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Author:	**Scott Dallimore**
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Affiliation:	**Natural Resources Canada 9860 West Saanich Road P.O. Box 6000 Sidney, BC V8L 4B2**
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MALLIK GAS HYDRATE PRODUCTION RESEARCH PROGRAM

WEEKLY SCIENCE REPORT #8 - THE END FOR THIS SEASON!

MARCH 11-22, 2008

AURORA RESEARCH INSTITUTE

DEAR READERS:

AS OF MARCH 22, MALLIK 2L-38 AND 3L-38 HAVE BEEN FORMALLY ABANDONED, OUR SITE IS BEING COMPLETELY DISMANTLED AND MORE THAN 40 TRUCKS ARE MOVING EQUIPMENT SOUTH. AFTER 4 LONG YEARS OF PLANNING AND TWO CHALLENGING FIELD SEASONS, WE HAVE FINALLY COMPLETED THIS PHASE OF THE RESEARCH. WHILE MANY ASPECTS OF THE PROGRAM HAVE BEEN REVISED AND ADJUSTED SEVERAL TIMES, IN THE END WE HAVE UNDERTAKEN THE FIRST SUSTAINED FLOW TEST FROM GAS HYDRATES BY DRAWING DOWN THE FORMATION PRESSURE. I BELIEVE WE HAVE ACCRUED A LASTING DATA SET AND A WEALTH OF LEARNINGS WHICH IN ONE WAY OR ANOTHER WILL FIND THEIR PLACE IN THE GAS HYDRATE R&D HISTORY BOOKS. SO FOLKS, WITH THESE ACCOMPLISMENTS BEHIND US, I AM HAPPY TO REPORT THAT THIS IS THE LAST SCIENCE REPORT YOU WILL BE RECEIVING ON MALLIK. OF COURSE MORE NEWS OF MALLIK WILL COME IN THE NEAR FUTURE AS WE ANALYSE OUR RESULTS AND WRITE THEM UP. WHILE PERHAPS NOT NEARLY AS ENTERTAINING, IF YOU ARE INTERESTED TO FOLLOW THIS PART OF THE WORK I WOULD BE HAPPY TO KEEP YOU POSTED (JUST LET ME KNOW BY EMAIL)

IT HAS BEEN MY PLEASURE TO SEND YOU THESE UPDATES. I DO HOPE I HAVE SUCCEEDED IN A SMALL WAY TO EXPLAIN THE COMPLEXITIES OF THE OPERATIONS PROGRAM AND THE RESEARCH AND DEVELOPMENT GOALS THAT HAVE DRIVEN IT. I APOLOGISE FOR THE TYPOS AND THE OCCASIONAL EMBELISHMENTS / INACCURACIES. BOTH ARE A CONSEQUENCE OF JUST WHO I AM. WHILE I CAN WRITE, AS FRED WRIGHT SAYS EVEN IF IT WAS A MATTER OF LIFE AND DEATH I WOULD HAVE TROUBLE KNOWING HOW TO USE A COMMA PROPERLY (MORE SO WHEN I AM OVER TIRED). THE EMBELLISHMENTS ARE FRANKLY SIMPLY BECAUSE I AM ETHUSIASTIC AND VERY, VERY PROUD OF THE TEAM OF PEOPLE ON THIS DISTRIBUION LIST WHO HAVE ALL CONTRIBUTED IN THEIR OWN WAY. PLEASE KNOW THAT NRCAN, JOGMEC AND AURORA ARE APPRECIATIVE OF ALL THOSE WHO HAVE HELPED US GET THIS JOB DONE!

