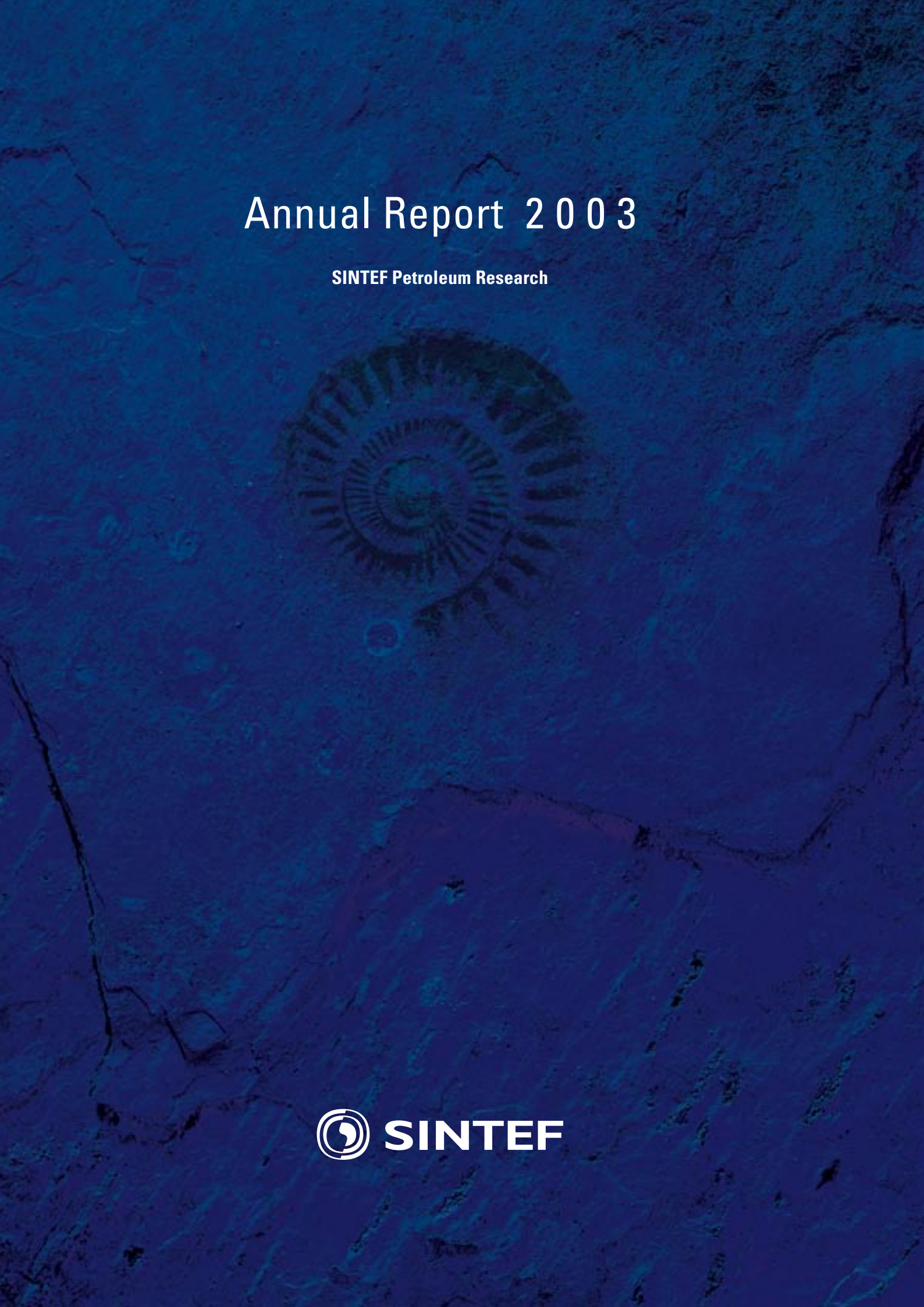
Annual Report 2003

SINTEF Petroleum Research



SINTEF

Leading edge technology – the driving force of our rapid growth!

In 2003, SINTEF Petroleum Research AS produced an operating result of NOK 8.4 million, equivalent to an operating margin of 9.6%. Net financial revenue for the year was MNOK 5.9, bringing the annual profit to MNOK 14.3, equivalent to a profit margin of 16.4%. Both the operating margin and the profit margin represent the best financial results ever obtained by the Institute since its inception in 1969. This is primarily due to the fact that all six of our departments are doing extremely well in a demanding global market. The competence of the Institute is in great demand, as is its leading edge technology in basin modelling, ocean bottom seismics, rock mechanics, well instrumentation and construction, production technology, multiphase technology, flow assurance, IOR and CO_2 deposition. The involvement of colleagues overflowing with creativity and enthusiasm has been an essential component of the excellent trend in the results we have obtained since 1998. The systematic implementation of high-quality strategic efforts has been another important factor.

The Institute has grown rapidly in the course of the past two years. Turnover has increased by 43% and the number of staff by 33%.

The time-horizon in petroleum research is growing steadily shorter, and every year it becomes more of a challenge to persuade the sector to raise its eyes and face the challenges that lie five or ten years in the future. In order to give our customers confidence that a particular concept can be implemented, we are forced to develop the first stage of the relevant technology ourselves. Our experience is that it can take as long as five years to reach this stage. In other words, our experts need to be able to predict what challenges the offshore industry will be facing five years before the offshore industry itself becomes aware of them, and ten to fifteen years before it will need the technology involved. The Research Council of Norway is one of the most important links in this chain of development. The two largest research projects currently under way at the Institute, LEDA (next-generation 1D/3D multiphase simulator, financed by ConocoPhillips, Total and SINTEF) and Coldflow (a cost-cutting method of transporting well-flow in pipelines over very long distances, financed by BP), are examples of how our experts have correctly predicted what will be the future technological requirements of the petroleum industry.

The Research Council of Norway decided to invest in these two ideas in the early 90s, and in the course of five to ten years we developed basic technologies that have opened the eyes of our clients and in so doing have released a significant amount of funding that has brought these technologies to the stage of commercial application. The two above-mentioned projects will result in significant reductions in the level of investment required in future Norwegian and international field developments. These technologies will make a number of discoveries commercially feasible and thus give added value, both for our clients and for the people of Norway. The Norwegian State stands to gain most by this process. The values created are far greater than the public-sector support that enabled the technology to be developed in the first place. The values to be created by these two technologies can be conservatively estimated at NOK 30 billion, while the contribution of the Research Council of Norway was around NOK 30 million. The public-sector funding will thus have created values equivalent to 1000 times its investment. This comes in addition to the commercial activities and new jobs generated by these technologies.

It is vital that our elected politicians understand these mechanisms of research and innovation. I would challenge them to move on as soon as possible from their apparently endless good intentions to real action, and to bring Norway up to the average level of investment in research in the OECD. Give the Research Council of Norway the financial muscle it needs to liberate the innovative ability and value-creation potential of Norwegian scientists.

David Lysne
President
SINTEF Petroleum Research

Report of the Board of Directors 2003

ACTIVITY

The company's growth and results for 2003 confirm the validity of the long-term strategy that is being followed by SINTEF Petroleum Research.

In 2003, SINTEF Petroleum Research made an operating profit of MNOK 8.4, corresponding to a margin on operations of 9.6%. Net financial revenues came to MNOK 5.9, so that the overall result for 2003 was a profit of MNOK 14.3. Both the operating margin and the margin on results were the best ever achieved by the company since it was established in 1969.

The Board is very pleased with the result for the year, and it extends its appreciation for positive cooperative efforts to the company's clients and partners. The Board also thanks the staff of SINTEF Petroleum Research for their excellent work throughout 2003.

During the third quarter of the year, up to 30 members of staff have been involved in a project for an Iranian client, which has made a positive contribution to the company. This project will come to an end in the first half of 2004.

SINTEF Petroleum Research is a research and development company located in Trondheim, Norway.

PERSONNEL AND ORGANISATION

The company performed 93.5 person-years of work in 2003. At the year's end, the company had 97 employees. Seventy-five of them are research scientists, of whom 36 (48%) hold doctorates. A further six are currently working on their doctoral theses. A total of four colleagues left the company in 2003, and seven new employees joined us. At the end of 2003 SINTEF Petroleum Research had one consultancy agreement with a member of NTNU's academic staff, and the company has supervised 16 project and diploma students at NTNU, in addition to 12 students via EU projects. In the course of the year, the company has employed one consultant and 16 persons paid on an hourly basis.

Four members of staff of SINTEF Petroleum Research have spent periods abroad, in Greece, Spain, Italy and France.

Annual conversations with each individual member of staff are an important element of the company's organisational development strategy.

At the end of 2003, the organisation of SINTEF Petroleum Research comprised six scientific departments plus administrative functions, which consist of the central staff and the data-processing department.

