - The costs involved must mean you are chasing larger targets than they are.

Steve - Yes plus we do not have to dewater so there is a cost benefit there.

Roger - Have there been any moves in Santos to target shallower coal seams?

Steve - The first two projects I discussed were shallower.

Scott Thomson, CoalBed Concepts - How consistent are the flows?

Steve - There are good and poor wells. The initial 7.8 MMcf/d flare shown on the slide is one of the best.

John Hanes, ACARP - What depth were you where the rods were sheared by ground movement?

Steve - 700 m.

Scott Thomson, CoalBed Concepts - Have you a standardised stimulation technique?

Steve - We use a fairly light weight gel.

Don McMillan, Origin Energy

Questions, Comments and Answers

Scott Thomson, CoalBed Concepts - How does what you have discussed compare with conventional oil field work in natural gas? It gives me a bad feeling that there are so many variables coming out of C B M.

Don - There is a lot more history in conventional gas. Basically the sweep efficiency in oil with good high permeability reservoirs in a very strong aquifer can be 85 - 90% which is very impressive. In a low permeability reservoir the number is much lower but even in the high permeability reservoirs, there will be accumulations of little pockets of oil everywhere. In a core, the geologist looks for a homogeneous sample but in the three dimensional sense, homogeneity is not the norm.

Steven Kelemen, Santos - If the CBM industry adopts the SEC rules, what will be the implications?

Don - This is scary. SEC is very good for conventional fields. According to SEC rules for unconventional fields, with CBM reserves, you can only book reserves when actually producing. You need to have a well-established field with a lot of history before you can start booking reserves. If you want to start a new project like Moranbah, I don't know the implications.

Dave Mathew, CH4 – In the mining industry we have no problem starting a project on what you would call 2P or 3P reserves. We do not try to prove up the entire field first. We just prove up enough reserves to get started. It looks like your problem is you have to prove up all your reserves before the banks will lend you any money.

Don – A long time ago when I was investigating the ASX rules in relation to floating, one thing I noted was that CBM reserves must be signed off by a “person”. This seemed ridiculous. For signing off on minerals reserves, you need to have +5 years experience and satisfy other criteria. When it comes to reserves statements, have a look at who signs off. Has he actually worked in the field and produced CBM, and then he will have an appreciation of the complexity in estimating reserves.

Scott Thomson, CoalBed Concepts - San Juan seems to be taken as the benchmark for CBM. Everyone seems to be inspired to replicate it. Do we come close to it in Australia?

Don – Yes. Comet Ridge would be close. The big issue though is recovery factor which we estimate is still very low mainly because of water production issues. It will take a long time to get the pressure down.

Dave Mathew, CH4 – Do they have the same amount of water in San Juan as you have in Comet Ridge?

Don – No. But Powder River does.

Ray Williams

Questions, Comments and Answers

The coal industry had some good results from initial MRD work, but a concern I have is that the coal mines are not contributing sufficient resources to MRD. There is a tendency to drill a hole and then walk away from it rather than adequately manage the hole completion, monitoring and maintenance.

Scott Thomson, CoalBed Concepts – Re underbalanced drilling from underground, clearly the problem is the high pressure gradient. By implication, in the deeper areas where there is high pore pressure, the problem is worse. Does that explain why the Chinese coal mines with high gas content and high reservoir pressures have such problems with underground drilling?

Ray – Stability might improve as you drill a long hole because ECD gets higher

Scott – I was thinking more in a general sense. If you do horizontal underground drilling, you underbalance all the time. The pore pressures are high and there are potential problems with the hole collapsing. There are increased problems over say, MRD.

Ray – Into the formation, you have higher pore pressures, in the borehole itself there are low pressures. The differential causes a lot of problems. The pore pressures are needed to counter some of the ground stresses. With MRD, you can keep the in-hole fluid pressure up while drilling to support the hole.

David Mathew, CH4 – Isn't there another issue when you are drilling underground, in that the coal is desorbing as you drill whereas in an MRD hole, you control pressure and there is no desorption while drilling?

Ray – In underground drilling, desorption happens in an uncontrolled way and the gas make has to be managed at the drill site. A lot of drilling is on the intake side, so the gas has to be got out of the mine. Some mines pollute their intakes.

John Weissman – Many underground holes produce 700 lps with rapid desorption. One would expect that such rapid desorption would cause destruction of the hole. But many holes in underground drilling produce well for a long time.

Ray – It is hard to know exactly what is going down the hole, whether the gas is coming from a discrete zone or from along the total hole. But many holes underground produce only a little gas.

Scott Thomson, CoalBed Concepts – With underground drilling, redundancy of holes might be the answer why drainage works, but the performance of individual holes might be poor. We are trying to float some interest in research in that area. There is not enough understanding of individual borehole performance. Monitoring processes and data collection need to be improved and the data utilised.

David Mathew, CH4 – We would support that from the MRD side. It could help us understand our holes better.

