Geothermal Energy Centre of Excellence

Hal Gurgenci's Geothermal Blog

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Monday, 5 October

We know that Google is a strong backer of renewable energy and geothermal energy is one of the technologies that gets their serious attewntion. As the US Congress is debating legislation to curb U.S. greenhouse gas emissions ahead of a global climate summit to be held in December in Copenhagen, the Director of the Climate Change and Energy Inititatives at Google.org is **speaking on geothermal energy** (http://www.syracuse.com/news/index.ssf/2009/10/qa_with_dan_reicher_googles_po.html) . I quote verbatim:

"One of the technologies we focus quite a bit on is advanced geothermal energy — how in addition to the traditional geothermal where you exploit an underground pocket of steam or hot water. That's a relatively limited resource compared to being able to just drill deep literally anywhere and get to hot rock. And if you can fracture that rock, put water down, bring it back up, you can make electricity. So we're very interested in that whole technology. We've made some investments in companies.And the reason I raise it is that we've also used some of our own Google tools — Google Earth, Google Maps — to better explain to the world the availability of the resource, for example.... There's $400 million in stimulus package that Congress passed for advanced geothermal.One of the attractive things about it is that it's what we call baseload power. Solar and wind are intermittent — the sun doesn't always shine and the wind doesn't always blow. But geothermal, like coal, is available near 100 percent of the time. And to take best advantage of renewable energy, we really need need a mix of both intermittent sources like solar and wind and baseload sources like geothermal."

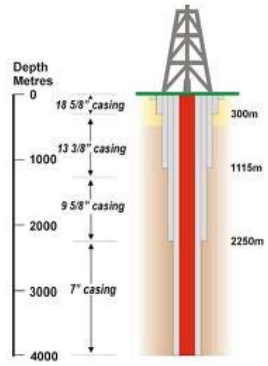
More news on the travails of the Hatch-1 geothermal plant in USA (see **my previous blogs** (http://www.uq.edu.au/geothermal/docs/pastblogs/june2009.html) on characteristics of this plant): "The company has contracted with Rocky Mountain Power to supply the city with about 4 MW of power. Reported sales in the second-quarter were $407,241 — but operating expenses exceeded $7.5 million." The reason for the revenue short fall is the failure for the plant to generate electricity at its nameplate capacity. **The UTC PureCycle web site** (http://www.pw.utc.com/vgn-ext-templating/v/index.jsp?vgnextoid=7400b924618b0210VgnVCM1000004f62529fRCRD) still maintains that the PureCycle engine is capable of generating electricity from a hot source at "195° to 300°F " and the Razer maintains that its wells are producing "240° Fahrenheit to 300° Fahrenheit with bottom-hole temperatures in excess of 350° Fahrenheit". Something is wrong here but we will probably find out in due time. As you know, especially after it purchased Turboden in June this year, UTC is probably the only serious competitor of Ormat in geothermal power plant industry. Hatch-1 plant with its 50 PureCycle units was a major coup for them at the time. The present experience at the same plant is bound to be a serious setback.

In the meantime, **DOE announced** (http://cleantechnica.com/2009/10/04/doe-introduces-big-oil-to-new-energy-source-waste-heat-geothermal/) that it will use an Ormat plant to demonstrate how the oil industry can produce electricity from the heat in the driling fluids. Apparently, every barrel of oil extracted in the US also produces ten barrels of hot fluids. The demo plant will use co-produced fluids from oilfield operations at the Rocky Mountain Oilfield Testing Center. The current press release does not mention the temperatures. I thought this was old news since I thought it had already been reported in the Stanford Workshop earlier this year. I checked it and it turned that I was right. The joint DOE-Ormat paper presented to the Stanford Workshop reported that "250 kW ORC power unit was designed to use 40,000 bpd of 170 °F produced water from the field's Tensleep formation to vaporize the working fluid, isopentane. Because of the lack of sufficient cooling water for the condenser, the cooling system was design as an air-cooled unit. The system was installed in August of 2008 and put into full-time service in September 2, 2008."

Friday, 2 October

Geothermal brine in California's Imperial Valley is not only hot but also contains enough Lithium. The company EnergySource is planning to extract the heat first and then Lithium. If it all goes to the plan, each 50-MWe plant will produce Lithium equal to the 5% of present world supply. With the lithium-ion battery industry set to grow, there will be growing demand for the mineral. It almost sounds too good to be true. In another example of a fortuitous use of geothermal energy , the University of Alberta reported that they are going to explore the possibility of using geothermal heat to replace some of the natural gas used in oil sand processing. The oil sand production facilities apparently use 40oC water to separate oil from sand and the industry uses about 1 billion cubic feet of gas per day to this purpose. Unfortunately, this is not the best place where you would be tapping for geothermal energy. The temperatures barely reach 100 oC even at a depth of 5 km.

I quote some figures from Terry Kallis' presentation today to the CEDA 2009 Energy Overview meeting in Adelaide: the Australian geothermal industry continues growing with the current count at 48 companies in total 10 of which ASX-listed with a combined expenditure over $1.5 billions. Kallis also reported that Paralana 2 well reached 2900m.



Wednesday, 30 September

The Geothermal Energy Association (GEA) released the Geothermal Power Production and Development Update(September 2009) for USA. The report shows strong growth in new geothermal power projects continuing through 2009. 144 new geothermal projects are under development in fourteen states that could represent as much as 7,100 MW of new baseload power capacity. When added to the 3,100 MW of existing capacity, 10 GWe of geothermal power appears to be feasible. The full report can be downloaded from (**http://www.geo-energy.org/publications/reports/US_Geothermal_Industry_Update_Sept_29_2009_Final.pdf** (http://www.geo-energy.org/publications/reports/US_Geothermal_Industry_Update_Sept_29_2009_Final.pdf))

The Abu Dhabi Government awarded a US$1.6 million contract to Reykjavik Geothermal to begin drilling exploratory wells for what would be the first geothermal power plant in the Gulf region. The plant will power the new Masdar City, which is intended to be a "green city" with all its energy coming from renewable sources. Two holes will be drilled at the first instance to a depth of 4 km. The current plan is to draw hot water at 140°C to 150°C from 4-km and use it to drive a binary power plant before the cooled water is reinjected back. A second pair, used to power cooling systems, will be drilled to a depth of 3km, expecting a temperature range of 80°C to 120°C. "If everything goes in the best way" the wells could generate up to half of the total energy used at the city, said Gudmundur Thoroddsson, the chief executive of Reykjavik Geothermal. A key challenge will be providing enough water for the wells, which could be up to 3,000 litres per minute in a high-consumption scenario, said an Abu Dhabi official, Mr Ahmad. I am not sure why so much water is needed for the wells. Mr Ahmad probably means the water used in the wet cooling towers for the binary plant condensers, although this was not clear in the news article.