EQUAL OPPORTUNITIES

At the end of 2003, SINTEF Petroleum Research had 97 employees, of whom 27 were women. The proportion of women among the research staff is 17%, and in the company as a whole, 28%. The Board has ten members, one of whom is a woman, and there is one woman in the company's management team. One of the personnel policy goals of the company's strategic plan is to raise the proportion of female research staff and management personnel to 25% by the end of 2005. The Board intends to raise the proportion of women among its members.

Like other units of the SINTEF Group, SINTEF Petroleum Research has a gender-neutral personnel policy, which is based on the conviction that our internal relationships should be based on paying attention to others, mutual respect and valuing diversity.

WORK ENVIRONMENT

Via the Work Environment Committee, the company enjoys close cooperation with its staff in the exchange of information and important aspects of the work environment. Three meetings of the committee were held in the course of 2003.

Virtually all the HSE initiatives proposed were implemented in 2003. Of these, the following are particularly worth mentioning: survey and following up of the work environment by means of safety surveys and/or risk assessments of offices and laboratories, as well as risk assessments of new activities. On the training

side, in 2003 we carried out practical fire-drills. Most of the measures were implemented in the Department of Multiphase Technology, where we made particular efforts with respect to infrastructure protection, document security, fire safety and personnel safety. We also placed sharper focus on work enjoyment, cooperation and motivation via joint arrangements and departmental measures. Physical environmental factors were also improved in 2003, for instance through a continuous process of systematisation of the chemical store.

Sick leave in 2003 was 2.9%, compared to 2.0% in the previous year. There was a single work accident in the course of the year, although the injury was not serious and did not result in sick leave. The incident has been investigated and the appropriate measures have been put into effect.

EXTERNAL ENVIRONMENT

The company's HSE system meets the requirements of the internal control regulations, which help to ensure that our laboratory activities and handling of chemicals do not lead to contamination of the work environment or the external environment. This means that all chemicals are handled in accordance with the regulations and that waste products are deposited in an approved manner. In 2003 the company produced no emissions that required an emission permit. We are currently not required to take any specific actions by the Norwegian Labour Inspectorate.

PROFIT AND LOSS ACCOUNTS AND BALANCE SHEET

SINTEF Petroleum Research's annual operating profit for 2003 was MNOK 8.4 (MNOK 2.8 in 2002). Net financial income was MNOK 5.9 (MNOK 5.4); this produced an annual profit of MNOK 14.3 (MNOK 8.1 in 2002).

Gross revenues rose from MNOK 108.4 in 2002 to MNOK 113.5 in 2003, i.e. a rise in turnover of 5%. Net revenues rose from MNOK 74.0 in 2002 to MNOK 87.3 in 2003, i.e. a rise of 18%.

Investments and acquisitions of scientific equipment in 2003 amounted to MNOK 1.3 and MNOK 2.1 respectively, i.e. a total of MNOK 3.3.

The company's equity has risen to MNOK 86.6, which is equivalent to 64% of its total capital, of which the company's share capital in turn is MNOK 9.0. This is a satisfactory basis for continued operation of the company, which is the assumption on which the accounts have been drawn up.

The cash flow analysis shows a net cash flow from operations of MNOK 29.5. The company's cash holdings rose from MNOK 75.5 million in 2002 to MNOK 102.9 in 2003.

The Board is not aware of any circumstances that have arisen since the accounts were balanced, that are of significance for evaluating the economic position of the company.

PUBLICATIONS

In the course of participation in national and international conferences, our scientists presented 46 contributions, while 14 articles published in reviewed journals included SINTEF Petroleum Research staff among their authors. The latter is equivalent to 0.2 publications per man-year of scientific work (0.3 in 2002).

FUTURE DEVELOPMENTS

As part of the SINTEF Group's development plan for 2003–2006, the Board of SINTEF Petroleum Research resolved to set up offices in Stavanger, Bergen and Houston on January 1, 2004. The aim of opening these offices is to enable us to engage more closely with our national and international clients. Most of the oil companies that operate on the Norwegian continental shelf have their headquarters in Stavanger, and there are important offshore field operation centres in Stavanger and Bergen. Hydro and Statoil have their R&D centres in Bergen and Trondheim, respectively. When we also take into account the large operation centre that Statoil has built up in Stjørdal, from 2004 onwards SINTEF Petroleum Research will be engaging

closely with the most important centres of offshore operations in Norway.

Houston is the largest market for the petroleum sector R&D in the world, and it is important to maintain a presence there.

Establishing these new offices is an important strategic step in the efforts of the company to further develop its market involvement in a situation of ever-increasing competition in the world R&D market.

DISPOSITION OF PROFITS

The company's annual profit of MNOK 14.308 will be transferred in its entirety to our equity capital.

Trondheim, March 3, 2004

Morten Loktu
Chairman of the Board

Karl A. Berteussen

Inge M. Carlsen

Eva Habetinova

Erik-Sverre Jenssen

Jon Kleppe

Ole Lindefjeld

Fridtjof Nyhavn

Svein Sivertsen

Ingve R. Theodorsen

David Lysne
President, SINTEF Petroleum Research

SINTEF Petroleum Research Board of Directors. First row from left: Ingve R. Theodorsen, Erik-Sverre Jenssen, Morten Loktu and Ole Lindefjeld. Second row from left: Martin Landrø, Fridtjof Nyhavn, Svein Sivertsen, Inge M. Carlsen and Sverre Aam
Karl A. Berteussen, Eva Habetinova and Jon Kleppe, were absent when the photo was taken.

Activities – Departmental Annual Report

BASIN MODELLING

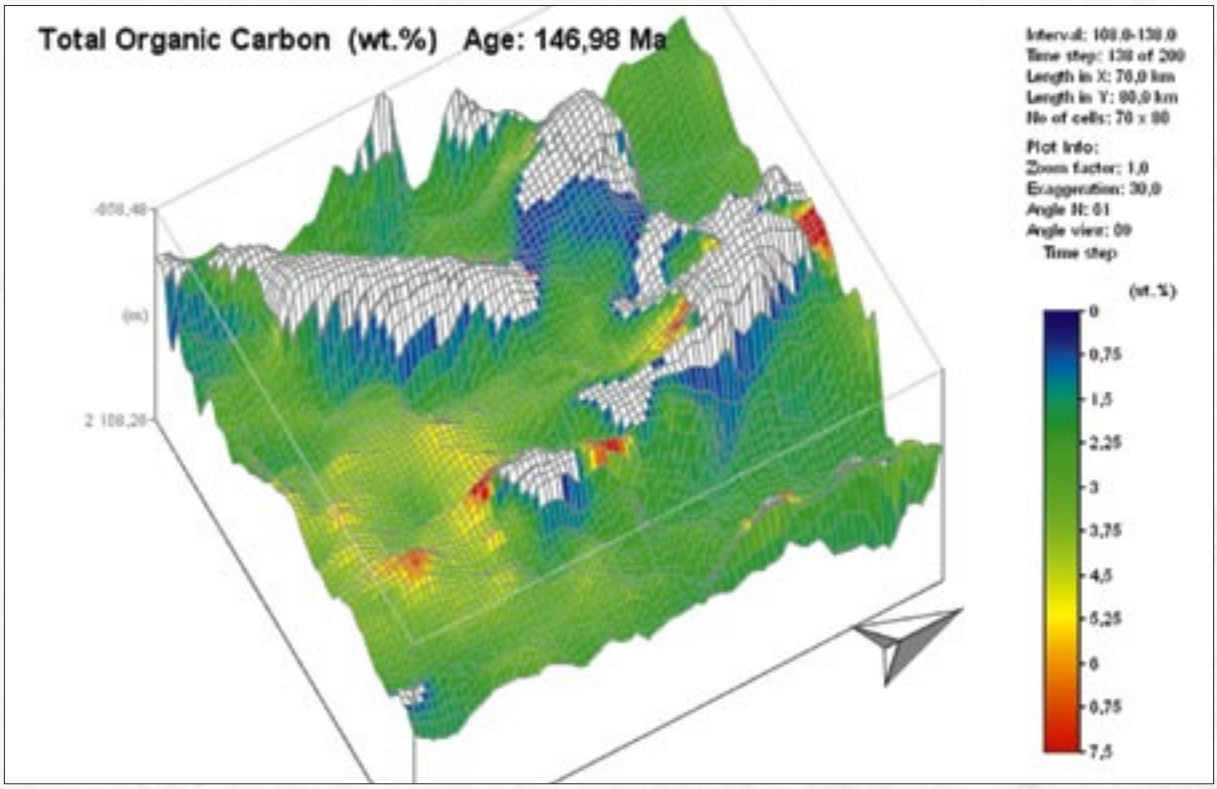
The basin modelling department continued to assist oil companies in quantifying exploration uncertainties in 2003, by supplying both study area-specific modelling services and cutting-edge modelling tools. The department is currently actively carrying out research on secondary hydrocarbon migration, pressure modelling, palaeobathymetric reconstruction, source rock facies modelling, source rock kinetics, primary migration, biodegradation and visualization. Case studies based on our technologies were carried out on data from more than ten different countries.

