THE DRILLER

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The New Zealand Drillers
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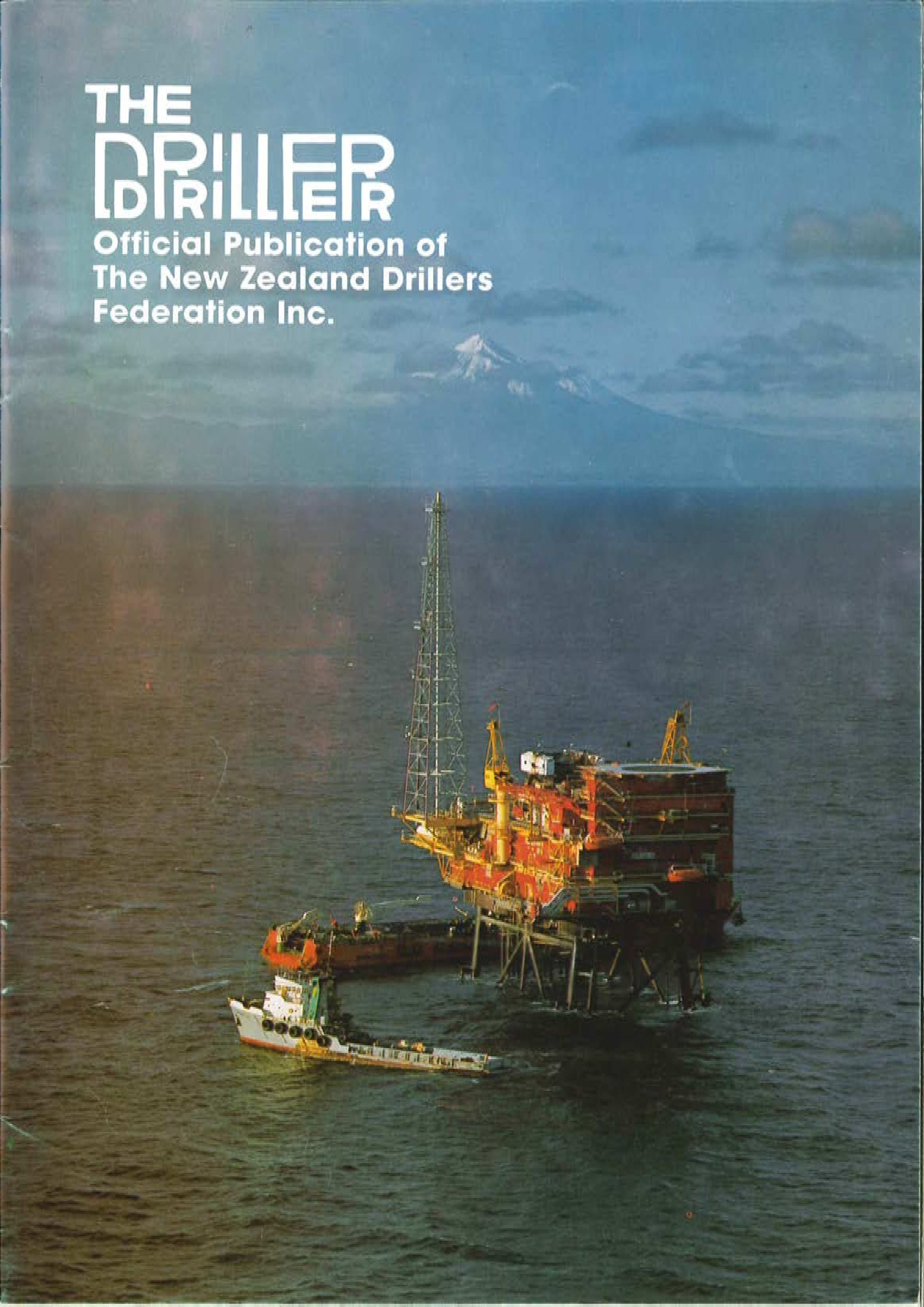

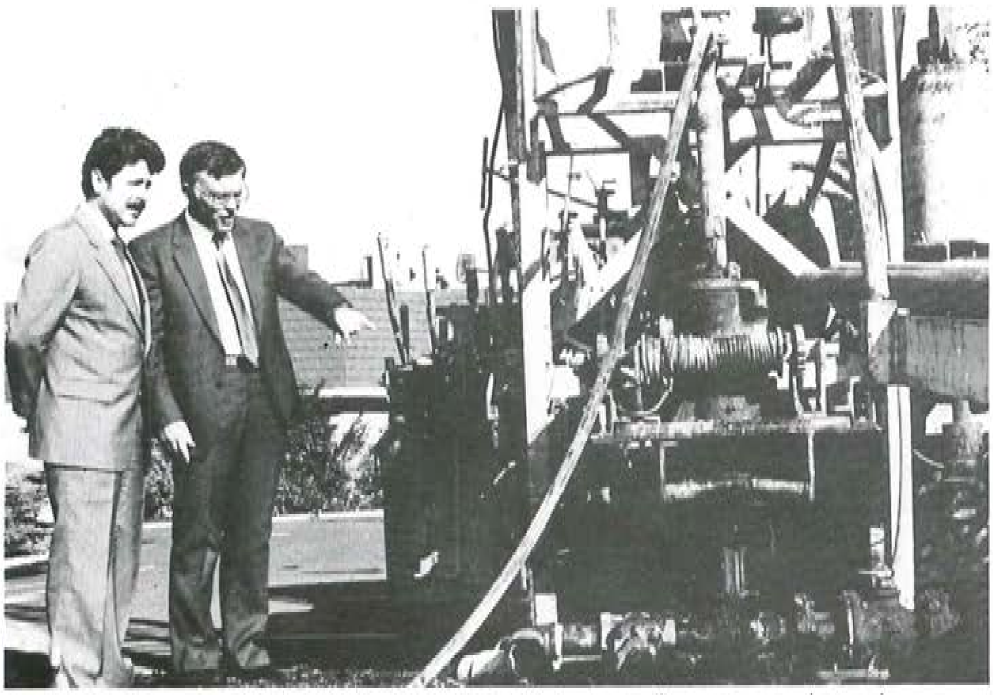

Secretary of Energy Dr Basil Walker (pictured, right) was in Rotorua recently to observe progress on the Ministry's geothermal management programme. Here, accompanied by Sheraton Rotorua Hotel manager Mr Rudi Scherb, he sees one of the bores which has been converted to natural gas heating by a management which support's the Government's efforts to restore the dwindling geothermal features at Whakarewarewa. While Dr Walker was in Rotorua Energy Minister the Hon R J Tizard, announced geothermal energy rebates of 90 per cent for users converting to alternative energy sources, and of 50 per cent for users upgrading their systems to comply with a new standard code of practice. The rebates, which are designed to encourage a reduction in overall draw-off from the geothermal field, and more efficient use of the geothermal energy that is taken, apply mostly to owners of bores more than 1.5 kilometres from Pohutu geyser. The Government conservation policy calls for the closing of all geothermal bores within 1.5 kilometres of the geyser — although some users within the crisis zone who have undertaken to convert to an alternative energy source before July 31 will also benefit from the 90 per cent rebate.

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CIROS I — ANTARCTICA 1986

by Kevin Jenkins, Drilling Supervisor, Geophysics Division, DSIR

August 20th 1986 proved to be a special day in Antarctica for 21 people. It was not because the minimum temperature for the year (-52.6°C) was recorded a few days earlier, but for the 11-man team wintering over at New Zealand's Scott Base on Ross Island, the arrival of Winfly (the first flight of the season) marked the end of the long winter's isolation. The arrival of the 10-man advance team also marked the start of the 1986 summer season and the start of the CIROS I drilling project.

CIROS (Cenozoic Investigations in the Western Ross Sea) is a joint venture between Victoria University of Wellington, who co-ordinated the science programme, Geophysics Division, DSIR, who supervised the drilling and Antartic Division, DSIR, who provided the logistic support. CIROS I is the fourth offshore hole in the Western McMurdo Sound and the climax of the programme started in 1984 with drilling of CIROS II near the snout of the Ferrar Glacier in the Ferrar Fiord. CIROS II sucessfully reached the basement gneiss after penetrating 167m of sediments.

The CIROS I borehole was designed to core strata deposited in McMurdo Sound over the last 50 million years or so and to record the major glacial advances and retreats during this period and also to find out when they began. The core was also expected to show evidence of the uplift history of the Transantarctic Mountains which grew during this period.

Working in temperatures of -25°C to -43°C with an unseasonal high of -18°C (the temperature of a deep freeze) the advance party opened up the camp at Butter Point and established the drillsite. Butter Point camp, 70km from Scott Base on the Victoria Land coast, was the base for the CIROS programme, being erected on the Bowers Piedmount (glacier ice) by DSIR, Antarctic Division in 1983 prior to the drilling of the CIROS II borehole in the summer of 1984. The camp provided comfortable accommodation for up to 26 people with washing, drying and showering facilities.

The drillsite was established 12km from the camp on the 2m thick annual sea ice that forms when McMurdo Sound freezes over during the darkness of winter. When established the drillsite took on the appearance of a small village with the three clusters of buildings. The rig, a Longyear 44, veteran of some 20 holes in Antarctica and her fourth offshore, sat on an elevated pipe subframe and was almost totally enclosed in a heated insulated drill shack with a large door opening onto the sloping rod rack. An enclosed stairway led down to the mud hut, a building that housed the five 200gal mud tanks with mixing and circulating pumps. The hole through the floor and ice for the sea water suction also became a favourite place for a local seal who literally kept an eye on proceedings.

The mess hut was the hub of the drillsite with its gas cooker and hot water urn ever ready for a quick coffee providing the common ground for drillers and scientists. The science huts housed the equipment for processing the core, from its exit from the core barrell, to its packing for shipment to NZ and the US. The core on entering the science hut was cut into 1m lengths, then split in half with a diamond saw, one half being boxed and packaged for transport to the US National Science Foundation Antartic Core Facility at Florida State University, the other was boxed, photographed and logged in detail then packed for shipment to NZ. After logging, samples were taken for paleomagnetic studies with offcuts used for other studies. Over 1,000 samples have been taken for study and analysis, by scientists in New Zealand, the United States, Japan and Australia. The results of this work will be published in various forms over the next few years.

A small hut, set aloof from the rest and resembling some sort of WWII obersvation post with its open slits was in fact the domain of the surveyor. It was with much nail biting that the slow, erratic but inevitable, NE drift of the ice was observed from here and recorded. The rig in fact moved some 6 metres during the period of drilling and an acide test showed the API casing moved to approximately 2° off vertical at the sea floor.

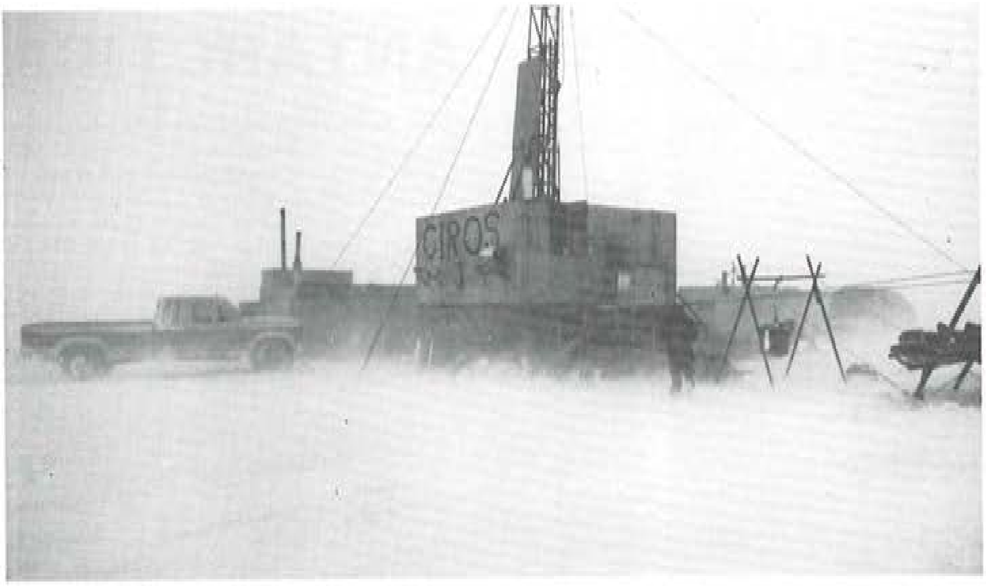
With the cold temperatures and limited daylight, establishing the drillsite was a laborious task requiring almost continual tractor trains hauling gear from its wintering position at Butter Point and supplies shipped into Scott Base at the end of the last season. During this period we were lucky enough to view some magnificent examples of the southern aurora in the night sky. However with the return of the sun and a tremendous effort by all, the site was ready when the main party arrived on October 9.

With the arrival of the rest of the team, the drillsite went into a 2-shift 24-hr operation beginning with the installation of the 5" API sea casing. With a sea pod and heavy collar at the sea floor 200m below the ice and buoyed by a series of 9 floats, a counterweight system on the ice dealt with the up to 1m erratic tide pattern at the site. A tricore bit was used to drill the first 20m of loose sand to allow HQ casing to be seated and coring began using the Longyear HQ3 wireline system with Longyear lightweight HCQ rods. Coring continued with very little return to 51m, then the HW was reamed to 48m and cemented in at 45m. A gantry was constructed on site to take a counterweight from the HW casing, allowing free movement with the tide. HQ3 coring then continued with full cirulation of the seawater, KCL, polymer and starch mud system for a while, but the returns diminished again. At 266m the HCQ rods were tripped and a Longyear impreg casing shoe run and the HCQ string cemented. The HCQ casing was clamped to the HW and more weight added to the counterweight to hold most of the casing string in tension. Coring continued using NCQ rods and a Longyear NQ3 barrel to 518m with all but full

Inside the Mud Hut with Drillers assistant Kim Stevenson from Christchurch, checking the mud viscosity. Note the mud heater in the background. Photo Corey Mills, Victoria University.

circulation. At this level a change was made to a NQ coring bit because of the composite nature of the formation, however, several layers of relatively uncemented sands were encountered but cored reasonably well due to the composition of the mud system. Circulation was lost at 699.2m, the mud level dropping to 150m below sea level and the hole terminated at 702m.