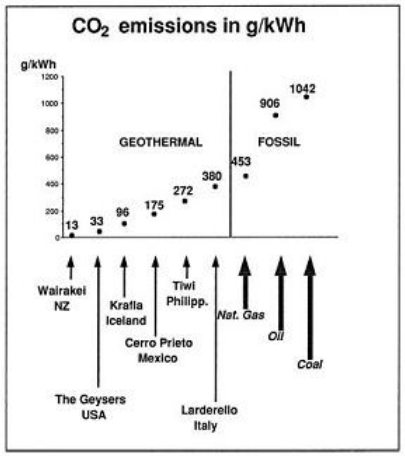
From another interesting place of the world, the tiny Island of Nevis is on the verge of becoming the "greenest" island in the Caribbean. Apparently, Nevis has the potential to produce 900 megawatts of electricity, which is perhaps much more than Nevis will ever need. Currently, the island only consumes 9 megawatts of power. With help from UNDP and accessing the EU carbon credits through a Geneva-based company, Carbon Resource Management, production of geothermal energy in Nevis is expected to begin in 2010 at an estimated capital cost of about US$50 million. When the geothermal plant is fully up and running, Nevis is expected to produce 35 megawatts of electricity.(**http://www.eturbonews.com/11986/nevis-soon-become-greenest-island-caribbean** (http://www.eturbonews.com/11986/nevis-soon-become-greenest-island-caribbean))

Finally, I quote from an interview with Colin Barnett, the Western Australian Premier, from a WA Government web site: Colin Bartnett explains that " *one said to me, we much prefer geothermal and I said, that's nice, but do you realise in Western Australia, geothermal is radioactive decay? She didn't like geothermal anymore.* " (**http://www.mediastatements.wa.gov.au/Lists/Statements/DispForm.aspx?ID=132539** (http://www.mediastatements.wa.gov.au/Lists/Statements/DispForm.aspx?ID=132539)) This is another example of confusion about radiogenic rocks being the main source of non-volcanic geothermal energy. It appears that the image some people have is a subterranean nuclear reactor generating heat. A logical follow-up is that accessing this heat may also transport harmful radioactivity to the surface. The readers of this blog know that nothing can be further from the truth. Firstly, the radioactivity and the associated heat production is very low (less than 0.0001 W/m3). Secondly, some of the same rock formations with similar radioactive decay appear at the surface in different parts of Australia without concerning anyone (because there is nothing to be concerned about). Thirdly, radiogenic decay is not unique to Australia and ius the main source of heat generation in the the continental crust across the world. Iin spite of this, the confusion persists as this posting on the WA Government site indicates. I am not sure how it can be dispelled.

Tuesday, 29 September

Origin Energy will pay Eden Energy $1m and will bear the first $500,000 of future expenditure in return for a 70% interest in the Geothermal Energy Licence #185 held by Eden Energy in Cooper Basin, South Australia. Eden chairman Gregory Solomon said the investment by Origin had several benefits to his company: "Apart from providing additional working capital to Eden, the farm-in by Origin provides a significant boost to Eden's plans to develop its geothermal interests by enabling Eden to progress the development of GEL 185 with a significant joint venture partner," Mr Solomon said.

New Zealand embarked on a four-year project to seek deep geothermal resources in the Taupo Volcanic Zone in North Island. To access these resources, it is suspected that one will have to drill to 5 - 7 km. **New Zeland Herald yesterday reports** (http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10599936&pnum=0) the project leader Greg Bignall of GNS Science saying that there could be the equivalent of up to 10,000MW of electricity, every year for 100 years, in fissures deeper and hotter than they ones they have tapped. While the geothermal water from volcanic sources at such depths is going to result in significant CO2 emissions when flashed through a geothermal power plant, the emissions are still expected to be less than fossil fuel plants. New Zealand geothermal resources are relatively low in CO2 content compared to other places in the world as seen in the following chart from an article by E Barbier in the Renewable and Sustainable Energy Review (2002):



Monday, 28 September

In his address to UN on Saturday, Iceland's Foreign Minister Ossur Skarphedinsson said Saturday that geothermal has a great potential as a renewable energy source in many parts of the world. "A generation ago, we were as dependent on imported fossil fuel as any other nation," he said. "A generation later, 80 percent of our energy needs are met by renewables. All our heating, all our electricity is 100 percent renewable." Skarphedinsson underscored the "vastly underestimated possibilities in geothermal" in many parts of the world including Africa and South-East Asia.

Over the past 20–25 years, worldwide electricity production based on geothermal sources has increased significantly; the installed generating capacity has grown from 1300MWe in 1975 to almost 10,000MWe in 2007. About 75% of this nearly 9000MWe increase comes from about 20 sites that produce in excess of 100MWe. A recent article by Darrell Gallup (Geothermics 38, 326-334, September 2009) reviews the advances in production engineering that have made this expansion possible. Darrell Gallup is a Senior Consulting Chemist advising Chevron USA on Production Chemistry and Field Applications. This is a good review article that highlights some production engineering advances made over the last two decades. While the potential contribution of EGS is acknowledged, the focus is on electricity production from vapour- and liquid-dominated conventional hydrothermal systems.

Friday, 25 September

Good progres is reported in the Hungarian project to provide geothermal district heating. The first well was drilled last week and, without pumping assistance, it managed to produce 5-10 liters/second of water in excess of 80ºC. With pumping, production increases to more than 20 liters/second. In total, 50 - 70 wells are planned in Hungary. The project manager reports that '"This is the first time in Hungary that a well has been drilled through a sedimentary layer to a reservoir in a fault zone at a depth of almost 2 km, where the purpose is to get hot water for space heating.' previous geothermal energy utilisation in Hungary was mostly limited to spas. The developer of the project is the privately owned Pannergy of Hungary, with Mannvit Engineering of Iceland supplying the engineering consulting. When complete, the project will provide heating for at least 70,000 homes and a new source of electricity - at a cost of between €350-500 million.