AND…IN BOLD CAPITAL LETTERS… I JUST HAVE TO PAY SPECIAL TRIBUTE TO A FEW HARD WORKING FOLKS WHO HAVE STEERED THE FIELD OPERATIONS. FROM OUR IPM TEAM; LUIS AND GERARDO… FOR TWO GUYS FROM SNOW-FREE CENTRAL AMERICA I TAKE MY HAT OFF TO YOU.. YOU HAVE LEARNED AND YOU HAVE REALLY DONE YOURSELF PROUD!.. BILL WHAT CAN I SAY BUT YOU ARE THE 'MAN', THANKS FOR BEING WITH US WHEN I KNOW YOU HAD OTHER PRESSING MATTERS ON YOUR MIND. BRAD, LORENA AND MARK THANKS FOR THE HARD WORK. DOUG AND KEVIN, WELL DONE GUYS IT HAS BEEN A PLEASURE TO WORK WITH YOU DAY IN AND OUT! FROM OUR OPERATOR TEAM; ANDREW, AL, ANICK , JERRY, WILLIAM, LARRY, PIPPA YOU HAVE SHOWN THAT A NORTHERN EDUCATIONAL INSTITUTION CAN BE THE OPERATOR OF A COMPLEX STATE OF THE ART R&D PROGRAM AND THAT IT CAN BE RUN IN THE NORTH BY NORTHERNERS. FROM JOGMEC; YASUDA-SAN WE HAVE MISSED YOU AT AURORA LODGE THIS YEAR BUT ARE THANKFUL FOR YOUR LEADERSHIP. YAMAMOTO, TOMOMOTO, NUMASAWA, K AND T. FUJII-SANS THANKS FOR YOUR HARD WORK THROUGH THICK AND THIN. FROM NRCAN; YODA AND MARK, FOR A LITTLE TEAM OF 3 I THINK WE DID DARN GOOD GUYS. THANKS FOR THE SUPPORT AND PLEASE FORGIVE ME FOR THE MOANING, WORRYING, AND LONG TIME AWAY FROM HOME !

 # 1 MALLIK ROAD: WHERE THE ACTION WAS ON MARCH 16, 2008 AFTER 6 DAYS OF SUCCESSFUL PRODUCTION TESTING.

R&D Contact: Scott Dallimore, Geological Survey of Canada
E-mail: sdallimo@nrcan.gc.ca Phone: 867-777-3298, ext. 27 Cell: 867-678-5346

PROJECT STAFF ON SITE

INUVIK

NRCAN- S. Dallimore,
JOGMEC-, M. Yasuda, K. Yamamoto, T. Fujii
J. Tomomoto
AURORA- A. Applejohn, J. McEachern, A. Jenks
D. Ashford, K. Martin
SKK-Y. Morikami, P. Primierio, , N. Sakiyama; **JOE**- M. Kurihara, K. Funatsu; **Tokyo Gas**- T. Kawasaki

MALLIK SITE 69 hearty souls
NRCAN - F. Wright, M. Nixon **JOGMEC** - M. Numasawa, K. Fujii
AURORA- L. Johnson, W. VanderBurgh, G. Serrano, L. Bueno
SKK- K. Suzuki

+ the more than 100 additional truckers, logistics staff and field personnel who have helped out this year.

WEEKLY WEATHER

No Mallik road closures all week.. Weather clear and cold with lows near -40 C. The Dempster Highway… well that is another story. With the exception of two hours yesterday, it has been closed for the past three days. Unfortunately, we have 2 B-trains backed up waiting to get to Mallik to pick up waste drilling fluid for disposal in N. British Columbia. But based on past experience, we are confident they will make it to Mallik just in time.

