# Årsmelding
# Annual Report 2009

NORSAR

# THE NORSAR FOUNDATION

**NORSAR is an independent foundation established with the following objectives:**

- To conduct research and development in the areas of geophysics and geophysical software.
- To promote the application of research results for the benefit of the Norwegian society and Norwegian industry.
- To establish and further develop the professional competence of its staff within its areas of activity.
- To act as a Norwegian national resource center for verifying compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT).

**NORSAR's research activities are focused on three main areas:**

1. Development of methods and processing systems for seismic monitoring and verification of compliance with the Comprehensive Nuclear-Test-Ban Treaty.
2. Basic seismological research associated with the recording of small and large earthquakes as well as assessing earthquake hazard.
3. Developing methods and software for seismic modelling of geological structures.

■ NORSAR is an internationally recognized research institution in seismology, and provides advanced, innovative products and services to its customers both in the public and private sectors.

■ Seismic modelling methods developed by NORSAR provide value-added services to oil companies, seismic contractors and consultant companies.

■ "Seismology for society" is an appropriate designation of NORSAR's activities in seismological R&D, which are supported through national as well as international organizations, and which focus on global, regional and local safety and security issues.

■ The Annual Report of the NORSAR Foundation gives an overview of activities that have generated interest among our customers, cooperative partners and governmental agencies. Besides containing basic information about NORSAR, it also highlights some selected research activities in 2009.

■ The Annual Report also describes the NORSAR organization, which comprises the NORSAR Foundation together with the wholly owned subsidiary NORSAR Innovation AS, and it presents the annual report from the Board of Directors as well as the consolidated financial result for 2009 for the organization. Furthermore, a list is provided of scientific publications as well as professional presentations in 2009 by the NORSAR staff.

# STIFTELSEN NORSAR

**NORSAR er en uavhengig, idéell og samfunnsnyttig forskningsstiftelse som har som formål å:**

- Utføre forskning og utvikling innen geofysiske og datatekniske fagområder.
- Arbeide for anvendelse av denne forskningens resultater i praksis til fremme av norsk nærings- og samfunnsliv.
- Bidra til opparbeidelse og utvikling av kompetanse og utdanning av fagpersonell innen stiftelsens fagområder.
- Fungere som nasjonalt kompetanse- og driftssenter knyttet til den internasjonale avtalen om forbud mot kjernefysiske prøvesprengninger, Comprehensive Nuclear-Test-Ban Treaty (CTBT).

**Forskningen ved NORSAR omfatter i hovedsak:**

1. Utvikling av metoder og systemer for seismisk overvåkning og verifikasjon av etterlevelse av prøvestansavtalen.
2. Grunnleggende seismologisk forskning knyttet til registrering av små og store jordskjelv og risiko ved jordskjelv.
3. Utvikling av metoder og software for seismisk modellering og avbildning av geologiske strukturer.

■ NORSAR er en internasjonalt ledende aktør innen forskning og utvikling av innovative, seismiske løsninger for kunder både i offentlig og privat sektor.

■ NORSARs metoder for seismisk modellering bidrar i verdiskapningen hos oljeselskap, seismiske kontraktører og konsulentselskap.

■ "Seismologi for samfunnet" er betegnende for virksomheten i NORSARs seismologiske FoU, som støttes av både nasjonale og internasjonale offentlige organer med fokus på global, regional og lokal samfunnssikkerhet.

■ Årsmeldingen for Stiftelsen NORSAR gir en oversikt over forhold som ofte blir etterspurt av oppdragsgivere, samarbeidspartnere og offentlige institusjoner. Den inneholder en del sentrale opplysninger fra virksomheten samt noen utvalgte eksempler fra Stiftelsen NORSARs forskning og faglige aktiviteter i 2009.

■ Årsmeldingen beskriver også organiseringen av konsernet NORSAR, som omfatter Stiftelsen NORSAR og det heleide datterselskapet NORSAR Innovation AS, den viser årsberetningen for konsernet og det økonomiske resultatet for 2009, og den lister opp årets publikasjoner, foredrag og posters der forskere fra Stiftelsen NORSAR har gitt sine bidrag.

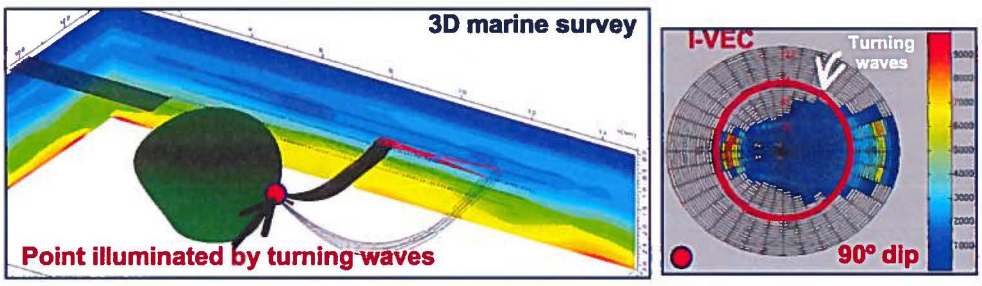
# Development of 3D seismic illumination methods

■ For a number of years, NORSAR has been engaged in the development of methods and products within the field denoted "seismic illumination". While the products can have several areas of application, the most important so far has been in connection with planning and optimization of seismic data collection. For this purpose, it is important to make use of data that are already available for the target area in order to make a geo-model of the subsurface. A geo-model is a computerized model which includes the most important structural geological features as well as available information pertaining to seismic properties (velocities and densities) in the various layers.

■ Illumination studies make use of methods for simulating seismic waves, so called ray-tracing, in order to map how well the various layers (horizons) in the model are being illuminated for specified survey geometries, i.e. placements of the energy sources/receivers. The purpose of such illumination studies is to find an optimal survey geometry with respect to the most important horizon. In complex models, such as geo-models with salt structures, it can easily happen that a given survey geometry results in shadow zones for the seismic waves, i.e. zones with little or no illumination. This implies limited possibilities for seismic imaging.

■ The figure shows a model with a salt structure in an area with strongly varying wave velocity as a function of depth (blue and red denote low and high velocity, respectively). In this case, we are interested in the seismic illumination of a target area at the steep slope of the salt structure (marked by a red circle). By calculating all possible ray paths between the shots/receivers and the target area, one can develop so-called illumination vectors (I-VEC) and plot them in a diagram showing those slopes/directions that are illuminated for a specific survey geometry. From this diagram, one can sort out the illumination vectors for pre-defined criteria and show the corresponding rays. The example in the figure shows ray paths for so-called turning waves, where the waves are reflected on the overhang of the salt slope, and due to the velocity field, are subsequently bent upwards so that they reach the receivers on the surface.

■ Illumination studies give possibilities to assess the rock properties that can be expected based on the illumination (imaging) of a specified survey geometry. Today, many oil companies and contractors use advanced NORSAR software in their planning and evaluation of seismic surveys.




*Illustrations of "turning waves" for seismic imaging of salt structures using advanced modelling with NORSAR-3D software.*

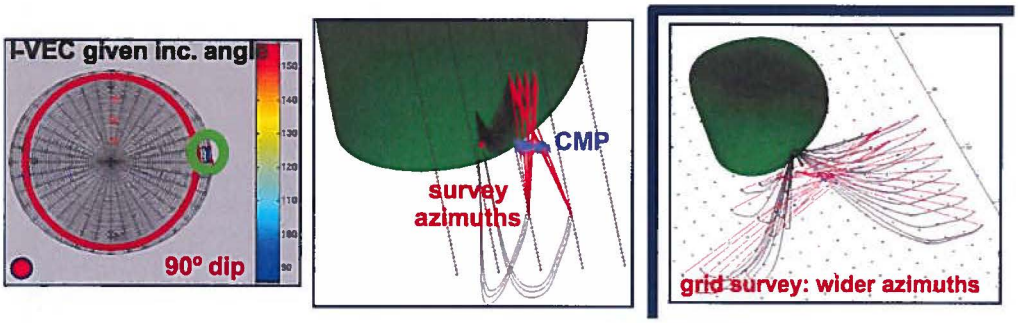
# Metodikk innen 3D seismiske belysningsstudier

■ NORSAR har i en årrekke arbeidet med utvikling av metodikk og produkter innen fagområdet seismisk belysning ("seismic illumination"). Produktene kan ha ulike bruksområder, men viktigste hittil har vært ved planlegging og optimalisering av seismisk datainnsamling. For dette formål er det viktig å nyttiggjøre seg data som allerede foreligger fra det aktuelle området ved å lage en geomodell av undergrunnen. En geomodell er en computer-modell som inneholder de viktigste strukturelle trekk av geologien, samt tilgjengelig informasjon om seismiske egenskaper (hastigheter og tettheter) i de forskjellige lagene.