Paralana-2 drilling reached 2777 m two days ago as reported by Beach Petroleum as reported in their weekly progress report. The progress in last week has been 311 m. The drilling of paralana-2 started on 31 August. The 2000HP LeTourneau Lightning Rig #828 contracted from Weatherford International is expected to drill down to 4000m.

I am asked about the difference between dry steam, flash steam, and binary power plants. I thought I should put together a short summary which I can refer to when asked again in the future. Basically, the following describes the three plants and why you should choose one over the other in different circumstances:

- in dry steam power plants, the reservoir is a dry steam reservoir. There is no brine in the reservoir. Steam comes to the surface, after passing through a trap for solids, the steam is run through the turbine and generates electricity.
- In a flash plant, the reservoir is filled with hot brine. It is compressed under the hydrostatic head (because it is deep). If it is hot enough, it would turn into dry steam when its pressure is reduced, similar to what happens in a pressure cooker when the valve is released, but still would be at a pressure high enough to turn a turbine. So, in a flash plant, hot compressed brine is brought to the surface and flashed to a lower pressure and converted into steam. The rest is similar to a dry steam plant.
- In a binary plant, the temperature of the compressed brine is not hot enough to produce steam at a pressure still high enough to turn a turbine. This means we cannot use steam in our cycle. What we do then is we extract the heat from the brine and pass it to another fluid which will evaporate and produce vapour at a pressure higher than steam at the available brine temperature. This vapour then turns the turbine. Recently, people are opting for binary plants, even in those instances when a flash plant may also be possible. This is because (a) in a flash-plant the non-condensable gases in the brine (CO2, H2S) are released to atmosphere, in a binary plant they are sent back to the reservoir; (b) no water is lost and there are no salt pans and salty discharges; (c) the binary plant technology has improved significantly to almost match flash plant efficiencies.

Thursday, 24 September

UK's **Balfour Beatty announced a few days ago** (http://enr.ecnext.com/coms2/article_bmco090917BalfourBeatt) that it is buying the US engineering consultancy firm Parsons Brickenhoff(PB) for US$626m. PB has been involved in planning of a number of New

Zealand and Ausytralian geothermal power plant projects. I thank Graeme Beardsmore for giving us this information in the teleconference yesterday on the approaching **AGEA/AGEG Geothermal Conference** (http://www.impactenviro.com.au/ausgeothermal/) . By the way, if you have not registered yet to attend the Conference, do so. It is going to be a great conference. Going back to PB, the acquisition does not look like it will have an effect on the way PB operates. It is said to be a strategic acquisition. Balfour Beatty has an annual revenue of nearly $15 billion, 41,000 employees and is "incredibly healthy," says one observer. By the PB acquisition, it will gain a nearly 125-year-old legend in professional services with a global reach from more than 100 worldwide offices and an annual revenue of $2.3 billion.

Here is **a detailed case study** (http://www.docstoc.com/docs/11825145/Geothermal-ice-plant-efficiently-replaces-aging-ammonia-system---Oliver-Curling-Club-Oliver-BC) on using geothermal heat to manufacture ice. An ammonia-based system was recently replaced in British Columbia with a system powered by geothermal heat pumps. This **document** (http://www.docstoc.com/docs/11825145/Geothermal-ice-plant-efficiently-replaces-aging-ammonia-system---Oliver-Curling-Club-Oliver-BC) tells in detail why and how. The experience so far indicates that the geothermal system is easier to operate and cheaper to maintain. Specialists are required to service refrigeration equipment using ammonia or freon but the geothermal plant can easily be handled by in-house personnel. Actual energy cost savings have been $8724 annually and the initial investment in the geothermal system has paid for itself in only three years.

In another important development of the week, although not in the area of geothermal energy, there was an important musical event in Brisbane last Monday, A **new Brisbane band called *Fiction*** (http://www.myspace.com/fictionhome) had its first gig at Ric's place in the Valley. I was there and enjoyed it. They were very good. The fact that one of the band members,Taylan, is my son does of course not affect this judgment at all.

Wednesday, 23 September

Greenearth Energy announced some details about their Geelong HSA (Hot Sedimentary Aquifers) project. The immediate plan is for a demo plant generating 12 MWe running the 170oC fluid from two wells through a binary plant. The future plans include a 140-MW plant. Drilling two wells at Geelong is expected to cost a total of A$30 million. Greenearth Energy is seeking $20 million from the Victorian government's Energy Technology Innovation Strategy program for its demonstration plant and has applied for a $7m drilling grant from the Commonwealth Government Geothermal Drilling program.

Chilean environmental authorities are investigating a well blow-out at Geotérmica del Norte's El Tatio concession that sent up a column of wet steam and debris yesterday. Not much information has been releaset about the incident. The majority shareholder in Geotérmica del Norte is Enel. The company is planning to develop two geothermal power plants, 100 MWe each, by 2012. El Tatio is the largest geyser field in the southern hemisphere and the third largest in the world, with more than 100 springs erupting at an altitude of more than 4,000 meters in the Andes Mountains. There were reports earlier this year that the Atacaman Indians living in the region opposed the drilling program the Geotérmica del Norte consortium began in July 2008 in the Zoquete Ravine, four kilometers from the geysers.

The picture of the El Tatio geyser field on the right was googled from someone's trip photos posted on **http://www.declankane.com /Chile.html** (http://www.declankane.com/Chile.html) . There did not seem to be a copyright restriction on it but please let me know if I am wrong. I will remove the image if it is infringing on anyone's copyright.

Tuesday, 22 September

Nordex North America announced that geothermal energy is powering its new wind turbine plant in Arkansas. The plant has two parts: a $40 million nacelle assembly facility with 115,000 square feet of production space, and a $60 million rotor blade facility expected to begin production in late 2012. Both are expected to be powered by geothermal energy.

In another corner of the world, investment interest is growing in air-cooled heat exchangers. The Indian firm GEI has been atracting international attention lately. GEI specializes in air-cooled heat exchangers and steam condensers. Thermal power plants discharge more than 27 trillion liters of waste water in India and account for more than 85 percent of total industrial water consumption, the company claims. This comes at a time when India's groundwater reserves are becoming depleted, and surface water sources are becoming too polluted for human use.