The Strategic Institute Programme on better hydrocarbon phase prediction will come to an end early 2004. So far, the programme has resulted in the following tools: OF-Mod – organic facies modelling, KING – kinetics of various component groups, PRIMIG – primary hydrocarbon migration and an improved multi component migration module in SEMI. The effects of these new technologies are currently tested in the northern part of the North Sea.

The software OF-Mod will significantly improve our ability to estimate the variation of source rock quality in a basin. OF-Mod was successfully developed into a working 3D version in 2003, and is already being used in a study for the Norwegian 18th licensing round. This means that all our modelling tools now are in 3D.

KING and PRIMIG improve our ability to model the temperatures and timing of different hydrocarbon component groups generated and expelled from a source rock. In total our suite of software makes it possible to get a better understanding of the petroleum system and improves the ability to predict the volumes and composition of trapped hydrocarbons in undrilled prospects.

Members of the department made 11 presentations at national and international geosciences conferences and contributed to three refereed papers in 2003. By invitation we presented palaeobathymetry as a tool for locating sandy facies on the Norwegian TV channel NRK1 (the popular science programme Schrødingers cat). This was illustrated with an animation from the



3D view of the modelled distribution of Total Organic Carbon in a Norwegian offshore basin.

Norwegian Sea that was made in collaboration with RWE-Dea Norge AS. We were also at the short-list of animations at the World Oil Awards in Houston in 2003 with a palaeobathymetry movie from the North Sea.

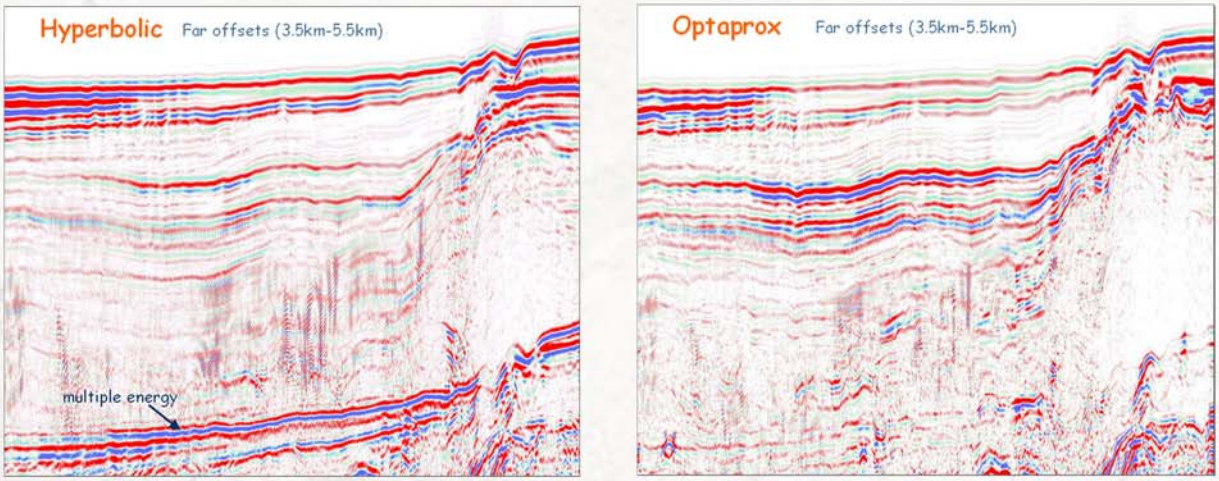
SEISMIC

The considerable computing power available to the Institute enables us to perform computing-intensive seismic processing applications. The department is doing a great deal of research on the processing and analysis of OBS (Ocean Bottom Seismic) data. Prototype software for vector-field imaging of multicomponent (4C) seismic data in media with anisotropy and attenuation has been developed. In the DEMO 2000-project IMPREDO, which was supported by Statoil, Hydro, Total and the Research Council of Norway , we have tested the new imaging methods on new multi-component data from geophone sensor nodes at the Volve field in the North Sea. This project was carried out in co-operation with Seabed Geophysical AS.

The department has recently been awarded a 15 MNOK research programme for 2004–2007 from the Research Council of Norway. The topic of the programme is the development of a more highly automated workflow and set of tools for depth imaging of OBS data in areas with complex geology. The programme involves such activities as vector fidelity, multiple attenuation, velocity model building, vector migration and inversion. This new generation work flow has the potential to significantly increase the accuracy of seismic imaging, both for exploration purposes and for reservoir monitoring with permanent seafloor installations.

INFAMI is a three-year EU project which we are carrying out in collaboration with Hydro, BG, University College Dublin and the University of Aarhus. It focuses on the development of software that uses shale smearing in faults to estimate fault sealing in basin-scale hydrocarbon migration simulations. The project is based on SEMI, and it includes development, implementation and validation of the methodology using data from several oil fields. This project is being performed in collaboration with the Department of Basin Modelling. The project will be completed in the spring of 2004.

In time processing and velocity picking, basic workflow concepts have remained unchanged in the industry for several years. The existing standard methods suffer from low accuracy in situations which have become more important during the past few years. For instance, in the cases of long offsets and anisotropy, more advanced methods are needed. We have developed a new concept for travel time estimation to solve



Far-offset stack for far-offset deep-water seismic data. The left-hand figure shows the results of a standard hyperbolic velocity analysis. To the right are the results of the new method. Surface-related multiple energy is attenuated and seismic resolution is improved.

these problems. The methodology is both very fast and highly accurate. A patent application has been filed, and a two-year programme (OPTAPROX) supported by the Research Council of Norway, Statoil and Hydro is close to completion. The improvements achieved by the method are clearly demonstrated in the figure.

MULTIPHASE FLOW TECHNOLOGY

As producing oil & gas fields enter the tail production phase, flow assurance becomes an increasingly important issue.

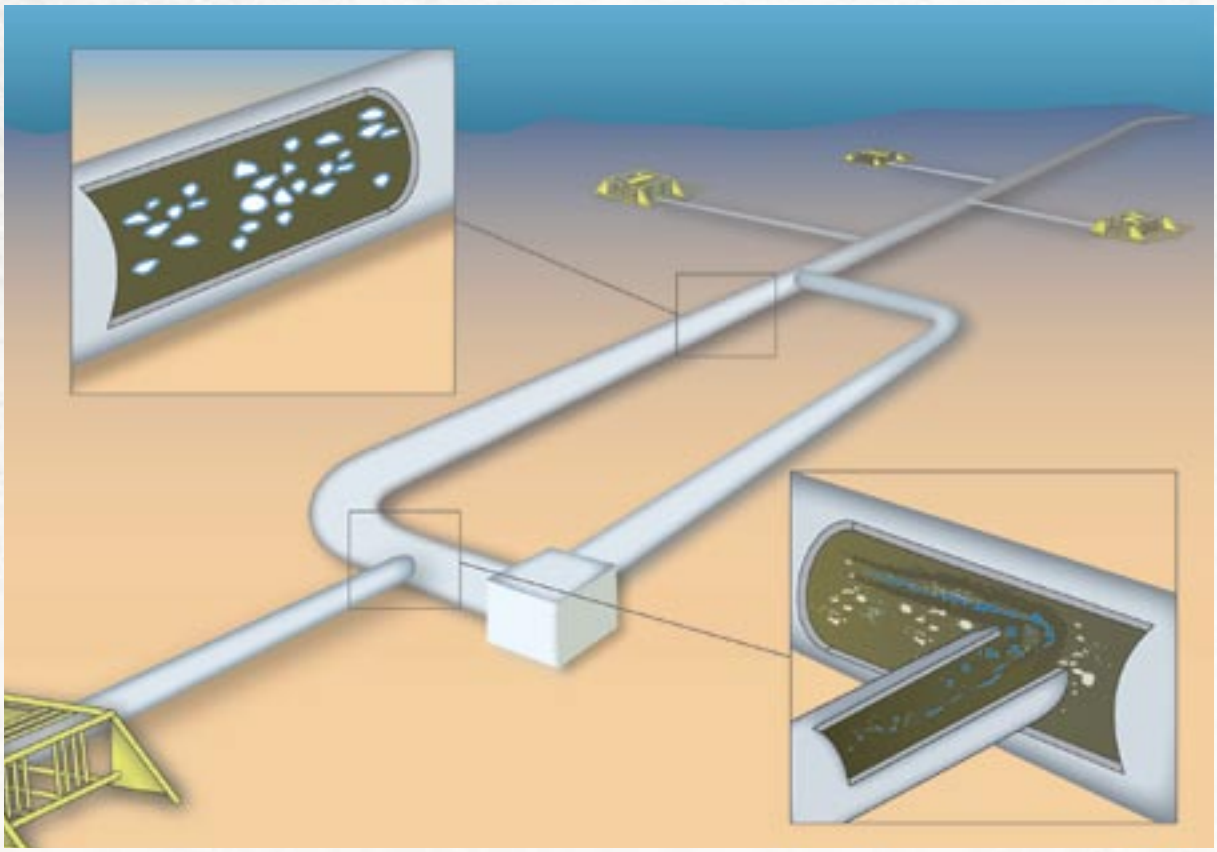
At the moment a rising number of major fields on the Norwegian Continental Shelf are entering this phase of their life cycles. Flow assurance issues are this department's main focus. The department operates unique laboratory facilities located at Tiller on the outskirts of Trondheim. The main asset is the world's largest industrial-scale multiphase flow laboratory, with approximately 1700 meters of high-pressure pipes ranging from 4–12 inches in diameter. In addition, the department operates a wide range of specialized laboratories for the study of flow assurance issues such as plain multiphase flow, gas hydrates, sand transport, scale and wax at pressures up to 1000 bar. The activities of the department are mainly concerned with two major long-term projects; LEDA and the SINTEF-BP Cold Flow project.