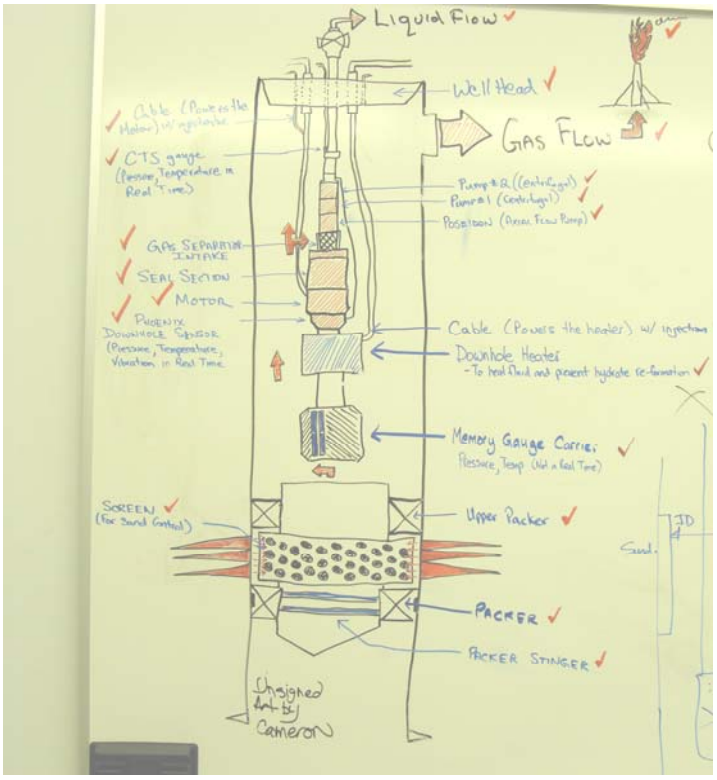
FIELD OPERATIONS

Oh happy days!: March 10@06:00-16@12:00hrs

We left off last week's Science Report with news that we had recovered from a gas kick, spliced our ESP and heater cables, run the pump intake down to 811m and had started production testing. Well good news folks! Operations for the past ten days and especially the 6 days of production testing have been by the book. While the science and R&D learnings were gloriously 'not' by the book (there is no book on this job after all), operations teams and equipment performed on time and as designed.

A summary is given below of operations during the production testing using the rationale that it is simplest to follow water/gas/sediment from the dissociating gas hydrates from 1093 to 1105m in Mallik 2L, up the completion assembly to the surface, through the testing spread, to the flare stacks for the gas, and back to the formation in Mallik 3L-38 for the water. And yes… I know … I have gone on a bit long here!

Other operations to report are that as of March 22 we are out of here! Equipment disappearing faster than you could believe.



Follow the gas, water and sediment: For reference all of the key operational elements are shown on this magnificent white board sketch made by Cam Cockle at the rig site. Follow the red arrows and the text below and all will be clear!

Heater on @6:00 March 10

Bob Isted of MADIS is one of our camp 'elders' with many years of practical experience under his belt. Bob designed and constructed our downhole heater for the Mallik program and he operated it throughout the test. It was fitting therefore that he began the production testing operations by turning on his downhole heater @6:00 am on March 10th. The primary purpose of the borehole heater was to heat the intake fluid and reduce the risk of gas hydrate formation within the production tubing string itself. A strange challenge in this project is that while we are trying to dissociate gas hydrate in the formation, there was also a risk that we could form gas hydrate. The main concern was that as the free gas flows to the surface some gas might get entrained in the pump intake and then enter the production tubing. As the pressure regime inside of the tubing was relatively high and the fluid relatively cold, gas hydrate in theory could reform and plug the tubing in a similar manner to gas hydrate formation inside gas pipelines. Bob's job was to heat the borehole fluids so that no gas hydrate could form in the tubing. Despite encountering some

damage to his equipment during shipping and having a truck drive into his heater, Bob and his equipment did an amazing job. From start to finish the borehole heater chugged away efficiently achieving target temperatures between 20 and 30°C and eliminating our risk of gas hydrate formation in the tubing. Job well done Bob!

Fred, Rod, Brandon, Jason, Bob the heater man in orange and Marisela

Pump on 16:20hrs March 10 - 12:00 hrs March 16

Schlumberger Artificial lift led by Cameron Cockle (artist who made white board sketch) and his team (Rodrigo Ayres, Kaley Nykolyshyn, Mariselas Rojas, Jason Schuman, Shane Wolfe) kicked off the production test by firing up their ESP pump @ 16:20 hrs on the 10th. The pump is Mariselas's mechanical baby as she supervised its design and construction. Given the experience with sand production last year, great care was taken during construction with boronization of many working components. Cam was the 'man' on site however, and that is saying something. At 6' 6", 160 lbs soaking wet, a mind that never slows down and a tendency to wear his pajamas around camp, he is not your typical oilfield hand. He was however an amazing leader for his team, able to excite his crew and to challenge them to run Marisela's pump far outside of the design specifications. With Brad Sproxton, Cam gave a much appreciated standing room only talk to the camp staff about gas hydrates. Cam also did not restrain from engaging his mind, weighing in with the IPM and clients about what he thought was going on during the many unexpected flow responses we observed over the course of the week. But perhaps the most impressive accomplishment of this team was their talent in handling their equipment. Frankly speaking it was the pump and the ability of the crew to dial in a fixed water level (intake pressure) that determined our bottom hole flowing pressure and therefore the effectiveness of our production test. Much easier said then done of course, as our first R&D observation was that water flow rates were very low. As Cam and his team wanted to keep the pump running at all times, the only way to adapt to this low flow rate was to manage all of their pump parameters to match the inflow rate. A very challenging job which was done very well.

Cam at far end of ESP/heater/testing shack manning his work station and waxing on about bubble theory with Fred, ESP/Testing watchers and anyone else who would listen.