The 2009 edition of the Explorer's Guide Petroleum and Geothermal Energy Western Australia is now **available online** (http://www.dmp.wa.gov.au/documents/000294.jemma.williams.pdf) . The document quotes a recent GSWA study which shows that that the most prospective basin for geothermal energy appears to be the Carnarvon Basin, followed by the Canning and Perth basins. Although most of the Report is dedicated to petroleum exploration, the part on geothermal energy provides interesting reading. It

appears that the Perth Basin is most prospective for low temperature systems, with heat to be tapped in the 1,000 to 1,500 m depth range. There are also hot aquifer systems in the Perth Basin, but it appears that the temperatures remain under 150 ºC even in holes drilled to 4000m, e.g. 144 ºC in West Erregulla. Higher temperatures are expected in Carnarvon basin but there is not enough deep-well data to support such expectations. The Canning Basin commonly has maximum BHTs(Bottom-Hole Temperatures) of about 90 to 100 ºC at approximately 2,000m. This is good but , where a well has been drilled to greater depths, the observed BHT does not necessarily increase linearly. For example, the maximum BHT at Mimosa 1 is 143 ºC and at St. Georges Range 1 is 113 ºC, being measured at 4,115 m and 4,431 m, respectively.

Monday, 21 September

Several references can be found by the reader in my blogs to the Hatch 1 Geothermal Plant of Raser Technologies. The plant is of modular design using 50 of the 250-kWe units by UTC. Only weeks after the plant was opened with glowing references, it now looks there may be problems. **According to Salt Lake Tribune, (http://www.sltrib.com/business/ci_13360860)** and I quote, "*The Problem: The plant can't operate at full capacity because its production wells are producing geothermal water that isn't hot enough, even though its temperature is higher than the 180 degrees Raser initially said it would need.* ". The company is hoping that its next well, which "will produce water with temperatures around 280 degrees," will solve the problem. It is difficult to make any categorical statement at this stage but this will be worth watching. As far as I know, the Hatch 1 was the first application of the UTC PureCycle principle. The $103 million plant, named after US Senator Orrin Hatch, was meant to produce 14-MWe but currently is only producing and selling 5 megawatts of electricity to the city of Anaheim, California. Raser, though, is buying just under 4 megawatts from Rocky Mountain Power to run the plant. So the net production is only 1 MWe, which was meant to be closer to 10 MWe. This is disappointing and if the Salt Lake Tribune quote from the Raser is correct and if they cannot fix this unless they have access to 280oC water from the new wells, it is not a good reference for the PureCycle technology so far.

Speaking of promising technologies, we keep hearing about the wonderful biphasic technology being developed by Peter McGrail of the Pacific Northwest National Laboratories (PNNL) in Richland. Read my blog references if you do not have a clue what this is. Unfortunately, all of the published references one can find are interviews in newspapers. Isn't it time to submit an article to scientific press and invite some scrutiny? I am sure it is the hype of the newspaper editors and not PNNL but with every rehash of the story in some other bulletin it is fast becoming bigger than Ben Hur and is in danger of losing credibility.

Friday, 18 September

Nevada Geothermal announced yesterday on the commissioning of the Blue Mountain Faulkner 1 plant. The project was announced in Oct 2002 with an expected on-line date of December 2009. The plant uses three Ormat Energy Converters(OEC) to produce a total of 49.5 MWe using 6 production wells drawing brine at a reservoir temperature about 200 oC. The total plant cost was reported as US$76m in April 2008 the contract was given to Ormat. A 33-km transmission line was constructed connect the plant to the electricity grid.

Here is an extract from an interview with Gianni Kovacevic in the **International Business Times (http://www.ibtimes.com.au/articles/20090917/geothermal-uranium-wind.htm)** . Kovacevic, a corporate development strategist and consultant, does not say anything the readers of this blog do not know already but I liked reading it from a business strategist external to the industry: "*Geothermal is a win-win-win. I like this industry. It's good for the environment. I like the fact that it basically goes forever. With fluid going into hot rocks, coming up creating steam and electricity, it just goes in perpetuity once that circuit is installed and efficiently managed and maintained. We've seen it in Italy. It's operated for 100 years. From an investment perspective, I like the fact that we have government incentives, which make an already very economic and very good business better and easier to finance and maintain. With all the "green" money out there development of each megawatt of power is going to be heavily supported. Investors need to fluently understand just how much government support will be offered companies like Magma. This is unprecedented and takes a lot of the financial risk onto the shoulders of others and less so to the shareholders and management. That's good. I just see this as an incredible win-win-win situation for the citizens around the world, for the shareholders of companies such as Magma, and for local communities. Rather than have a coal-fired or other fossil fuel-fired power plant, if a community can have a geothermal plant, where's the downside in this equation? I don't see it.*"

Thursday, 17 September

Wall Street Journal (http://s.wsj.net/public/resources/documents/Innovation-Awards-Winners.pdf) named Electrathem Green Machine as one of the top technology innovationsof 2009. You will find find several references to this machine in my earlier blogs this year. The 50-kW unit uses a screw expander and can produce electricity from geothermal streams at relatively low temperatures (as low as 93 oC **according the company literature (http://www.electratherm.com/products.html)**). Electratherm product was a runner-up in the Energy category. The best technology innovation of the year under the Energy heading according to the editors of Wall Street Journal was the "SFC Smart Fuel Cell" from germany, which are "lightweight fuel cells that can be used by soldiers instead of heavier batteries to power battlefield equipment".

The DOE finalised the $7.1m grant to US Geothermal and the University of Utah for an EGS stimulation project. **More detail from my blog last week (#Sep9)** .

The public discussion on the earthquake risks of EGS continues following the Landau tremors. Probably in response to earlier remarks by Rudolph Braun, Roy Baria is reported **in a New Scientist article (http://www.newscientist.com/article/mg20327265.200-geothermal-energy-on-shaky-ground.html)** saying that "engineers rather than the technology could be partly to blame. Past quakes triggered by similar plants in Switzerland were avoidable ... The [Swiss] engineers failed to adhere to best practice guidelines." Roy is a geophysicist and an EGS stimulation expert and he has been involved with the European geothermal projects for a long time, including Soultz and Landau. He was a Keynote Speaker in last year's AGEA/AGEG Geothermal Energy Conference in Melbourne.

The Western Australian Business News quotes the Managing Director of New World Energy, John Libby about the prospects of geothermal energy in the Pilbara region. "The geology of the Pilbara has significant potential for geothermal energy " he says and he is expecting geothermal energy to be a significant part of the new demand of over 1000MWe required to power the iron ore expansion in the region and the LNG boom. I need to ask Tonguc when he comes back from leave. He is our local expert on the geothermal potential in Western Australia. I remember him talking about the considerable potential in Carnarvon. Maybe it extends down to Pilbara.