■ Belysningsstudier går ut på å benytte metoder for simulering av seismiske bølger, såkalte stråleberegninger, og kartlegge hvor godt de forskjellige lagene (horisontene) i modellen blir belyst (avbildet) for gitte plasseringer av energikilder/mottakere (survey-geometri). Ved hjelp av seismiske belysningsstudier prøver man å finne en optimal survey-geometri med hensyn på den viktigste horisonten. I komplekse modeller, f. eks. geomodeller med saltstrukturer, kan det lett oppstå skyggesoner for de seismiske bølgene for en gitt survey-geometri, dvs dårlig eller ingen belysning. Dette betyr igjen begrensede muligheter for seismisk avbildning.

■ Figuren viser en modell med en saltstruktur i et område med sterkt varierende bølgehastighet som funksjon av dypet (blått angir lav og rødt høy hastighet). I dette tilfellet er man interessert i den seismiske belysningen i et målområde på den bratte saltflanken, angitt med en rød sirkel. Ved å beregne alle mulige stråler mellom skudd/mottakere og målområdet, kan man framstille såkalte belysningsvektorer (I-VEC) og plotte dem i et diagram som viser hvilke helninger/retninger av målområdet som belyses for en gitt survey-geometri. Fra diagrammet kan man sortere ut belysningsvektorer for gitte kriterier og vise de tilsvarende stråler. Eksempelet viser strålebaner for såkalte "turning waves" , der bølgene reflekteres på "overhenget" til saltflanken og på grunn av hastighetsfeltet bøyes opp igjen og treffer mottakere på overflaten.

■ Belysningsstudier gir mulighet for å analysere hvilke bergartsegenskaper som kan forventes på grunnlag av belysningen (avbildningen) fra en gitt survey-geometri. Mange olje- og kontraktorselskap benytter i dag avansert NORSAR-software ved planlegging og evaluering av seismiske survey.




*Illustrasjoner av "turning waves" for seismisk avbildning av saltstrukturer ved bruk av avansert modellering med NORSAR-3D software.*

# Earthquake risk

Among all natural disasters, earthquakes are the cause of the largest losses of human lives as well as the greatest economic losses. One of the most recent examples is the earthquake in Port au Prince, Haiti, on 12 January 2010, which claimed about 300,000 human lives (latest estimate). Reduction in the vulnerability to earthquakes can only be achieved on the basis of improved understanding and mapping of the associated risk, and this has been one of NORSAR's tasks since the mid-1970s.

Earthquake hazard analysis is the term denoting the speciality within seismology that uses a probabilistic approach to calculate the expected shaking due to earthquakes at a given site at a specified level of probability. By using earthquake hazard and vulnerability as a starting point, one can calculate the risk of loss of human lives and economic losses. In recent years, NORSAR has strengthened its competence within earthquake risk analysis, and today the institution employs three civil engineers working within this field. During the last 10 years, earthquake risk analysis has undergone a remarkable development, and through strategic choices, NORSAR has successfully positioned itself in the forefront internationally within this field. The most important achievement has been the development of the software products SELENA and RISe, but NORSAR's participation in several projects concerning earthquake risk in Central America, the Himalayas and Kashmir have also been contributing factors. The development of software has been accompanied by increased competence building, and the two software products have found and continue to find new areas of application. This has led to a situation where NORSAR today is an active participant in the global initiative for mapping and mitigation of earthquake risk (GEM). NORSAR has had an active role in the development of Eurocode 8 for earthquake-resistant design, which will be introduced as standard in Norway in 2010 and is also involved in international seismological investigations related to storage of radioactive material.

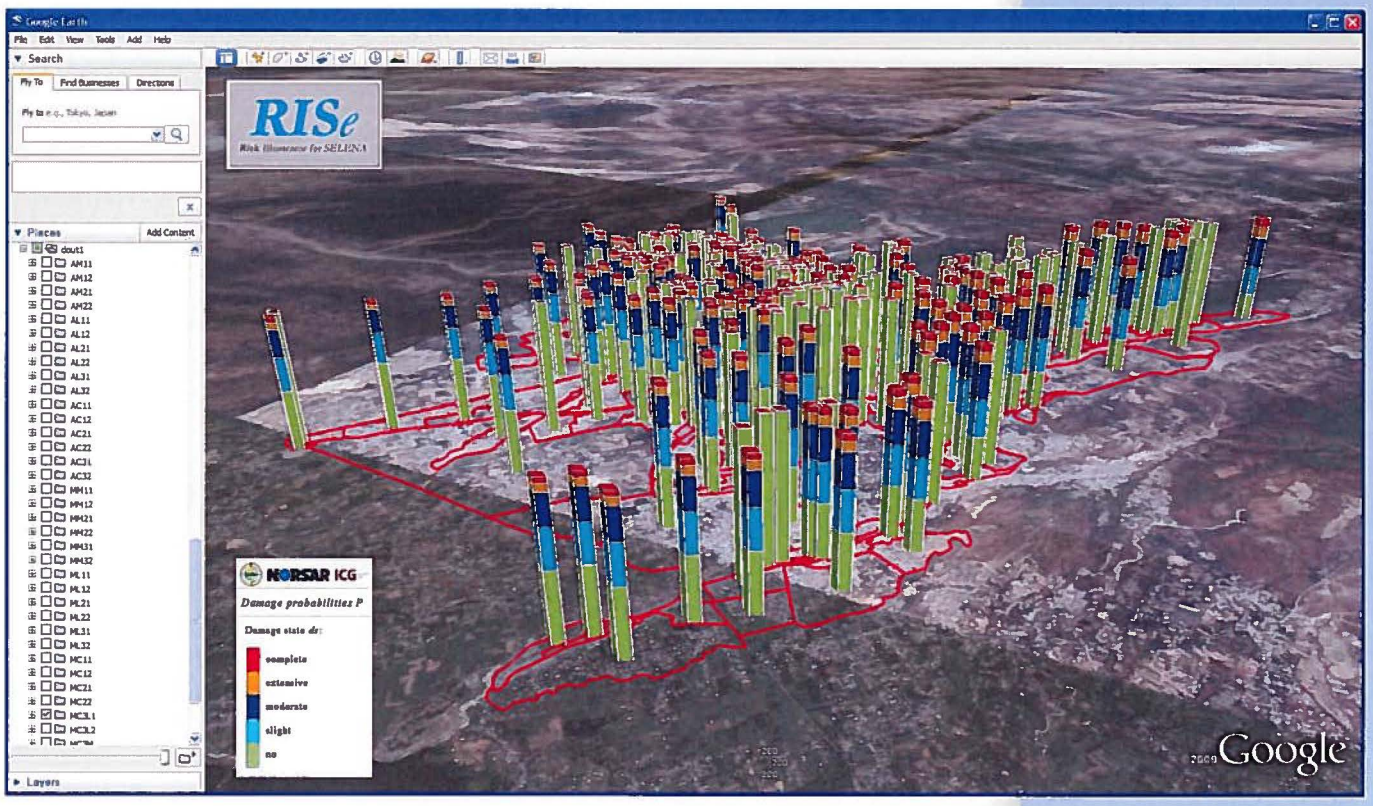
*Seismic risk mapping can be achieved using the software product SELENA, which has been developed at NORSAR. Results from such calculations for a given scenario can be shown in the web-based global map system Google-Earth. In this picture the risk is illustrated in color-coded columns, where the color indicates the risk for destruction of buildings in five levels. The green color represents level 1 (no expected damage), whereas the red color (level 5) denotes complete destruction.*

# Jordskjelvrisiko

■ Av alle naturkatastrofer, er jordskjelv det naturfenomen som fører til de største tap av menneskeliv og de største økonomiske tap. Et av de seneste eksemplene er jordskjelvet i Port au Prince, Haiti, den 12. januar 2010, som kostet ca. 300,000 menneskeliv (siste estimat). Reduksjon i sårbarhet for jordskjelv kan bare skje på basis av forståelse og kartlegging av risikoen, og dette har vært en av NORSARs oppgaver siden midt på 1970-tallet.

