PETROLEUM HISTORY SOCIETY

ARCHIVES

Newsletter of the Petroleum History Society *June 2014; Volume XXV, Number 4*

P.H.S. Lunch and Learn Meeting – Wednesday, June 4, 2014

Growing up in a Petrostate

by Dr. Alan MacFadyen – Professor of Economics, U. of C.

This talk will review the reasons that the perspective of the economist is particularly important for studying the petroleum industry. It will summarize the development of the Alberta petroleum industry over the past 70 years and its impact on the provincial economy. It will conclude by raising some questions about what the industry's development may imply about our province.

Dr. Alan MacFadyen is an Emeritus Professor in the Department of Economics at the University of Calgary. Alan was born in Calgary and attended Alberta public schools in Edmonton and Calgary, going on to a B.A. at McGill in Honours Economics and Political Science and a Ph.D. in Economics, with a Minor in Mineral Economics, at Penn State. He joined the Economics Department at the University of Calgary where he was responsible for introducing the Department's graduate and undergraduate courses in Petroleum and Energy Economics. He also introduced the first course in Canada in Behavioural Economics. In addition to journal articles, Alan is author or co-author of a number of books including "Modeling Exploration Success in Alberta Oil Plays" and "North American Economic Integration". He is particularly proud of one of the first books ever published in the area of Economic Psychology which he edited and co-authored with his wife Heather. His latest book, co-authored with G. Campbell Watkins, is entitled "Petropolitics: Petroleum development, markets and regulations, Alberta as an illustrative example" from the University of Calgary Press.

TIME: 12 noon, Wednesday, June 4, 2014.
PLACE: Calgary Petroleum Club, 319 – 5th Avenue S.W. – Viking Room
COST: Members $30.00 and Guests $35.00 (most welcome) (cash or cheque only)

R.S.V.P. if you wish to attend to: Micky Gulless, 403-283-9268 or micky@fuzzylogic.ca by noon, Monday, June 2, 2014, if not sooner.

Individuals who indicate that they will be attending - but do not materialize - will be considered "no shows" and will be invoiced for the cost of the luncheon. Individuals who do not R.S.V.P. by the deadline cannot be assured of seating.

Next Luncheons: Our luncheon slate is shaping up for the Fall of 2014. We are seeking speakers and interesting subjects. If you are considering making a presentation, please contact Clint Tippett, President P.H.S., at 403-208-3543.

June Luncheon: For those of you who wish to do some pre-reading for Dr. MacFadyen's talk on June 4, the digital version of his new book is available via the University of Calgary website at: http://uofcpress.com/books/9781552385401 The book itself is available at the U. of C. bookstore and also at the Glenbow gift store. Make sure that you leave yourself adequate time – the volume is 492 pages and retails for $44.95 (less your 10% discount if you are a member of the Glenbow).

John Allan Book: P.H.S. Member Willem Langenberg together with Dave Cruden have published a book through the Edmonton Geological Society entitled "*John Allan – The Founding of Alberta's Energy Industries*". The very well-illustrated volume of 85 pages retails for about $20.00 and is available through the E.G.S. Allan was a pivotal figure in the early days (early 1900's) of both the industrial world in Alberta and in the growth of its educational institutions including the University of Alberta. Mount Allan, in the Canadian Rockies near Calgary, is named in his honour. The book can also be accessed on the internet at: http://www.egs.ab.ca/Default.aspx?pageId=1854602

C.R. Stelck Chair of Petroleum Geology, University of Alberta – call for donations: The University of Alberta has established this research chair named in honour of Dr. Charlie Stelck who was a teacher and mentor for several generations of petroleum geologists including many who were involved in major discoveries in the Western Canada Sedimentary Basin. The Chair is endowed with $1.5 mm with a target for sustainability of $3.0 mm. P.H.S. Member George Pemberton is the current Chair-holder. If you would like to contribute to this worthy cause, please contact Kim Taylor, Assistant Dean - Development at 780-492-7411 or at kjt@ualberta.ca

A Snapshot of Calgary in 1950: In the process of researching potential nominations for the Canadian Petroleum Hall of Fame, an important website was discovered that includes a scanned copy of a volume called "*Calgary 1875-1950: A Souvenir of Calgary's 75th Anniversary*". It includes approx. 100 short articles such as "*The Herron Story*", "*AngloCanadian Oil Co.*", "*The Royalite Oil Ltd. Salutes the City of Calgary*" and "*The Story of R.A. Brown*". The volume can be accessed through www.ourroots.ca/e/toc.aspx?id=4217

Google Initiative: It has come to our attention that some of the entries in Google that relate to the history of the Canadian petroleum industry are in error. Scope exists to make corrections. If you would like to be involved in this or have spotted flaws, please let us know.