LEDA is a nine year research project with a 51 MNOK budget for the first three years, 2002–2004. The objective of LEDA is to develop a full 1D/3D flow assurance simulation tool which in particular will handle local flow assurance issues in a large pipeline network. The project is operated in close cooperation with the flow technology group at SINTEF Materials and Chemistry. In 2003 the main design basis for the simulator tool was established and the implementation of the simulator was started. The experimental programme was also successfully completed. A new element in 2003 was the start of development of a brand new 1D model in addition to the Q3D/3D models developed in the first year. So far the results delivered from the project have been very promising, and when fully developed, the LEDA simulator will surpass OLGA, today's industry standard technology in the area. The development of OLGA was managed by the department in the 80s and 90s. The LEDA project is a cooperation between SINTEF, ConocoPhillips and Total. The next generation multiphase flow simulator, LEDA, will significantly improve the design of long range well stream transport, particularly in deep waters.

The other major project being run by the department is the SINTEF-BP Cold Flow project. This project is operated in close cooperation with SINTEF Materials and Chemistry. The objective is to develop a very robust process for long-distance transportation of unprocessed well stream containing water, by converting the water to a very stable and transportable gas hydrate as shown in the figure. In 2003, the process was successfully proven in a 1 inch flow loop facility, operated with field fluids. Towards the end of 2003, BP announced that the company intends to continue the project. The project is now entering a pilot test phase. The Cold Flow technology is fully owned by SINTEF and patent protection has been applied for and awarded in all important markets in the world. The potential royalty revenues from the application of the technology are high. It is estimated that the SINTEF-BP Cold Flow technology can reduce the required investments in satellite fields by as much as 15–30%.

Other major projects in 2003 include the EU project THREEPLEX and SIMlab. The first project involves cooperation between SINTEF, the Institute for Energy Technology, Imperial College and IFP. The objective of the project was to study three-phase water gas and oil flow in complex terrain. The project was successfully completed in November 2003. In the SIMlab project, SINTEF offers European scientists access to its unique laboratory facilities in Trondheim. In 2003 the department hosted a number of visiting groups from Germany and the UK.

The department has initiated an internal multidisciplinary cooperation with SINTEF departments that are involved in offshore pipeline-related research. This venture is called SINTEF Pipelines. This initiative has highlighted the substantial amount of activity



Schematic illustration of the simple Cold Flow concept. High temperature well stream containing water arriving from the well-head (located in the bottom left-hand corner) is mixed with a seafloor temperature stream containing hydrate particles that has been recirculated from the downstream flow. The water (blue) is quickly adsorbed on the surface of the hydrate particles (white), where it is rapidly converted to gas hydrate. Further downstream more wells can be attached to the main stream without the need for new recirculation. *Illustration: J.H. Johansen, SINTEF Media.*

taking place in the SINTEF Group on pipeline-related research. The group will work together to support marketing and perform new projects in this domain. The effects of this cooperative effort will be seen in 2005 at the earliest.

WELL AND PRODUCTION TECHNOLOGY

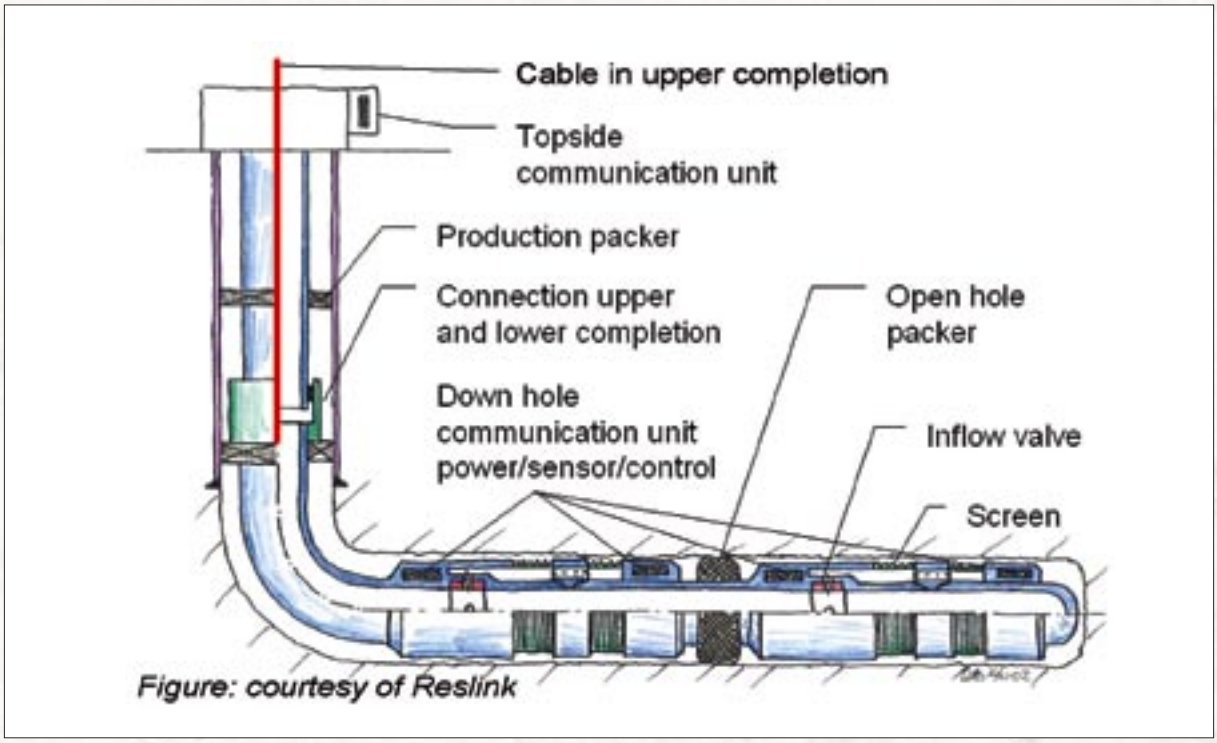
Applications of smart field technology are attracting more and more attention from oil companies as potential means of boosting recovery rates from subsea wells. SINTEF is working on some very exciting and innovative concepts for fluid monitoring and production optimization.

The ResMan downhole in-flow monitoring system is based on chemical principles. The system is part of a patented SINTEF technology that offers long-term monitoring of produced fluids from individual pay zones or multilateral branches. ResMan is based on the controlled long-term release of chemical tracers to the wellstream from a matrix embedded in the production liner. This is an inexpensive technology that permits production logging of wells that may not be easily accessible due to downhole pumps or for some other economic reason, i.e. subsea wells. Downhole electronics are not required, and a ResMan unit can be installed as part of a normal well completion without restricting production or intervention. ResMan was awarded DEMO 2000 funding in 2003, and we will approach the field pilot demonstration level in Norway

and Venezuela in 2004, in addition to commercialization of the technology. The ResMan system is expected to add significant features to future well/reservoir monitoring, particularly where monitoring is hard to perform, i.e. HPHT wells, subsea wells and in complex well completions.

Through the Strategic Institute Programme "Intelligent Wells", funded by the Research Council of Norway, focus has been concentrated on future field developments with advanced instrumentation. Special attention has been paid to multilayered reservoirs with injector/producer well pairs (Snorre B and similar reservoirs). The subsurface part of such a production system has been modelled and a tailor-made simulator has been developed – the SAVE tool. The objective has been to study actual production responses, particularly dynamic pressure-flow behaviour, while operating downhole chokes. The implications of moving chokes from the surface downhole are clearly visualized. SAVE can be used as a learning tool for the operation of complex wells, as well as to provide short-term production forecasts and a decision-making basis for production optimization. Significant knowledge of the dynamic performance of well/reservoir systems is incorporated, with the possibility of analysing challenges such as well lift and start-up of well clusters. The current SAVE version is mainly made for research and demonstration purposes. However, the methodology and the embedded fit-for-purpose models meet the visions of future real time reservoir management and the tool may form a basis for further effort towards this.

Several studies of fully autonomous, wireless downhole instrumentation systems have been carried out by SINTEF. As a consequence of these efforts, the institute has received funding to carry out a study together with the companies ResLink and SICOM on autonomous downhole power generation. The scope of work involves the evaluation of alternative concepts and the building of a laboratory prototype in 2004. Since poor reliability and high installation costs seem unavoidable for cable-based systems, a wireless system will be a significant contribution to future reliability requirements.



Future wireless completion with cable in the upper part.