■ Jordskjelv hazard er betegnelsen for den spesialiseringen innen geofaget seismologi som på statistisk grunnlag beregner størrelsen av jordskjelvrystelser for en gitt sannsynlighet på et gitt sted. Med utgangspunkt i kartlegging av jordskjelv hazard og sårbarhet, kan risikoen for økonomisk tap og tap av menneskeliv beregnes. NORSAR har de seneste årene styrket kompetansen innen jordskjelvrisiko og har i dag tre sivilingeniører i arbeid på dette feltet. Fagområdet har vært i rivende utvikling de seneste 10 årene og gjennom noen vellykkede, strategiske valg, har NORSAR posisjonert seg i fronten av den internasjonale forskning og utvikling innen jordskjelvrisiko, først og fremst gjennom utviklingen av softwareproduktene SELENA og RISe, men også gjennom flere prosjekter om jordskjelvrisiko i Mellom-Amerika, Himalaya og Kashmir. Utvikling av software har gått hånd i hånd med utvikling av kompetanse, og SELENA og RISe har funnet og finner stadig nye anvendelser. Det har bl.a. også medført at NORSAR i dag er aktiv deltager i det globale initiativet for kartlegging og reduksjon av jordskjelvrisiko (GEM). NORSAR har deltatt aktivt i utviklingen av Eurokode 8, for jordskjelvsikker bygging, som i 2010 innføres som standard i Norge og er også involvert i internasjonale seismologiske studier knyttet til lagring av radioaktivt materiale.

*Kartlegging av jordskjelvrisiko kan utføres med softwareproduktet SELENA, utviklet ved NORSAR. Resultater fra slike beregninger for et gitt scenario kan vises i det web-baserte, globale kartsystemet Google Earth, her som søyler med fargekoder som angir risiko for ødeleggelser av bygninger på en fargeskala med fem nivåer der første nivå representerer ingen ødeleggelse (grønn farge) og femte nivå er fullstendig ødeleggelse (rød farge).*



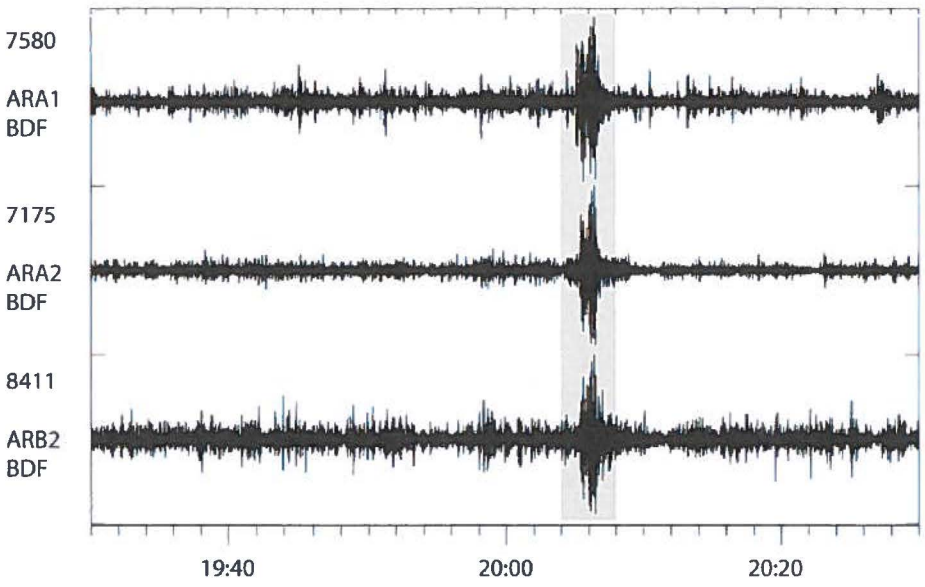
# Meteor over northern Norway

■ The international monitoring system for the comprehensive nuclear-test-ban treaty comprises, as one of its four basic technologies, a network of 60 monitoring stations designed to record low-frequency sound waves (infrasound) from explosions in the atmosphere. One of these stations is planned to be located in northern Norway. In this connection, NORSAR has carried out some experimental measurements of infrasonic waves at the seismic monitoring station ARCES near Karasjok. In addition, we have obtained access to data from four infrasound stations in northern Sweden and Finland, as well as one such station in Apatity on the Kola Peninsula. The stations in Sweden and Finland are operated by the "Institut för Rymdfysik" in Umeå, Sweden, while the station in Russia belongs to the Kola Regional Seismological Centre in Apatity.

■ In the evening of 15 January 2009, light flashes and a fireball from an assumed meteor entry into the atmosphere were observed over parts of northern Norway. According to eye witnesses, the object was observed approximately at 20:40 Norwegian time (19:40 UTC) and was reported to propagate in a north-northwesterly direction into the Barents Sea.

■ The figure to the left shows infrasound recordings by the experimental station near Karasjok for a time interval covering the event, and strong signals can be seen around 20:06 UTC. Within one hour, signals were observed also at the other infrasound stations mentioned earlier.

■ We applied different methods to estimate the location of the event. Based on the observed time of the light flash (19:40 UTC) and the time of observation of the infrasound signals, we were able to estimate the distance to the event from each station. These distances are shown as red arcs in the figure to the right, and the point of intersection of these arcs indicates the source area of the event. As shown in the figure, the source is estimated to be over the western Barents Sea, south of Bear Island.




Starttidspunkt: 15. januar 2009, 19:30 UTC

*The figure to the left shows infrasound signals (shaded) from the meteor event on 15 January 2009 as recorded near Karasjok.*

*The white ellipse in the figure to the right shows the estimated area for the meteor event on 15 January 2009. The center of the ellipse is 72.1°N 20.3°E. The calculated distances from the different infrasound stations are shown as red arcs.*