Tuesday, 15 September

Petratherm announced (http://www.petratherm.com.au/announcements.html) last week that its Spanish subsidiary Petratherm España will undertake an extensive magneto-telluric (MT) survey across the volcanic island of Tenerife in Spain's Canary Islands commencing in October 2009 to pinpoint locations for a deep test well site. Previous exploration on the island suggests a 200oC isotherm at about 2000m depth.

A report I received from **Activated Logic** (http://www.activatedlogic.com/) argues that the investment in the Australian geothermal sector is at an all-time high in spite of the challenging global investment climate. With market sentiments improving, successful first round Geothermal Drilling Program (GDP) grant recipients, Petratherm (ASX: PTR) and Panax Geothermal Ltd (ASX: PAX) led the capital raising efforts earlier in the year by bolstering their balance sheets by $7 million and $9.3 million respectively. More recently Green Rock Energy (ASX: GRK) also managed to successfully place $1.43 million through a private placement. With more than 50 private geothermal companies active in Australia and appetite for risk returning to financial markets, a string of initial public offerings are expected in the next 3-9 months, with Sydney based Granite Power likely to be the first to hit the market with an expected $50 million IPO later this year or possibly early next year. The Report suggests that the strong interest in the Australian Geothermal Sector is in line with what is happening in the global invetsment markets. A report released by HSBC Global Research earlier this year estimated that "more than US$430 billion out of the US$2.8 trillion in tax cuts, credits and extra spending by governments has been allocated to climate change investment themes".

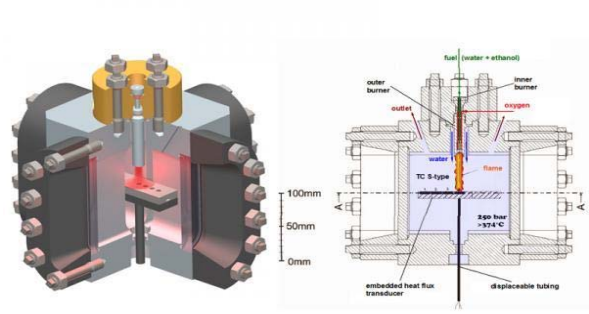
To conclude today's blog on a sobering note, I will quote **Ziggy Switkowski in Business Spectator** (http://www.businessspectator.com.au/bs.nsf/Article/Inside-the-green-energy-bubble-pd20090915-VVS8Z?OpenDocument&src=sph) , who maintains that in spite of the flurry of activity in the renewable energy stocks, the transition to a low-carbon economy will take longer than expected and "The path from promising energy start-up to industrial scale player (will be) formidably difficult for many start-ups....To understand our energy future, watch the actions of the major generators such as Origin Energy, AGL and TRUenergy. Only such companies have the scale, resources, shareholder obligations and compelling self interest to make the big calls that make a difference and to do so with discipline. No pure play alternative energy provider will emerge to survive for long, in my opinion. That doesn't mean that, for a time, such companies might not prove to be good investments – but as a trading opportunity and future acquisition target, not as a going concern."

Monday, 14 September

A small earthquake in mid-August caused a review of the Landau geothermal plant. The earthquake measured only 2.4 on the Richter scale but was large enough to scare some residents. Geox, the company operating the Landau plant, at the present is not able "to deny nor confirm" that the earthquake was caused by the operations of the plant. Landau plant cost $30m with a capacity of 3.6 MWe and started operation at the end of 2007.

Here is a picture that I took when i visited the plant in October 2007. I was having problems with my Olympus camera at that time and that is why it is an awful picture but this is the best of a very bad bunch.

The Landau tremors coming soon after closure of Altarock project in California, makes it imperative that the managers of EGS projects should accept the fact that eartquake risk is a significant risk in the eyes of the public even if the EGS stimulation is not likely to produce anything other than minot temblors. I quote Rudolph Braun **from the New York Times article** (http://www.nytimes.com/2009/09/11/science/earth/11quake.html?_r=1) , who is the leader of the Basel study which was also terminated due to earthquake risk: ""My concern is that the project leaders for different geothermal projects are about to waste public confidence as long as they don't talk openly about the seismic risks involved in their projects."



You surely have heard about the Potter Drilling technology, in this Blog if nowhere else. **Science Daily** (http://www.sciencedaily.com/releases/2009/09/090912144809.htm) reports on another drilling-by-thermal-spalling technology being developed in ETH Zurich. From what I read, it looks like they are not too far behind and are able to "ignite a flame underwater at a pressure of around 250 bars and 450 degrees Celsius" in their experimental reactor in the laboratory.

The auto-ignition of the oxygen+ethanol mixture underwater is being observed through small sapphire-glass windows by means of a camera. During the experiment, the flame reaches a maximal temperature of about 2000°C. Rapid heating of the upper rock layer induces a steep temperature gradient in it and spallation of millimeter-scale fragments occur starting from naturaly-occurring flaws in the rock. "One of the main challenges of the spallation process is to prevent the rock from melting, whilst it's being rapidly heated", says Tobias Rothenfluh, the ETH Zurich PhD student working in this area, "the lager the temperature gradient in the rock, the faster you can drill." The experimental results from the current test set-up are being used to design a pilot plant, on which Panagiotis Stathopoulos is working. The 1.2 million-Swiss-franc plant should demonstrate that it is actually possible to drill through rock by means of hydrothermal flames. The project is funded by the Swiss Federal Office of Energy, the industrial organization swisselectric research, ETH Zurich and the Swiss National Science Foundation.

As we all know, driling is an important part of the cost of an EGS project and any improvement would be welcome. Thermal spalling has a significant potential, because if it works, it would be especially suitable for those rocks, i.e. hard crystalline rocks, that are the hardest to drill using the conventional technology.

Friday, 11 September

I learn that **Oregon Institute of Technology** (http://www.oit.edu/) decided to be "the first campus in the world to be 100% powered from a geothermal source on its campus". A new 280-kW (gross) Pratt & Whitney "Pure-Cycle" system started operation last month and will provide about 20% of the campus electricity demand saving the school $100,000 annually. This is apparently the first step in OIT's plan to develop a larger-scale (1.0 MWe) binary power plant.