A growing share of our project portfolio is in services that comprise third party verifications, technology studies, concept and front-end engineering related to onshore and offshore field developments.

In 2003, SINTEF delivered field development plans (integrated conceptual subsurface, surface facilities, economy and risk study) for three onshore oil fields in southwest Iran (Paydar, West Paydar and Dehluran). The plans for the remaining four fields of the Zagros West Oil Fields Development Project are scheduled to be completed by June 2004. The Oil Engineering and Industries Development Company is the managing contractor on behalf of the National Iranian Central Oil Fields Company. SINTEFs partners and sub-contractors are the two Iranian companies RIPI and Pars Kani, and the Norwegian companies Reinertsen Engineering and IPRES.

In 2003, the institute performed a number of studies related to scale prediction and management, and interventions for scale clean-out on the Åsgard field in the Norwegian Sea. Through this work, a research group has been formed with the objective to create an international cross-disciplinary expert team in the area of well chemistry and flow assurance.

Shallow or deep over-pressured formations may have serious effects on a drilling programme. Experience shows that more accurate pressure predictions are required to avoid drilling hazards and to ensure cost-effective well construction. The Pressim simulator has been successfully applied in basin modelling in several exploration projects. Pressim is a fast interactive tool with great potential for drilling applications, both at the pre-drill evaluation stage and for updates while drilling. DEMO 2000 awarded funding for the pilot demonstration of Pressim as a decision-support tool for drilling applications in 2000. So far, pilots have been conducted for Hydro in the Barents Sea and offshore Venezuela for Statoil. The Pressim service is now being offered as a commercial service all over the world.

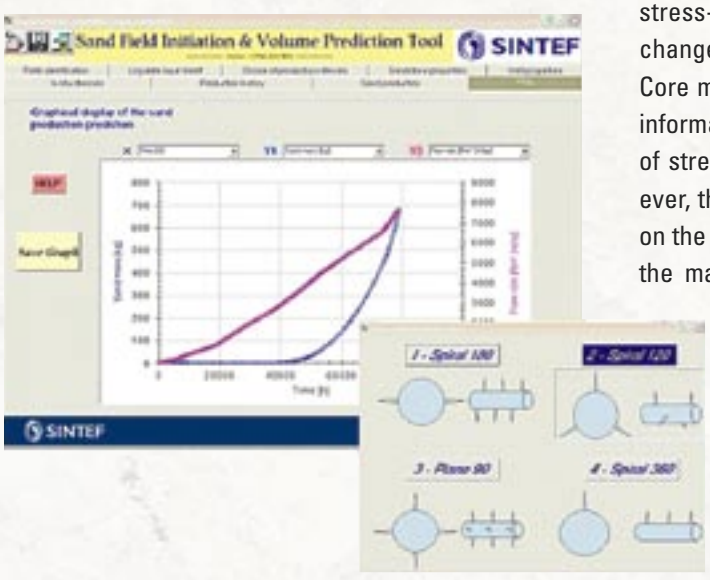
FORMATION PHYSICS

Because of the change in attitude of the industry regarding sand production in the late 80s and early 90s, the aims of research on sand production have moved on from the determination of initial sand production in the 80s to the prediction of total sand production and sand-production rate in the 90s. A research project entitled "Volumetric Sand Production I" started in 1998, and was supported by ConocoPhillips, Hydro, Statoil and Shell. This project developed first-generation sand prediction models that are capable of estimating the expected mass and rate of sand production throughout the lifetime of a well under given production scenarios. "Volumetric Sand Production II" started in 2001 and is continuing throughout 2004, with the participation of Hydro, ConocoPhillips, Statoil, Eni, Shell and Petrobras. This project focuses on developing prediction models in terms of the understanding and proper modelling of the coupling between formation failure and sand removal in a sandstone formation. Studies already carried out have shown that the presence of water in produced fluids significantly increases the amount of sand produced, and we are currently trying to quantify and model this effect. Sand production in high flow-rate gas reservoirs is also being studied, as such conditions can lead to a different type of behaviour and may require a separate gas-reservoir option in the prediction models. An analytical PC-based sand prediction tool called SINTEF SandPredictor has been developed and tested in the course of this project.

Research and studies related to wellbore stability problems in shales have been among the major activities of the department for many years, and a major research project, "Improved Drilling Efficiency by Better Handling of Shale Problems" (IDE) continued into 2003, with the participation of ConocoPhillips, Hydro, Eni, Statoil, PDVSA and BP. This project focuses on generating new knowledge to improve mud design and the ability to actually handle borehole failures. It includes the continued development of correlations and models needed for borehole stability evaluation over a period of time after drilling, as well as further development of the PC-based wellbore stability simulation programme

PSI ("Preventing Shale Instabilities"). It also involves further activities in a field in which the department possesses leading-edge competence: the development and utilization of experimental equipment that permits the mechanical characterization of small samples. A new instrument for triaxial testing of small samples has been developed in 2003.

Drilling in fractured formations is often accompanied by severe mud losses. For this reason, the development of a methodology for the quantitative analysis and prediction of mud loss amounts and dynamics would be of great practical benefit. As part of an internally financed research project on borehole stability in fractured formations, an analytical model of mud loss into a single horizontal circular fracture from a vertical borehole was developed in 2003. The model was implemented in SINTEF Mud Loss Demo software, which allows mud loss dynamics (delta flow rate as a function of time) and pressure distributions in the fracture to be calculated for various combinations of operational factors and formation properties. The program can be used as a support tool, not only for the estimation of potential mud loss hazards, but also to interpret measured mud loss data for the purpose of formation characterisation. As further steps, non-Newtonian mud rheology, multiphase flow and fracture networks will be incorporated into the model.



SandPredictor: an analytical sand prediction tool that calculates sand production, onset and quantity, based on intended draw-down and assumed depletion field history.

A four-year project linking petrophysics and rock mechanics continued in 2003, with ConocoPhillips, Hydro, Shell, Statoil, Petrobras and the Research Council of Norway as participants. The "Petrophysics under Stress" project performs experimental and numerical studies of stress effects on petrophysical properties. The main deliverable will be a numerical petrophysical "laboratory" based on pore-scale descriptions of rock (from petrographic analysis), that permits mechanical and petrophysical rock properties to be calculated as functions of external stress and pore pressure.

For several years, the department has been doing a considerable amount of research on the significance of core damage caused by stress release during coring. Last year we have been focusing on modelling the effects of core damage, in particular the consequences for prediction of reservoir compaction, using both elastoplastic and discrete particle approaches.

A major project that aims to distinguish between stress-induced and saturation-induced velocity changes during seismic monitoring continued into 2003. Core measurements are often the principal source of information for the calibration of seismic data in terms of stress/pore pressure and saturation effects. However, the reliability of this method is highly dependent on the quality of the cores. During the coring process, the material goes through stress changes that can induce significant mechanical damage in the cored material. This project focuses on quantifying the effect of such damage on the stress dependence of acoustic velocities as measured in cores, and on how such damage can be corrected for.

The considerable computing power available to the Institute enables us to perform computing-intensive seismic processing applications. The use of 3D AVO inversion to estimate rock parameters on the basis of seismic data continued in 2003. The objective

of the ongoing project entitled "Well Planning from Seismic Data: Establishing the Geomechanical Link", sponsored by ConocoPhillips, is to develop tools for determining recommended drilling fluid density on the basis of seismic data.

A project sponsored by Statoil with the objective of developing a descriptive model describing in-situ stresses on a regional scale in Venezuela in general, and in the Ceuta Tomoporo area in the eastern part of Lake Maracaibo in particular, started in 2003. On the basis of the descriptive regional model, local stress simulations were carried out in the Ceuta Tomoporo area. Stress variations in map view versus depth were addressed, with special focus on the high horizontal stresses observed in the study area. Available geomechanical and production data were used to calibrate the models. In order to gain a better understanding of the 3D pressure distribution, overpressure modelling in the Plataforma Deltana area (offshore Venezuela) was carried out using available input data (interpreted seismic).

RESERVOIR TECHNOLOGY

As in previous years, 2003 was characterised by a high level of activity and a good inflow of projects. CO_2-related activities have taken up a large proportion of the capacity of the department, but other areas of our activities have also developed satisfactorily. Particularly encouraging was the launch of a new project related to mobility control of gas by means of foam, following several years of stagnation in work within this area. The results obtained during the FAWAG project on the Snorre field, 1998–2000, has confirmed the potential of using foam for enhanced oil recovery from Norwegian oil reservoirs.

The department was involved in several projects dealing with storage of CO_2 in oil reservoirs and aquifers. Underground storage of CO_2 is a viable option to meet the challenge of a possible climate change due to the extensive use of fossil fuels. In the early phase of a CO_2 deposition era, the costs of CO_2 deposition can be reduced by CO_2 injection into oil reservoirs since large amounts of additional oil can be recovered by this technique.