Tim Meyer, CRC Mining – There have been a number of factors talked about as affecting well bore such as effective stress, fines migration, permeability and coal

shrinkage among others. The range of permeabilities can be huge from 1 mD to 100 mD. Which factors are more important for low permeability coals?

Ray – The low permeability coals tend to be deeper. The gas comes out more slowly, so the issues with rapid draw-down are not so great. With higher permeability, the gas can come out more quickly and potentially cause more problems. I think you are alluding also to variations in permeability. I agree it is difficult to say which factors are most relevant. My talk is focusing on the theoretical at a time when a lot of holes have been drilled and people are just starting to have a close look at the performance. I am not prepared to hang my hat on one factor at this stage knowing that the importance can change as more information becomes available. There is a lot we do not understand.

Tim – Can you suggest which mechanisms are coming into play. Are there patterns starting to emerge from monitoring of production which might imply hole blockage or other factors?

Ray – There are complicating factors. I feel the liners which are currently used tend to complicate the understanding of what is happening. When you start getting a few problems starting to occur in a hole, it complicates the issues, especially if the borehole goes up and down dip as well, producing highs and lows which cause water to run down hills into the troughs where velocity is slowed and fines are deposited. I have looked at many wells to try to work out the causes of variations in production, but it is difficult to come out with a definitive answer. All you can do is say that at this point in time, there are a few principles on the drawdown side to look at. But experience will change what is important. I have seen holes which have been rapidly drawn down which are poor producers, but I have also seen holes which have been textbook managed which are also poor producers. The uncertainty of understanding causes of variations in production is the problem. This uncertainty is spooking the coal miners. They need to devote resources to monitoring the process to develop a better understanding.

Richard Grigg, CH4 – In your experience, are you getting better production from MRD holes or in-seam holes?

Ray – I cannot say. Across panel drainage underground has been proven to get results. The SIS has huge potential, but it must be used well ahead time of mining to get results. It is less efficient using SIS just ahead of the next gate road drivage. It can be a good tool where you think well ahead about what is needed, as it is a much more cost-effective way of getting the gas out.

Dave Mathew, CH4 – What we have learned from MRD is interesting. I think we are getting a handle on the drilling issues, we are pushing holes out further, we are doing under-balanced drilling. The big issue for us is we are a long way from understanding how to bring these holes into production efficiently. Rules developed in one location to help understand what is going on are not necessarily transferable to another site. More resources have to be applied to determine how best to bring these wells into production. Ray has said that the coal companies may question the success of SIS holes, but they should consider where they apply their resources to better understand their holes. Most resources need to be applied to understanding and carefully controlling a hole. We are opening up huge amount of surface area of coal and we are desorbing it. The desorption can be very violent. We desorbed some of our early holes without any control and I had

pieces of coal flying out of the flare stack. A hole can be destroyed in no time if it is not controlled properly. This is an area we have to put a lot of emphasis on.

Ray – Trevor, it was interesting to see what has been achieved at Moura. Your 350 m hole spacing in essentially parallel holes leads to quick interaction and fast results.

David Mathew, CH4 – You have to be careful. What suits Moura is fine, but if the dip were flatter, you could have a different condition. It is horses for courses.

Trevor – The positioning of the laterals within the seam at Moura is important. The permeability varies through the vertical section of the seam. Keeping the drill bit in the best permeability section of the seam can be a challenge.

Tim Meyer, CRC Mining – In a mine with both SIS and underground drilling in nearby areas, how are the litres/m/min stacking up?

Ray – It would be nice to have a comment from someone from Oaky Creek or other mine on this.

Anon, Moranbah North – We have SIS and in-seam close together. The in-seam drilling is more productive than the SIS initially, mainly due to the water situation.

**Scott Thomson, CoalBed Concepts, Coal Interface Detection
Questions, Comments and Answers**

Richard Grigg, CH4 – We have used directional gamma for about 70 odd in-seam holes. We could not drill without using directional gamma. We typically do between 10-15% overdrill because we cannot see ahead. The directional gamma allows us to differentiate roof from floor, but we cannot see structures such as rolls ahead.

Scott – We are using a single gamma device which we rotate to look up or down.

Henk Verhoef, AMT – I agree with the usefulness of gamma in 50% of cases. The problem comes with how far back behind the bit the gamma tool is. All the other tools you mentioned such as the shuttle, the dielectric and radar are all post-drilling survey tools. AMT have considered most of these tools over the years and the problem comes with trying to drill with these tools.

Scott – Part of the problem is getting data from holes for geological models. So pump-down tools should be no problem. Gamma used during drilling should help reduce overdrill. The driller is much worse off without gamma. Mitchell Drilling used to do 30% overdrill before using gamma. Now it is more like 5-10%. The gamma does work better in some seams than in others. The depth of investigation is a limiting factor. Overall, drilling in-seam should be using gamma as a routine tool, but there should be other geophysical tools also used to improve the amount of useful geological information retrieved from the holes.