On completion of drilling the hole was logged through the rods by Paul White (MWD) with several probes recording properties such as density, natural radioactivity and temperature. A caliper was also run. After this the hole was cemented and abandoned.



The CIROS 1 Drillsite during a bit of a blow. *Photo: Corey Mills. Victoria University.*

Results

The hole was continuously cored from a depth of 27m below the sea floor to the bottom at 702m, and over 98% of that interval was recovered.

The core is all of Tertiary age, and a preliminary study of morifossils from the bottom of the hole suggests it goes back 35 to 38 million years. This in itself makes the core particularly interesting because rocks of this age are not exposed on the Antarctic continent.

The core also has the oldest physical record so far of Antarctic galciation. The strata are mainly shallow marine sandstone and mudstone with scattered stones deposited by floating or grounded ice. The stones, many of which are striated, and other features in the core are positive indication of the continued presence of ice throughout the time period represented by the core.

Variations in stone content and sedimentary features record the advance and retreat of the ice, and indicate two distinct phases to the glacial history. Planned studies of the microfossils and magnetic reversal statigraphy will allow these events to be accurately dated.

A number of bivalves were found at various levels in the core, and shell fragments along with other shigns of animal activity, such as burrowing, are common. However the most significant macrofossil in the core is part of a leaf in mudstone at 218m between two glacial beds. The age at this level is about 30 million years. The find is significant because it shows that during this period trees were able to re-establish themselves in Antarctica after extensive glaciation.

An unexpected bonus was the coring of conglomerate with boulders up to 50cm long in the lower few metres of the hole, suggesting that the base of the sedimentary section was no more than a few metres away. This discovery allows us to determine for the first time the displacement across the mountain front.

Traces of methane were found in the upper part of the hole, but none was encountered lower and down. Two metres of dark-stained sand were encountered at 630m. The stain appears to be caused by a waxy hydrocarbon residue, but may represent the residue of deposit that has escaped naturally. Further tests are planned to identify the substance.

Acknowledgments

The drilling of CIROS I was the climax of a programme started in 1983 and its success was partly due to the hard lessons learnt from the drilling of the three previous offshore holes (DVDP 15, MSSTS, CIROS II).

The planning of this project was another factor of its success and the input of Jack Hoffman, Drilling Co-ordinator, Peter Barrett, Science Co-ordinator, and Alex Pyne, Science Manager, clearly show in the results achieved.

CIROS releid on DSIR Antarctic Division for its logistic support and the assistance receivd from both Christchurch and the OIC (Stewart Guy) and staff as Scott Base enabled the project to continue without interruption.

All the best preparation and planning would have been in vain if it had not been for the efforts of the crew at Butter Point. The success of CIROS I is in no small way due to the great effort Pat Cooper (Assistant Drilling Superintendent, MWD) and the team unselfishly put into this job to ensure its ultimate success.

Special mention must also be made of the organiation who supported the programme by making their members available for the project especially Ministry of Works and Development, Geophysics Division DSIR, Rockdrill, Gordon Hadfield and Longyear.

I wish to acknowledge the kind assistance I received from Peter Barrett and Alex Pyne of the Antarctic Research Unit, Victoria University of Wellington, in the preparation of this report.

Book Review

Johnson Division Announces the Second Edition of "Groundwater and Wells"

Water well screen manufacturer, Johnson Division has released the second edition of "Groundwater and Wells". The origional, first published in 1966, has become a classic in the field with more than 60,000 copies in use by water well drillers, university students, geologists, engineers, environmentalists and government officials around the world.

With over 1100 pages the second edition includes new chapters on the formation of aquifer systems, drilling fluids, pumping test analysis, groundwater monitoring techniques and special applications of wells and well screens. Significant new material has also been added on groundwater exploration, well development and water treatment.

Also new is a complete glossary of hundreds of terms and many appendices containing virtually all the technical data needed in water well design and construction such as strengths and weights of pipe, friction loses in water lines, field welding procedures and more.

Clarity and readability have been enhanced by hundreds of new charts, graphs and full colour photographs. Like the original "Groundwater and Wells", the new edition is a gold-stamped, hardbound volume printed on fine paper. The new edition is a major reference text which will be consulted again and again at the drill site, the office or in the classroom.

You may purchase you copy from your nearest Johnson Screens Agent or contact:

Johnson Screens (Australia) Pty Ltd
96 Bath Road, Kirrawee.
N.S.W. 2232. Australia
Telephone (02) 521-3444
Telex: JNAUS AA 25371.
FAX: (02) 521-3947

Antarctica — A Roughnecks Eye View

Early last year I was lucky enough to be selected as a drillers assistant in the DSIR drilling project in Antarctica.

After the interview and medicals were taken care of I attended a seven day training course near Lake Tekapo at a military camp. I enjoyed this course as I had the opportunity to do many things for the first time. Worming my way through a smoke filled house, rope climbing, a night spent in a tent above Tekapo skifield and a flight in an airforce helicopter to name a few.

Six weeks later I arrived in Antarctica. After a five and a half hour flight aboard a USA Navy Starlifter. We were met by Stewart Guy, the officer in charge and taken to Scott Base for a 1 night stay. A quick hello and goodbye to the huskies and we were off to our new home for the next two months, Buttler Point Camp.

The camp was a collection of small 2 man huts and a larger building comprising kitchen, mess and bar. A day working around the camp and then it was off to have a look at the rigset up 11km out on the sea ice.

It was a Longyear 44 rig with hydraulic chuck. The rig and wireline core recovery system were completely new to me but I was eager to learn. We were to take a continuous core from the sea floor 200 metres below us.

It was decided to start straight away and the night shift, myself included, started a 12 hours on 12 hours off shift at the Ciros 1 site. It was a night shift in name only as only a three to four hour period of twilight existed and that too soon turned to a continuous 24 hours of sunlight. We blacked out our windows to help us sleep during our sleep period.

After arriving back from my shift having a meal, a beer and sometimes even a shower I had no trouble getting to sleep. Drilling continued down in search of basement or until a 700 metre sub bottom was reached. Drilling stopped at 702.45 metres where a total circulation loss was encountered.

This added to the pulling weight already close to recommended limits. Everyone was well pleased with the drilling results, drillers included as this was the deepest hole in Antarctica with a 98% core recovery. The 3 metre core was sawn in half down its length with half the core being kept by the Victoria University, the other half going to the Florida State University for analysis and storage.

We had an end of hole party and barbeque. Our stay was nearly over and I spent some time trying to soak up all the views and the atmosphere of Antarctica.

We left camp in the Hagglund tracked vehicle headed for Scott Base. On the way we visited Cpt. Scotts base hut where everything is as he left it in 1913 and we stopped in on the Footsteps of Scott expedition guys for an hour of chatting and hot chocolate.

We carried on around Ross Island to Cape Royds and the nesting Adelie penguin colonies and Ernest Shackletons hut, also in original condition. The atmosphere captured in these huts gave us some idea as to how these pioneered the harsh environment with their primitive equipment. We ventured into some ice caves using ropes and ice steps to travel through tunnels and eerie caverns where blue light filters through from above giving us an experience few others will experience.

We arrived at Scott Base in time for breakfast and brief rest before heading over the hill to McMurdo Base to check in our bags as our RNZAF Hercules flight was scheduled for 1am that night.

After a fond farewell party at Scott Base we boarded our plane for an excellent flight with some spectacular parting views of Antarctica to cap off a fantastic trip. The next day I was back at work in Rotorua working over a geothermal bore.

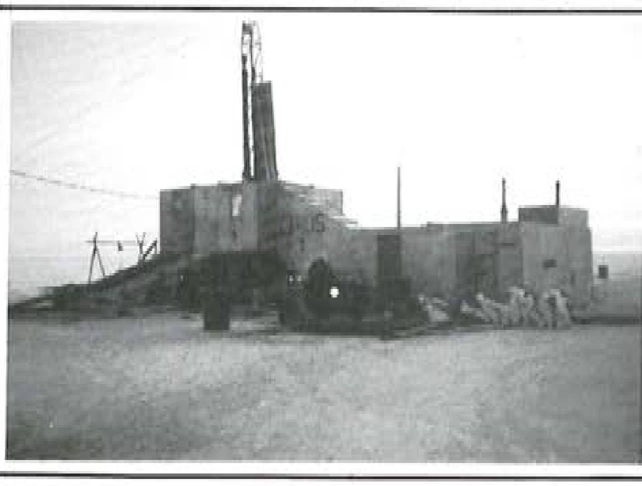
It was a trip I shall always remember for its beauty, harshness and comaraderie.

Garry F. Brown

Garry Brown

Driller — Colin Weaver (½ pint)

End of hole Bar-B-Q.



Charge Out Rates

By Bill Washington

For a number of years now I have been concerned at our drilling rates and service charges. For an industry with thousands of dollars invested in equipment and with years of expenses we continue to undervalue our services. However this problem seems to be migration and a recent article by Andy Crow in the American Water Journal confirms the same problem.

The costs of doing business constantly continue to rise and your service rate should be based on what it actually costs you to put someone out in the field, including the vehicle, tools, parts and experience to perform what is a demanding technical job.

The historical concept of charging the same as the guy down the street or charging "what you think the market will pay" is patentedly ridiculous!

Ground Water Age recently published a survey of how various firms charge for a service call. One of the things that especially interested me was the relationship between the number of pump units sold per year and the amount charged for service work. Dealers were divided into three groups based on pump unit sales: 49 or fewer per year 50 to 149 and 150 or more.

The group with the fewest pump unit sales per year contained the lowest percentage charging $19 or less per service call!

The group with the most pump unit sales per year contained the highest percentage charging $40 or more per service call!

I find this fascinating. Many small operators seem predisposed to business practices that are destined to keep them both small and poor. The larger contractor does the opposite.

Some other questions immediately pop into my mind.

Does a difference in service rates also mean a difference in the quality of service performed? I doubt it. It seems more likely that the ability of any size cntractor to provide adequate service work would be very similar.

Does the public respond to differences in service rates? Again I doubt it. Our own experience is that the customer wants his problem solved and he is not going to spend very much time shopping service prices. In fact, we find the most important condition of service work is our response time. If customers can neither talk to us or get us to schedule the work quickly, only then will they go to another contractor. We find customers to be very loyal, not because they like us or our rates, but simply because they are interested in reducing the dimension of their problem.

We find that there are really only two important factors. First, most of the public is already geared to high service performed on some other appliance or equipment they already own, such as their car.

Second, is letting them know, up front, what you charge for service. If they know in advance, they have no excuse for being surprised or for arguing about the bill when you present it.

Now for a couple of personal comments.

I'm no different from any other customer. I have to have service work done on things I own and I would prefer to know in advance what I am going to spend.

With this in mind, we have developed a service rate plan that I find is comfortable for us and seems to be well accepted by our customers.

We explain our service by quoting a price for the intial service call. We continue by saying that if the problem is minor, say less than $100 total, we will finish the job without further consultation with the customer. An example of this would be a service call where we replace the control box components for a submersible and air up a waterlogged tank.

If the problem is more severe, we stop work and prepare an estimate for the customer we feel reflects the total cost of the job. Once accepted by the customer, we try to stay within the figure if at all possible.

Regardless of cost, we find that the cusomer becomes comfortable with us once he knows that the bill is no longer open-ended.

Next, it is my belief that the larger dealers charge more for their service because they are aware of what their costs really are. Also, as service costs escalate, it rapidly becomes more economical and practical to replace the unit rather than effect repairs.

We are also finding that the customer is thinking this way. He would rather have a new pump rather than pay to fix his old one.

I have a brother who is both successful and well-to-do. His advice to me, when I became a contractor, was, "They are going to scream whether you charge $75 or $25, so you may as well charge $75". Time has proven him right.

Working hours

While I am talking about my brother, he offered me two other pieces of advice, he said that I seemed to be doing nothing more than buying a job. So far, he seems to be right. For the last six or seven years I could probably have earned more if I had worked for a large corporation. However, my goal is to prove him wrong on this point, and I can new see where that will become a reality.

However, the other piece of advice he gave me finally penetrated my thick skull only recently, after eight long years. My brother and his wife began with a car dealership. They, like us, committed all their energies to the business, working long, long hours, six to seven days a week. One day, he told me, they decided it was not worth it. They were going to work only eight or so hours a day and try to hold the work week to five days.

Their reasoning had nothing to do with finances, but with their desire to spend more time together and with family and friends.

Yet, my brother told me, they found that cutting back on the work ended up not having any impact at all on their income!

Well, I have been putting in many long days all of these years. I've been available to my customers at any time, night or day. I have become so angry at having my private life interrupted by demanding customers that I began to emulate my brother.

I decided to go home at five, or as close to it as possible as often as possible. I decided to eliminate weekend work and do those things that bring me pleasure and the business be dammed!

This plan producted two very interesting results. First, I once again began to enjoy this business, my stress level dropped and I worried less! It was amazing how much better I feel.

Second, our sales have continued to grow and we are now faced with a record year!

Now that does not mean I will not respond to a real emergency on a weekend. The only difference is in how much it is going to cost the customer for my time. It is more important to me than to him unless he is really willing to pay me well.

Asian water expo

THE SECOND Asian Water Technology Exhibition will return to Kuala Lumpur's Putra World Trade Centre from 16-20 November 1987.

The exhibition will enable suppliers of related equipment, technology and services to mount a comprehensive presentation in the heart of south-east Asia, a fast expanding market. The event will again be supported by the Ministry of Works, Government of Malaysia, and will build on the success of its predecessor which attracted 200 companies from 18 countries to Kuala Lumpur in 1985.