Gas, Water and Sediment to surface 16:25hrs March 10 - 12:00 hrs March 16 (and beyond)

With the start of the pump, two flow routes were possible for gas, water and sediment moving from our formation. By design, we anticipated fluid would enter the pump intake and flow to the surface, perhaps with some entrained sediment but hopefully without significant gas. With a fluid level in the well substantially above the pump, by design the route for the gas was up the annulus between the production tubing and the production casing. While Cam and Bob's jobs were to kick off and maintain the production test, the task of dealing with the various components returned to the surface was that of Schlumberger testing led by Hassen Kamel and his team (Robert Byrne, Roderick Estrop, Scott Greenland, Tristan Gros, Seth Osborne, Majid Ahmad Khan, Lee Richard, Kahlid Sultan, Randy Penny). Hassen is from Algeria and has worked recently in eastern Canada on large scale, large flow gas wells. Scott, Doug, Kasumi and Hassen had one memorable drive to Mallik early on in the program. In addition to listening to Doug's country and western music, we challenged each other to share memorable experiences in our lives. Hassen certainly had a few interesting ones, included the hottest working environment (more than +50°C) and most interesting meal (I am not going to share that one). The six hours we spent in the truck also were used for work however as Doug, Hassen and Scott went through every step in the production testing spread. Hassen explained the care he and his team had taken to build redundancy in case we had unexpected formation response. Clearly one of the challenges was adapting oil field testing equipment to our expected low gas flow rates. Two flow routes were established at the

surface. The A-train was designed to handle the tubing flow, receive the water at the surface, separate the sediment, measure the water and gas and then send any gas to a independent flare stack and the water to large bulk storage tanks for subsequent injection in Mallik 3L-38. The B-train was designed to handle the gas dominant flow up the annulus, accommodate the possibility of water return at the surface, separate off and measure the pure gas flow, and then send gas to the flare stack. Testing was largely responsible for compiling production data and the collection of water, gas and sediment samples which were of prime R&D interest. While there were a few hiccups with steam and condensation in the flare lines, overall the testing equipment and staff worked tirelessly to deliver a quality product.

Kamel opens sediment filters from A-train

Produced water back down Mallik 3L-38

Lost in many of our science reports has been the performance of Nabors drilling. With more than 25 Nabors employees on the job during the course of the program this year there are too many to list. It suffices to say that from start to finish this year toolpushs Darrel James, Clayton Fadden, John Barnett, Neil MacLeod have led an able crew. These are the folks who day in day out dealt with the well control events, the storms, the broken BOP, the troublesome boilers and power systems etc.. etc.. For the testing however these were the folks who kept our long injection line to Mallik 3L thawed and functional. It was a testament to their considerable skill that the injection program went very smoothly.

Nabors crew rigging down at the end of a successful season

SKK Monitoring Team and client brain trust

This week I am including the SKK monitoring team and JOGMEC/NRCan field staff in the operations overview as these folks basically worked 24- 7 through out the course of the testing program.

Coordinated by Kasumi from JOGMEC, the SKK team was led by Paulo and run by Yoko, Naoki, Naushad and Katsuko. This able crew provided updates twice a day on temperature trends during the testing program contributing much valued insights on well bore temperatures. The performance of the SKK team was outstanding.

The other operational element of the client group was the team of folks in Inuvik. The overall voice of decision making came from Yasuda-san who sought R&D guidance from Dallimoto-san (Koji and Scott). But in support of this group was almost a dozen additional participants from JOGMEC, NRCan and Aurora. Two shifts were set up to monitor field data and the progress of the testing. Koji worked the day shift (04:00-16:00) with Kurihara-san (voted the most able and honorable participant of our field team!), Kawasaki-san and the ever able Mark-san. Scott worked the night shift with pranksters Tetsuya and Kunihiro. Andrew, Al and Jerry kept up the operator side of things and Tomomoto-san kept an eagle eye on overall activities offering many suggestions about next steps. Fred and Numa-san and Kasumi/Tetsuya were the client representatives in the field and probably had the most challenging job as they had to consolidate the field data, operations status and deal with the Inuvik folks and take care of sampling.

Suzuki and Sakiyama-sans in SKK/GSC trailer

Client brain trust in Inuvik… missing Koji and Kasumi!

Gerardo, Luis, Bill, Medic, Fred and Mark at morning well site meeting

A word for the support crew

In case you have not picked up on this yet. The testing program at Mallik was a team effort. In addition to the components mentioned above all those in the field have to be fed, have roads to drive on, communicate with the outside world and simply be able to flush the toilet. At any one time at least 40 folks have tended to these needs for more than two months. Thanks to all.