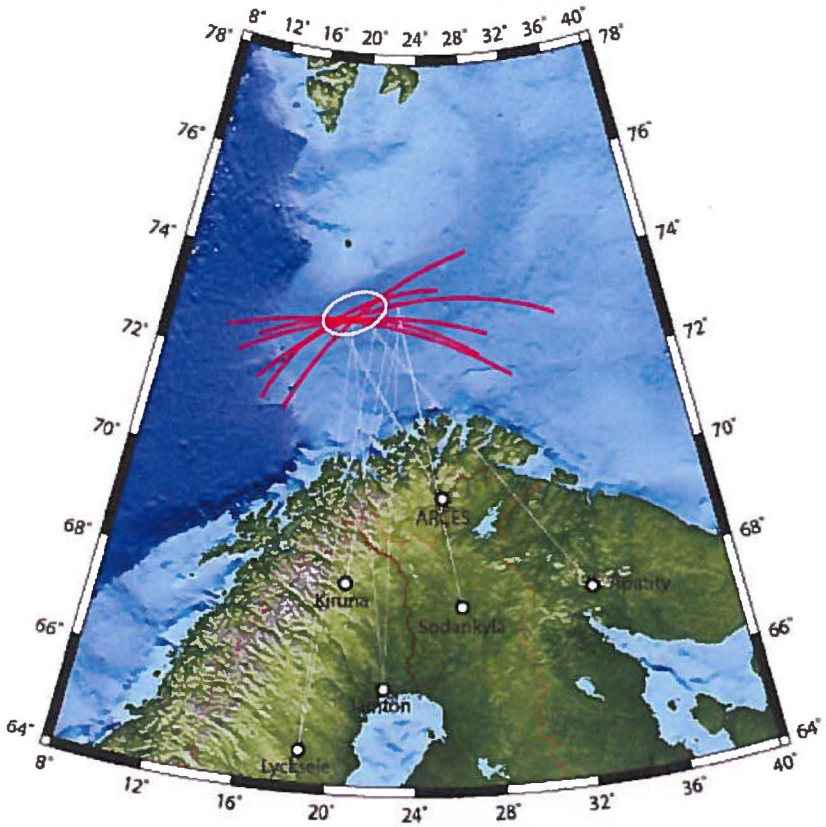
# Meteor i atmosfæren over Nord-Norge og Barentshavet

■ I det internasjonale overvåkningssystemet for den kjernefysiske prøvestansavtalen inngår 60 målestasjoner som har til oppgave å fange opp lavfrekvente lydbølger (infralyd) fra eksplosjoner i atmosfæren. En av disse stasjonene er planlagt bygd i Nord-Norge, og NORSAR har i den forbindelse utført en del eksperimentelle infralydmålinger ved den seismiske målestasjonen ARCES nær Karasjok. I tillegg har vi fått tilgang til infralyddata fra fire stasjoner in Nord-Sverige og Finland, samt fra en stasjon i Apatity på Kolahalvøya. Stasjonene i Sverige og Finland tilhører "Institutet för Rymdfysik" i Umeå, Sverige, mens stasjonen i Russland tilhører "Kola Regional Seismological Centre" i Apatity.

■ Om kvelden, den 15. januar 2009, ble et sterkt lysglimt og en ildkule fra et antatt meteorinnslag i atmosfæren sett over store deler av Troms og Finnmark. Ifølge øyenvitner ble objektet observert ca. kl. 20:40 lokal tid (19:40 UTC) og det beveget seg i nord-nordvestlig retning ut i Barentshavet.

■ Figuren under til venstre viser infralydobservasjoner nær Karasjok for et time-intervall omkring hendelsen, og sterke signaler kan sees ca. kl.20:06 UTC. Innen en time etter hendelsen ble tydelige infralydsignaler observert også på de andre infralydstasjonene på Nordkalotten.

■ Kildeområdet for meteorinnslaget i atmosfæren ble anslått med forskjellige metoder. Basert på tidspunktet for lysglimtet fra kilden (19:40 UTC) og observasjonstidspunktene for infralydsignalene, var man i stand til å bestemme avstanden fra de forskjellige stasjonene. Disse avstandene er vist som røde sirkelbuer i figuren under til høyre, og skjæringspunktet mellom disse indikerer kildeområdet for hendelsen. Som vist på figuren anslås kildeområdet å være i det vestlige Barentshavet, sør for Bjørnøya.




*Figuren til venstre viser infralydsignaler (uthevet) fra meteorinnslaget i atmosfæren den 15. januar 2009 registrert nær Karasjok.*

*Den hvite ellipsen i figuren til høyre viser det antatte området for meteorinnslaget i atmosfæren den 15. januar 2009. Senteret for ellipsen er 72.1°N 20.3°Ø. De beregnede avstandene fra de forskjellige infralydstasjonene er vist som røde sirkelbuer.*

# Organisasjon
## *Organization*

Program 1:
**Nasjonalt Datasenter**
*National Data Center (NDC)*

Jan Fyen - Programleder
Ulf Baadshaug
Paul W. Larsen
Kjell Arne Løken
Berit Paulsen
Michael Roth

Program 2:
**Seismologi og prøvestans-kontroll**
*Array Seismology and Monitoring Research*

Tormod Kværna - Programleder
Steven John Gibbons
Svein Mykkeltveit
Myrto Pirli
Frode Ringdal
Johannes Schweitzer

Program 3:
**Jordskjelv og miljø**
*Earthquakes and the Environment*

Conrad Lindholm - Programleder
Jorge Crempien
Emrah Erduran
Fredrik Lingvall
Hom Nath Gharti
Jürg Hauser
Daniela Kühn
Dominik Lang
Volker Oye

Program 4:
**FoU Seismisk modellering**
*Seismic Modelling Research*

Håvar Gjøystdal - Programleder
Einar Iversen
Tor Arne Johansen
Tina Kaschwich
Isabelle Lecomte

Program 5:
**SW Produktutvikling**
*Software Product Development*

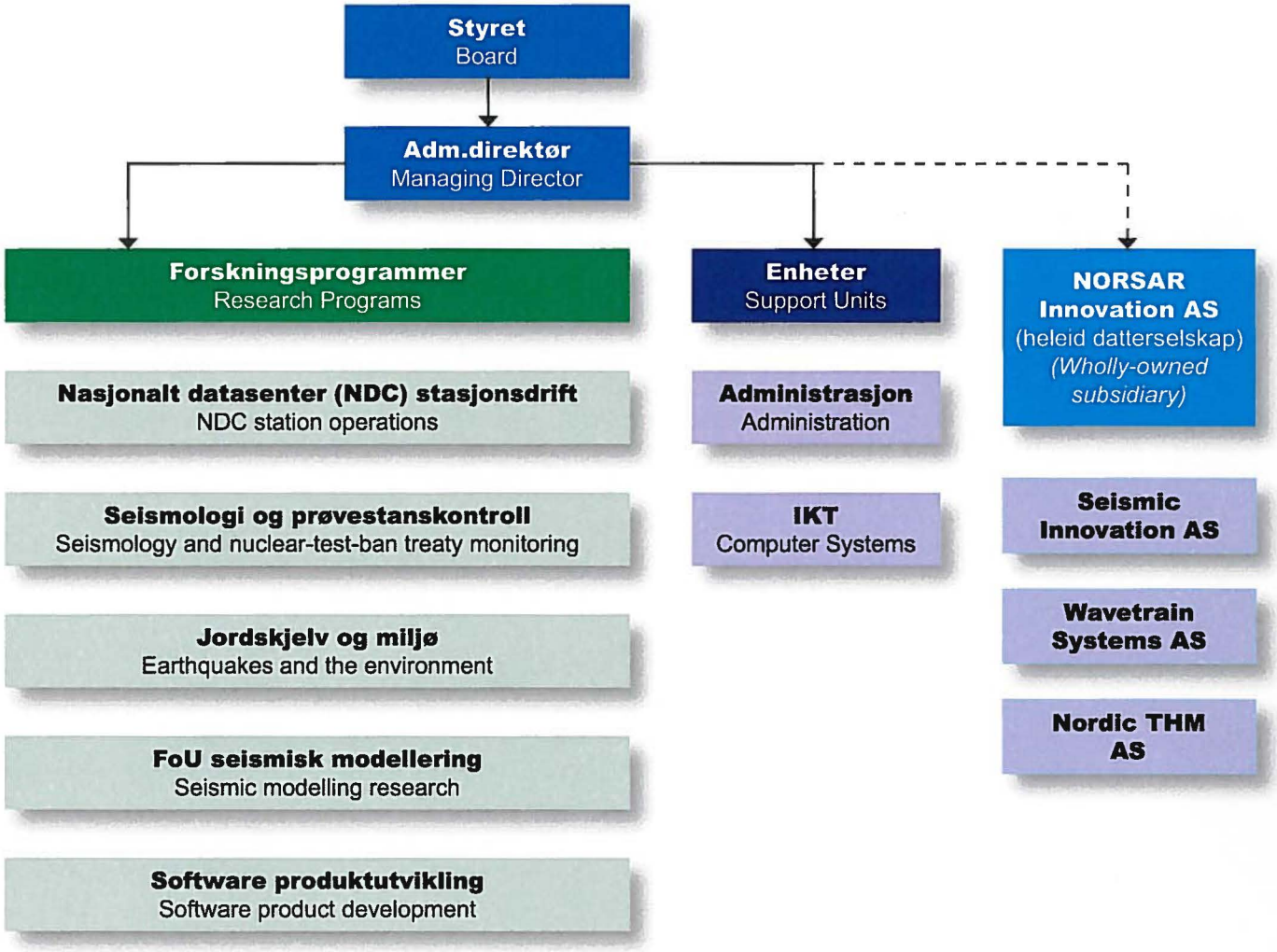
Arve E Mjelva - Programleder
Håkan Bolin
Kamran Iranpour
Håvard Iversen
Lars W. Lind
Stein Inge Moen
Andreas Paulsen
Ludovic Pochon-Guerin
Ketil Åstebøl