The SACS project came to an end in 2002. This project was followed by the new EU-supported project CO_2 STORE. In this project, CO_2 deposition at other sites will be evaluated. The Beitstadfjord case was studied in 2003 as one of three case studies that will be performed by the department. In the international Carbon Capturing Project we completed a preliminary study of the possibility of CO_2 leakage from storage sites through wells as a result of the degradation of well and sealing materials.

In our five-year KMB-project, a competence project with user involvement sponsored by the Research Council of Norway, Statoil, Hydro, Total and ConocoPhillips, on CO_2 EOR and aquifer storage, two PhD studies were started in 2003. These focus on reservoir simulator development and the coupling of geophysics and reservoir technology. EOR from chalk fields, CO_2 dissolution and escape from aquifers, laboratory studies of cement testing and the development of new CO_2 compatible cements are other topics that were addressed. In another project sponsored by the Research Council of Norway, we completed work on a techno-economic model that calculates key technical and economic figures related to the large-scale use of CO_2 for EOR and aquifer storage in the North Sea. The model is based on an EOR module that estimates the potential for incremental oil production in selected oil reservoirs. The model is based on reservoir-specific input data, a transportation module that calculates CO_2 transport costs and other techno-economic data related to CO_2 injection projects.

A major effort was made by the department to formulate projects for the EUs 6th Framework Programme. As a result of this the department will participate in the integrated CO_2 capture and storage project CASTOR and the network of excellence, CO_2 GeoNet, together with a large number of European research institutes and industries.

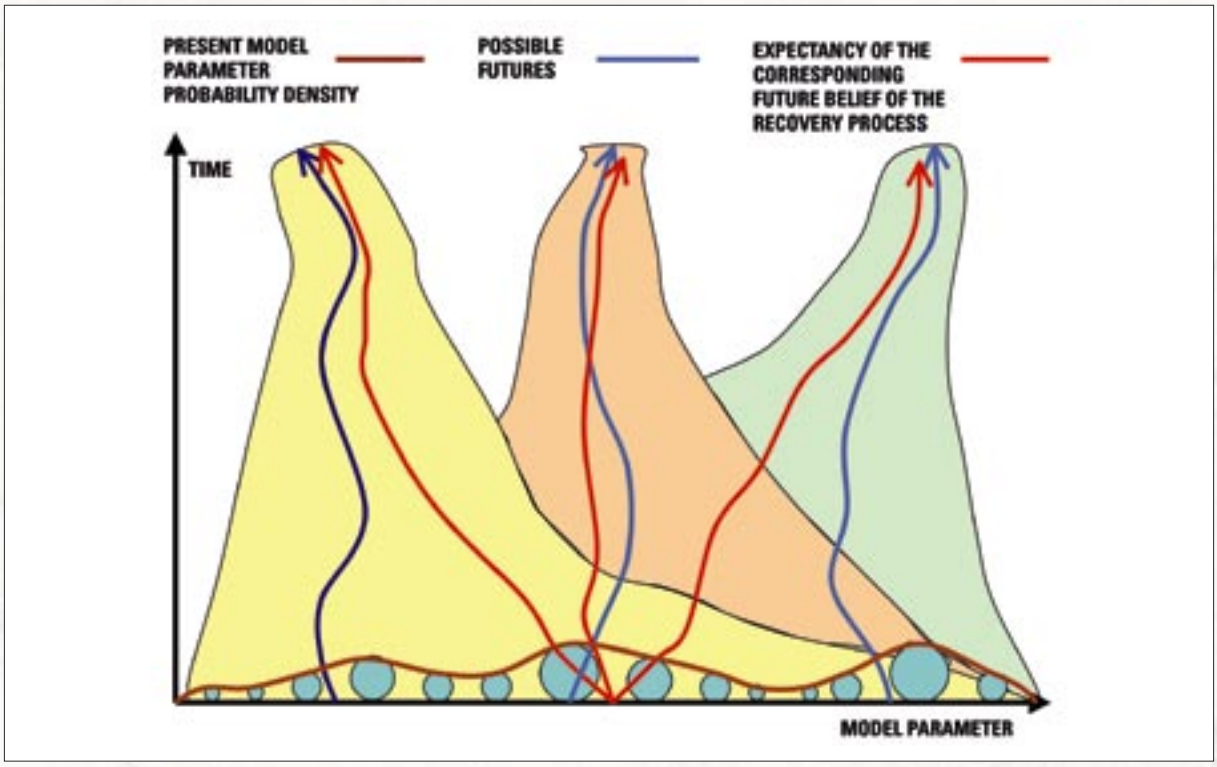
In the project "Mobility Control by Foam" the main objective is to integrate our foam relative permeability model into a commercial reservoir simulator, to extend the model to include conditions with various oil saturations and to work out design rules for making foam with given desired properties. Well-defined laboratory

experiments are needed for this work. The project is sponsored by the Research Council of Norway, Statoil, Hydro and Total, and is being carried out in co-operation with Rogaland Research.

Efforts to develop a mathematical, statistical, and numerical model for a simplified physically based and very fast two-phase reservoir simulator continued in 2003. This simulator, CREDO, will be suitable for automatic stochastic information processing and control of intelligent wells.

The integrated reservoir study involving several West Zagros oil fields continued in 2003. The department has been involved in the building and history-matching of reservoir models based on seismic, geological, well, fluid and core data, and has performed reservoir simulations for a number of production scenarios.

The department operates laboratories for fluid and core flow studies that enable us to perform a wide range of special studies. In co-operation with the petroleum industry (mainly Statoil), several projects within near-well problems have been carried out. Fluid studies and measurements of interfacial tensions under HPHT conditions, measurements of relative permeability by the steady-state technique at elevated conditions, asphaltene studies and scaled studies in a visual 2D model are other examples of work that we have done. The department has also participated in Statkraft's "Salinity Power" development programme, together with other SINTEF institutes.

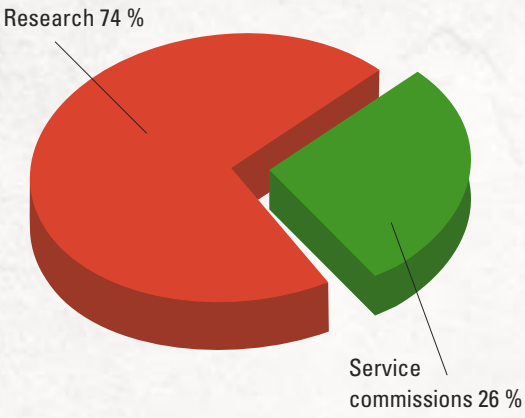


Control of a recovery process is based on the current belief of the recovery process, requiring a probabilistic setting for numerical analysis of investments and control. The above is a 1-dimensional illustration of how CREDO would analyze the future economical benefit of a given investment and control scheme by simulating 3 realizations of possible futures. Each future will generate observations (blue line) continuously updating one's future probabilistic belief, where decreasing uncertainty is illustrated by a narrowing volcano. Future belief again, determines the actual control exercised in the future. Thus, control at early times for the left and right realization would be based on a poor conception of the reservoir, as opposed to the middle realization. Summing over all future realizations then determines the probabilistic benefit of a given investment and control scheme.

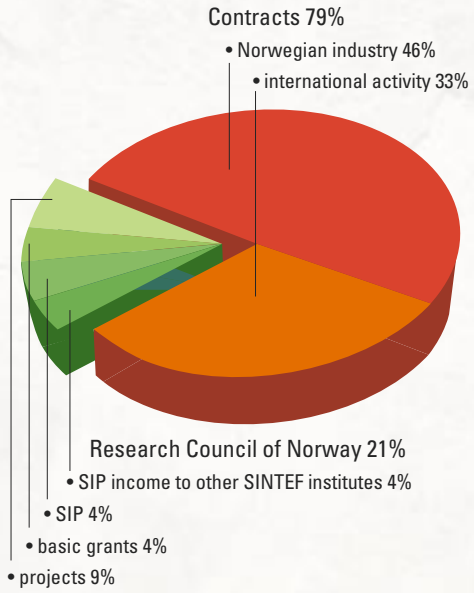
Income statement for the period 1 January – 31 December (Figures in NOK thousand)

OPERATING INCOME	2003	2002
External projects	89 726	85 855
Project funding from Research Council of Norway	19 292	18 506
Basic funding from Research Council of Norway	4 500	4 000
Other income		11
Gross project income	**113 517**	**108 372**
– Direct project expenses	26 229	34 412
Net operating income	**87 289**	**73 960**
OPERATING EXPENSES		
Wages and social expenses	52 906	43 852
Ordinary depreciation	2 522	3 002
Other operating expenses	23 442	24 354
Total operating expenses	**78 870**	**71 208**
OPERATING RESULT	**8 418**	**2 752**
FINANCIAL INCOME AND EXPENSES		
Interest	6 878	5 511
– Financial expenses	988	123
Net financial income	**5 889**	**5 387**
ANNUAL RESULT	**14 308**	**8 139**
Dispositions		
Transferred to the equity	**14 308**	**8 139**