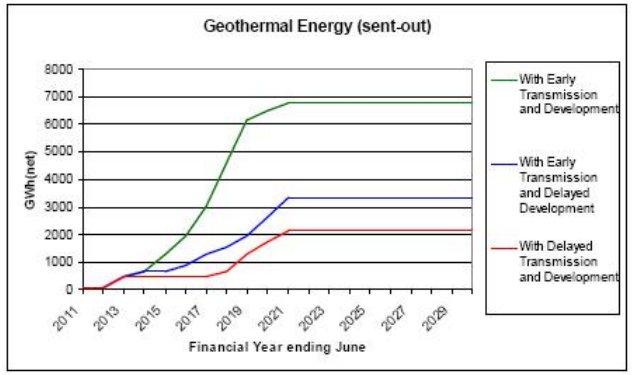
The Geothermal Energy Expo is being held in tandem with the GRC's annual meeting, opening on 5th October. It is a must-go event but unfortunately I will miss it due to teaching commitments. As I understand there is going to be a large Australian contingent as in the previous few years.

Thursday, 10 September

The readers of this Blog would know that the hottest geothermal prospects in Australia are unfortunately furthest away from the grid, e.g. Innamincka and Paralana. A question that is always raised in public fora is the cost of transmitting the geothermally-produced electricity to the customers. A study commissioned by the AGEA addresses this question. A new report prepared by McLennan Magasanik Associates (MMA) concluded that geothermal energy from hot rocks is cheap enough to justify building transmission lines as soon as possible. In fact, the MMA's economic assessment covering the period from 2011 to 2030 concludes that the benefits of early construction of the required transmission lines is $860m for the South Australian customers and $2,800 million for the Australian NEM. This follows as a direct result of lower cost geothermal energy replacing higher costs of renewable energy. It is interesting that these numbers are based on a REC shortfall penalty of $40/MWh. This was increased to $65/MWh under the RET legislation passed last month and, if re-calculated, the above benefits would be even higher.

The following chart shows the aggregate generation at Paralana and Innamincka under three different scenarios considered by MMA in their study:

Figure 3-2 Build up of geothermal energy supplied from Paralana and Innamincka



I referred to the ElectraTherm in an earlier blog. This 50-kW unit uses a screw expander and can produce electricity from geothermal streams at relatively low temperatures. Reuters reports a recent purchase of two ElectraTherm machines by the Florida Canyon Mining to produce electricity from 104oC groundwater found in the mine. The electricity comes as virtually free because the water needs to be pumped out anyway for the mining operations to continue.

Another piece of mildly interesting news is that Raser technologies is reportedly moving away from their preference of small generators. In an earlier blog, I referred to their Thermo-1 or "Hatch" plant that used 50 UTC units of 250-kWe each. The company announced that while they will continue these smaller units, they will not be limited to them. In their new business strategy, they will be aiming for power plants up to 20-MWe powered by two to eight generators.

Wednesday, 9 September

University of Utah received $7.1m from the US Department of Energy to (http://www.eurekalert.org/pub_releases/2009-09/uou-mgm090509.php) hydrofracture a dry well near the Raft River geothermal plant, Malta, Idaho. An additional $1.7m is coming from the company US Geothermal, which is operating the Raft River plant. The plant is currently generating about 11 MW from 5 production and 4 injection wells. A well drilled recently did not produce enough steam and it is hoped that it could be made more productive by hydraulic fracturing in this new project. I think this is going to be the first example of EGS techniques applied to save a geothermal well failing to deliver in a conventional hydrothermal field. If successful, it will reduce the risk in drilling to hydrothermal reservoirs. The main risk in the proposal I think is whether it would be possible to fracture the sedimentary formations usually found in hydrothermal reservoirs. Since oil industry has been able to do it for years, one would think that it should be possible to repeat the performance in geothermal reservoirs. On the other hand, increased rock temperatures in a geothermal reservoir would work against fracturing. Then again, it seems to have worked in Soultz and in Landau. It should probably work in Idaho. The program will study the in-place permeability of the geologic horizon that hosts the geothermal reservoir and then will measure the impact of thermal fracturing using three different temperatures of fluid. I am sure many people will be closely watching this test.

Tuesday, 8 September

Before I start I would like you to note that we now have RSS feed from our web site. You can subscribe to it by using **the link on our Latest news entry page** (http://www.uq.edu.au/geothermal/?page=80653&pid=80653&action=rss) and receive regular updates on the new additions to this blog and other news.

Many places in Africa are known to have substantial geothermal resources but their development has been slow due to many reasons. **It is reported that** (http://www.waltainfo.com/index.php?option=com_content&task=view&id=14708&Itemid=47) this might be

changing soon. A $22m project to be funded by the European Union will be used for feasibility studies and exploration work in order to lay the groundwork for private investors to develop geothermal power in Kenya. "Geothermal energy covers one of the four interdisciplinary core programmes of our centre and is part of its strategic priority in developing eco-friendly renewable energy", says Giorgio Rosso Cicogna, the managing director of International Centre for Science and High Technology — United Nations Industrial Development Organization (UNIDO). The project will be implemented by UNIDO at the request of the Africa Union which submitted the project's proposal to the European Union — the financiers of the project. Kenya derives 130 megawatts of power or about 10 per cent of its installed power capacity from geothermal sources despite the potential of about 7, 000 megawatts.The country's peak demand stands at 1,070 megawatts.

Last week I reported on the Chinese plans to utilise geothermal energy to replace fossil fuels in heating and air-conditioning. Some follow-up statistics were published in the People Daily yesterday. According to statistics recently released by the National Shallow Geothermal Energy and Geothermal Resource Management Conference, the utilization of geothermal energy could reduce annual carbon dioxide emissions by 25 million tons based on 2008 consumption patterns, equivalent to the exhaust emissions of more than 8.6 million vehicles. China's geothermal resources are mainly used to supply heat and power, healthcare, provide heat for hot springs, aquaculture, and greenhouse cultivation etc. The number of existing hot springs exceeds 2,700, and about 700 of them have been developed and utilized. 1,048 geothermal fields exist in China, 259 of them have been developed. There are over 1,800 geothermal exploration wells and annual geothermal (water) extraction volume amounts to 368,000,000 cubic meters. At present, there are 71,000 practitioners in the field of geothermal exploration in China, and its profit reaches more than 7 million yuan.

A web presentation prepared by New York Times (http://www.nytimes.com/interactive/2009/06/23/us/Geothermal.html?ref=multimedia) explains how EGS works based on the Altarock project in California. The main focus of the presentation is the earthquake risks associated with stimulation in the Californian context. It is a well-prepared presentation and makes a convincing case.