**Administrasjonsenhet**
*Administration*

Anders Dahle - Adm. direktør
Gunn Berget
Rune Lindvik
Winnie Lindvik
Linda Loughran
Mette Berg Sandvold
Turid Schøyen

**IKT enhet**
*Computer Systems*

Nils Schøyen - Leder IKT enhet
Vidar Døhli
Frode Johansen


Styret
Board
Adm.direktør
Managing Director
Forskningsprogrammer
Research Programs
Enheter
Support Units
NORSAR Innovation AS
(heleid datterselskap)
(Wholly-owned subsidiary)
Nasjonalt datasenter (NDC) stasjonsdrift
NDC station operations
Administrasjon
Administration
Seismologi og prøvestanskontroll
Seismology and nuclear-test-ban treaty monitoring
IKT
Computer Systems
Seismic Innovation AS
Jordskjelv og miljø
Earthquakes and the environment
Wavetrain Systems AS
FoU seismisk modellering
Seismic modelling research
Nordic THM AS
Software produktutvikling
Software product development

# Annual Report 2009

■ The NORSAR organization comprises the NORSAR Foundation and NORSAR Innovation AS. The areas of activity are research, innovation and commercialization of research results within seismology and seismic modelling.

■ The NORSAR Foundation, which is a research institution with basic funding from the Norwegian government, is the parent company and administrative headquarter of the organization. NORSAR Innovation AS is a wholly owned subsidiary of the NORSAR Foundation, and is responsible for the commercial exploitation of the intellectual property of the NORSAR Foundation, including marketing and sales of services and software products.

■ Both the parent company and the subsidiary have their headquarters at Gunnar Randers vei 15, 2007 Kjeller, Norway.

■ The NORSAR Foundation has permanent seismic field installations in Hedmark (southern Norway), Finnmark (northern Norway),and on the islands of Spitsbergen and Jan Mayen. A field maintenance section is located at Ajerhagan 98, 2319 Hamar.

■ NORSAR Innovation AS has a branch office at Thormølensgate 49, 5006 Bergen and a regional office in Kuala Lumpur, Malaysia.

**Consolidated financial statement**

■ Gross revenues in 2009 for the NORSAR organization totaled 60.5 MNOK (70.6 MNOK in 2008). The result amounted to an operating loss of 7.6 MNOK (profit of 2.9 MNOK in 2008). Financial transactions resulted in a loss of 1.2 MNOK (profit of 1.9 MNOK in 2008)

■ The operating result corresponds to -12.6 % of total revenues (+4.1% in 2008) The capital assets at the end of the year amounted to 52.1% of total assets (56.1% in 2008).

■ The overall result before taxes was -8.8 MNOK (+4.7 MNOK in 2008) and the net tax liability for 2009 is estimated to be -3.5 MNOK (+0.5 MNOK in 2008).

■ NORSAR is exposed to financial risk through fluctuations in exchange rates. The risk is sought mitigated through contract clauses allowing for rate adjustments where possible, and otherwise through forward contracts with the bank for about 50% of the total volume of foreign currency. NORSAR has low debt, and is therefore exposed to fluctuations in interest rates mainly for its liquid assets.

■ Traditionally, the NORSAR Foundation has had very few losses due to non-paying customers. The gross credit risk (outstanding receivables from debtors) by 31 December 2009, including debt between parent company and subsidiary, was 16.4 mill NOK (26.9 in 2008).

■ The liquidity is satisfactory, and consequently no decision has been made to change the liquidity risk. A bond in the amount of 3 MNOK can be redeemed at a rate close to 100% if this should be required to improve liquidity.

■ The Board considers that the annual report presents an accurate view of the NORSAR organization's assets and obligations, financial situation and operating result.

# Årsberetning 2009

■ Stiftelsen NORSAR og NORSAR Innovation AS utgjør til sammen konsernet NORSAR. Konsernets virksomhetsområder er forskning, innovasjon og kommersiell videreføring av forskningsresultater innen seismologi og seismisk modellering.
■ Stiftelsen NORSAR, forskningsstiftelse med statlig basisbevilgning, er morselskap i konsernet og står for konsernledelse og konsernadministrasjon. NORSAR Innovation AS er et heleid datterselskap som ivaretar oppgaven med kommersiell videreføring av Stiftelsen NORSARs intellektuelle verdier.
■ Morselskapet og datterselskapet har begge sine hovedkontor i Gunnar Randers vei 15, 2007 Kjeller, Skedsmo kommune.
■ Stiftelsen har etablert permanente feltanlegg for seismologisk dataregistrering i Hedmark, i Finnmark, på Svalbard og Jan Mayen, og et teknisk vedlikeholdssenter for disse feltanleggene er lokalisert i Ajerhagan 98, 2319 Hamar.
■ NORSAR Innovation AS har også virksomhet i Bergen med adresse Thormølensgate 49, 5006 Bergen og et regionalt kontor i Kuala Lumpur, Malaysia.

**Økonomi**

■ Driftsinntektene beløp seg i 2009 til 60.5 mill kroner (fjorårets tall 70.6). Driftsresultatet ble -7.6 mill kroner (fjorårets tall 2.9). Finanspostene summerer seg til -1.2 mill kroner (fjorårets tall 1.9).
■ Driftsresultatet tilsvarer en resultatgrad på -12.6 % (fjorårets tall 4.1) av driftsinntektene og egenkapitalen beløp seg til 52.1% (fjorårets tall 56.1) av totalkapitalen.
■ Resultat før skatt er -8.8 mill kroner (fjorårets tall 4.7) og årets skattekostnad er beregnet til -3.5 mill kroner (fjorårets tall 0.5).
■ Stiftelsen er eksponert for finansiell markedsrisiko ved endring i valutakurser. Risikoen søkes redusert ved oppdragsavtaler med justering for valutaendringer der det er oppnåelig og terminavtaler for om lag 50 % av valutainntektene. Konsernet har lav gjeldsgrad, og er hovedsakelig eksponert for endringer i rentenivået på innskuddsmidler.
■ Historisk sett har det vært få tap på fordringer mot Stiftelsens kunder. Brutto kredittrisiko for kundefordringer pr 31.12.09, inkludert gjeld mellom selskaper i konsernet, utgjør kr 16.4 mill kroner (26.9).
■ Konsernets likviditet er tilfredsstillende, og det er ikke besluttet å innføre tiltak som endrer likviditetsrisikoen. En obligasjon på 3 mill kroner kan innløses til tilnærmet pari kurs hvis dette blir nødvendig for likviditeten.
■ Styret anser årsregnskapet å gi et rettvisende bilde av konsernets eiendeler og gjeld, finansielle stilling og resultat.