Company displays were assessed by over 4,000 visitors drawn not only from ASEAN member states (Malaysia, Indonesia, Singapore, Brunei, Thailand and Philippines) but from as far afield as Japan, Australia and the Arabian Gulf.

The World Water magazine is organising a three-day specialist international conference in parallel with the exhibition. This journal has an international circulation of 18,000 and the conference it is organising at the exhibition has attracted more than 300 delegates.

Malaysia and its ASEAN neighbours have an expanding population and are rich in oil, natural gas and commodities. They are all undertaking large scale water and sewage projects in urban and rural areas.

Demand for water in Malaysia has grown nearly 10 times since 1959, from 345 mld to 3250 mld in 1985 and water supply has a high priority in the Fifth Malaysia Plan (1986-1990). By 1990 the government aims to provide 99% of urban dwellers in Peninsular Malaysia with public water supplies, compared with 93% in 1985.

Hunly West No. 1 Mine Drilling Dispute

— History and Aftermath —

Geological conditions in the Huntly Coalfield are complex. (Fault offset) coal seams (and shear zones) in places, severely impede mine development.

Drilling over the past 15 years has confidently proved that vast reserves of a good quality and relatively thick coal seams exist within the coalfield. However despite drilling grids as close as 250 meters, faults of 10 — 15 meters throw (full seam displacement) cannot be reliably predicted. Indeed faults that can form mine boundaries (30 — 50 meter throws) are not always 'fixed' in terms of their exact orientation and nature.

In the absence of coal outcrops, with surface seismic techniques severely limited due to inclement surficial sediments (mainly peat and pumice) and with limited data from underground roadway mapping, drilling is essential to prove the existence of faults if the mine is to proceed on a sound economic basis.

Prior to the Blair dispute, drillhole compensation was paid for site restoration (if not completed by SCM), the utilisation of existing facilities and to maintain goodwill with the landowner concerned. Good public relations are of the utmost importance bearing in mind that the mining and farming communities in the Huntly District are long-term neighbours. Payment of compensation was for various reasons, generally paid in material goods (mainly road/track metal and fencing materials) with the site restoration compensation portion being a minor cost. Over the past 2 years payments averaging $400.00 per borehole were made, however the sum varies according to the time spent on site, ground pasture conditions and access.

In the case of the drilling on Mr. W. Blair's 191ha property, a proposal to drill 5 boreholes (each to 300m coal depth) on his Pukekapia Road property was made by the author in March 1986. The purpose for drilling, location of sites, commencement date and period of drilling was discussed and accepted. The drill sites were surveyed and drilling commenced in mid -April.

In addition to the 5 aforementioned boreholes which were being drilled for an in-seam seismic survey, a request was made in April 1986 to drill 2 additional boreholes to prove the fault structure in the area. Once permission was granted work commenced on this programme utilizing the same two drilling rigs. It was agreed prior to the commencement of drilling that track metal to the value of $500.00 would be delivered immediately to repair farm tracks before the arrival of Winter rain. The metal supplied was an initial compensation payment.

Drilling progressed with no apparent problems through to late May 1986 when without warning Mr Blair ordered the rigs off the property. Initially the boreholes (where drilling operations were in progress) were not allowed to be completed. This included cementing up the holes, thereby posing a safety hazard to the adjacent underground mining operation. Finally it was reluctantly agreed that boreholes in progress could be completed so long as no SCM employee entered the property. Thus on 28.5.86, 5 of the total 7 boreholes in the programme were completed. The 2 remaining undrilled boreholes however were essential elements of the proposed in-seam seismic survey.

Prior to and during drilling, material goods to the value of $2505.00 had been paid, with a further $603.00 to be paid, as earlier agreed with Mr Blair, on completion of the drilling. Materials supplied included 182m cub of metal, bridging timber, draindigger hire and the hire of a rotary hoe contractor. The great majority of these materials were not utilised by the drilling operation. The bridge for example was not used for rig access at any stage.

The above payments do not include 'items' supplied by the drilling contractor which have included mutually agreed cash payments and bottles of whisky for the filling of drill pits and the replacement of damaged fence posts.

Despite attempts on numerous occasions to settle the dispute, SCM in mid October decided to invoke a section of the Coal Mines Act enabling its employees and authorised contractors to enter the property to complete the 2 remaining boreholes and to undertake a geological survey.

Incidentally the Act has never been used before to the authors knowledge and on the rare occasions in the past when permission to drill has been refused, despite SCM's legal right, that decision has been respected. It is the authors belief that in this instance an agreement had been reached prior to commencement of work and therefore should be upheld.

Obviously there were other reasons why the programme had to proceed notwithstanding the fact considerable sums of taxpayers money was being spent in mine development for which the risk of wasting that investment was increased for as long as the geologic conditions remained unknown.

In late October 1986 drilling operations recommenced. The in-seam seismic survey was completed by mid November with the drilling rigs leaving the property 2 days later.

SCM requested the District Valuer (Valuation Department) to complete a report assessing the value of any loss of pasture and to make recommendations for the resoration of drill sites. His recommendations were to have fertiliser and grass seed spread on the sites in Autumn.

It is widely accepted in the Huntly District that this dispute had little to do with drilling or drilling compensation. The farming community felt that imposing a drilling ban was the only means of protest available to highlight their concerns in respect to SCM policy in respect land compensation and purchase in those areas to be subsided by mining. Farmers felt that as large areas of farmland was peatland their farms would be rendered unproductive if longwall mining proceeded. Further, they felt that the prospect of mining was reducing the market value of their properties.

From SCM viewpoint, and it must be noted that the author's responsibility is restricted to geological concerns, drilling is an entirely separate issue to that of mining. Drilling is utilized to prove the presence or otherwise of mineable coal and does not automatically pre-empt extraction of the coal. Further, SCM Land Acquisition, makes provision for land purchase and/or compensation where it can be shown that the economic viability of a farming operation is affected — so long as the farm is within the 5 — year mine plan. In brief SCM could not afford to buy-up farmland that may or maynot be mined 10 to 20 years hence — the risks associated with mining are too great to predict that far ahead.

Subsequent to the seismic survey and associated waning of media interest (which may be best described as sensationalist) SCM and the Pukemiro Riding Mining Committee (representing local farmers interests) have reached an agreement in respect to compensation for drilling and seismic works. The agreement makes formal provision for site restoration and includes 'entry' and 'disturbance' fees. Drilling has continued with few problems experienced and it is hoped that exploration activities at least will not be impeded in the future.

John Gumbley
District Geologist SCM

A New Service for the Drilling Industry

Otipua Road, Timaru. October 1986.

A closed circuit TV video camera service based in Christchurch was recently established by Canterbury Groundwater Ltd. Employing the latest technology including a solid state colour camera accurate information from visual inspections of wellcasings and screens can be provided and recorded on video tape.

While black and white "down-the-hole" cameras have been around for some years the introduction of colour technology brings a new dimension to the water well industry particularly. Visual inspection in colour can not only locate and identify problems in pipelines and wells but also provide the detail to allow accurate assessment of well conditions.

Considerable savings in the cost of well rehabilitation work can be made when the remedial work is recommended by an experienced operator using colour video data. In addition to their TV video camera service, Canterbury Groundwater Ltd are drilling and water supply consultants offering a wide range of services to drillers local government and industry. Included are water supply design and planning, test pumping and data analysis, well rehabilitation and maintenance programmes and project supervision.

Directors of the new company are Bill Washington of Timaru, Russ Harris formerley of Bisleys and Russell Farquhar of Christchurch, who is also the manager. Each of the three principals have a long practical experience in the water supply industry.

For more information contact
CANTERBURY
GROUNDWATER LTD.
P.O. Box 65, Kaiapoi,
CHRISTCHURCH.
Phone (03) 276-631

WA Engineer Wins Drill Contracts in Singapore and Thailand

WEST AUSTRALIAN engineer, George Moss Ltd has just been awarded a $150,000 contract to supply drilling rigs to Singapore and Thailand.

Singapore's Public Works Department will use an HT7 tractor-mounted rig for soil invesigation work on roads and to test foundations for public buildings.

This product played a major role in the construction of Changi Airport and 11 of the rigs are currently in use on the Republic's rapid transit system.

The HT7 is an auger rig with rotary drilling capabilities and hydraulics powered from a tractor engine. The rig has a considerable advantage over truck or trailer systems in Singapore because of its mobility and ability to operate in confined and difficult areas.

An HT7 drilling rig mounted on a light truck will be supplied to the Royal Irrigation Department of Thailand for damsite work and soil investigation. The rig is lightweight and can be dismantled, locally and with ease, for transport to remote areas.

The company has already supplied three rigs to the Australian Development Assistance Bureau for village water supply projects in northeast Thailand, an arid region similar to Australia's interior.

The drill rigs are used to search for water to allow farmers to irrigate small vegetable plots to supplement their rice diet in the dry season.

DRILL '87

EXCITING LOCATION FOR THIS YEARS DRILLERS' CONFERENCE
NEW PLYMOUTH, THE DRILLERS PARADISE
Tuesday 28th July 1987 — Saturday 1st August 1987

It is not too many years ago that a prominent Australian oil man was heard to comment that he didn't believe significant oil or gas finds would ever be made in the New Plymouth area; his reasoning being that such finds are invariably in barren or inhospitable places such as the North Sea or Alaska. He described New Plymouth and Taranaki as a South Pacific Paradise and far too beautiful to become a centre for such activities. These predictions could not have been further from the truth. The present rapid growth of Taranaki province and its city New Plymouth is closely linked to the area's burgeoning oil industry. An industry steeped in local history. The first oil from the Moturoa fields on New Plymouth's foreshore was drilled in 1865. The modern era began with the discovery of natural gas at Kapuni in 1959 when eleven gas producing wells were developed. The Maui offshore field was discovered in 1969. Since that time there has been a rapid development in petrochemical industries with the Waitara Valley Methanol Plant coming on stream in 1984 and the Motonui Synthetic Fuels Plant in late 1985. Gas and oil wells with the McKee distribution plant have an estimated potential to produce 10% of New Zealand's oil requirements. 1986 has been a particularly hectic year, with drilling crews being kept busy at several sites in the province. However as the organiser for the '87 conference, Terry Griffiths, is quick to remind me, the Drillers Association does not just mean 'oil and gas' — drilling for a major seismological survey in Taranaki is planned to commence in early 1987. Water and mineral explorations forms the nucleiei of the conference and all in all the Taranaki sea and landscape, dotted as it is, with drilling rigs of all shapes and sizes should be sufficient to gladden the heart of any driller.

Although aptley call New Zealand's energy province New Plymouth is also known as the 'city for all seasons'. It is an exciting city of contrasts with an unrivalled variety of attractions.

PARKS AND GARDENS abound in the city, many only minutes from the city centre, such as Pukekura and Brooklands Park; recognised as the most outstanding gardens in the Southern Hemisphere.

WALKWAYS: Wherever you stay in the city, you won't be far from one of the walkways which offer ideal picnic spots or jogging routes, as the tracks meander along the banks of clear, cool mountain streams.

MOUNT TARANAKI/ EGMONT: (2,158 m) Well developed walkways allow visitors of all ages to experience the changing moods of the mountain through every season.

HISTORICAL HERITAGE: One of the finest provincial museums in New Zealand, The Taranaki Museum displays a priceless collection of Maori artefacts including carvings in the unique, vigorous Taranaki style. The Gables is the oldest surviving hospital in New Zealand. St Mary's Church, Richmond Cottage and Te Henui Vicarage are fine examples of stone architecture within the city, while Hurworth, a wooden farm cottage built in 1855, is only a few minutes drive from the city.

CULTURAL ATTRACTIONS: World famous for its collection of contemporary New Zealand art, including the Len Lye kinetic sculptures, the Govett-Brewster Art Gallery offers an ever changing and diverse calendar of exhibitions.

SPORTING FACILITIES:
'Something for Everyone' •Indoor for cricket, bowls, ten pin bowling. •Outdoor — immaculate greens attract many croquet and bowling tournaments, while seven golf courses in and around the city are a golfer's delight. •Water Sports are well catered for in the lakes; jet boating, water skiing, fly fishing; rivers; trout fishing, white water rafting and canoeing, swimming; sea; surfing, wind surfing, swimming, yachting snorkeling, and surfcasting.

SHOPPING: The city, made affluent by the exploitation of oil and gas reserves, reflects this in the modern well-appointed and busy shopping complexes, boutiques and craftshops.

INDUSTRIES closely associated with the production of oil and gas, such as the gas-fired power station and the Taranaki Port, are also worthy of a visit. Cottage industries are a new and interesting development in the area with visits possible to fruit wineries, potters, weavers and glass blowers.

CONFERENCE PROGRAMME: Drillers contemplating attendance at the '87 conference are guaranteed a very full and interesting programme. Whilst the full programme is not yet finalised there will be a guest speaker from the Canadian Embassy. Interesting papers to be presented include, 'Geothermal Drilling in Malaysia', 'The Coal Fields of Mokau', 'Geology', 'Air Drilling'.

The field trips will take delegates on a tour of oil drilling locations in Taranaki and to view aspects of seismic drilling as well as visits to energy projects such as the Synthetic Fuels Gas to Gasoline Plant.

For the two days prior to the conference proper the Australian Drilling Federation Training Committee Limited is planning to hold three courses over 27-28 July 1987.

27-28 July: 'Screen and Gravel Packs'

27 July: 'Drilling Fundamentals for Geologists/Engineers/ Hydrologists'

28 July: 'Conventional and Wireline Coring'

The social programme has been well taken care of also and the first evening kicks off with the opening of the conference followed by a lively discussion panel, drinks and supper.

The conference is being held in a modern conference centre with quality, onsite accommodation. Registration forms will be posted out at the end of March, or if you think you may not be on the mailing list they will be available, on request, from the Convention Bureau.

The New Plymouth Convention Bureau is assisting with management of the conference and along with Terry look forward to welcoming a large contingent to liven up the conference!

See you in July.