Thanks Jerry for coming back after an absence of 10 yrs!

The boys man the IPM control center

VIP Trip

As if our last 8 weeks of work have not been eventful enough. On March 17-19 the Mallik R&D team received nearly 20 VIPs. In addition to key players from JOGMEC/NRCan/Aurora, a number of key players in the Canadian gas hydrate world came to pay hedance to those who had worked so long and so hard (ok at least I am going to go with the idea they were). Included in this group was a Minister and officials with the Government of the NWT, the Vice President of the National Research Council of Canada, the Chief Conservation Officer of the National Energy Board, the head of a gas hydrate panel at the Canadian Council of Academies and the Director of the Northern Oil and Gas Directorate with INAC.

The events kicked off with a closed meeting on March 17 with the VIPs and then a very well attended public talk at Aurora College (still not clear if they were attracted by the free food or Scott's used car salesman speaking skills). Although a little late (i.e. two days after the testing was completed), the big event was on March 18 when half of the VIP group drove to Mallik while the other half flew in three chartered helicopters. The tours went very well except when Scott, Sandy, John and Christina climbed a pingo and returned to the pick up spot only to find that the main VIP group was huddled together in a bivouac position waiting for the helicopters to return (-36°C can be a bit cold after 1 hr lying in the snow). March 19 included a very interesting morning discussion about the future of gas hydrate research in Canada.

Fred entertaining the VIPs!

Doug doesn't let VIP's or public forget it is St Patrick's Day!

Yikes hordes of VIPs arrive on site!

CCA's gas hydrate chair John Grace and GNWT Minister Bob McLeod strapped in and ready to go!

Two cool dudes, Fred and Yasuda-san at Aklisuktuk Pingo

Colleen and Marc D'Iorio toasting Mallik!

Safety briefing at rig site (Sandy taking notes, Carol, Bharat taking on food for upcoming tour, Sandy, Christina, Giles, Marja, and Yasuda listening studiously for safety tips!)

Ok this was not part of the VIP trip but heck...Andrew, Maurice well done guys that is one heck of a carving!

R & D ACTIVITIES

Tricky business this…as behind all the pretty pictures I know some of you are going to be looking for some substance. Unfortunately, I have to be cautious in this report to not release any data or specific trends from the production test. There are a few reasons for this, first we are still dealing with raw unedited data, second it is top secret for at least the next short while and while I trust you…really this should not be the venue to release substantive results. My thinking however is that there is room to tell you exactly what we did, touch on the data compiled and the higher level learnings that are apparent even at this early stage.

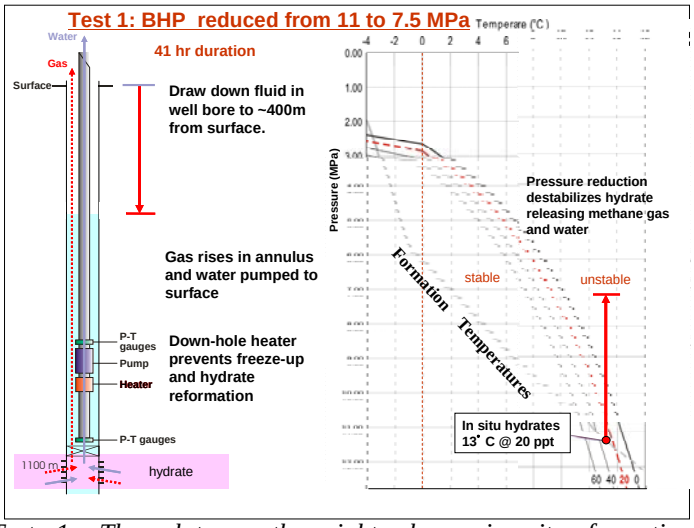
What did we do and why did we do it?

At a high level it turns out that the steps we took during the production test were quite similar to the procedures we laid out in our NEB applications submitted in December. However, when we submitted these applications we did not know the length of our testing window, nor did we have the experience of dealing with a very active well from the first moment we exposed our formation. All decisions taken during the test were made as a team. From a science perspective the goals were quite clear. We had to design our testing program to acquire a quality data set that would stand the rigor of peer review. However in the elusive quest to establish 'proof of concept' we also were aware that we were striving to acquire data and operational learnings that would stand the rigor of a board room decision of a VP thinking about investing $50M in the next gas hydrate production well. From an operations point of view we had to take decisions based on the reality that if we pushed things too far we could have an operational interruption that could risk our whole program. We had to take decisions based on what we had seen to date and what we thought would work.