**Future Perspectives**

- The worldwide financial crisis that emerged during the second half of 2008, coinciding with a strong decrease of the oil price, had a significant effect on the NORSAR organization. During 2009 it was difficult to obtain financial support from the oil industry for research projects. It is anticipated that this situation will continue for some time.
- During 2009 NORSAR Innovation AS had lower than expected sales of software products. This led to a need for provision of additional capital from the parent company and also caused a plan for restructuring to be established, accompanied by close monitoring of the subsidiary's activities by the administration and the Board of Directors.
- NORSAR Innovation AS is strongly exposed to the market conditions of the oil industry as well as to the fluctuations in the exchange rate between Norwegian kroner, Euro and US dollar. It must be anticipated that some of the uncertainty and low investment activity that characterized the oil sector in 2009 will continue in 2010. Nevertheless, there is still considerable technical interest for NORSAR's software products in this environment. Once the market conditions return to normal, there is hope that NORSAR Innovation AS will be able to sell software at the same rate as before the financial crisis emerged.
- NORSAR's role as the Norwegian national data center as well as a center of competence for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) is an essential part of NORSAR's activities, and in 2010 several tens of million NOK will be invested in establishing and upgrading field installations. There is still much uncertainty regarding the possibility of treaty ratification by the nine remaining countries whose ratification is required for the treaty to enter into force.
- Beginning in 2010, NORSAR will participate in a four-year EU-funded research project in connection with deep geothermal energy. This type of renewable energy source is not yet considered in Norway to have the same priority as biological, wind and solar energy, and it is a challenge to establish political support for this alternative. Deep geothermal energy has a large potential if the necessary knowledge and technology can be developed to exploit this energy source.
- In 2009 NORSAR began work within the project Safe$CO_2$, which addresses safety issues in connection with storage of $CO_2$ in geological structures. It has been a challenging task to obtain industry support for this project in the wake of the financial crisis. A considerable effort in this regard was made in 2009, and it appears that such support can finally be established during 2010.
- The NORSAR Foundation acquired the remaining part of the office building and the associated lot in Gunnar Randers vei 15, from Skifte Eiendom, and received title to the property in 2009. This improved the financial position of the foundation, in the sense that possible future loans can be secured against the property.
- In 2009, the NORSAR Foundation received a request from Skatt Øst (the tax authorities) to submit a declaration of its financial activities in 2008, in order to assess the status of the foundation with regard to taxes. Subsequently, Skatt Øst determined that the NORSAR Foundation is indeed liable to pay taxes. This decision has been appealed. The organization of research institutions (FFA), of which the NORSAR Foundation is a member, has as a goal to achieve tax exemption for all research institutions, and is working on this matter.

**Framtidsutsikter**

- Stiftelsen NORSAR er både direkte og indirekte (gjennom datterselskapet) berørt av finanskrisen som oppsto høsten 2008 og førte til et dramatisk fall i oljeprisen. Støtte fra oljeindustrien til forskningsprosjekter har vært vanskelig å etablere i hele 2009. Dette forholdet må forventes å vedvare enda noe tid.
- Manglende omsetning av software i datterselskapet NORSAR Innovation AS i 2009 ledet til et behov for kapitaltilførsel til selskapet, planlegging av driftsmessig strukturendring, og tett oppfølging av virksomhet og resultater fra ledelse og styre.
- NORSAR Innovation AS er sterkt eksponert både for konjunkturene i oljemarkedet og svingninger i vekslingskursen mellom norske kroner og Euro og US dollar. Videre må det tas i betraktning at noe av den manglende besluttsomhet og investeringslyst som karakteriserte oljeindustrien i 2009 kan fortsette i 2010. Interessen for NORSARs softwareprodukter er imidlertid fortsatt god i oljeindustriens tekniske miljøer. Dette gir håp om at når konjunkturene normaliseres, kan det forventes at NORSAR Innovation AS igjen vil omsette software på det nivå selskapet gjorde året før finanskrisen satte inn.
- Rollen som norsk, nasjonalt kompetanse- og datasenter for den internasjonale avtalen om totalforbud mot kjernefysiske prøvesprengninger (CTBT) er en svært viktig del av virksomheten ved NORSAR, og i det nærmeste året vil det bli investert flere titalls millioner i bygging og oppgradering av feltanlegg. Det knytter seg fortsatt stor usikkerhet til utviklingen når det gjelder de gjenstående lands undertegning og ratifikasjon av prøvestansavtalen (til sammen 9 land) før den kan tre i kraft.
- Innenfor nye strategier og satsninger, vil NORSAR fra 2010 delta i et EU-finansiert, 4-årig forskningsprosjekt i tilknytning til dyp, geotermisk energi. Dyp geotermisk energi er enda ikke fullt ut etablert i Norge som fornybar energikilde med samme (forskningsmessige) status som bio-, vind- og sol-energi, og det gjenstår å forankre dette alternativet i politiske- og byråkratiske fora. Dyp geotermisk energi har et stort potensial dersom den nødvendige kunnskap og teknologi kan utvikles for å utnytte denne energiformen.
- I 2009 startet NORSAR kompetanseprosjektet Safe$CO_2$, som handler om sikkerhet ved lagring av $CO_2$ i geologiske strukturer. En utfordring i dette prosjektet har vært å skaffe industrifinansiering i etterkant av finanskrisen. Det er lagt ned et betydelig arbeid for å få dette til i 2009, og det ser endelig ut til å lykkes fra 2010.
- Stiftelsen NORSAR erververt den resterende del av bygningsmassen og tomtegrunn i Gunnar Randers vei 15, fra Skifte Eiendom, og fikk utstedt skjøte på tomten i 2009. Stiftelsen kom ved dette ervervet i en forbedret finansiell stilling ved at eventuelle framtidige låneopptak kan sikres mot pant i eiendommen.
- Stiftelsen NORSAR mottok sommeren 2009 krav fra Skatt Øst om levering av selvangivelse for 2008, for vurdering av skatteplikt. Skatt Øst har vurdert Stiftelsen NORSAR som skattepliktig, en avgjørelse som er påklaget til skatteklagenemda. Forskningsinstituttenes Felles Arena (FFA), der Stiftelsen NORSAR er medlem, har som mål å oppnå en politisk avgjørelse om fritak for skatt for hele instituttsektoren, og arbeider med dette.

- The organization is exposed to credit risk through its international activity, especially through the subsidiary NORSAR Innovation AS.
- The Board considers the future prospects of the NORSAR organization to be satisfactory, and notes that the organization continues to be in an adequate financial position. In accordance with requirements in the Norwegian accounting legislation, the Board confirms that the annual accounts have properly taken into consideration the continued operation of the organization.

**Personnel and working environment**

- By the end of 2009, the NORSAR organization had 54 employees (45 in the NORSAR Foundation), two of whom were working at the field maintenance center at Hamar, four at the branch office in Bergen and one at the office in Kuala Lumpur, Malaysia. A total of 51.05 man-years of work were conducted during 2009 (47.4 in 2008).
- The NORSAR organization is an equal opportunity employer. The established working conditions provide equal opportunities for male and female employees with regard to recruiting, conditions of employment, and possibilities for professional development and advancement.
- Total sick leave at the organization was 1.9% during 2009 (2.0% in 2008). No accidents or injuries have been recorded in connection with the activities of the organization during the year.
- The working environment in the NORSAR organization is considered satisfactory. The organization encourages the improvement of this environment through an active dialog between employees and management, and through emphasis on HSE-work and quality assurance.
- The organization's activities do not contribute to environmental pollution.

The Board of Directors thanks the employees for constructive contributions to the development of the organization during the challenging year of 2009.

- Omsetning internasjonalt, spesielt gjennom datterselskapet NORSAR Innovation AS, eksponerer konsernet for kredittrisiko.
- Styret vurderer konsernets framtidsutsikter som tilfredsstillende, og konsernet er fortsatt i en tilfredsstillende økonomisk stilling. Forutsetningen om fortsatt drift er lagt til grunn ved avleggelsen av årsregnskapet.