If you have any queries do not hesitate to call either Gail Lambert or Paulette Meldrum at
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New Crawler Drill Rigs For Rough Terrain

A new series of air-powered, bench drilling crawlers which can travel almost anywhere --across the roughest terrain and up the steepest slopes in order to reach the most remote and hilly of drilling sites -- has been introduced by Atlas Copco. The new series replaces all previous crawler rig models.

The ROC 400A series can carry either top hammers or down-the-hole drills. Besides bench drilling, they can be used for numerous applications within areas such an anchor drilling, prospecting and water well drilling. The series is designed to cover the total range of hole diameters from 35 to 140 mm.

All the controls necessary for moving and positioning are placed together on a swing arm, which provides the operator with excellent visibility while enabling him to maintain a safe distance from operations. Drilling dust can be removed by an optional DCT dust collector unit and noise can be minimized by silencing systems.

The rigs can be equipped with two alternative types of boom: a short-length, single-type boom featuring a so-called offset boom head that enables the holes to be drilled at ground level, and a folding boom which extends the rig's coverage and enhances its travelling ability.

High efficiency drill units proving best sellers

The South African Department of Water Affairs recently took delivery of a T4W waterwell and exploration drill to be used in the dolomite areas of Transvaal. The machine is a powerful tophead rig for deep-hole rotary or downhole drilling.

The unit supplied to the Department is fitted with the optional derrick for deep-hole drilling, which has a pullback of 31,750kg. It has a 25,5m₃/min. at 20,7kPa (900cfm at 300psi) compressor.

The result is a machine with exceptional speed, both in setup time and drilling speed. It is designed for increased productivity and its versatility is ensured by the fact that it can rotary drill with mud or downhole drill with foam.

Dual hydraulic cylinders, operating through heavy-duty roller chains, provide infinitely variable pulldown.

After the driller sets the proper feed pressure, the system automatically adjusts the feed rate to suit changing conditions in the rock formation.

The machine is mounted on a 6 by 4 Crane Carrier which was especially designed for it. It ensures that rough roads, mud and hills present no problems. The separate deck engine produces power for the compressor and rig hydraulics.

For downhole drilling, the worm gear tophead delivers torque up to 7153Nm with speed infinitely variable from 0-109rpm. For rotary drilling, the high torque spur gear tophead option provides 0-80rpm at 9763Nm.

The carousel holds seven lengths of drill pipe and a rack on the derrick holds four more. With one on the tophead, a total of 91m of pipe is carried on the rig. With all operations being performed from the control console, total change time is less than one minute.

The 508mm (20 inch) centraliser means that holes of up to 432mm (17 inch) diameter can be drilled.

The 3400kg hydraulic casing hoist is mounted on the side of the derrick and is controlled by a lever on the console.

Long strings of drill pipe and casing are handled with the tophead and feed system. This permits rotation, feed and circulation during pipe handling.

The drilling power pack (deck engine, compressor and hydraulic pumps) is mounted on a rigid steel channel base which if float-mounted to prevent distortion, even though the truck chassis may flex during drilling or movement. This maintains alignment, greatly reducing wear and maintenance.

Blasthole drill

An Ingersoll-Rand DM-H blasthole drill has been ordered by Reitspruit Opencast Coal Mine, and should be delivered by the end of the year. During 1981 Reitspruit conducted performance tests on the first machine of its type to be imported into South Africa.

That first machine was later sold to Middelburg Mines, who now have a total of two of these machines. At Middelburg Mines, 250mm diameter holes are drilled to a depth of 25 to 30m. These two drills have given excellent service and production.

Rotation power is supplied by two 56kW nominally rated axial-piston hydraulic motors mounted on the rotary head. Each motor has a variable-pitch swash-plate which allows an infinite selection of speed and torque within the limits imposed by the motor and pump capacities.

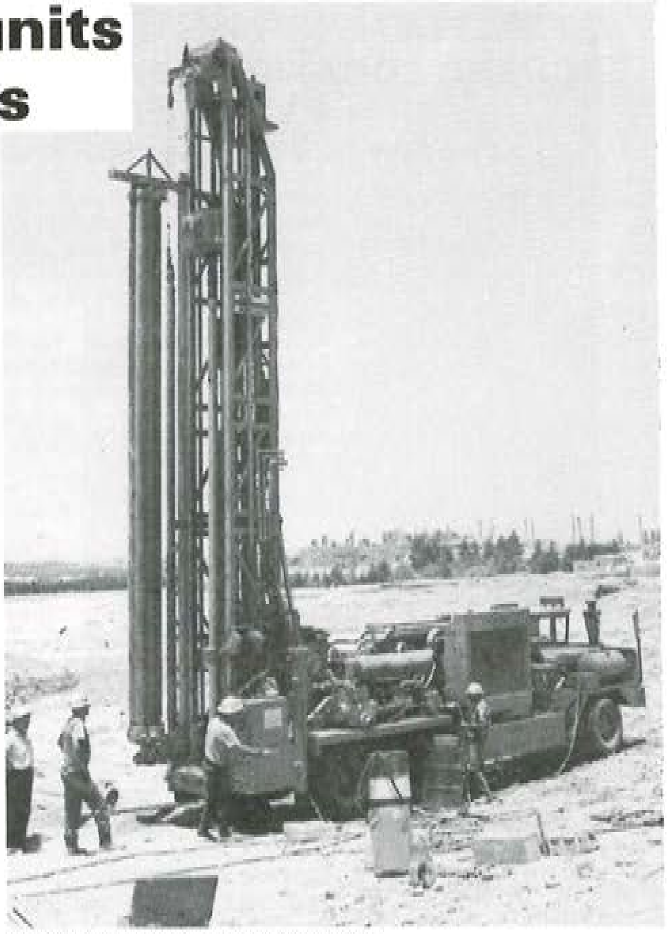
	Torque	Speed
High range	6780Nm	1-150rpm
Low range	13560Nm	0-75rpm

In practice, the drill operates at a fraction of maximum available torque until there is an increased resistance to rotation. Because a constant volume of hydraulic oil is supplied at any set speed, rotation oil pressure immediately increases to supply added torque. The differnce between minimum and maximum and maximum torque may vary be several hundred per cent, which is especially useful in broken ground where torque reqirements fluctuate widely.

The rig itself is a rugged, self-contained and self-propelled crawler type, with hole diameters ranging from 229 to 311mm (9 to 12,25 inches). Hole depths are 19,8m with a single-pass; up to 38m with a double pipe changer; and up to 68,6m with a four pipe carousel.

The tower, complete with a full complement of pipes in the carousel and one in the rotary head, can be raised or lowered in 60 seconds.

The pulldown capacity of



The T4W exploration and waterwell drill.

The DM-H blasthole drill.

40825kg is accomplished with twin hydraulic cylinders working at a 1:2 chain ratio to the rotary power head. Hydraulic pressure in the feed cylinder is monitored by a pressure compensated pump which gives a pressure-balanced feed system, instantly responsive to changes in rockdrill ability.

If the bit tooth sinks deeply into the rock, the cylinder receives a larger volume of oil and effectively increases the penetration trate. If, however, the rock is harder than normal and the bit tooth does not sink quite so far, the flow of oil is cut back to accommodate the decreased penetration while maintaining constant pulldown force on the drill bit.

The DM-H has an asymmetrical screw compressor with a maximum working pressure of 758kPa. Though a pressure drop of 207kPa across the bit is generally sufficient for rotary drilling, any kind of restricion in the hole or plugging of the bit results in loss of air volume when using a low pressure air supply. This loss of volume results in the regrinding of cuttings and the entry of foreign material into the bit bearings.

The usual cure is to back off the bottom of the hole until the obstruction is cleared. With the asymmetrical screw compressor, the usual pressure at the bit while drilling is 276 to 483kPa. When the passage of air is restricted, the receiver pressure rises until the restriction is blown free or the compressor reaches maximum pressure.

Angle drilling is achieved by telescoping the top of the mast back on a hydraulic arm. This is unlike more conventional machines, where the mast is pivoted from the bottom by raising the base of the tower. The advantages of the DM-H system is a more stable drill steel and drilling is always confined within the dust curtain.

The power plant consists of a 373kW double ended electric motor driving the compressor from one end and the hydraulic pump through a five-hole gearbox at the other end. The entire power pack floats on the main frame thus eliminating drilling and tramming shocks.

The operator cab is soundproofed and pressurised, the operators seat faces a simplified control console directly overlooking the working table. Dust is kept to a minimum on the drill deck by a dry dust collector system and an inflatable rubber pipe seal.

Breakout and pipe changes can be carried out from within the cab. A pneumatic powered wrench is used to break the joints. Two hydraulic cylinders move the carousel into or out of the loading position and a hydraulic motor rotates the carousel about its own axis to bring the next pipe into position over the drill string.

The rig propels and steers through individual 126,8kW hydraulic motors built as an integral part of each track assembly. Each motor is served by an individual, reversible and variable displacement axial piston pump. This means that each motor is independently driven in terms of direction and speed, enabling the machine to turn about its own centre and resulting in very fast hole-spotting.

Deep hole wireline drilling

HEATH & SHERWOOD DRILLING has, over the past 15 years, developed some 'unique' equipment and procedures for the drilling of deep diamond drill holes. This paper presents some details on the rod strings, derricks and drill equipment used by Heath & Sherwood Drilling to drill wireline cored holes to over 3000m in depth.

Heath & Sherwood Drilling was formed in 1927 at Kirkland Lake, Ontario, Canada. It provided diamond drilling services to the gold mines in the immediate area and later supplied services to other parts of Ontario and Quebec, in Canada.

In 1951 ownership was reorganised. The drilling division enlarged the territorial scope of the company's activities to cover the whole of Canada, as well as the supplying of services to other parts of the world.

The company has since supplied equipment, personnel, expertise and training to all parts of the world such as France, New Zealand, Jamacia, Chile, Bolivia, Panama, Botswana, New Caledonia, the United States and South Africa. In some of these countries, either partial or total training orientated programmes in the art of diamond drilling were initiated.

Heath & Sherwood Drilling and Universal Drillers are subsidiary companies of Challenger Resource Services Limited of Calgary, which is a private company.

Records achieved by Heath & Sherwood Drilling include the deepest cored hole in the Precambrian Shield at 3 440m; the deepest wireline cored hole in the USA at 2 300m; and most recently the deepest wireline cored hole in the world — 4 030m in South Africa. *(Editor's note: The company has recently broken this record by drilling a hole to 5 422,76m, also in South Africa.)*

This is probably a good place to describe the differences between wireline drilling and conventional or standard drilling. With conventional diamond drilling, when the core barrel at the bottom of the rod string is filled with drilled core, the entire rod string must be pulled out of the hole to recover the few metres of core from the core barrel.

Wireline drilling, on the other hand, has a rod string with larger inside diameter rods, which allows a device to be lowered down inside the rod string on a wire cable. This picks up the core tube and pulls it out of the hole complete with the core. The only time that the rod string needs to be pulled out of the hole is to change the diamond cutting bit or when problems are encounted in the hole. This paper deals with the wireline type of drilling.

The impact of wireline drilling for deep holes can be seen in the following comparison.

Using standard rods and core barrels, when drilling at 4 000m depth for example, you would drill for about 10m and then halt production for about 18 hours while the rods were pulled, the core brought out and the rods lowered back down the hole. With a wireline system, it takes about three hours to remove the core, which is brought out through the centre of the rods.

In 1969 Heath & Sherwood Drilling initiated a programme to use small hole wireline coring techniques for exploration drilling of oil and gas wells. New lightweight equipment was developed in Kirkland Lake and programmes designed to utilise this small diameter 'slim-hole' system were successfully implemented.

As requests for deeper drilling programmes in hard rock increased, Heath & Sherwood Drilling recognised the fact that very little equipment was available for drilling in the 1500m to 3000m depth range. This prompted the adaption of some of the oil and gas 'slim-hole' equipment to be used on these hard rock programmes. Most of the equipment was found to be readily adaptable.

The first major concern in drilling these holes was to have a rod string capable of drilling to such depths. This means having equipment with the required strength necessary at hole bottom; increased resistance to wear over the extended period of time required to drill these holes; be leak proof at pressures required for drilling; and most important, still be light enough to allow it to be powered by a drilling machine of reasonable size and horsepower.

There are many large drilling machines in the oil and gas drilling field, but very few, if any, could be adapted economically to suit hard rock diamond drilling with small diameter rods.

Development of special rods

It was with the above criteria in mind that Heath & Sherwood developed its 'Super' series drill rod for deep holes, consisting of an aluminium alloy body and high strength alloy steel couplings.

These rods are produced in 'Super H' and 'Super N' outside diameter and are capable of drilling up to 6 000m in depth. Rod lengths are 3,65m to minimise the number of connections required on the deeper holes and still be manageable to transport them through bush areas, although 6m lengths can also be produced.

Both sizes of rods have been laboratory tested to establish actual torque and tensile limitations. Typical ultimate load figures are 63 500kg for the 'Super N' size and 137 000kg for the 'Super H' size. A seal can be installed in the coupling to ensure a leak-proof joint, but on most applications this is not required.

Increased wear resistance has been proven in the field by the fact that with proper lubrication (grease, soluble oil, and so on) some of these rod strings have drilled many thousands of metres. All rods are flush on the outside to minimise turbulance in the annulus.

Standard North American diamond drill rods are produced in five common sizes — E, A, B, N and H — with each size able to drill a hole

larger than the one preceeding it, and with H rods having an outside diameter of 89mm.

In the 'Super N' size rod produced by Heath & Sherwood Drilling, instead of recovering 'N' size wireline core as would normally be done, one size smaller, or 'B' core, is drilled and recovered. This requires special diamond bits and core barrels, but allows the inside diameter of the rods and couplings to be reduced to less than standard wireline size, thus allowing increased rod strength and the ability to drill to record depths.

Another advantage of these rods is the increased velocities of the core tube both in coming out and going down the rods. Because the rods are still filled with fluid while the core tube is pulled out and then pumped back down through the rods to the bottom when empty, any increase in annulus between the core tubes and the inside diameter of the rods will allow for these greater velocities.