David Mathew – In your research have you found any tool that might give an indication of fracture pattern or intensity relative to permeability?

Scott – No one tool will do it, but a combination of the drilling parameter tool and the geophysical tools might help.

David – We have talked today about why one hole underperforms a neighbouring hole. It might simply be a geological issue that one hole has lower permeability than another. The way we measure permeability now is in boreholes which might be a kilometre apart. Is there a tool I can use in a SIS hole which can give me an indication of permeability variation down the hole?

Scott – Almost. There is a combination of sondes which should give you the answer you want, but they require packaging. With MRD, there is no IS problem, so we should be able to do it in a few months.

Mike Wold, CSIRO

Questions, Comments and Answers

Ray Williams, GeoGas – Outbursts are very complex. Measuring properties in non-outburst coal is difficult but doing measurements in outburst coal will be very problematic with the definition of the boundaries of the zone and the materials involved. I wonder how you can get to a point where you characterise the outburst coal and differentiate it from non-outburst coal.

Mike – If and when outburst events happen, we will have to sample very carefully and take measurements. Until then we need to continue to press ahead and do what measurements we can. The careful experimental work as part of Xavier's project looks at failure of coal, its desorption rates, permeability changes etc to try to better understand which components contribute to the outburst. We can only continue to increase our knowledge and better understand the mechanism until we can get measurements with an outburst and then compare measurements. It has been understood for many years that outbursts are complex. Ripu Lama set the criteria for thresholds and the application of them has saved lives. There are economic costs of applying the threshold criteria. In a general sense we can show that stronger coal has a lesser potential to outburst, therefore we might be able to use coal strength as an indicator. The modeling using good real measurements can then be applied to obtain real outcomes. The coal seam is extremely variable.

Ray – You mentioned incremental advances, in the conclusion. We have benchmark mines which have big issues with outbursts. However, extending the understanding to other areas is important because there could be quick practical gains. An example could be people wanting to know what size barriers to use around roadways. This is partly controlled by the permeability. But the number you use in the model must be the worst number you have.

Mike – I recognize the variability can be so great that it will be difficult to quantify, but the work has to be advancing the science in the right direction.

Ting Ren, CSIRO – Permeability is dependant on stress. Do you use uniaxial or triaxial stress?

Mike – We try to replicate the stress in the coal seam. We do not stress to failure. We will be doing tests using triaxial stresses.

Bruce Robertson/John Hanes

Questions, Comments and Answers

Ray Williams, GeoGas – I am concerned about what you have said. From my way of thinking, a tool that could define outburst structures in boreholes should be within reach. Definition of lack of structures ahead of the face would then allow the mines to mine to the higher threshold value. RIM between holes has promise.

John – I have agreed with you on this subject for many years. But although the technology is basically available, mine support and uptake has been poor. There was a monitored rotary drill rig developed under ACARP funding, which was proven to detect outburst prone coal ahead of mining, but nobody used it and it fell by the wayside, literally. Fitting the same rotary rig with Ian Gray's torque-thrust tool for coal toughness index and his on-board survey tool would provide a very useful device for proving coal ahead of the face to be structure-free. To develop technology to prove up structures, there has to be commitment by the mines to test new technology. There has been ACARP funding to develop several tools. But to complete development and to have them commercialised, they have to be tested underground. The tools Scott described earlier seem to have promise, but there will be considerable difficulty getting them into mines for testing.

Scott Thomson, CoalBed Concepts– It should be possible to use the tools underground if they can pass a risk assessment where it can be shown they are not electrically activated until they are in a water-filled hole.

Henk Verhoef, AMT – It is not a question of risk assessment. It is up to the Department of Mines and they define the borehole as Zone 0 which requires IS.

Scott – Last year we went through the process with radio imaging where with risk assessment and site-specific managers rules we were able to use non-IS equipment in a gassy mine. It is the mine manager's call.

Anon?? – There are conflicting regulations. One says you can do as you have described and another regulation is about EOv 0 which says you cannot.

John – A few years back, there were discussions with the Queensland Mines Department mainly by the late Jon Sleeman of ACARP, about the approval of trials of equipment in water filled holes. The indication at the time was they were prepared to listen to suggestions. At the time, Jon did not even get a reply to his queries to the NSW Department of Mineral Resources. Henk is giving us his advice having been there and done that. It seems logical to put more effort into detection of structures ahead of mining. Such knowledge could save a lot of money.

Ron Cassidy, Central Colliery – From an operator's point of view, we have a system which seems to work. But applying the system, we have so much pressure on us to get done what we have to, that we do not have the ability to provide people for doing tests or supporting researchers or developing equipment. Unless the instruction comes from senior management, we cannot provide logistical support.

Scott – It is too hard to get things done in mines to assist research.

John – It is a problem today, but if the industry is going to advance and be able to handle the problem of outbursts in the future, the people who make the decisions and commit company money will have to act.