This is not related to geothermal energy but I will include it here. In a surprise announcement **reported by Gilkes Parkinson in The Australian** (http://www.theaustralian.news.com.au/business/story/0,28124,26040367-36418,00.html) yesterday, TRUEnergy decided to write off its entire A$53m investment in Solar Systems, because of its failure to attract another strategic or financial equity partner. This places in doubt the future of the solar dish project in Mildura. Solar Systems' $420 million, 154-megawatt project near Mildura was touted as the world's largest and most efficient solar photovoltaic power station when TRUenergy came on board last year. The project involved 192509 heliostatsconcentrating the solar radiance onto a relatively small PV array. **According to the Solar Systems** (http://www.solarsystems.com.au/HCPV_Technology.html) , More expensive solar cell technology could be used because less of them was required at the high concentration levels achieved by the heliostats.

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Finally, in a very exciting news item from USA, **Enhanced Oil Resources Inc announces Joint Venture** (http://news.prnewswire.com/DisplayReleaseContent.aspx?ACCT=104&STORY=/www/story/09-03-2009/0005087786&EDATE=) with GreenFire Energy for development of a CO2-based demonstration Geothermal Power Plant near St. Johns Dome. The demonstration project is expected to commence in 2010 with the drilling of up to four deep wells to access high heat crystalline rock underlying the dome. The construction of the demonstration plant will commence during 2011 and will initially be sized for 2 megawatts and will require up to 5 million cubic feet per day of CO2 at a purity of 95% for a period of at least 2 years. If the demonstration project is successful, modular commercial-scale plants, each with a generating capacity of approximately 50 megawatts may be built nearby. Five million cubic feet, assuming standard conditions, corresponds to about 3 kg/s. This is not a very high flow rate to fill the reservoir but it may be the availability of the CO2 that is the limiting factor. Watch this space for reports on further information.

Friday, 4 September

From The Economist, two news items from the oil industry with implications for the Geothermal energy sector:

1. Baker Hughes, one of the world's biggest providers of oilfield services, agreed to buy BJ Services, a former subsidiary, in a transaction valued at $5.5 billion. The deal greatly boosts Baker Hughes's business in "pressure pumping", which enables drillers to squeeze more oil out of older wells and access hard-to-reach natural gas, such as that found in shale rock formations.
2. BP located a "giant" oil field after drilling 10.7 km below the se the bed in the Gulf of Mexico some 400 kms off the Texas coast. Deeper driling becoming more common in oil and gas industrywill help the geothermal sector.

Yesterday, I reported on Altarock suspending its EGS demonstration project in California due to "geological anomalies". **San Francisco Chronicle** (http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2009/09/02/BU5K19HN9G.DTL) quotes "a geologist familiar with the project" that the cause for the suspension is the drillers hitting a particularly tough layer of cap rock above the target formation. This supports once more the argument that drilling is one of the principal risks in a geothermal project and any advances in that area would be well received.

In another drilling project closer to home, **Beach Petroleum reported the Paralana-2 well** (http://newsstore.smh.com.au/apps/previewDocument.ac?docID=GCA00984855PTR&f=pdf) reaching 2100 m as of the morning of 2 September, with 150-m progress since their last weekly report.

According to the People's Daily Online, Chinese Ministry of Land and Resources **announced yesterday** (http://english.people.com.cn/90001/90778/90857/90860/6747720.html) that "over the next five years, China will intensify the development and utilization of shallow geothermal energy 200 meters or less underground in the construction industry." Geothermal air conditioning using shallow heat pumps is spreading like wildfire around the world. Yesterday, there were two big facilities commissioned with geothermal air conditioning: the auditorium for the Leddy Centre for Performing Arts, Stratham, New Hampshire, and the new head office building for the Pen Air Credit Union, Santa Rosa, California. 30% tax credits **are available in USA** (http://www.reuters.com/article/internal_ReutersNewsRoom_BehindTheScenes_MOLT/idUSTRE5817F220090902) for air conditioning project using geothermal heat pumps.

Thursday, 3 September

A 2-MW geothermal plant is to be built in Lower Saxony, Germany (http://www.cleantech.com/news/4927/well-efficiencies-cut-costs-germany) , using a new geothermal heat extraction technology. Branded as a GeneSys plant, a single 4-km well is used to extract the heat from the mid-triassic tight sandstone formations of the Northern German Basin. The new system is expected to help to cut drilling costs in half, for a total cost of about $13m, because it uses one hole instead of two to pump water into the ground to be heated and then pump it back up to produce heat or electricity.

Since it sounds interesting, I did a bit of research on it following this article. The technology is being developed in Germany by a Hannover-based alliance of Leibniz Institute of Applied Geosciences(GGA), Federal Institute of Geosciences and Natural Resources (BGR), and the company Jung-Geotherm (which sounds like a spin-off from the first two partners). The concept is based on cyclical injection and production. Water is injected into the artificially-fractured reservoir and heated up. The injection can be done using off-peak electricity. The water is extracted periodically to produce electricity and/or to provide heat for district heating. It is a brilliant concept and would probably work better with CO2 instead of water. It is something we should follow up. There was a paper submitted to the 2005 Stanford Workshop on the project by Jung, Orzol, Jatho, Kehrer and Tischner, and another paper submitted to the WGEC in Antalya in the same year. These papers argue that the tight sedimentary formations in the Northern

German Basin are formed by alternating layers of fine grained sandstones, siltstones and clay stones. Their porosity and permeability is generally low. Accessing heat from these rock formations therefore requires EGS techniques such as hydro-fracturing.

Incidentally, while searching for Genesys, I came across a **Genesys LLC** (http://www.genesys-hydrogen.com) based in North America and it is involved in hydrogen production using geothermal steam. I thought I should mention it here. It sounds interesting, two papers are posted on their web site and I will try to read them in due time.

AltaRock announced on Wednesday (http://www.reuters.com/article/rbssTechMediaTelecomNews/idUSN021765020090902) that it has suspended its EGS demonstration project in California due to "geological anomalies". A year ago, AltaRock raised $26.25 million from Google, Khosla Ventures, Kleiner Perkins, Advanced Technology Ventures and Vulcan Capital. The company's demonstration project also received a U.S. Department of Energy grant of up to $6 million last year. In previous blogs I gave references to this project and to some of the concerns raised by various people about the seismic risks.