Turner Valley Anniversary Activities: May 14, 2014 marked the 100th anniversary of the discovery of the Turner Valley Oil and Gas Field. There were numerous events related to this milestone, many of which involved the P.H.S. and its members, as follows:

Press Coverage: The Calgary Herald ran a series of sections and articles over the May 8 to May 16 period with the overarching banners "100 Years of Oil" and "Oil at 100". This included major multi-feature sections on May 8, 9 and 10 as well as a special souvenir edition on May 14. Although the treatment was not entirely about Turner Valley, substantial amounts were. Coverage was also provided for the subsequent milestones for the upstream industry such as Leduc and also for current and future issues that the industry is coping with. Overall an excellent treatment that raised the public profile of the events.

On-Site Activities at t he Gas Plant: The Government of Alberta committed to make the on-site celebration a worthy one. Large tents were set up for the ceremonies and for supporting societies, including the P.H.S. Director Neil Leeson's work in this regard is well deserving of recognition – many books and membership pamphlets were distributed to the people who attended. Approx. 2000 individuals visited the gas plant on May 14 including about 900 students who were bussed to the location from their schools. Tours were run by a combination of volunteers and government staff. Copies of the most recent Turner Valley-themed issue of Alberta History magazine were distributed. The P.H.S. had provided financial support for the printing and distribution costs associated with this outreach by the Historical Society of Alberta. A children's choir performed the "Pumpjack Song". Laureen Harper attended.

Historical Play: A play entitled "Centennial – The Play", commissioned by the Turner Valley Oilfield Society, was written and produced by Sharon Pollock. There were 4 showings.

Field Trip: Although the P.H.S. trip that was previously planned was cancelled, the C.S.P.G. did run a trip to Turner Valley on May 11 with leaders Paul MacKay and P.H.S. President Clint Tippett. This involved a tour of the gas plant led by P.H.S. Member David Finch.

Technical Session: As a part of the annual C.S.P.G. – C.S.E.G. – C.W.L.S. Geoconvention at the Telus Convention Centre, a series of 6 talks about Turner Valley was held on the morning of May 13 and was chaired by Clint Tippett and David Finch. Abstracts can be accessed through the convention website.

Public Talks: Both David Finch and Ian Clarke gave or will give talks – see the P.H.S. website. Clint and David also gave a luncheon talk to the CSPG on May 21 for an audience of approx. 600 people.

Government Recognition: The Federal Government provided two new historical plaques for the gas plant. The plant and overall oil field are National Historical Sites – more federal support is needed.

Industry Support: Legacy Oil and Gas was a major sponsor, as is befitting their role as the key operator in the Turner Valley Field at this time. Their new investments and the application of modern technologies such as horizontal drilling have seen production levels rise to levels not realized for many decades.

Special Recognition: There is little doubt that this combination of celebration activities would not have happened without the dogged determination of P.H.S. Member David Finch. Bravo!!!

Archives is published approximately eight times a year
by the Petroleum History Society for Society members.

Back issues are archived on our website at www.petroleumhistory.ca
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A REVIEW OF: *PRIVATE EMPIRE: EXXONMOBIL AND AMERICAN POWER*

By Steve Coll. 2012. Penguin Books. New York. xiii + 685 p., including notes and index. Soft cover. $18.00 USA.

Review by: P.H.S. Member C.B. Sikstrom, Thelon Environment & Communications Ltd., P.O. Box 8054, RPO Marine, Cold Lake, Alberta, Canada, T9M 1N1.

Our thanks to Cal for this contribution.

Steve Coll's revelatory book about ExxonMobil, international politics, and the petroleum industry in general, is an impressive work of journalism. A Penguin Press team of specialists aided Mr. Coll and his team of researchers in interviewing more than 450 individuals in USA and abroad. He also visited many countries of the ExxonMobil realm. The cast of characters is broad and the scope encompasses events in countries as diverse as Venezuela, Chad, Indonesia, Papua New Guinea, Equatorial Guinea, the Middle East (Saudi Arabia, Iran, Iraq, and Kuwait), Russia and the USA including Alaska, Maryland and, most importantly, Washington D.C.