The decrease in time for tripping out the core tube becomes more significant as hole depths increase. A typical trip out from 2 500m, hoisting core and returning the empty tube down, takes about an hour. This is a substantial reduction over times using standard wireline rods.

As well as the aluminium alloy string, a string of all steel rods has been manufactured. A quantity of these rods are placed on the bottom of the string before starting to add the aluminium rods above.

This weight at the bottom of the string helps to keep the upper aluminium rods under tension while drilling. It was discovered that the life expectancy of the aluminium string increased dramatically when this procedure was followed. These rods also provide a pendulum effect which helps to minimise deviations.

Drill rig modification

The drilling rig, the HS-150 drill, is a modificaiton of the rig developed to drill the oil and gas 'slim-holes'. This drill varies quite significantly from the standard diamond drill configuration, which has all the components mounted and attached together on a mobile base.

The HS-150 drill is made up of many separate component pieces, such as the drawworks or winch, head transmission assembly, wireline winch and power unit assembly. Each of the components can be transported and moved separately if required, thus allowing the creation of easy to handle loads.

In Canada a wheeled skidder and sloop are used for moving the rig in bush areas. Both the hoisting and rotation functions are hydrostatically controlled and powered by the main diesel engine. Hydrostatics allow full rpm control while winching or drilling. They also provide inherent hydraulic braking while lowering the rods into the hole. This eliminates the 'free fall' of rods while lowering and thus the smoking brake bands associated with drilling very deep holes using some of the conventional mechanically driven rigs.

The operator's controls are of the push button hydraulic-electric type and control all functions of drilling, as well as the lowering and raising of rods by means of remote control.

Hydrostatics also power the wireline winch and water pump. These are driven by the single diesel engine mentioned previously, and thus there is only one engine required in the drill shack to power the complete rig. This allows greater organisation of equipment on the drill floor and a reduced diesel fuel consumption.

In addition to the basic rig, rods and tower, other equipment is used to make the drilling less hazardous and more efficient for the three man crew. These include a hydraulically operated rod chuck and hydraulic rod tongs for breaking out and making up the rods. These rod tongs can be preset to give proper make up torques while lowering the rods, thus preventing over-torquing make up in the hole while drilling. This then allows for the easier breaking of the rods coming out of the hole.

A recorder can be used to give permanent records of some operations of the drill rig on a 24 hour basis. Gas detector units can be installed in areas where conditions require such equipment. Sensors are placed near the top of the drill hole and also in the drill shack. These sensors are connected to a readout unit and a warning buzzer system. This system can be set to respond to various percentages of air-to-gas mixtures, well below the explosion or flash points.

Other safety features include the use of safety equipment while climbing and working on the tower as well as a hydraulic bypass emergency system which diverts all hydraulic motors and automatically engages the draw works brake system when activated.

Control of bit weight

One major problem in the past with mechanically driven rigs has been the method of controlling the amount of weight on the bit in a deep hole. The rod string can weigh up to 30 to 40t and if allowed to push on the bit it would destroy it.

The old method with a standard type drill of trying to slip the brake band while holding back the required rod string weight was at best very erratic. Bit loads varied greatly up and down and the band 'slipped and grabbed'.

The HS-150 has two systems to control this function. The first is a normal pull-down provided by the hydraulic feed cylinders on the head. This method is used at the top of the hole until the rod string weight becomes sufficient to provide bit weight without the necessity of pull-down pressure. The second system which is activated at this point is a separate hydraulically powered line feed out system. It ensures that as total rod weight is being held back by the main hydrostatic system, a second system over- rides the hydrostatic system and provides a constant line feed out from the winch and thus controls the amount of rod string weight allowed on the bit.

This system of holding back and line feed out provides very precise control, as the line feed out speed can be changed according to conditions. Hold back and bit weight can be observed on the weight indicator guage. This allows for more consistant drilling rates and longer bit life.

Special tower design

The drill components and drill shack were used initially under a square 'four legged' conventional tower design, about 30m high, which allowed 20m strings to be pulled and stacked within the tower. These towers were erected on a piece by piece method from the ground up to drill height.

The HS-150 now use two step cantilever erection towers which were developed during the oil and gas drilling programmes. These towers are assembled completely on the ground and then lifted up into place entirely by rig power. The two step cantilever erection design is used because there is not enough rig weight available on the floor to counterbalance a single lift tower pull up. The new towers will also pull 20m stands and are rated at a hook load of 100t.

Heath & Sherwood Drilling recently developed a tripod type tower which can pull 15m stands. This is used with a three skid sub base system, allowing the components to be moved without lifting them off the three sub base skids and floor. This system allows for very fast moving and set-up and is used on 'intermediate' depth rigs i.e. down to 2 500m and in areas where terrain allows movement for these larger skid assemblies.

Rod handling using nubbins

Pulling and lowering of the 20m stands is accomplished with the use of rod nubbins and elevators. Nubbins are made with the male rod threads on them and an oversized shoulder at the top. These are then screwed into the top of the rods when pulling and the elevators are clamped around the rod. These pull against the shoulder to lift the rods out of the hole.

Each 20m rod stand which is pulled has a nubbin screwed in the top of the rod as it is standing in the tower. The nubbin and elevator arrangement helps speed up pulling and lowering, as a nubbin can be screwed in the top of the rod string waiting to be pulled while one stand of rods is being set aside and the block is on its way down. The elevator clamps located around the rods can be removed and put on without having to come to a full stop. This eliminates having to stop, screw and unscrew a hoisting plug at the top and bottom of each pull.

Rod thread life is also prolonged because the nubbins are not screwed in or taken out under load, which can fail or strip the thread as sometimes occurs with a hoisting plug arrangement.

Hole deviation - a problem

In any deep hole drilling programme, hole deviation still presents a contiuing problem. Various methods can be used to minimise the deviations in the hole. Methods include feed control; bit control; and straight hole or longer than normal reaming shells combined with special stabilised core barrels.

These methods only minimise deviation and other procedures must be used to correct the deviations that do occur. In the past, conventional 'Hall-Rowe' steel wedges were placed in the hole if corrections were to be made in hole deviation or direction. These are tapered pieces of steel which cause to rods to bend back on course.

Many holes have been lost because of the movement of badly installed steel wedges. On some deep holes, as many as 50 steel wedges could be installed.

Over the past number of years,

Heath & Sherwood has gained proficiency in the application and use of the retrievable type wedge. This tool allows correction of hole deviation both in angle and orientation. It is similar to the familiar 'Hall-Rowe' steel wedge, but the removal of the steel deflecting wedge blade is allowed after the operation is complete.

This concept allows the actual wedge deflecting blade to be used again for another operation. Thus a hole can be deflected many times during the course of a drilling programme and end up without problems caused by steel wedges remaining in the hole.

The application of this wedge is somewhat different than with a 'Hall-Rowe' wedge, as a pilot hole, one size smaller than the main hole, must first be drilled off the wedge blade. After removal of the blade from the hole, the pilot is reamed out to the full hole size.

Photographic orientation equipment ensures accurate alignment of the wedge blade in the hole before the actual shearing of the rivets and the setting of the locking unit is done. This photographic equipment is used inside three non-magnetic rods located at the bottom of the string, thus allowing magnetic directional alignment without interference from the steel rods above.

The photgraphic equipment is lowered and pulled out by the wireline, and is aligned by a mule shoe device which is located at the bottom of the non-magnetic rods. If directional alignment is not required or if there is a magnetic influence in the hole from the formations, a simple low point indicator can be used to set the wedge for only angle corrections.

Down-hole motor units are now also available, such as 'Dyna Drill' or 'Navi Drill' units, which are run by a drilling fluid which is pumped down through the rods. These motors are used with bent subs or deflecting subs at the bottom of the drill strings which cause the hole to be deflected back on course.

The experience of Heath & Sherwood with these units is that there is a low efficiency in the small hole sizes required. The overall cost per application as compared to a retrievable wedge application is very high.

Mud systems

Deep hole rigs have been equiped with various mud systems to condition the hole in areas that require such systems. The drill itself can be placed on a sub base in order to facilitate a high enough standpipe to ensure that the mud runs back properly into the mud tanks. Two cone desilters can be used to clean the mud which allows it to be reused.

It has been found that by using a mud system on a very deep hole, annulus pressures build up signifcantly higher than levels occurring on shorter holes of the same size because of greater viscosities.

To counter this, Heath & Sherwood sometimes drills an oversize hole. Instead of holes of 76mm or 100mm diameter as in standard N or H sizes, holes of 83mm or 108mm diameter are drilled. It has been found that this expanded annulus helps bring pressures back down to what would be considered a normal range and still keep fluid velocities high enough in the annulus to carry cuttings out in the mud and clean the bit face.

Other than these problems and the problems of providing adequate mixing facilities and proper maintenance of mud viscosities, drilling with mud is very similar to drilling with water on these holes.

Diamond bits

I would like to give a few details on the various types of diamond bits used on the different programmes in which Heath & Sherwood has been involved.

It is very important to select the proper bit for the types of conditions to be encountered in the hole, in order to minimise actual bit costs and maximise on-bottom time, thus getting the most advantage from the wireline system of core recovery.

For surface set bits, which are bits using industrial diamond stones of various sizes and having only one layer of diamonds on the surface, the very general rule is larger stones for softer ground and smaller stones for harder ground. There are other variables, such as flat face or step bit, regular or face discharge and these must be considered when one steps up the drilling programme.

In the past five years or so there has been a dramatic change in diamond products with the improved development of impregnated bits and man-made diamonds. These are different from surface set bits because imbedded small man-made diamonds are used thoughout the matrix of the bits. As the matrix wears away, new diamonds are exposed and the bit remains sharp. This uniformity allows consistency of bit performance.

It is most important to have the hardness of the matrix suited to the abrasiveness of the formations being drilled in order to keep the matrix wearing away at the proper rate.

A great deal of experimentation is being undertaken with these impregnated bits, with a large degree of success.

Work in South Africa

In October 1981 a HS-150 drill was sent from Kirkland to South Africa and drilling on the first deep wireline hole was begun in February 1982. The complete system that had been developed and used in Canada was used in South Africa, including the latest bit technology with impregnated bits and aluminium rod strings.

The efficiency of the total system was proven by the fact that this first hole was drilled to a depth of 4 030m in 152 days. Since that time other holes have been completed. Within the past few months a third HS-150 drill was sent to South Africa.

Conclusion

In conclusion, this paper has shown the techniques that Heath & Sherwood Drilling and Universal Drillers have developed to drill deep cored holes efficiently and economically. This is extremely important, as in Canada the cost of labour and the attending benefits represent close to 50% of job costs.

It is this ever present pressure of rising labour costs that hastens the development of new and better drilling techniques.

Grade contol drill rig now manufactured locally

A South African Company has recently designed and manufactured a grade control drill rig. The design objective was to offer maximum drilling flexibility and productivity with minimum capital and running costs. The rig achieves these requirements by being able to handle 6m rods under the head and a total of 9m under the jib. The high performance rig uses a mere 37kW diesel engine.

Hotline Equipment was approached by Terrasearch with the request to design and manufacture a grade control rig which would be economical in terms of captital and running costs yet not lose out on productivity. I had to be efficient and have the wide range of head rotation speeds necessary to perform all the types of drilling required by such a rig.

In the past, grade control rigs have been imported. With the present unfavourable exchange rate, it was only natural for a local company to design and manufacture such a rig.

A major requirement by Terrasearch was that the rig be demountable. In grade control drilling, the drill normally spends many days over one particular hole. If the unit is not demountable, the truck is tied up for long periods of time, resulting in its uneconomical use. If demountable units are used, one truck, which does not have to be purchased expressly for the rig, can be used to serve several units. The result is a far more economical use of equipment.

This demountability has been achieved by means of swinging jacks. These are swung close to the wheels during travel, resulting in a good angle of departure, but are swung far out when drilling, creating optimum stability.

Another problem which Hotline overcame regarding the demountability requirement was the need for the jacks to have a very long stroke and yet not result in great increases in cost. Hotline opted for relatively cheap agricultural hydraulic cylinders in tension to lower and raise the unit on the jacks, and then fitted infinitely variable mechanical locks to take up the mass once the unit has been correctly located.

"The jacks are thus an example of high field practicality at a very low cost" said Roger Briggs, director of Hotline.

The mast features a 'unique' system which was developed by Hotline for the R6H rig, whereby the loads are taken up in the bottom of the mast. The result is a fairly light mast which can handle an 8t liftout without

the need for a massive supporting structure. This means that the unit can be transported on a standard two axle vehicle, which is another saving in cost.

The head, which has a 6,6m travel, has the ability to swing foreward to pick up new rods and swing sideways by means of hydraulics for winching activities. It is compact and light and is fitted with a locally designed and manufactured gearbox. This gearbox results in a multi-purpose through head with four speed ranges, from zero to 1.200rpm.

The mast jib extension can be telescoped out using the power of the head. This allows the mast to pull a 9m string at a time.

The ability to function adequately using a small power source was achieved by using a load sensing winch. The result is that a four cylinder 37kW engine can be used without the problem of very slow winching of light loads.

The unit is capable of angle drilling and the mast can be set at any required height by sliding it hydraulically through the tilt frame.

The grade control drill rig was recently shown off by Terrasearch to mining houses, drillers, other interested parties as well as suppliers at a function at Hotline's premises in Germiston South Africa.

The new grade control rig from Hotline

The new grade control rig from Hotline.

Coring underwater: The Vibrocorer

A tool with a future
Robert A. Creelman
Dan Fitzhenry

Sediment samples taken underwater has long been a necessary part of marine geology. Methods of sampling are various, but increasingly there is demand for core at ever increasing depths below the water-sediment interface. Gravity cores, box corers and machines that use a variety of techniques to punch in a piston are suited to soft silts and muds, but the problems posed by coarse sand, gravels, and clay-sand mixes preclude such techniques. Vibrocoring tecniques are the solution to such problems and have been in use since the early 1950s with numerous drive techniques and modifications to suit specific problems (McQuillin and Ardus, 1977). The form of the modern vibrocorer is now well established. Figure 1 shows the essential parts of a vibrator unit: piston, catcher, core barrel and frame, but the most effective energy transfer is achieved by electrical power.