**Personal og arbeidsmiljø**

- Antall ansatte i konsernet ved årets slutt var 54 (45 i Stiftelsen NORSAR), hvorav 2 hadde arbeidsplass på Hamar, 4 i Bergen og 1 ved kontoret i Kuala Lumpur, Malaysia. Det ble utført 51.05 årsverk i konsernet i 2009 (47.4 i 2008).
- Konsernets selskaper har tilrettelagt arbeidsforholdene for arbeidstakere av begge kjønn og praktiserer kjønnsmessig likebehandling i saker som handler om rekruttering, ansettelsesbetingelser og utviklings- og avansementsmuligheter.
- Sykefraværet i konsernet var 1.9 % i 2009 (2.0 % i 2008). Det har ikke forekommet eller blitt rapportert arbeidsuhell eller ulykker knyttet til konsernets virksomhet.
- Arbeidsmiljøet i selskapene anses som godt, men søkes kontrollert og opprettholdt gjennom aktiv dialog mellom ledelse og personale, internt HMS arbeid, og et system for kvalitetssikring.
- Konsernets virksomhet forurenser ikke det ytre miljø. Styret takker de ansatte for konstruktive bidrag til konsernets utvikling gjennom et krevende år, 2009.

Kjeller, 29. april 2010

| | | |
|---|---|---|
| Annik M. Myhre | Rigmor M. Elde | Arne Øfsthus |
| Styreleder | Styremedlem | Styremedlem |
| Jarle Skjørestad | Michael Roth | Anders Dahle |
| Styremedlem | Styremedlem | Adm. direktør |

# Stiftelsen NORSAR
## *NORSAR Foundation*

**Resultatregnskap 2009** / ***Profit and Loss 2009***

| | 2009 | 2008 |
|---|---|---|
| Midler fra NFR<br>*Grants from the Research Council of Norway* | 8 321 591 | 11 056 479 |
| Prosjektmidler fra UD<br>*Funding by the Ministry of Foreign Affairs* | 15 790 360 | 15 050 347 |
| Ander salgs- og oppdragsinntekter<br>*Other sales and project income* | 29 749 257 | 33 159 867 |
| Sum driftsinntekter<br>*Total operating revenues* | 53 861 208 | 59 266 693 |
| Lønn og sosiale kostnader<br>*Pay and social costs* | 33 949 102 | 36 982 447 |
| Avskrivninger / *Depreciation* | 1 649 758 | 1 804 581 |
| Prosjektrelaterte kostnader<br>*Project expenses* | 10 115 787 | 12 789 679 |
| Administrative kostnader<br>*Administrative expenses* | 4 979 699 | 6 697 829 |
| Sum driftskostnader<br>*Total operating expenses* | 50 694 346 | 58 274 536 |
| Driftsresultat / *Operating result* | 3 166 862 | 992 157 |
| Netto finansposter<br>*Net financial transactions* | 21 822 | 1 203 038 |
| Resultat før skattekostnad / *Result before taxes* | 3 188 684 | 2 195 195 |
| Skattekostnad på ordinært resultat / *Tax* | -442 660 | |
| Ekstraordinær inntekt<br>*Extraordinary income* | | |
| Årsresultat / *Annual net result* | 2 746 024 | 2 195 195 |

# Konsernet NORSAR
## *NORSAR Organization*

**Resultatregnskap 2009** / ***Profit and Loss 2009***

| | 2009 | 2008 |
|---|---|---|
| Midler fra NFR<br>*Grants from the Research Council of Norway* | 13 029 095 | 12 348 975 |
| Prosjektmidler fra UD<br>*Funding by the Ministry of Foreign Affairs* | 15 790 360 | 15 050 347 |
| Ander salgs- og oppdragsinntekter<br>*Other sales and project income* | 31 648 313 | 43 179 421 |
| Sum driftsinntekter<br>*Total operating revenues* | 60 467 768 | 70 578 743 |
| Lønn og sosiale kostnader<br>*Pay and social costs* | 42 286 659 | 39 968 302 |
| Avskrivninger / *Depreciation* | 1 649 758 | 1 804 581 |
| Prosjektrelaterte kostnader<br>*Project expenses* | 16 568 384 | 17 834 534 |
| Administrative kostnader<br>*Administrative expenses* | 7 556 776 | 8 106 636 |
| Sum driftskostnader<br>*Total operating expenses* | 68 061 577 | 67 714 053 |
| Driftsresultat / *Operating result* | -7 593 809 | 2 864 690 |
| Netto finansposter<br>*Net financial transactions* | -1 174 922 | 1 879 638 |
| Resultat før skattekostnad / *Result before taxes* | -8 768 731 | 4 744 328 |
| Skattekostnad på ordinært resultat / *Tax* | 3 469 448 | -485 730 |
| Ekstraordinær inntekt<br>*Extraordinary income* | | |
| Årsresultat / *Annual net result* | -5 299 283 | 4 258 598 |

# Stiftelsen NORSAR
## *NORSAR Foundation*

**Balanse 2009** / ***Balance 2009***

| | 2009 | 2008 |
|---|---|---|
| Utsatt skattefordel / *Deferred tax asset* | | |
| Eiendeler / *Assets* | | |
| Anleggsmidler / *Fixed assets* | 25 046 590 | 26 041 566 |
| Langsiktig lån til datterselskap<br>*Long-term loan subsidiary company* | 6 000 000 | 6 000 000 |
| Investering i datterselskap<br>*Investment in subsidiary company* | 1 000 000 | 1 000 000 |
| Oppdrag i arbeid / *Work in progress* | 3 529 620 | 2 290 168 |
| Debitorer / *Debitors* | 17 101 064 | 16 139 602 |
| Andre kortsiktige fordringer<br>*Other short-term receivables* | 629 105 | 636 462 |
| Kasse, bank / *Cash, bank* | 9 543 524 | 9 753 678 |
| Sum eiendeler / *Total assets* | 62 849 903 | 61 861 476 |
| Egenkapital / *Equity* | | |
| Grunnkapital / *Basic capital* | 200 000 | 200 000 |
| Overskuddsfond / *Share premium reserve* | 843 000 | 843 000 |
| Annen egenkapital / *Other equity* | 36 765 031 | 34 019 007 |
| Sum egenkapital / *Total equity* | 37 808 031 | 35 062 007 |
| Gjeld / *Liabilities* | | |
| Pensjonsforpliktelser / *Pension allocation* | 2 646 638 | 3 469 420 |
| Avsetning vedr. feltanlegg<br>*Allocation field installations* | 1 500 358 | 1 500 358 |
| Langsiktig gjeld / *Long-term debt* | 4 687 500 | 3 947 000 |
| Leverandørgjeld / *Suppliers* | 3 249 735 | 3 479 513 |
| Betalbar skatt / *Tax liability* | 472 290 | 0 |
| Skyldige avgifter og skattetrekk<br>*Tax withholding reserves* | 3 283 934 | 4 020 141 |
| Annen kortsiktig gjeld<br>*Other short-term liabilities* | 9 201 417 | 9 383 036 |
| Sum gjeld / *Total liabilities* | 25 041 872 | 25 799 468 |
| | | |
| Sum egenkapital og gjeld<br>*Total equity and liabilities* | 62 849 903 | 60 861 476 |