Wednesday, 2 September

There was **an interesting article on the prospects for geothermal energy** (http://seekingalpha.com/article/159339-geothermal-is-getting-red-hot-part-i) published yesterday in a stock market commentary web site called "**Seeking Alpha** (http://seekingalpha.com) ". The article compares geothermal energy against a number of other renewable sources. The comparison generally is favourable although there are some significant disadvantages unique to geothermal. I copy some of the advantages and disadvantages raised by Andreas Schreyer in this article:

Advantages	*Disadvantages*
High capacity factor (84%) -- only nuclear is said to be better at 94%. Solar PV is 20%.	Capital costs ~ $3,400 per KW installed
Low levelized cost of energy, $42 - $69/MWh	Long development cycle
Mature and proven technology, yet still evolving	Dry hole risk/cost (you drill but do not hit a geothermal reservoir)
Large number of untapped natural resources	Bureau of Land Management - BLM - permitting critical bottleneck to new development
Land use compares favorably with wind (3 to 1 advantage), solar (8 to 1) and coal (9 to 1)	Transmission network availability
Low water usage, none for binary air-cooled plants	

China's Global Times reports a subsidy program from the Ministry of Land and Resources to expedite utilisation of shallow geothermal energy for building air conditioning. Under a recently adopted subsidy program, real estate developers in Beijing can get 30 to 50 yuan per square meter for buildings utilizing geothermal energy. This is about A$6-A$10 per m^2 -- not much but better than none.

Closer to home, the deadline is approaching for submissions on the **Queensland draft Geothermal Energy Bill 2009** (http://www.dme.qld.gov.au/Energy/geothermal_energy_bill_2009_consultation_paper.cfm) . There are some interesting issues that need commenting, especially the definition of a "large" geothermal activity, which is the only one to be regulated by the proposed legislation and will require geothermal exploration or geothermal production leases. Closing date for submissions is 4 September 2009, or this Friday.

Tuesday, 1 September

A Report published last month (http://www.geo-energy.org/publications/reports/GEA_Final_Comments_RETI_Phase_2A_Report.pdf) by the Geothermal Energy Association(GEA) in USA notes that geothermal energy is an essential part of the renewable energy future of that country. I quote from the Report: "*After a thorough review of the WGA, California and Nevada renewable energy reports, the Geothermal Energy Association (GEA) believes that the new economic and environmental data, and the long-understood value of grid reliability, should lead states such as California and Nevada to one, simple conclusion: if we are about to spend billions of dollars on developing new renewable energy projects and transforming our electricity grid to access "green electrons", let's start our transmission planning with a focus on geothermal power as the resource that will serve as the reliable "backbone" for this new energy delivery system*." This is probably why there has been a strong upsurge in USA even before the Obama geothermal stimulus package. **An earlier report by GEA** (http://www.geo-energy.org/publications/pressReleases/Geothermal_Power_Continues_Dramatic_Growth_Release%20_2_.pdf) reported a 25% increase in new geothermal projects from August 2008 to March 2009 and identifies a total of 126 projects under development with the potential to put 5,500 MW of new geothermal power on line, equivalent to 15,000 MW – 20,000 MW from wind turbines. **An article published in Energy Current yesterday** (http://www.energycurrent.com/index.php?id=3&storyid=20282) gives a good summary of geothermal projects in USA and elsewhere, including Australia. Recommended reading, especially for the people legislating for our Commonwealth Renewable Energy Targets.

Friday, 28 August

The **RET(Renewable Energy Target) bill** (http://www.climatechange.gov.au/renewabletarget/legislation.html) passed ten days ago commits Australia to producing 20% of its electricity from renewable sources by 2020. Inclusion of Waste Coal Mine Gas utilisation as an eligible renewable technology has been criticised but this is probably an unfair criticism because it is not easy to capture waste coal mine gas and without an extra motivation the companies would find it easier to let it go - and as we all know methane is 23 times more potent as CO2 as a greenhouse gas. A more relevant criticism for the RET bill is its failure to distinguis between intermittent and baseload electricity generation. The marginal cost of adding intermittent sources to the grid is lower for for lower penetration ratios because you do not need to worry about issues like storage and reliability. In other words, if the fraction of wind-generated electricity in the AEMO (used to be known as NEMMCO) grid is say 2%, it is said to be a better commercial proposotion to add more wind power plants instead of other renewables.

Obviously, there is a limit to wind penetration of the grid. Since wind is an intermittent source, thousands of megawatts turning on and off unpredictably makes it very difficult to maintain the voltage and the frequency in the grid. Such network stability issues start limiting the introduction of more wind only when the wind penetration into the grid is around 20%. This is based on the European experience. 20% is magically the number for the RET bill. Therefore, some commentators have argued that this bill wil be a godsend for the overseas wind turbines manufacturers such as Vestas and Suzlon, which have nearly saturated their home markets and have agressively been marketing in other countries, including Australia. These commentators argue that the attention given to wind will support these manufacturers and will do nothing to help Australia to exceed the 20%-renewable target in the future because there is no way wind can provide more than 20% of the Australian grid without very expensive electricity storage facilities and also redundant investment. I am not as pessimistic. While I agree that the RET bill has failed by not marking some of the 20% as "baseload only", I do not think this will be a major setback because even with the RET incentives I do not think there

is enough wind in locations close to the grid to fulfil the RET target.

Geodynamics (http://www.geodynamics.com.au/IRM/content/home.html) issued **an ASX release** (http://www.geodynamics.com.au/IRM/Company/ShowPage.aspx?CPID=2000&EID=52288072&PageName=Habanero%203%20Well%20Incident%20Investigation) last week on the results of their investigation into the Habanero-3 well blow-out on 24 April 2009. The press release the results of a technical investigation which has found that the cracking of the blow-out was caused by cracking of the casing material and this cracking was caused by hydrogen embrittlement of the high-strength casing steel and the thermal fatigue between flowing and shut-in conditions. Hydrogen embrittlement occurred due to dissolved gases, principally carbon dioxide as well as hydrogen sulphide in the reservoir fluid. These findings have implications for future well design, material selection and operating procedures and the company is investigating these implications. These follow-up investigations are expected to take at least eight weeks and may also affect the the commissioning date for the 1MW Pilot Plant.

Past Blogs

September 2009 Blog (docs/pastblogs/sep2009.pdf)

August 2009 Blog (docs/pastblogs/aug2009.html)

July 2009 Blog (docs/pastblogs/july2009.html)

June 2009 Blog (docs/pastblogs/june2009.html)

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