Land and Marine Pty Ltd have built a vibrocorer system for their needs that, although based on the general form of the modern machine, has a number of important differences. The system, capable of operating 200m below the sea surface, is an electrically powered unit. The drive units are constructed in two sizes, one weighing 150kg and the other 200kg. The 150kg system will core to 2m, but the 200kg system can routinely core to 6m, and in optimal situations 10m. It is the larger unit that has proved to be the most useful for special applications.

The drive units operate at 1500 cycles/min, with a 3000 c/m option where necessary. The smaller unit exerts a force of 900kg, and the larger 1800 kg with an amplitude range of between 10 and 25mm. Power is supplied by a 415 volt 3 phase system that delivers 720 watts to the 150 kg unit and 1450 to the 200 kg unit.

The cable connections to the unit when operated at depth have to be carefully built, and the 12mm submersible system with Marsh Marine connectors throughout has proved most reliable.

Land and Marine have always employed 76mm core barrels at two wall thicknesses: 1.2mm and 2mm. This practice has dramatically increased penetration rates and consequently gives better core recovery accompanied by less core disturbance. The penetration rates improve because of the lesser area to which the drive energy is applied compared with conventional units. The Aimers McLean machine, in many ways an industry standard, uses thicker core barrels. The core barrel is readily detached from the drive unit, and becomes the core carrier when the bit and core retainer are detached. Steel barrels can be used if necessary, but, if used, other advantages are lost such as the ability to easily cut the core up into readily transportable and easy-to-store lengths.

In normal marine applications the aluminium retaining frame with the vibro cover attached is lowered to the sea floor and the machine activated. The frame is constructed to accommodate extensions suited to the core barrel being used e.g. 6, 8, or 10m. It has been found that a 7.5m lift gantry attached to the deck of a service vessel is the most serviceable and flexible unit for marine operations. Winches attached to the gantry provide the lift necessary to pull the vibrocorer from the sediment after drilling; approximately 500kg are required for a 2m core and 4000kg for a 6m core. Recovery is greatly assisted by a switch on-switch off technique developed by the operating crew.

The operational sites for marine work are geographically diverse, and consequently all components of the vibrocorer are housed in aluminium transport containers. Typical mobilization weights range from 1100kg to 1700kg. In extreme circumstances such loads can be air-transported, but few jobs have required this.

An important feature of the vibrocorer is that it is independent of the surface vessel, so a rigid mooring system is not critical. Work on the Exmouth Plateau has deployed the equipment using only one anchor, and such operation is expedient because location, coring and recovery are possible within less than half an hour.

Fast deployment, good core recovery, undisturbed core and general portability make the vibrocorer a useful coastline estuarine engineering tool. Offshore pipelines, anchor holding studies, mooring system studies are all conventional applications. Sand body inventories, sedimentological studies, port silting studies, and rig footing studies for large marine structures are especially aided by the recovery of little disturbed core.

To date Land and Marine Pty. Ltd. have been commissioned to take cores in both near shore and off shore situations. Nearshore jobs include sediment studies for the Botany Bay Pipeline Crossing, Kurnell-Banksmeadow (Caltex, A.O.R.), siltation studies of power station outfalls in Lake Macquarie (Elcom), studies of the Port of Townsville (Shell) and pre-dredging study/sand-body inventory of areas around Fishermans Island in the Brisbane river (Port of Brisbane Authority).

Further out to sea applications have been concerned with engineering studies for marine structures associated with offshore oil exploration and recovery. Esso has required ground testing for jackup rig sites on the N.W. shelf. Other similar tasks have been completed in the Bass Strait and the Arafura Sea. The group has investigated the use of the vibrocorer onshore in sand and sediment bodies associated with a number of man-made and natural situations. It has been demonstrated that the larger drive unit will successfully penetrate 6-8m in unconsolidated sand and recover core. The drill site was in tailings after sand mining for heavy minerals; the problem concerned the amount and distribution of silt/clay in the sand thought to be impeding the re-establishment of the water table. The core recovered was a little more disturbed than that taken underwater, but still suited to providing the required information. The sand body was wet in the main, but not water-saturated as it would be underwater.

Trials on unconsolidated but compacted sands have shown the present machine is in need of modification for such applications. "Old" sand bodies such as alluvials have almost continuous grain-to-grain contact and are difficult to fluidise by vibraton. If the grain space is entirely water filled, the

larger unit will penetrate by a 'liquefaction' response. Without the liquid, penetration is limited by gagging in the core barrel. 'Gagging' is really a friction effect in the barrel. Methods of overcoming this effect are currently being investigated as there appears to be sufficent power available for penetration.

Perhaps the most useful onshore application has been coring tailings dams. Cores have been recovered from the tailings dams at Mary Kathleen as part of an environmental investigation. A more difficult, but successful exercise was the coring of 'red mud' ponds, the waste product of bauxite mining at Gove in the Northern Territory. In both cases the unit was operated from a barge on which the detachable gantry was mounted.

The rapidity of deployment, coring, delivery of cores from unconsolidated sediments and the fact that the unit operates underwater combine to make vibrocoring a useful tool for many applications. Marine applications are well established, and a number of people working in the environmental field are well aware of the potential. The unit has many applications as yet unexploited, such as geochemical studies of inland waters. Much is yet to be learnt of the fluid, and the chemical exchange factors are vital in any reasonable assessment of environmental pollution.

Underwater resources, especialy sand bodies, are important sources of raw materials for building, and many contain valuable mineral resources such as heavy minerals and precious metals. The vibrocorer is therefore a potential proving tool, operating under the water effectively and efficiently for up to a 10m depth which is deep enough for proving up dredging operations.

Reference: McQuillan, R. and Ardus, D.A. 1977. Exploring the Geology of Shelf Seas. Graham and Trotman: 234pp.

Further details on the Vibrocorer are available from:

Land & Marine Pty. Ltd.
8 Cowdroy Ave. Cammeray.
NSW 2062
Telephone (02) 909-3437.

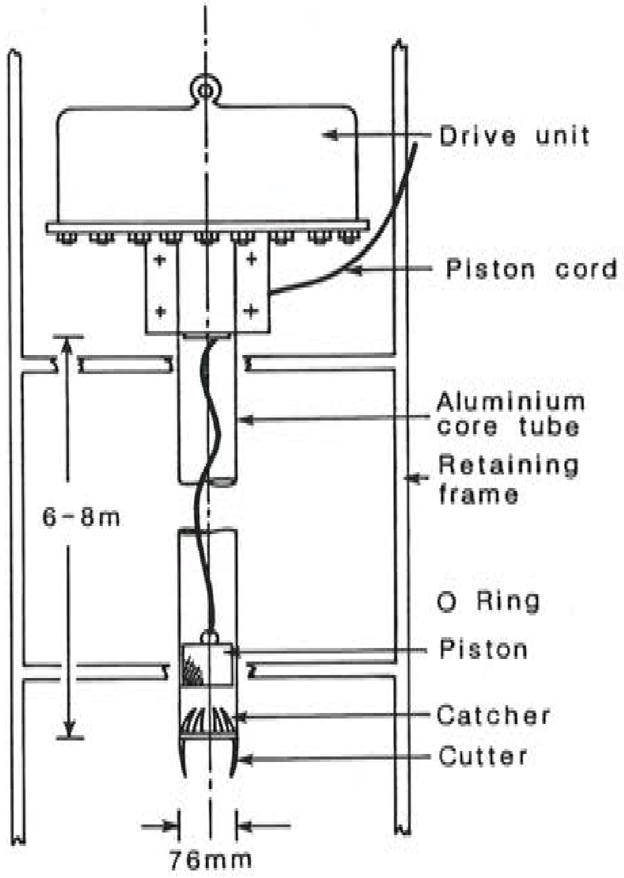
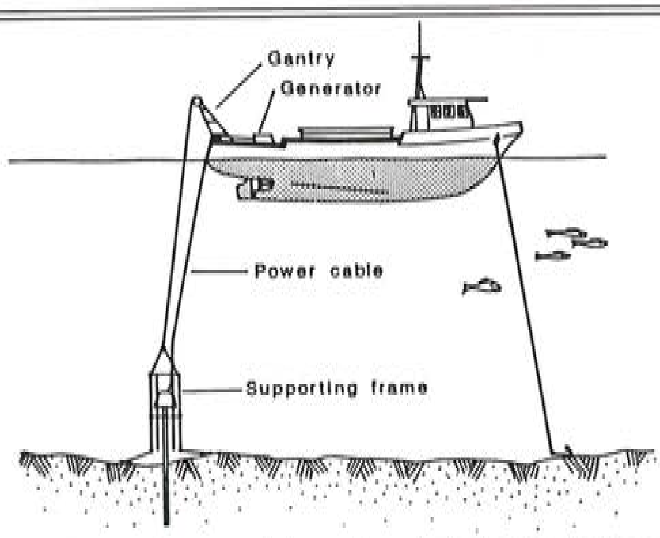
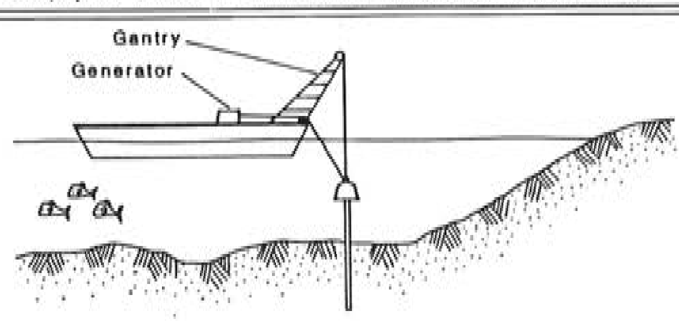


Figure 1 Components and arrangement of Vibrocover (not to scale)



a. Deployment of Vibrocorer in deep water employing the supporting frame



b. Deployment of the Vibrocorer in shallow water mounted on a barge system. It is possible to use the unit in very shallow water accessible to the barge

THE FIRST UNIT OF THE NEW ROC 434H HYDRAULIC CRAWLER DRILL SERIES GETS FULL MARKS IN FRANCE

The ROC 434H is a new hydraulic crawler drill from Atlas Copco for down-the-hole bench drilling in the 105 -125mm hole diameter range. It operates at pressures of between 6-20 bar. Its design features ensure fast and economic bench drilling, high availability, excellent reliability and easy service, plus outstanding cross-country characteristics.

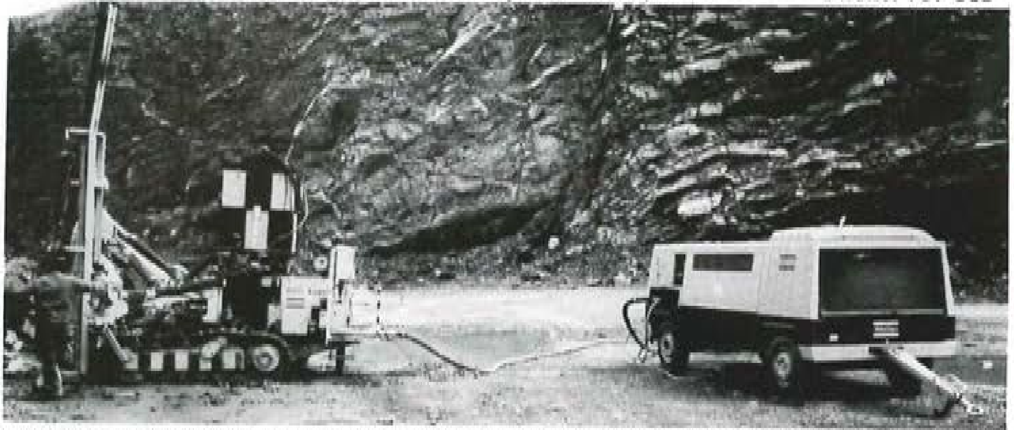
The first unit of this new series was bought by the French company CPB for operation at their limestone quarry near Givet, just south of the Belgian border. As part of its immediate after-sales and start-up service, Atlas Copco dispatched a team of engineers to the site to supervise and monitor the rig's first 200 operating hours.

Rock conditions at the site consist of 2000 bar compressive strength limestone, partly broken and fissured. The benches are 21m in height. A drill pattern of 4x4.5 is used. Five or six holes of 23m in depth and inclined at 10° are drilled each shift. The quarry has an annual production of one million tons.

The ROC 434H was equipped with a COP 42 rock drill using 110mm button bits. Drill rods of 3m length, with 76mm diameters, were used. The compressor was an Atlas Copco XRH 350, which ususally operates at 20 bar. In this case, however, it was set at 16 bar which provided optimal results in these conditions.

The Atlas Copco team observed that during 89 drilling hours a net penetration rate of between 42-50 cm/min was maintained. Drill bit service life averaged 2000m. It took between 12-13 minutes to extract each 7-rod drill string (incuding stoppages). The rotation unit for breaking the rods functioned very well as did the new feed inclination measurement system. In fact, it was apparent that all possible teething problems had been anticipated in the design and prototype pases and that the start-up of this first customer unit was completely trouble-free.

With compliments of
Atlas Copco (NZ) Ltd
released by: Rex Monigatti,
P.O. Box 3514,
Wellington.
Phone: 767-318



The new ROC 434H hydraulic crawler drill operating with an Atlas Copco XRH 350 compressor in a limestone quarry.

ROC 512HC — A NEW SERIES OF SMALL BUT POWERFUL, ALL-HYDRAULIC CRAWLER DRILLS FROM ATLAS COPCO

Atlas Copco is introducing yet another series of crawler drill: An all-hydraulic series with versions for production drilling (in small surface mines and quarries) and for civil engineering applications. They are small, light-weight, one-man-operated, but capable of exceptional power outputs, and, therefore, of outstanding net penetration rates and high annual production capacities.