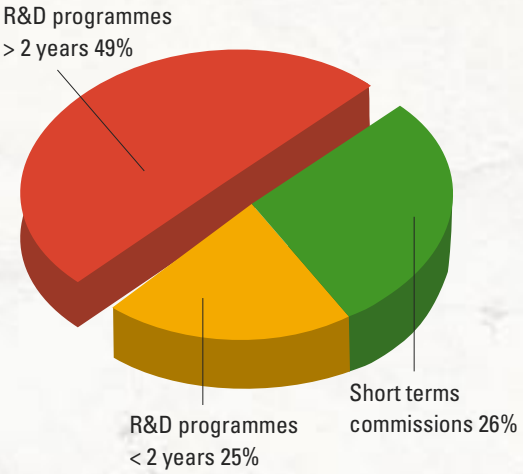
Commisions



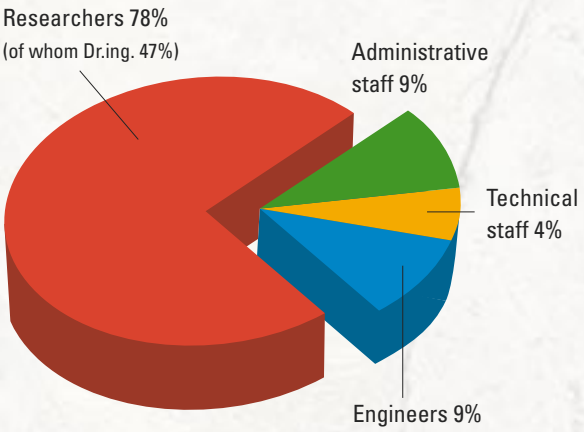
Distribution of gross operating income by client



Distribution of gross operating income by project duration



Distribution of employees by position



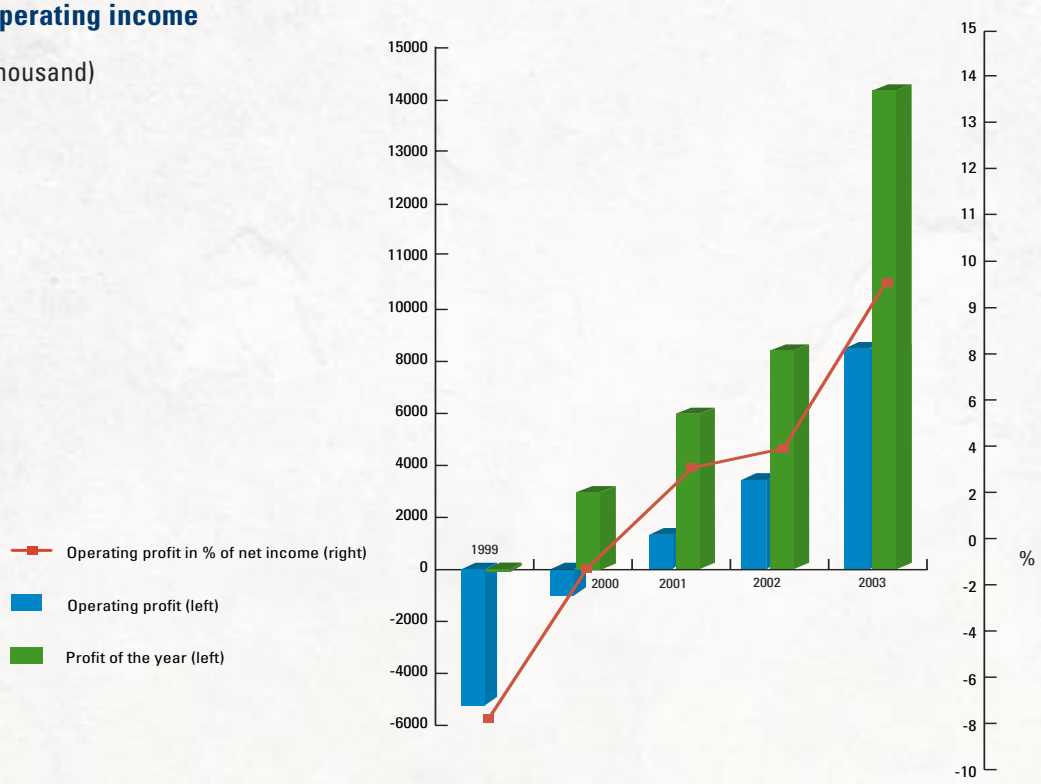
Balance sheet on 31 December

(Figures in NOK thousand)

ASSETS	2003	2002
FIXED ASSETS		
Scientific equipment	2 647	4 267
Office equipment, vehicles, inventories	563	139
Fixed assets	**3 211**	**4 405**
Other shares	76	
Deposits, companies within the SINTEF Group	3 000	3 030
Pension reserve	–	1 025
Financial long-term assets	**3 076**	**4 055**
Total fixed assets	**6 287**	**8 460**
CURRENT ASSETS		
Work in progress	**3 572**	**6 432**
Accounts receivable	20 007	29 957
Acc. receivable, companies within the SINTEF Group	1 093	943
Other accounts receivable	855	620
Receivables	**21 954**	**31 519**
Other shares	–	76
Investments	60 818	52 017
Investments	**60 818**	**52 093**
Cash, bank accounts	**42 056**	**23 589**
Total current assets	**128 400**	**113 633**
TOTAL ASSETS	**134 687**	**122 093**
EQUITY AND LIABILITIES		
EQUITY		
Share capital (900 shares at NOK 10,000)	9 000	9 000
Other equity	77 558	63 250
Total equity	**86 558**	**72 250**
LIABILITIES		
Pension liabilities	2 463	258
Long-term liabilities	**2 463**	**258**
Delivery liabilities	4 898	4 338
Liabilities, VAT, tax deductions, social security, etc.	4 845	4 802
Payment in advance	23 225	25 705
Liabilities, companies within the SINTEF Group	2 638	4 628
Other short-term liabilities	10 061	10 113
Current liabilities	**45 667**	**49 586**
TOTAL LIABILITIES	**48 130**	**49 844**
TOTAL EQUITY AND LIABILITIES	**134 687**	**122 093**

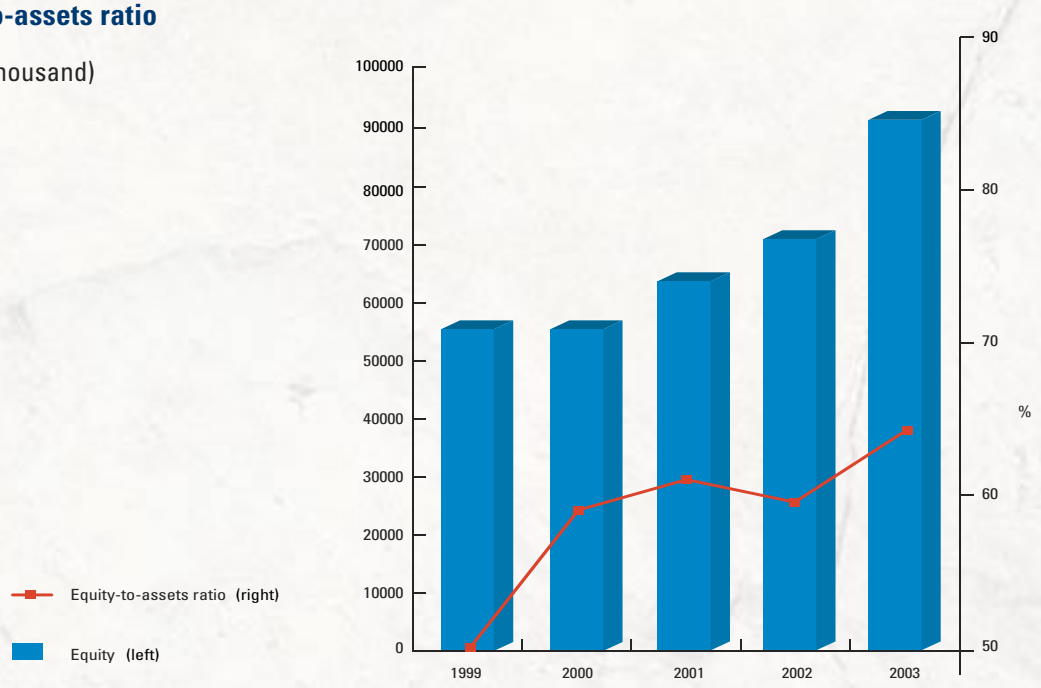
Net profit/Net operating income

(Figures in NOK thousand)



Equity/Equity-to-assets ratio

(Figures in NOK thousand)



Employees as of 1 January 2004

▲ Lysne, David (President)

Administration Support
● Berg-Hanssen, Harald
● Flo, Rune
◆ Fossum, Berit
❄ Påsche, Elin
❄ Sagmo, Mette A.
❄ Sneen, Marit
❄ Aaen, Anita

Basin Modelling
▲ Borge, Hans
▲ Grøver, Arnt
❄ Guldseth, Bodil
▲ Hamborg, Martin
▲ Kjennerud, Tomas
▲ Kleppe, Vegard
● Lind, Kristin
▲ Mann, Ute
▲ Myhr, May Britt (RD)
▲ Ritter, Ulrich
▲ Tømmerås, Are
◆ Vinge, Torun
▲ Weiss, Hermann M.
▲ Wien, Stein Tore
▲ Zweigel, Janine