Test 1 Slow start up from 11 to ~7.5 MPa

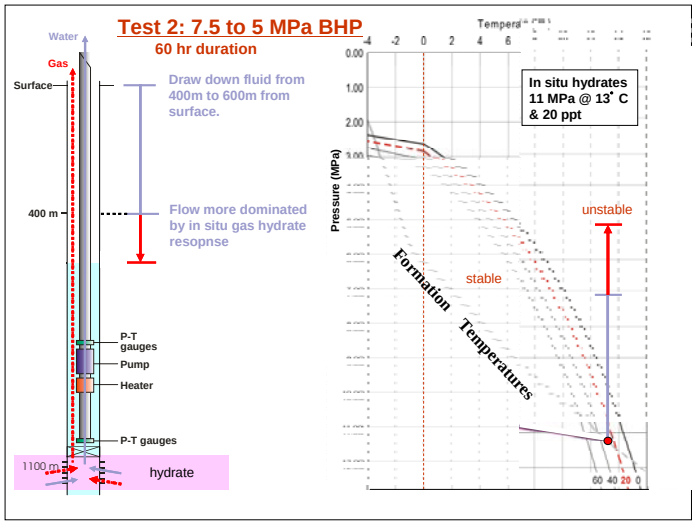
Laboratory work by Wright, Dallimore and Nixon carried out on core samples had suggested that the sediments at the 1100 m test zone were just at the pressure temperature equilibrium for 20 ppt gas hydrates (pressure ~ 11 MPa and temp ~13°C. Our first decision in managing our production test was to decide if we should start off hard, or go at things gently. There were a few different schools of thought on this: our lab work suggested we were just at equilibrium and during well operations, our gas hydrate formations seemed to be releasing gas with virtually no stimulation. Hence, we decided on a slow start up. Our paper plan for the first step was to lower the water elevation over the course of 6 hours by approximately 300 m and with this drop, the in situ pressure regime dropped to 8 MPa, just outside of equilibrium conditions. Practice of course is different from reality. Our practical learnings came quickly, gas arrived within minutes of turning on the pump and at a considerable rate. However water from the dissociating gas hydrates at depth did not arrive in nearly the

abundance we originally expected. With the low water inflow rate and the rather efficient capabilities of the ESP pump, we actually lowered the pressures faster and further than planned. The actual bottom hole pressure we achieved will only be determined once we have analyzed all of the down hole data. At this time it suffices to say it was less than 8MPa and more than 7MPa. Initial gas flow rates were very positive but what was more encouraging was that we could manage the pump and run the test efficiently. Initial water inflow was significantly less than expected as was the amount of sediment entrained in the water. Data quality looked excellent and all in all a great load was lifted off of our shoulders. There were many happy and relieved faces.



Test 1- The plot on the right shows in situ formation temperatures and a family of gas hydrate stability curves for sediments of different salinity. Test 1 lowered the formation temperatures to 7.5 MPa.

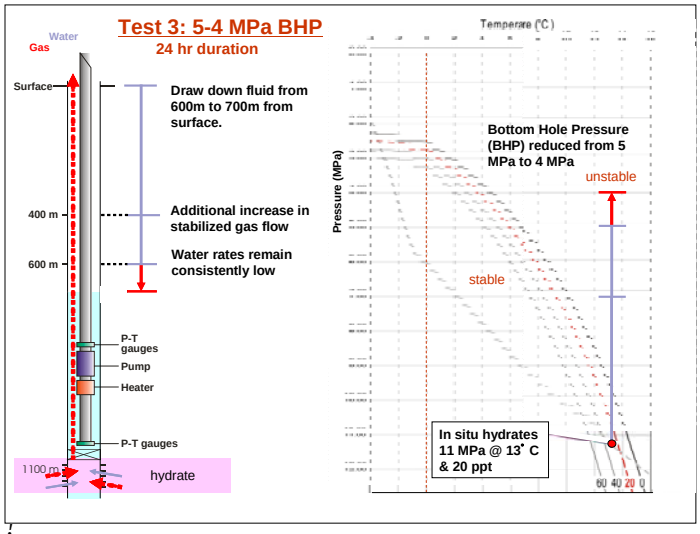
Test 2 'A kick in the pants' from 7.5 to 5MPa