# Konsernet NORSAR
## *NORSAR Organization*



**Balanse 2009** / ***Balance 2009***

| | 2009 | 2008 |
|---|---|---|
| Utsatt skattefordel / *Deferred tax asset* | 4 148 832 | 236 724 |
| Eiendeler / *Assets* | | |
| Anleggsmidler / *Fixed assets* | 29 384 322 | 25 332 290 |
| Langsiktig lån til datterselskap<br>*Long-term loan subsidiary company* | 0 | 0 |
| Investering i datterselskap<br>*Investment in subsidiary company* | 0 | 0 |
| Oppdrag i arbeid / *Work in progress* | 3 529 620 | 2 290 168 |
| Debitorer / *Debitors* | 9 289 849 | 21 382 949 |
| Andre kortsiktige fordringer<br>*Other short-term receivables* | 3 550 766 | 3 222 939 |
| Kasse, bank / *Cash, bank* | 14 862 430 | 13 520 741 |
| Sum eiendeler / *Total assets* | 60 616 987 | 65 749 087 |
| Egenkapital / *Equity* | | |
| Grunnkapital / *Basic capital* | 200 000 | 200 000 |
| Overskuddsfond / *Share premium reserve* | 843 000 | 843 000 |
| Annen egenkapital / *Other equity* | 30 535 801 | 35 835 084 |
| Sum egenkapital / *Total equity* | 31 578 801 | 36 878 084 |
| Gjeld / *Liabilities* | | |
| Pensjonsforpliktelser / *Pension allocation* | 3 578 452 | 4 065 318 |
| Avsetning vedr. feltanlegg<br>*Allocation field installations* | 1 500 358 | 1 500 358 |
| Langsiktig gjeld / *Long-term debt* | 4 687 500 | 3 947 000 |
| Leverandørgjeld / *Suppliers* | 4 718 007 | 5 310 370 |
| Betalbar skatt / *Tax liability* | 472 290 | 0 |
| Skyldige avgifter og skattetrekk<br>*Tax withholding reserves* | 3 699 915 | 4 156 987 |
| Annen kortsiktig gjeld<br>*Other short-term liabilities* | 10 381 664 | 9 890 970 |
| Sum gjeld / *Total liabilities* | 29 038 186 | 28 871 003 |
| | | |
| Sum egenkapital og gjeld<br>*Total equity and liabilities* | 60 616 987 | 65 749 087 |

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- Czuba, W., M. Grad, R. Mjelde, A. Guterch, A. Libak, F. Krüger, M. Schmidt-Aursch, Y. Murai and J. Schweitzer: Crustal structure beneath seismic profile Mohns Ridge-Bear Island and tectonic implications for the continent-ocean transition between the Mid-Atlantic-Ridge and Barentsia. 2nd Workshop for IPY Project "The Dynamic Continental Margin Between the Mid-Atlantic Ridge System (Mohns Ridge, Knipovich Ridge) and the Bear Island Region", Kjeller, 5 – 8 November 2009

- Dębski, W., J. Schweitzer, G. Lizurek, T. Kværna, P. Wiejacz, Ł. Rudziński and J. Suchcicki: A new joint Polish-Norwegian broadband seismic station at Hornsund (Svalbard) EGU General Assembly 2009 (poster)

- Evers, L.G., S.J. Gibbons, T. Kvaerna and D.G. Simons: Seismo-acoustic analysis of explosions observed in Norway and the temporal variations in the state of the upper atmosphere. EGU General Assembly 2009, Vienna, Austria

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- Gibbons, S. J., J. Schweitzer, F. Ringdal, T. Kværna and S. Mykkeltveit: Improvements to seismic monitoring of the European Arctic using three-component array processing at SPITS. EGU General Assembly 2009 (poster)

- Gibbons, S. J., J. Fyen and F. Ringdal: Construction and Application of Time-Delay Correction Surfaces for Improved Detection and Estimation on Seismic Arrays. 40th Nordic Seminar on Detection Seismology, Stockholm, 14-16 October 2009

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- Iversen, E.: Ray-theoretical aspects of seismic time migration and demigration. Mini-symposium "Mathematical and Computational Problems of Time-domain Seismic Imaging" at the SIAM conference, Leipzig, Germany, 16 June 2009

- Kühn, D., V. Oye, I. Lecomte and A. Drottning: SafeCO2: Safety Monitoring of CO2 Storages Using Microseismicity and 4-D Seismic Modelling -- a new CCS Project in Norway, CO2 Sequestration Geophysics, 2009 SEG Summer Research Workshop, Banff, Canada, 23-27 August

- Kværna, T: Processing and analysis of seismic data at NORSAR. International Scientific Studies workshop on Data Mining and Seismology, Vienna, Austria, March 2009

- Kværna, T and J. Fyen: Infrasound activities at NORSAR; status and future ideas. Workshop on European Infrasound Project, CEA, Paris, October 2009

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- Kværna, T., D. B. Harris, S. Gibbons and F. Ringdal: Matched Field Processing for Enhanced Array Resolution. IASPEI General Assembly 2009, Cape Town, January 2009

- Kühn, D., H N. Gharti, V. Oye and M. Roth: Microseismic data analysis: examples from NORSAR research projects. Talk given at 5th Annual Meeting of the PHASE Consortium Project, Berlin, February 2009

- Kühn, D., H.N. Gharti, V. Oye and M. Roth: Automatic determination of full moment tensor solutions from P-wave first motion amplitudes. Talk given at the 2nd EAGE Passive Seismic Workshop, Cyprus, March 2009

- Kühn, D., V. Oye, H.N. Gharti and M. Roth: Moment tensor inversion: challenges in highly heterogeneous media. Talk given at the University of Potsdam, October 2009

- Kühn, D. and H. Bungum: Finite element computation of seafloor displacement as input for tsunami model. Talk presented by H. Bungum at Tsunami risk Reduction Measures Phase 2 Dissemination Seminar and Workshop, Indonesia/Philippines, May 2009

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- Lecomte, I.: Geophysics for Geohazards in 2009, Annual ICG workshop, Oslo, 3 December 2009

- Lecomte, I.: A little bit about geophysics and seismic imaging, some key elements, lecture, SVALEX 2009 multi-disciplinary field course, Svalbard Archipelago, August 2009

- Lecomte, I.: Modern applications of ray tracing in seismic O&G exploration, invited talk, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 18 May 2009

- Lecomte, I.: International Centre for Geohazards, Oslo: activity overview with focus on geophysics, invited talk, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 19 May 2009

- Mykkeltveit, S.: The verification regime of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) – current status of implementation. 40th Nordic Seminar on Detection Seismology, Stockholm, 14-16 October 2009

- Mykkeltveit, S., F. Ringdal and J. Fyen: Opportunities for CTBT-related cooperation between Kazakhstan and Norway. Kazakhstan – Norway: Strengthening the global partnerships for a nuclear weapons free world. A conference to explore common challenges and opportunities. Oslo, 24 March 2009

- Pirli, M. and J. Schweitzer: The 21st February 2008 earthquake in Storfjorden, Svalbard and its aftershock sequence. 1st Workshop for IPY Project "The Dynamic Continental Margin Between the Mid-Atlantic Ridge System (Mohns Ridge, Knipovich Ridge) and the Bear Island Region", Zakopane, 20 – 24 May 2009

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- Schweitzer, J., F. Krüger, T. Kværna and IPY Project Consortium: The temporary small aperture Bjørnøya array (BJOA). AG Seismologie, Freudenstadt, 22. – 24. September 2009

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- Weidle, C., V. Maupin, J. Ritter, B. Wawerzinek, T. Kværna, J. Schweitzer, N. Balling, H. Thybo and J. I. Faleide: MAantle investiGations of Norwegian Uplift Structure (MAGNUS) - a temporary network in Southern Norway. 69. Jahrestagung der Deutschen Geophysikalischen Gesellschaft, Kiel 23. – 26. März 2009 (poster)

- Weidle, C., V. Maupin, A. Levshin, J. Schweitzer and N. Shapiro: Surface wave tomography of Northern Europe. 2nd Workshop for IPY Project "The Dynamic Continental Margin Between the Mid-Atlantic Ridge System (Mohns Ridge, Knipovich Ridge) and the Bear Island Region", Kjeller, 5 – 8 November 2009

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### Student reports and theses (I. Lecomte supervisor or co-supervisor):

- Guy, A. (2009): Flexible and target-oriented Prestack Depth Migration tools: a ray-tracing approach, Dipl. Eng. Geophysics Thesis, EOST, University of Strasbourg.

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Layout: Nygaard Design
Trykk: Interface Media as