Their hydraulic rock drills have three different impact stroke settings which enable them to be easily adapted to differing rock conditions and varying types of drill steel. The on-board compressor maximizes manoeuvrability and reduces set-up times. The tramming controls are mounted on the rear platform together with one set of controls for positioning the feed. Positioning can also be carried out from a front panel mounted on the feed. Positioning can also be carried out from a front panel mounted on the feed. The drilling controls are also located on this front panel. A wide range of standard options are available from the factory, for example, dust collectors, flushing-air sensors, anti-freeze dosimeters, feed rod racks, inclination instruments - in order to make each rig tailor-made product for its particular purpose.

SMALL - BUT PACKING A PUNCH!

The power-pack consists of a turbo-charged, four-cylinder Deutz diesel engine, BF4L913, which can deliver a maximum power output of 69kW at 2,300 rpm. The rigs are equipped with four hydraulic pumps. The main pump, which provides the power for the drill's impact mechanism, is flow and pressure regulated to optimize energy utilization. The other pumps, which provide power for service functions, all operate individually. This makes them easily adjustable to differing rock conditions to use the different drills and rock tools.

AUTOMATED SYSTEMS FOR INCREASED CAPACITY & REDUCED WEAR

The hydraulic system has built-in automatic functions which maximize drilling capacity and avoid damage to the drill steel. Impact energy can easily be reduced at the beginning of drilling operations, in order to ensure safe collaring, and also in situations where the bit meets no resistance. This can occur, for example, where the bit breaks through into rock fissures. The problem here is that the full impact energy from highly effective, hydraulic rock drills, (such as those mounted on these rigs) — when not absorbed by the resistance of the rock — can cause damage to drill steels, Another automatic system prevents jamming. This monitors torque resistance. When excessive torque is indicated, i.e. when jamming is likely to occur, the system automatically stops exerting feed pressure on the bit and reduces the impact energy. Drilling proceeds very gently until the bit can rotate normally again. Regurlar drilling is then recommenced. (The same procedure is automatically follwed if the bit's flushing holes become blocked.) These automated systems increase penetration rates and reduce spare part costs.

SINGLE BOOM VERSION

The single boom, ROC 512HC-00 version is equipped with the COP 1238LP hydraulic rock drill. This drill delivers an impact power of 11 kW. Used in conjunction with R 32 or T 38 extension rods, it covers the 48 to 76mm hole diameter range. The net penetration rate in limestone (1500 bar), drill a 51mm diameter hole, is 2.1 m/min. Its annual production capacity, working a single 8-hour daily shift and using a 76mm hole diameter, can be estimated at 1.1 million tonnes.

FOLDING BOOM VERSION

The ROC 512-01 is equipped with a folding boom, which gives it the kind of wide reach which is especially useful in virgin and/or rough terrain. The low centre of gravity combined with options such as the hydraulic winch makes this crawler ideal for all types of civil engineering applications. For the hole diameter range 35 to 64mm, it can be equipped with the COP 1032 rock drill (impact power output; 8 kW) and used in combination with R 28 threaded integrals or R 32 extension rods. This drill has a net penetration rate of 1.7m/min in 1500 bar limestone, drilling a 51mm diameter hole. For the 27 to 40mm range, it can be equipped with the COP 1025 used in combination with threaded integrals.

With compliments of
Atlas Copco (NZ) Ltd

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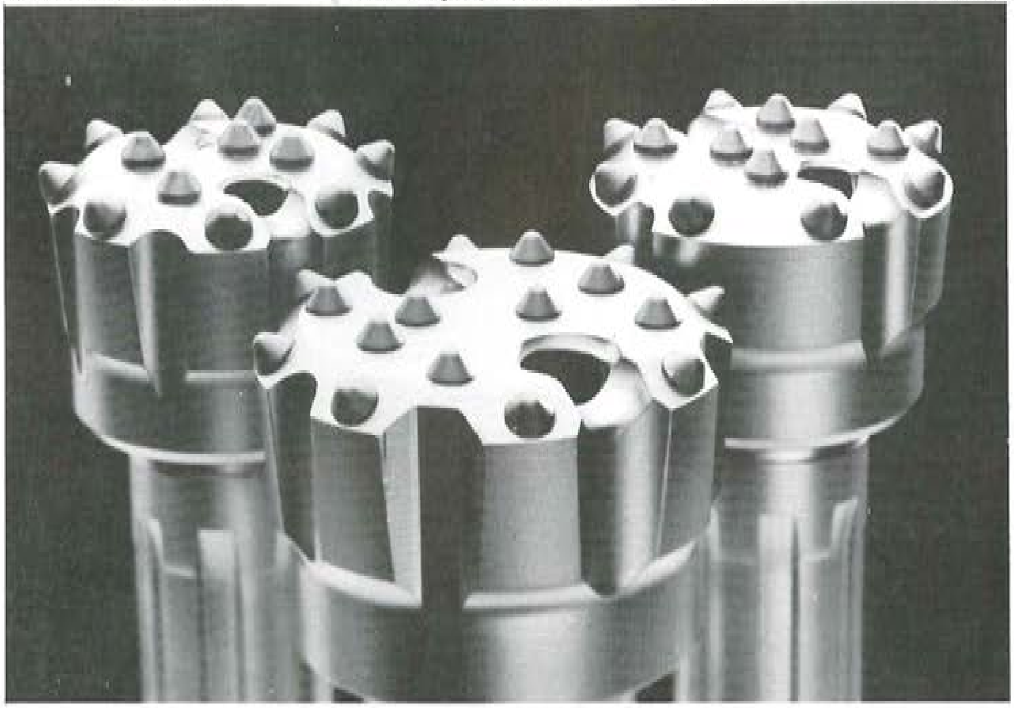
Atlas Copco's new ROC 512HC all-hydraulic crawler drill.

NEW CONICAL BUTTON BITS FOR DTH DRILLS

A new type of DTH bit for soft and medium-hard, no-abrasive rock is now available.

Manufactured by Sandvik Rock Tools and marketed by Atlas Copco, these new bits have pointed, conical shaped buttons, which are more effecient in fracturing rock at low air pressures than spherical buttons.



The new conical button bits for DTH drills.

The use of conical buttons can provide increases in penetration rates of between 10% and 25% when drilling at pressures below 12 to 15 bar.

The bits are currently available for the CCP 32 in diameters and 85 and 90mm and for the CCP 42 in diameters 105, 110 and 115mm.

These new conical button bits complement the range of DTH bits introduced in 1984, which were developed to meet the reqirements of drilling at medium to high air pressure, i.e. up to 25 bar.

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Where the Sand Goes: Or When Will the Other Shoe Fall?

Have you ever wondered why so many wells that sand-up don't full up with sand? I'm speaking of course about those damn nuisance wells that require an in-well pump protection sand separator to extend the life of the submersible or turbine pump.

For more than a decade now, since in-well sand separators have been in common use, people have been worried; if the well pumped a couple of coffee cans full of sand every day before the separator was installed, why didn't that sand eventually fill up the well once it was no longer being sucked through the pump? Why didn't the separator and pump eventually suffocate itself by means of its own power to draw sand through a formation until it virtually buried itself in grit? ("A little bit of sand" can actually be quite a lot. For example, a concentration of 25 ppm of sand in a flow rate of 100 gpm will produce 1,000 pounds of sand every 500 hours of operation) Experience long ago taught me to tell them with a twinkle in my eye, "not to worry, it may never fill up." Now, after two and one-half years of research, I am convinced that nine times out of 10, I'm right.

How nerve-wracking it must be for these well owners and drillers to wait for the other shoe to fall, never knowing when the well will fill but certain that it will. Yet it never seems to happen.

I have looked at situations across the country afflicted with this dilemma, and the story is commonly the same. No amount of development appears to end the constant stream of sand appearing in the water.

With little confidence, dersire or money to drill a new well, owners and drillers decide to live with the problem and install a sand separator in the well at the suction of their turbine or submersible pump. They hope they can get a few good years of service out of this ornery hole in the ground. And even if they know the pump will now last longer, and produce sand-free water, they know intuitively that they have merely replaced one problem with another. The well is sure to fill up with sand!

Yet, plumbing the well depth initially and then a signifcant time (six months to a year) later finds only a few feet of sand in the well bottom, lessening its effective depth a little. Another six months or a year later, driller and owner alike are surprised to find the depth about the same. The conscientious home owner or driller may on occasion of periodic maintenance, pull the pump, clean out the sand and re-install the pump. More often than not, but not always, the well will again fill up with sand to the pre-maintenance level but not further and, again, driller or home owner wait for the seemingly inevitable to happen — but it doesn't. When a well does not refill, it is generally because at long last, over time, the well did develop a clean envelope of coarse sand around it.

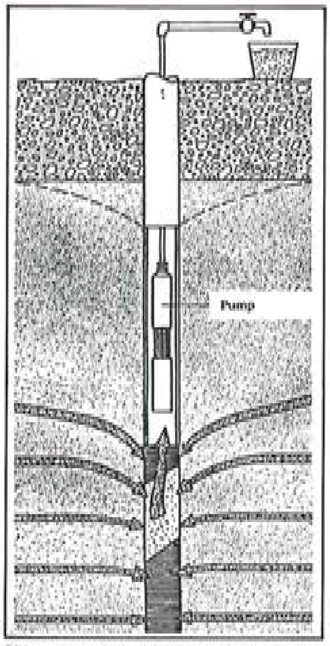

Figure 1. When a well is first drilled it can carry in a maximum amount of sand.

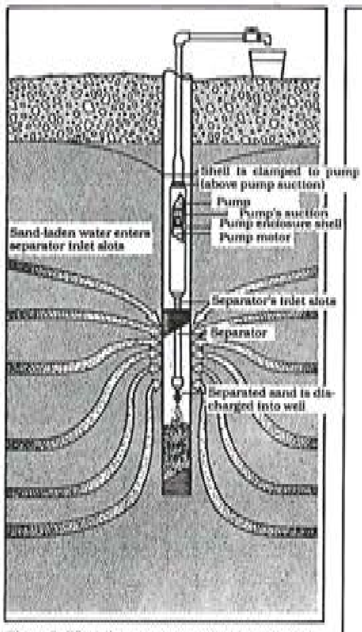

Figure 2. When the separator purges enough sand into the well, the flow patterns change, making it difficult for water entering the well to carry sand.

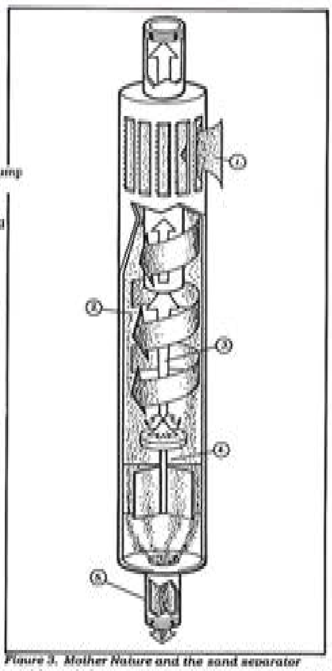
Figure 3. Mother Nature and the sand separator combine to help us solve the problem, as shown here.

Let me now try to put all your restless drillers and well owners at peace with your wells and sand separators, calming your anxiety so that you may direct your nervous energy elsewhere.

You see, it takes the energy inherent in flowing water to carry sand into a well. When a well is first drilled, its screened or open area is capable of letting in maximum amount of water. That water can carry in a maximum amound of sand as shown in Figure 1. The flow path for each particle of water is the shortest relative distance in the saturated zone of influence around the well. Thus, the water suffers the least energy loss in moving through the aquifer, enabling it to use excess energy to carry sand through this devilish formation whose sorting characteristics won't allow the development of a clean, coarse sand envelope we love to grow around our wells.

But all is not lost. If we give nature a chance, she will most often work in our behalf if only we "go with the flow" and do not choose to fight her (like when we build dams, straighten rivers, build homes hanging over soft hillsides, block recharge areas and so on and so on). In sanding wells, as shown in Figure 2, when the separator purges enough sand into the well to fill it with the right amount of sand, the flow patterns in the zone of influence around the well are no longer efficient and orderly but, instead are tortuous and elongated. As with all inefficient things, energy is lost — but in this case, for a change, that energy loss works in our favour. It is just that loss of energy that makes it difficult for the water entering the well to carry any more sand with it. Thus, the very fact that the pump protection separator has caused a controlled sand buildup in the well establishes an impediment to continued sanding of the well. If this were not the case, the result would always be ultimate self-destruction (with or without a sand separator).

In the situation in Figure 2, the sand separator will continue to recycle the sand in the well in a virtual never-ending cycle. The separator is still necessary. Without it the pump impeller, bowls, shaft, or bearing wear would cause decreased pump efficiency, as well as increased energy consumption. Besides if the separator were removed from the well, the sand would go up through the pump, upsetting the equilibrium existing in the well, reducing the inefficiency outside the well, and increasing the energy available to carry more sand into the well to replace that which is pumped out. Therefore, instead of reaching equilibrium with a fixed volume of sand in the well (and no more movement through the formation outside the well), we would have a continuous movement of sand into the well and up the pump.

So hand on to the separator, don't worry about the reduced depth of your well, and thank Mother Nature for an almost free lunch. (Remember floods, pestilence, drought damage, etc. are not a result of Mother Nature working alone; man is part of the equation that results in havoc.) Here Mother Nature and pump protection separators combine to help us solve a knotty problem. We have only to understand the strange way they work as shown in Figure 3. Actually, it is basic physics of flow through porous media — nothing really mysterious about ground water flow — and a unique form of the hydrocyclone that does the trick.

If per chance you know of a

well where the other shoe did drop, here is why:

• The distance between the depth of the pump setting and the bottom of the well was not great enough to allow adequate sand buildup to reduce ground water flow energy. In turn, the water's sand-carrying capacity was never reduced enough to set up the equilibrium. If room allows, this can be remedied by raising the level at which the pump intake is set in the well. There are occasions where adequate depth does not exist.

