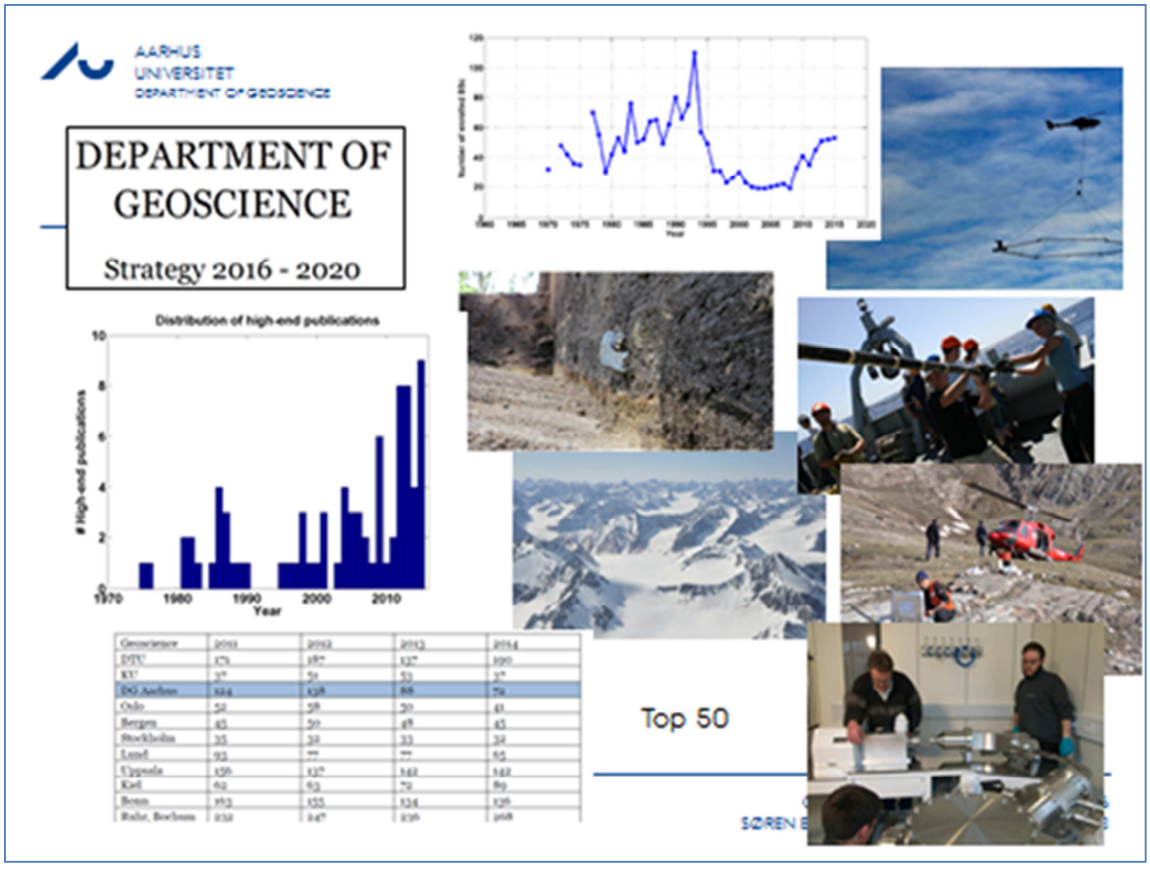
DEPARTMENT OF GEOSCIENCE

Strategy 2016 - 2020



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1. Preface

As the previous strategy from 2012 needed a revision in order to match today's situation and take advantage of new possibilities in relation to research, talent, teaching, and business, and to match the new organisational setup of the faculty DG went to the task of making a new strategy in the beginning of 2015.

All staff was involved in working with the strategy from the beginning of spring 2015, discussing themes and contents at several joint meetings, and everybody has had a chance of participating in a post-it- notes session in connection with the SWOT analysis (chapter 6).