Seismic
▲ Alerini, Mathias
▲ Causse, Emmanuel
▲ Lescoffit, Severine P.
▲ Maaø, Frank
▲ Nguyen, Kiet Ahn
▲ Riede, Matthias
▲ Sylta, Øyvind
▲ Østmo, Svend (RD)

Multiphase Flow Technology
▲ Dahl, Arne Morten
◆ Gustavsen, Karl G.
▲ Habetinova, Eva
▲ Jacobsen, Kjell Arne (RD)
▲ Kjølaas, Jørn
▲ Kristiansen, Olav
▲ Ladam, Yves
▲ Larsen, Roar
◆ Larsen, Rolf Erik
◆ Lervåg, Johan H.
▲ Onsrud, Gisle
◆ Sneeggen, Cecilie
▲ Straume, Erlend
▲ Unander,Tor Erling
❄ Wanvik, Hilde
▲ Wolden, Marita
● Øyangen, Terje

Well and Production Technology
▲ Abdollahi, Jafar
▲ Balov, Mohsen K.
▲ Carlsen, Inge Manfred
▲ Gustavsen, Øyvind
❄ Harrang, Ingrid
▲ Krogh, Espen
▲ Lund, Bjørnar
▲ Mjaaland, Svein
▲ Nakken, Erik I. (RD)
▲ Nyhavn, Fridtjof
▲ Stolz, Anne Kristine
▲ Vebenstad, Anita
▲ Ytrehus, Jan David

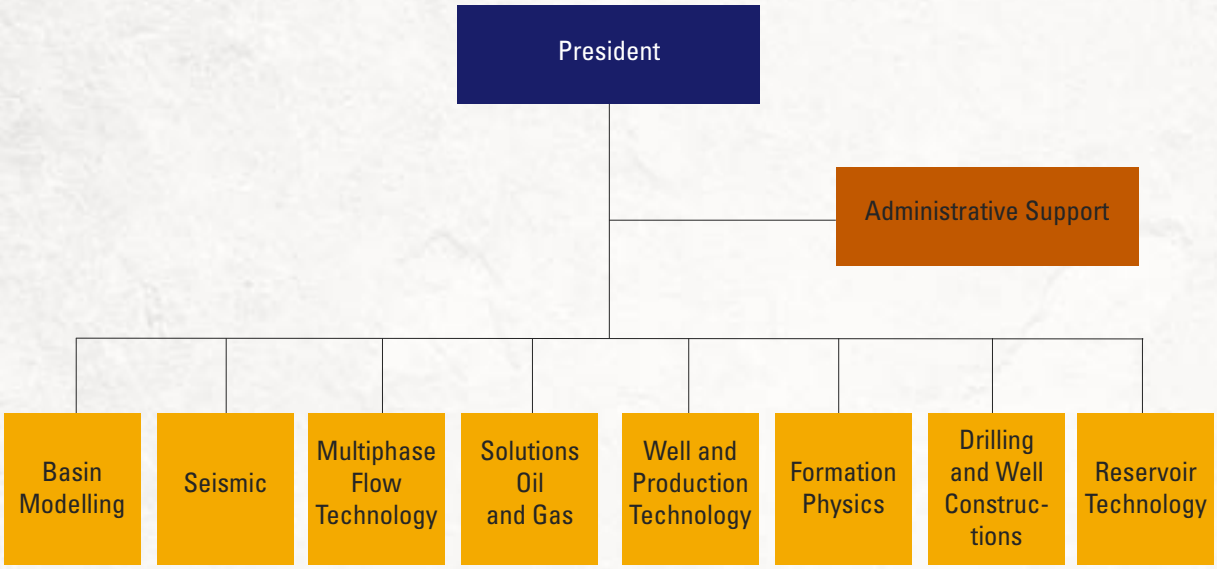
Formation Physics
▲ Bøe, Reidar
▲ Cerasi, Pierre
▲ Fjær, Erling
▲ Gotusso, Angelamaria P.
▲ Holt, Rune Martin
▲ Larsen, Idar
▲ Lavrov, Alexandre Vadimovich
▲ Li, Liming
▲ Lothe, Ane Elisabet
● Lund, Hans
▲ Nes, Olav-Magnar
▲ Papamichos, Euripides
▲ Schei, Grethe
▲ Scheldt, Therese
▲ Skjetne, Tore
● Stavrum, Johannes
▲ Stenebråten, Jørn
▲ Sønstebø, Eyvind F.
❄ Tiller, Ingunn
▲ Tronvoll, Johan (RD)

Drilling and Well Construction
▲ Rommetveit, Rolv (RD)

Reservoir Technology
▲ Akervoll, Idar
▲ Bergmo, Per Erik
▲ Bjørkvik, Bård
❄ Bjørseth, Eva Kristin
● Frigård, Oddmund
▲ Ghaderi, Amir
▲ Holt, Torleif (RD)
▲ Lindeberg, Erik G. B.
▲ Mo, Sjur
▲ Moen, Arild
▲ Mørk, Atle
▲ Olivier, Marie-Laure
▲ Polak, Szczepan
▲ Utne, Svein Arild
▲ Wessel-Berg, Dag
▲ Zweigel, Peter

Legend
▲ Scientist
● Engineer
◆ Technical staff
❄ Administrative personnel
RD Research Director

Organisation as of 1 February 2004



Management

David Lysne	President
Torleif Holt	Research Director, Reservoir Technology Department
Kjell Arne Jacobsen	Research Director, Multiphase Flow Technology Department
May Britt Myhr	Research Director, Basin Modelling Department
Erik I. Nakken	Director Field Development, Solutions Oil and Gas
Fridtjof Nyhavn	Research Director, Well and Production Department
Rolv Rommetveit	Research Director, Drilling and Well Construction Department
Johan Tronvoll	Research Director, Formation Physics Department
Svend Østmo	Research Director, Seismic Department

Board of Directors, 2004

Morten Loktu (chairman)	President and CEO, SINTEF
Karl Andreas Berteussen (until April 2004)	Professor, The Petroleum Institute, Abu Dhabi
Inge M. Carlsen	Senior Scientist, SINTEF Petroleum Research
Eva Habetinova	Scientist, SINTEF Petroleum Research
Erik-Sverre Jenssen	Director, Norsk Hydro ASA
Jon Kleppe	Professor, IPT, NTNU
Ingve R. Theodorsen	Director, STATOIL ASA
Ole Lindefjeld	Research Director, ConocoPhillips Norge
Fridtjof Nyhavn (until April 2004)	Scientist, SINTEF Petroleum Research
Torleif Holt (from May 2004)	Research Director, SINTEF Petroleum Research
Svein Sivertsen	Senior Executive Vice President, SINTEF

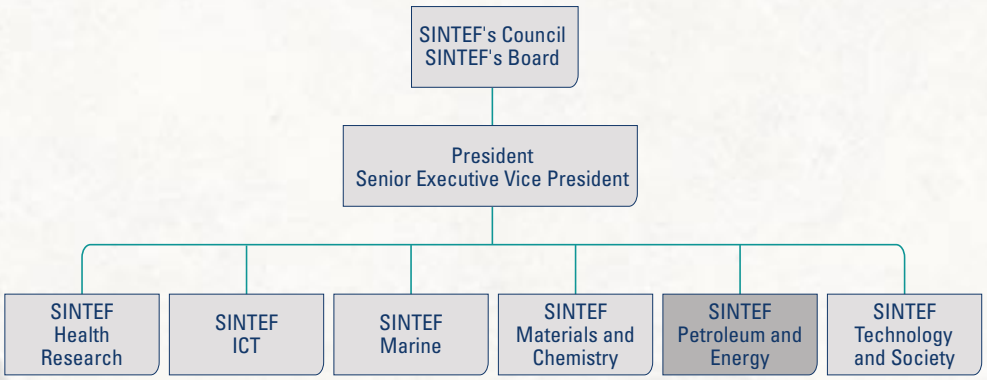
This is SINTEF

The SINTEF Group is the largest independent research organisation in Scandinavia. We generate new knowledge and solutions for our customers, based on research and development in technology, the natural sciences, medicine and the social sciences. The SINTEF Group comprises six business areas.

In 2003 the number of employees was 1758, who were responsible for a turnover of NOK 1.7 billion in 2003. Contracts for industry and the private sector account for more than 90% of our income, while just 3% is in the form of basic grants from the Research Council of Norway. SINTEF cooperates closely with the Norwegian University of Science and Technology (NTNU) and the University of Oslo. NTNU personnel work on SINTEF projects, while many SINTEF staff teach at NTNU.

Our vision is: "Technology for a better society"

The two limited companies SINTEF Petroleum Research and SINTEF Energy Research constitute the business area SINTEF Petroleum and Energy.



www.sintef.no

Layout og trykk: Tapir Uttrykk

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