The book covers events that started with the Valdez oil spill disaster in 1989 and closes after the British Petroleum Deepwater Horizon Gulf of Mexico disaster in 2010, with the deaths of 11 men and the largest oil spill in the world. During this time the reigns of ExxonMobil passed from Larry Rawl to "Iron Ass" Lee Raymond, until 2005, and to Rex Tillerson since then. They steered the Exxon ship through executive kidnappings, murders, spills, explosions, fires, piracy, insurrections, political intrigues, negotiations, the mega-merger with Mobil in 1999 and the most recent merger with giant XTO Energy Inc. in 2010. The voyage is not a calm one but they kept their course through every storm and by 2011, the United States of America's credit rating was downgraded to AA+ due to a negative cash flow of $5.7 trillion. During the same period ExxonMobil's coffers grew to $493 billion and their credit rating was still AAA.

The Private Empire is nearly 130 years old and this book draws the curtains back on 25 years of its most recent history.

Notice of Correction: In the March 2014 issue of *Archives* we ran a review by Cal of the book "*Exxon Transforming Energy. 1973-2005*" by Joseph A. Pratt with William E. Hale. Cal has asked us to point out that ExxonMobil is the largest fully integrated <u>private</u> oil and gas company in the world, as opposed to the various state-owned enterprises such as Petrobras (Brazil) and Aramco (Saudi Arabia).

Killing the King Christian D – 18 well, Arctic Islands
By Len Maier

This article was written by P.H.S. Director Len Maier and relates to the luncheon talk with accompanying video that he presented to the P.H.S. on November 27, 2013 that was entitled "Blow-out on King Christian Island - 1970-1971". His initiative was recognized with the P.H.S. Multimedia Award for 2013. Our thanks to Len for this transcript.

I would like to present this video of one of the more incredible events in the history of our country. Panarctic Oils Limited drilled a series of the most northerly exploration wells ever drilled in the world, one of which unfortunately blew out of control and caught fire on October 25th, 1970. This was on their King Christian Island well D-18. This video illustrates the control and killing of the burning, wild gas well, under the most difficult conditions imaginable.

The first question everyone asks is, where the heck is King Christian Island? It is located in the high Arctic, shown at the end of the red line on this map. It is quite a small island, approximately 39 kilometers long, by 26 kilometers wide. Located at approximately 78 degrees latitude, the well was approximately 1340 kilometers south of the North Pole, and approximately 210 kilometers north of the magnetic north pole. It is about 3000 kilometers flying distance from Calgary.

Most of this video was prepared from an original film shot in 16 millimeter format by Chinook Film Productions at the time of the blowout. In addition, portions of Super 8 home video, shot by participants on the job, were added as well. The original films were digitized and consolidated in 2007. Considering the original technology, plus the severe environmental conditions under which much of it was shot, it is not surprising that the quality is less than perfect. However, it is the story that counts. The individual names shown on the video were inserted to give recognition to everyone on the job that could be identified in the film.

D-18 was the seventh well drilled by Panarctic above the Arctic Circle. After setting surface casing at a depth of 1935 feet, they drilled on to 2010 feet, into the Heiberg Formation, which they felt may be gas-bearing. Then they began tripping out of the hole, or pulling the drill pipe and bit, in order to run in with wireline instruments, or logging tools, to evaluate the zone. Unfortunately, while tripping out, the pressure in the gas-bearing zone exceeded the hydrostatic pressure of the drilling fluid in the well, and gas began to flow to surface. They unsuccessfully attempted to shut the well in. The gas caught fire at the surface and burned the rig down. Fortunately, all of the crew members escaped. Panarctic estimated the gas flow at 200 million cubic feet per day, making it by far Canada's largest blowout ever.

One of the very unusual characteristics on this blowout was the apparent fracturing of the permafrost in an area surrounding the well. Flowing gas penetrated into this region, resulting in a number of smaller fires burning in the area around the rig. These fires prevented access to the burning well with any type of equipment such as bulldozers or cranes, thus nullifying any attempt to seal the well at the surface, or blow out the fire with explosives, as is sometimes used as a control method.