The chairmen of the four committees in relation to research, talent, teaching, and business, took the task of putting together the outcomes from these meetings, and discussing strategy in their respective meetings, into the overall strategy.

Chairman of research committee	Marit-Solveig Seidenkrantz/David Lundbek Egholm
Chairman of talent committee	Steen Christensen
Chairman of teaching committee	Mads F Knudsen/Bo Holm Jacobsen
Chairman of business committee	Esben Auken

The first draft was presented at a joint meeting in August 2015 where all staff had the possibility to contribute and comment further to the content.

The goals with this work is to draw a simple and clear strategy for all staff to relate to, so that we take ownership of the tasks ahead and feel we are working for the same goals.

2. Vision, mission, and executive summary

Vision
To belong to the top 50 of Geoscience departments worldwide and to contribute to resolving global and national threats to the immediate and deep future sustainability of life in the Earth system.

Mission
We perform basic and applied research, consultancy of governmental organisations and research-based teaching at the highest international level with a clear view to the demands of society. We collaborate with the best international researchers and research groups as well as rising academic environments, and with private and public companies and organisations. We are committed to recruiting and retaining the highest quality researchers and staff to work in a culture that supports diversity and equality at all stages of employment, from recruitment to retirement within a departmental atmosphere of ambition, mentoring and team spirit.

Executive summary
The Department of Geoscience (DG) was founded in 1962 and is one of two geoscience university institutions in Denmark. The educations comprise a BSc program in Geoscience and MSc programs in Geology, Geophysics, and Technical Geology. The broad BSc education comprises all relevant geoscience disciplines. The MSc programs in Geology, Geophysics and Technical Geology provide top-level educations in a broad spectrum of disciplines ranging from basic to applied studies and spanning most Earth surface and deep Earth environments relevant for understanding the Earth system and its relevance to modern human societies. The MSc geophysics accreditation is unique and instrumental in defining the renowned brand of Aarhus geoscience masters with highly coveted quantitative competences. The BSc enrolment now at c. 50/year has been dimensioned to 45/year by 2020. It is our strategy to increase the number of BSc applications and sort students based on qualifications. Geophysics is not dimensioned and it is our strategy to increase the volume of this MSc program by national and international recruitment with the potential scope of gaining momentum to open a bi-lingual (English & Danish) BSc-entry in Geophysics by 2020. The geophysics masters are required to sustain growth in the sectors of society (water, environment, energy, construction) relying on subsurface imaging for resource development and management. DG will implement educational pathways and student mentoring. Some paths will come with a geology, geophysics or geochemistry flavour. Research performance (volume, impact and excellence) is in strong growth and we will continue this trend and aim to reach a global ranking of c. 50 by 2020 (NTU). The research focus is within five areas characterized by high growth, large impact and/or high societal significance: Climate & Environment; Water; Energy & Natural Resources; Deep Earth Systems; Geochronology. It is the strategy to win centres of excellence within these areas by gathering forces internally, and by further developing external co-operations. The world-class metal-free geochemical analytical facility will create new momentum for all research areas and the educations, as well as enhance interdisciplinary research and teaching as witnessed by the emerging co-operations with Archaeology and Health and Medical Science. Excellent research is strongly coupled to talent development, and DG will actively attract talent and expand its support and mentoring of PhD students, postdocs, and junior staff. This is articulated in the general recruitment and gender policy of the Department.

3. Organisation and physical environment

DG was founded in 1962. DG is a broad geoscience department where the expertise of the scientific staff fit into one or more of the three categories geology, geophysics, and geochemistry. Most of the classical geoscience disciplines are present although the balance between them has changed over the years. Geophysics emerged in the early 1970s and is now one of the cornerstones of DG along with micropaleontology, sediment geology, ice age geology, structural geology, petrology, geochemistry, hydrogeology, numerical modelling, and basin analysis, all contributing to one or more of the main research subjects (see below). This suite of disciplines and the associated experimental facilities allow DG to engage in a number of strategic and basic research problems addressing the global challenges, and to educate candidates at the BSc, MSc, and PhD level.