One reality of the first test was that flow during the initial part of the test was almost certainly affected by gas emanating from the disturbed near well bore area that was affected during testing in 2007 and possibly our 2008 operations. While we were satisfied with the equipment and Test 1 overall, our next consideration was to step down to a lower draw down pressure. Our hope was to quantify changes in flow rates in response to the lower pressure regime and also perhaps initiate a cleaner more pristine test which was less influenced during start up by near well bore effects. A decision was taken to move from 7.5 to ~5 MPa after 41 hrs resulting in flow to surface nearly 10 times the gas flowed in 2007.

With the exception of the rather dramatic response during the first few hours of Test 2, this test, was simply put, 'stellar'. Basically so stellar it got boring at times as pressures were dead stable and flow rates were consistent and followed a very interesting trend vs. time.

Test #3 Last step from 5 to 4 MPa



A decision was taken to move on to Test #3 after we had consensus that Test #2 was a success. This decision was not taken lightly as we realized that we would be lowering the fluid level in the annulus to within 100 m of the pump intake. This test therefore ran a real risk that we could entrain free gas within the pump adding an operational risk. However, we were very interested to see if a further lowering of the drawdown pressure would stimulate higher gas flow rates or changes in water production.

End of testing at 12:00hrs on March 16

There were very mixed feelings about ending the test at noon on March 16th given that the decision was mainly financial and not because of any operational problems or logistics issues. The equipment, personnel and test would have been very happy to continue on. On the other hand, there was a realization that all good things must come to an end and that we could wrap up the program with the confidence that we had delivered.

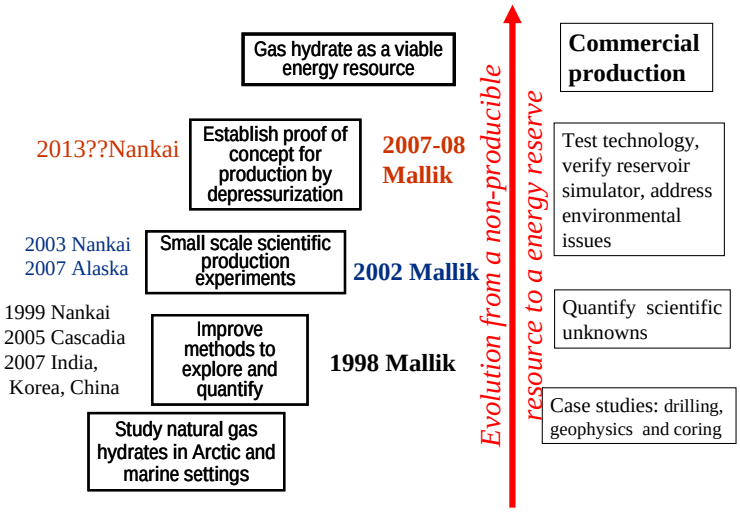
Kasumi and Fred-san working on water samples collected during testing. Lab testing will determine the change in water and gas chemistry vs. time and also quantify the grain size of the sediment retained in the sand screens.

Iron man Numa pushes the button to end the test @ high noon on March 16th

Early snap shot of R&D learnings

As with past Mallik programs my guess is that the advancements and learnings from 2007 and 2008 will cut across a number of disciplines. The 2007 program, despite its problems, taught us much about the challenges of directional drilling in gas hydrate formations, installing complex monitoring devices and, with our advanced well logging programs we gathered much new information on in situ gas hydrate properties. Testing in 2007 gave us much operational experienced and documented the importance of geomechanics. While some might question the decision to not use sand screens in 2007, the mobility of sand after the gas hydrate was quantified and substantive insights were gained on just how reactive the gas hydrate formations were. In 2008 we achieved our primary goal set by JOGMEC and NRCan to undertake a sustained gas hydrate production test. Again while some might judge the duration to be too short, I believe most will agree that we took sound decisions and have accrued many valuable insights.

Bottom line - I believe together, some how, we have managed to step most of the way in the following carton to accrue the knowledge and experience to establish proof of concept that gas hydrates can be realized as a viable energy resource.



Dallimoto-sans (Japan and Canadian R&D leads) shake hands during the last hours of testing and on behalf of the more than 200 contributors to this year's program sign off at Mallik.