• There may by some situations where the high permeability of the aquifer (whose sorting characteristics produce sand) is so great that no amount of sand buildup in the well will reduce the energy of the water to carry more sand into the well. In this case, the problem can be solved in one of two ways:

1. Dramatically reduce the flow rate and subsequent drawdown till the yield is the minimum necessary for use. Such highly permeable formations usually have an extremely high specific capacity, making possible a reduction in hydraulic gradient outside the well that will thwart sand movement. Here, a separator may be needed to further reduce the energy of the flowing water via sand buildup in the well, as well as to eliminate any sand or grit that might damage the pump.

2. Such high-yeild wells can also be lined with a screen and sand pack that will act as a filter to physically block the entry of sand. A drop of 40 to 60 percent in specific capacity can be expected, but the high-yeilding characteristics of the aquifer, which posed the problem with using the sand separator may still produce acceptable amounts of water.

It is important to point out here that a large percentage of our sand producing wells are not entirely due to irrevocable geologic conditions but are the result of poor well design, construction and development. Our first line of defense is to be sure the job is done correctly and preclude the need for a sand separator; failing this, however, it's great to know that nature and the pump protection separator can limit our losses and keep our wells operating for a long and useful life.

Monitoring Well Development

Upon completition, all wells require development. Well development corrects damage done to the borehole during drilling; removes clay, silt or fine sand from the formation adjacent to the well screen to minimize or eliminate the pumping of fine particles; and stabilizes the borehole. Unfortunately, because of their design and intended use, the ground water monitoring wells are difficult to properly develop. This month's column will address these difficulties and describe appropriate procedures for monitoring well development.

Borehole damage

All drilling methods impair the ability of an aquifer to transmit water to a drilled hole. The impairment may be due to the physical rearrangement of the matrix of the aquifer material, or to formation damage as a result of the invasion of drilling fluids or solids into the aquifer. Regardless of cause, the damage to the borehole must be corrected if well evacuataion and sampling of the monitoring well are to be successfully performed.

Problems associated with monitoring well development

Well design and the use of wells for water quality sampling place restrictions on the types of well development methods appropriate for monitoring wells. Because of the low rates at which ground water is extracted from a monitoring well, the typical monitoring well will have a short screen, often machine-slotted, with slots ranging from .006 to .020 inches in diameter. Although the total open area of the well screen is small, in most cases there is enough open area to keep entrance velocities low enough during sampling to avoid degassing and/or alteration of ground water quality. Unfortunately, the narrow slots and limited open area, combined with well diameters as small as 1½ inches, make well development extremely difficult. The limited open area makes correction of borehole damage difficult; adequate removal of fines in the adjacent formation is all but impossible. Wells having a diameter of 2 inches or less cannot be overpumped or rawhided, and other surging techniques are of limited effectiveness. If the well has a sand pack, then the ability to correct borehole damage is further restricted, although if properly designed, the sand pack should prohibit the migration of fine paricles into the well during sampling.

A large-diameter well (4 inches or larger) with a wire-wound screen and a naturally developed filter pack, will provide good conditions for well development. Unfortunately, the high cost of some well construction materials has resulted in the proliferation of 2-inch wells with machine-slotted casing for screens. In addition, some state and federal regulations appear to encourage the use of sand packs for most monitoring wells.

An arsenal of various chemicals has been developed to facilitate the development of water supply wells. These chemicals include acids, surfactants, chelating agents, wetting agents and disinfectants. Unfortunately, these chemicals can migrate into the formation and may affect the quality of ground water in the vicinity of the well. As a result, chemicals are not generally used for development of monitoring wells.

Most monitoring wells have been designed for low capacity pumping. Typically, the well diameter is so small that standard well development tools are impractical, and if things were not bad enough, chemicals that would facilitate well development are prohibited.

Methods of well development

In spite of all the restrictions, we must still develop monitoring wells. In areas where the formations consist of clean sands or gravel, development will be relatively easy, but where the well has been completed in a silty fine sand, some glacial tills or formations considered to be aquitards, development of a 2-inch well is going to be a nightmare. Nonetheless, we do have some options available that may allow the contractor and consultant to sleep easier at night. These methods involve mechanical well development. Factors such as well design and hydrogeologic conditions will determine which development method will be most practical and cost-effective. Several methods of well development and their advantages and disadvantages are described.

Overpumping involves pumping the well at a rate substantially higher than it will be pumped during well evacuation and ground water sampling. The intent is to pump the well at the highest rate attainable, increasing the draw-down in the well to the lowest permissible level. This results in increased flow velocities that induce the flow of silt, clay and other debris into the well, opening screen slots and pore spaces, and/or cleaning fractures.

For effective overpumping, it is usually necessary to pump the discharge to waste. This can be a problem where ground water extract during well development may be contaminated by hazardous waste or hazardous constituents.

Overpumping works best in relively clean, coarse formations and in some consolidated rock aquifers. Perhaps its most significant advantage lies in its simplicity.

Its disadvantages include problems associated with the disposal of discharge water; bridging of particles against the well screen; the inability to pump most 2-inch wells at a rate high enough to permit effective development and the fact that the technique is realitively ineffective in poorly sorted and "dirty" formations.

Rawhiding overcomes the bridging that results from overpumping by allowing the water that is pumped to the top of the well to flow back through the pump and out through the intake portion of the well. The back flushing breakes up the bridged particles, allowing them to be subsequently pumped from the formation and removed from the well. This method offers the advantages of low cost and simplicity. However, it has the disadvantage of preferentially developing the most permeable zones of the formation surrounding the intake portion of the well.

Surging can be a very effective means of monitoring well development even in small-diameter wells. A surge block (Figure 1) is attacted to drill rod or drill stem and is of sufficient weight to cause the block to drop rapidly on the downstroke, forcing water contained in the borehole into the aquifer surrounding the well. In the recovery stroke or upstroke, water is lifted by the surge block, allowing the flow of water and fine sediments back

into the well from the aquifer.

Drilling contractors frequently fabricate their own surge blocks for wells of specific diameters. However, this is rarely done for wells' smaller than 4 inches. As a result, we have designed and constructed our own surge blocks to fit wells with inside diameters of 1½ inches or larger.

The surge block is schematically represented in Figure 2. The rubber belting should be cut to fit snuggly within the inside of the casing. Metal washers placed above and below the belting will help keep it rigid. A pair of hexagonal nuts are used to sandwich the washers and belting material together tightly.

For screens 5 feet in length or less, surging above the screened interval is very effective for development of the full length of the screen. However, for screen lengths longer than 5 feet, especially where the formation adjacent to the screen is variable, there exists the potential for preferential development of either the upper 25 percent of the screen or the most permeable zones adjacent to the screen.

For screens longer than 5 feet, surging within the screened interval may be performed, but only after taking precautions to avoid sand locking the surge block in the screen or causing damage to the screen. Surging within the screen can be successfully accomplished by cutting down the diameter of the belting material so that it is from ¼- to ½-inch smaller than the inside diameter of the screen. The reduction in size serves two functions. First, it reduces both the positive and negative pressures exerted on the casing and screen by allowing some water to flow past the surge block on the up and downstrokes. Second, it allows fine sediment to flow around the belting rather than lodging between the belting and the screen. When surging within the screen, slow short strokes are used directly opposite the zone you wish to develop. A 3-foot stroke is adequate. The surge block is then raised or lowered to initiate development in the next part of the screen.

Periodically, the surging should be stopped and the well should be bailed or sand pumped to remove sediment and debris that may accumulate near the bottom of the screen. Since it may be difficult to remove all the sediment that may accumulate in the well during development (and in some cases during subsequent sampling) we often attach a 1-to 5-foot length of casing to the bottom of the screen in which to allow sediment to accumulate.

Jetting has been used satisfactorily for developing wells in unconsolidated and consolidated formations. Water jetting can open fractures and remove drilling mud that has penetrated the aquifer. A typical jetting tool is shown in Figure 3.

The discharge force of the jetting tool is concentrated over a small area of the well screen. As a result, the tool must be rotated constantly while it is raised and lowered in very small increments to be certain that all portions of the treated zone are exposed to the jetting action.

Like a surge block, the jetting nozzles should fit close to the inside of the screen or the borehole face because the velocity of the jet stream is dissipated within a few inches. Like a surge block, jetting tools can be readily fabricated to fit into wells with diameters as small as 1½ inch.

Perhaps the only signifcant disadvantage to the use of jetting is the fact that an external supply of water is necessary. The quality of this water should be determined prior to its use to ensure that it will have no long-term effects on the integrity of ground water samples.

The jetting method has several advantages. The equipment is simple to use and readily available, and the technique is easy to apply. The jetting energy can be concentrated to perform development where it is most needed. By pumping, or air lifting during the jetting process, the fine, dislodged materials are drawn back into the well and pumped out.

Air surging is perhaps the most widely used method of developing small-diameter monitoring wells. The attractiveness of air surging lies in the fact that it is simple and easy to perform and "appears" to work. While it may be an extremely effective method of cleaning debris from the well, it has very little positive effect beyond the well screen. To some extent, blowing air out into the well may cause air to become entrained in the narrow slots of the screen and/or the ports of the formation immediately adjacent to the borehole. This creates two problems: 1) the entrained air is difficult to remove and reduces formation permeability and the precent of open area of the well screen; 2) the entrained air may affect ground water quality during sampling.

If possible, air surging should be avoided and replaced by air-lift pumping. Figure 4 illustrates the critical components of a typical air-lift system. This is a two-pipe-system, where an air injection pipe is installed inside a discharge or eductor pipe. Air is injected through the inner pipe at sufficient pressure to bubble out into the surrounding eductor pipe. The bubble, thus formed, reduces the unit weight of water in the pipe causing this column of water to be lifted upward and allowing water from outside the well to rush into the well. Not that all air discharged into the well should be filtered to remove compressor lubricant.

Other methods of well development are also available. For example, a bailer can be used in much the same fashion as a surge block in small-diameter wells. Or a well can be backwashed by adding water to agitate and remove fines plugging the screen and formation. Of course there are a whole list of variations that can be applied to the methods I've discussed for different well designs and hydrogeologic conditions.

Regardless of the method of well development selected, there are a few points that are universally applicable. First, well development should be initiated gently. As flow is established through the intake portion of the well, then the degree of agitation can be slowly increased. Second, do not try to place a time limit of development, such as an hour or two. The well should be developed to a point that water can flow as readily into the well as aquifer conditions will permit. The flow should also be reasonably clear and free of sediment. Third, if one method does not work, try another or use a combination of methods. Do not be afraid to experiment and do not give up too hastily.

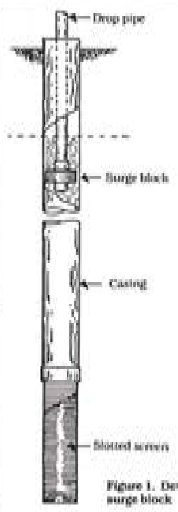

Figure 1. Development with a surge block

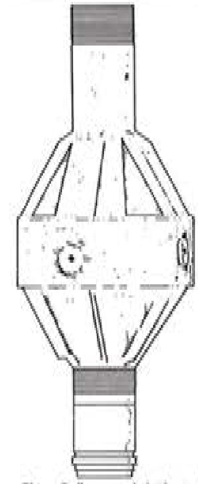

Figure 3. Four-nozzle jetting tool designed for use inside 8-inch well screen for jet development

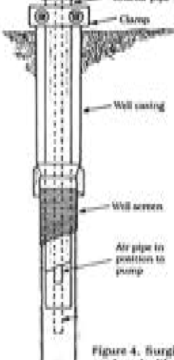

Figure 4. Surging action can be produced with compressed air using modified air lift

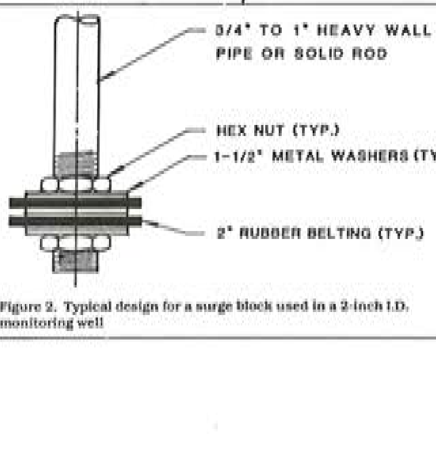

Figure 2. Typical design for a surge block used in a 2-inch I.D. monitoring well

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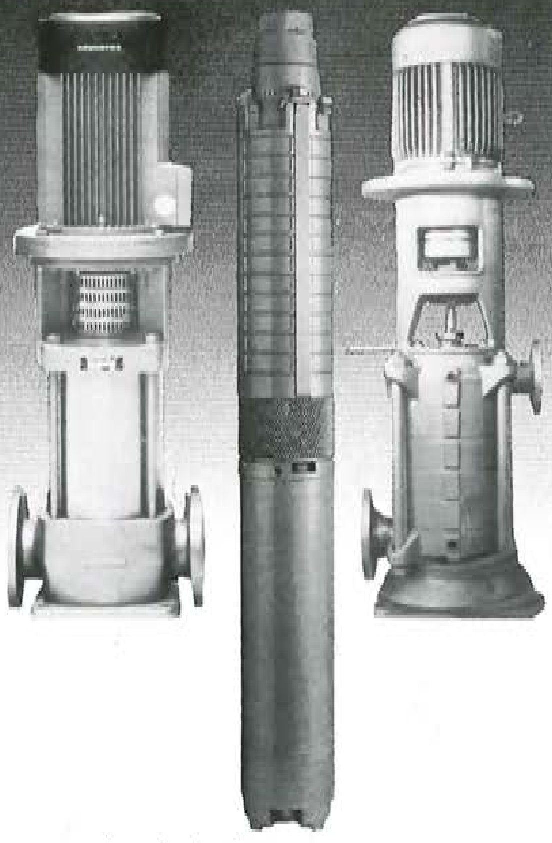

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