The main flame column was about 250 feet high. The flames were visible to aircraft flying the polar route, from as far as 300 kilometers away. Because of the publicity, the Federal Government, who were financially involved in this operation through their 45 percent ownership of Panarctic, ordered them to kill the well quickly rather than wait until Spring, when they could move in all equipment by ship. This would be a much simpler and less expensive operation.

In the summer season, equipment and fuel was normally sent by rail from Edmonton to Montreal, then onward by ship for the 5500 kilometers to Eureka, their supply base on Melville Island. There was no precedent for killing a well in the dead of an Arctic winter, with total darkness, frequent blizzards and temperatures of minus 50.

It was obvious that a relief well would have to be drilled to intersect the wild wellbore in the gas zone and large volumes of water pumped into it to stop the gas flow. The company that I worked for, Halliburton Services Limited, was awarded the pumping services contract for this very difficult and complex operation.

As is common in such situations, a famous blowout specialist from the United States was called in, and it was expected that he would be in charge of all the planning and supervision of the entire killing operation. However, apparently the relationship between him and Panarctic was not favorable, and he left. Panarctic Vice President Jim Strain then called me in to work with their engineer Gordon Hood to study the problem and design a solution. Thus a couple of us neophytes then sat down and tried to figure out what to do. Without any prior experience, we now had to design and plan the operation, as well as overcome such major problems as distance, technology, weather and environment.

The relief well would have to come close to intersecting the wild well at the zone of production. This position was not known exactly, since the wild well had not been surveyed or logged. Seismic surveys were run in the area to determine the extent of the fractures in the permafrost. The data indicated that the relief rig had to be located at least 700 feet away from the burning well to be safe, so it would be quite a whipstock job to angle drill the relief well to get close to the target. This was back in the days before advanced directional drilling technology.

Computers were not in general use by engineers at that time, so I got out my slide rule and began to calculate. Injecting the water into the gas at the source should result in a slight increase in hydrostatic head in the wellbore as it flowed. This should slow down the gas flow a bit, and as we continued to pump and increase the ratio of water to gas, thereby continuing to increase the hydrostatic head, the gas flow rate should continue to decrease and eventually subside. My calculations indicated that pumping at 100 barrels per minute for 12 to 14 hours should kill it. I understand this type of calculation is now common today, using computer programs of course, called something like Dynamic Kill.

Panarctic's closest rig available to drill the relief well was located at Drake Point on Melville Island, several hundred kilometers south of King Christian. The rig was quickly disassembled, then flown by Hercules to King Christian, and set up on location by the Commonwealth Hi Tower crews.

On a normal well kill on land, a number of tanks would be set on location and water or drilling mud trucked in to fill them. The fluid would then be pumped down the relief well to stop the flow. Due to the extremely high rate of gas flow in D-18 and the unusually large quantities of fluid required to kill it, plus the remote location and difficult weather conditions, this approach would not be possible.

We had to come up with a completely different method, unique to this situation.

The well was located approximately 3 kilometers from the ocean. This could provide an endless supply of water, provided a pipeline from the ocean to the pump station at the rig could be built, and the water heated sufficiently to prevent it from freezing. Much of our hydraulic fracturing equipment was of modular design, where the high pressure reciprocating HT400 pumps, engines and transmissions could be stripped off their trucks or trailers and operated as skid units. They were designed specifically for this purpose, where they could be transported anywhere in the world. The skids would all easily fit into Hercules aircraft.

Different types of specialized Halliburton equipment had to be assembled in order to carry out this very unique and daunting job. At that time, high pressure steam injection into low gravity, viscous crude oil reservoirs as a method of improving production was in its infancy. Portable equipment was being built for this purpose, which were of very high capacity, so two of these steam units were made available for use in heating the cold ocean water. In order to pump sea water at the required high rate through 3 kilometers of pipeline up to the main kill station, the pumps at the ocean had to be capable of overcoming the friction pressure loss, plus the pressure to overcome the elevation difference from the ocean up to the rig. Ordinary centrifugal pumps could not handle this, while the use of high pressure reciprocating pumps would in essence duplicate the equipment required at the relief well, significantly increasing the cost and complicating the logistics and dependability of the operation. Fortunately, we were able to provide the required number of a special type of diesel powered high pressure centrifugal pump units to handle this job.

So we told Panarctic, if you can drill'er, we can kill'er! They said OK. The relief well was spudded on November 16th. This diagram shows the details of the whipstocked relief well, directionally drilled to intersect the wild well. Sperry Sun gyroscopes were run to confirm the accuracy of the drilling. The well was not drilled into the gas-producing zone at this time, waiting for all the pumping equipment to be installed and operational.

160 tons of Halliburton equipment of various types were taken out of their regular service and assembled from as far away as Sarnia, Ontario and Duncan, Oklahoma. It was all trucked to Yellowknife in December over the bladed ice road across Great Slave Lake. It was then flown on to location by Hercules aircraft, operated by Pacific Western Airlines, as intermittent blizzards permitted. As a fuel supply for the pumping equipment, several large rubber bladders full of diesel fuel were flown in as well.

At this time of year the sun never rises in the High Arctic, so everyone worked in total darkness 24 hours a day. The typical temperatures were around minus 50 Fahrenheit, but frequent winds up to 65 miles per hour made it feel incredibly cold. Wind chill charts indicated the conditions to feel as cold as minus 110 degrees Fahrenheit. 400 feet was about as close as one could get to the fire, where your parka would fry on one side and freeze on the other.

During the holiday season our crews hooked up the high pressure pumping skids inside a large tent set up near the relief rig. We had to install lights and build manifolds for all exhausts, piping, fuel and so forth.

This shows the layout of the main pumping station, where 8 high pressure pumps were installed. They were manifolded to 7 large tanks of drilling mud, which would be required later.

A 40 by 60 foot tent was set up on the ocean ice near shore, and it housed our equipment used to supply the sea water required for the kill. Water would be sucked out of the ocean, which was covered by about 5 feet of ice. The seawater temperature was 28 degrees Fahrenheit. It freezes at 27. A portion of the water would be passed through the steam generators and into hot water storage tanks. It would then be continuously blended with cold water to warm it up, so the blend would not freeze going up the pipeline to the high pressure pumps.

Panarctic operated 2 Electra aircraft for their regular crew changes. The men worked 2 weeks on and 1 week off. The Halliburton personnel were not relieved, and remained on location for the entire job. With no telephones, Panarctic had radio communication between the rig camp and their Calgary office, where President Charles Hetherington was located. The Halliburton personnel had no communication with anyone else in the company, thus with no information, advice or support, all decisions were made by those on location.

Panarctic had a supply of 9 5/8 inch diameter steel casing at their supply base on Melville Island, several hundred kilometers away. With 15 airlift trips, sufficient quantity to build the pipeline was flown in from that source. The rig crew then did a miraculous job of building the pipeline, which was a 10 day operation. They screwed together the 30 foot joints of threaded casing, one joint at a time, in a horizontal position on the floor inside a tent by the rig. As it was being assembled, it was pulled out with a Cat, eventually down to the ocean. Expansion loops were installed every 2000 feet, connected by flanges, to allow for thermal expansion of the pipeline as warm water was pumped into it. They laid two pipelines, so that we could circulate warm water up to the high pressure pumps and back again in case of a problem injecting into the relief well. Thus we could keep it from freezing in event of an unplanned shutdown.

The tough catskinners then bladed up to 3 feet of snow over the line wherever they could, to help insulate it. Since this area is really a frigid desert, and the total precipitation is only about 2 ½ inches per year, the only snow available was in very thin drifts, so hard you could walk on them without leaving a footprint.

This diagram illustrates the layout of the entire operation.

We began to pump water heated to 180 degrees Fahrenheit up the line to the main pump station, where it arrived at 100 degrees. This proved to be too warm, as the pipe expanded, developed several leaks and broke one of the expansion loops. We then had to drain up, use the air compressors to blow the line dry, inject alcohol, fix things and then start all over. All work was done in total darkness, with frequent blizzards hampering all activities. Water circulation was now resumed at lower temperatures. During the kill, water was heated to 60 degrees, and it arrived at the pump station at 35 degrees.

Meanwhile, the ice floor in the tent on the ocean sagged about 2 feet due to the weight of the equipment, flooding the area with sea water. We then moved the heavy hot water storage tanks on shore, under another tent. The remaining weight of equipment on the ice still caused it to sag about 4 inches throughout the job, making it uncomfortable to work and walk around in the cold water. The rig delayed drilling into the gas zone until we were circulating water to the pump station, in event of unexpected pressure and another blowout.

The high pressure pumps were ready to go. Ten of our pump operators were to be flown in at this time, to provide relief in event of long term continuous pumping, however a severe blizzard diverted the Electra aircraft to a small landing strip on nearby Amund Ringnes Island. Fortunately, a Twin Otter then barely managed to bring them in on one trip before the blizzard stopped all aircraft from flying. Consultant Tip Moroney came with them, to help advise us, on this his first trip to the site. There were now about 90 men on location. Since the camp was designed for only a portion of that, the beds were occupied in 8 hour shifts. With constant darkness, it was hard to tell night from day.

We started slowly pumping into the relief well at about 5 barrels per minute at 8:30 PM on Jan. 23 1971. We were able to communicate into the flowing well. Pumping rate was gradually increased to a maximum rate of about 110 barrels per minute, at a pressure of almost 1000 psi. The eight high pressure pumps were run at their maximum of 3000 horsepower to maintain this rate for the duration of the job. A fine spray of water came out the top of the flames. The spray quickly turned into wet, salty snow, which continuously fell around the area of the well, to a depth of about 3 feet by the end of the job.

The subsidiary fires burning from fractures in the permafrost slowly went out as pumping continued, but the main blaze refused to give up. Meanwhile, back at the ocean, a curious seal stuck his head up through the pump suction hole in the ice. After feeding him fish that was stealthily borrowed from the camp kitchen without the cook's knowledge, he became our mascot. Pumping continued at over 100 barrels per minute, at a pressure of approximately 1000 psi. Eventually the freshly painted exhaust manifolds on the engines began to smoke so badly the tents had to be opened up to allow us to breathe. After pumping for about 10 hours, slugs of water began to come to the surface. We thought we were observing success, but the fire was very persistent. We had to continue pumping.

After a couple of more hours, the fire finally went out and the well was eventually killed. By this time we had pumped over 60,000 barrels of sea water. Pumping was continued for several more hours. Without the roar of the flames, things became eerily quiet and dark. 3000 barrels of heavy 12.8 pound per gallon drilling mud was then pumped into the well to displace the water. The well was completely dead. Next, the mud was displaced with 1500 sacks of cement. As a precaution, we continued to circulate warm water through the dual pipelines for another 12 hours, until the cement had set and the well was permanently sealed.

Needless to say, Panarctic management was extremely pleased that they were now able to report to the government and the public that their major problem was solved. To quote the press at the time "Successful capping of the wild, burning gas well on King Christian Island in the High Arctic must go down as one of the most remarkable feats in oil exploration history".

Panarctic was later sold to Petro-Canada. They proceeded to remove all visual evidence of any drilling on King Christian. The surface in the area was completely restored to its original condition.

Once again, the unsung heroes were the hard working and innovative oilfield crews. They all worked together as a team, and overcame unbelievable difficulties to achieve success and get the job done. In recognition of their efforts, the individuals identified in this film who could still be located, all received a copy of this video as a Christmas present in 2007.

As a bit of history, since most of the Arctic islands have little or no soil or vegetation cover, by the late 1940's geologists who studied the surface geology, became confident of the subsurface presence of minerals and hydrocarbons. In subsequent years a large number of exploration permits were taken out by a number of mining and oil companies, mostly smaller independents who could not afford the high cost of exploration and development in this remote region. One of Canada's most respected geologists, Dr. J.C. Sproule, proposed a consolidation of the various oil companies into one entity with sufficient capitalization to conduct a significant exploration program. This idea materialized in 1968, with the formation of Panarctic, which was 55% owned by 19 oil companies and 45% owned by the Canadian Federal Government.

Panarctic was later sold to Petro-Canada. They proceeded to remove all surface evidence of drilling on King Christian. The surface in the area was completely restored to its original condition, thus removing any evidence of this historic site. This was presumably done to satisfy some radical environmentalists, although Saint Suzuki in early 2013 used this event as one reason why drilling in the Arctic should not be permitted.

King Christian D-18 blow -out in the Arc tic Islands. The primary vertical plume of fire is above the former position of the wellhead. The rig has been destroyed and the remains of the equipment have been dragged away from that point in order to facilitate the kill. In the case of King Christian D-18, a surface kill was not possible and a relief well named D-18A had to be drilled to intersect the original wellbore in the subsurface and to kill it there with materials pumped down the relief well's wellbore. Note the subsidiary fires here along long fissures in the ground away from the wellhead and in several spots to the right, significantly removed from it. Panarctic picture.