DG is organized as follows:

Head of Department	Søren Bom Nielsen

Department steering committee:

Head of Department	Søren Bom Nielsen
Vice head	Jan Piotrowski
Head of secretariat	Lene Kjeldsteen
Professor	Charles Lesher
Professor MSO	Esben Auken
Associate professor	Mads Faurschou Knudsen

Workshop manager	Per Trinhammer
Laboratory manager	Charlotte Rasmussen

DG furthermore comprises three “fora of interest” each with a forum manager. The fora titles are: Earth surface systems, Deep Earth Systems, and Computational Earth Science. The purpose of these fora is to further scientific discussions and interdisciplinary research and teaching. The fora managers invite to regular meetings that are open to all staff. This setup ensures regular coordination and exchange between all research related subjects such as research applications, international meetings, paper writing and discussion of initiatives. The fora also provide opportunities for PhDs and postdocs to present and discuss projects. The fora managers have regular meetings with the Head of Department.

Fora managers:

Deep Earth Processes	Associate professor Niels Balling
Earth Surface Processes	Professor Jan Piotrowski
Computational Earth Science	Associate professor Bo Holm Jacobsen

Educations

BSc level: geoscience. MSc level: geology, geophysics, technical geology (in cooperation with Engineering). All three types of masters are in strong demand in both the private and public sector, with very low unemployment rates. Some continue as PhD students either at DG or internationally. In order to highlight the competences of our candidates, and to ease the administrative problems of students and staff, four

educational pathways ("elephant tracks") are being developed in collaboration with faculty administration. These will highlight typical ways through our study programmes. Each of the pathways comes in flavours of geology, geophysics and geochemistry.

Permanent staff
Table 1C of Appendix C shows the number of staff of different categories.

Scientific staff: Many scientific staff were recruited during Department build-up in the 1960ies and 70ies. This led to a skewed age profile, which is only now being gradually resolved (Figure C1, Appendix C). The age retirements and reduced AU funding have resulted in a reduction in permanent scientific staff from 37 in 1995 to 20 in 2015 (Fig 1A, below). The retirements have led to a fairly large number of emeriti (in total 16), who overall contribute to research output.

Technical and administrative staff: The scientific staff reductions have been accompanied by significant reductions in technical and administrative staff. The number of administrative staff went from 7 staff members in 2012 to 3 in 2015 (excl. Head of Department). The change was effectuated by moving various functions to faculty or university level (i.e. HR, economy and study administration, library, IT support); closing the technical drawing services; optimizing workflows locally. Much of this has caused relatively minor reductions of services after an initial transition period. DG is in charge of a metal workshop (1 TAP), an electrical workshop (3 TAP), and laboratory facilities (1 AC TAP + 1 TAP at Risø; 5 TAP at 8000 C). In connection with the new clean lab DG has hired a spectroscopist to maintain and run some of the advanced analytical equipment. Further, DG has now a scientific coordinator to facilitate building up new avenues of funding, maintain and developing networks, and improving the of number and quality of research applications.

Physical framework and Infrastructure:
In 2006 DG moved from six locations to its present three locations. This made it possible to centre much of the Geoscience research and teaching in close proximity of each other. Two groups, however, (hydrogeophysics and the Nordic Laboratory for Luminescence dating (NLL, Risø)) are still housed in separate locations.

The gathering of many Geoscience locations in fewer buildings has enabled the sharing of laboratory facilities between disciplines, leaving room to establish new laboratory infrastructure, especially a clean room facility for precise geochemical analyses, a sample preparation laboratory for cosmogenic isotopes, as well as a core scanning facility. Unfortunately, DG is soon reaching its maximum capacity for new infrastructure housed in the existing buildings. In addition, DG benefits from the close proximity to the AMS ^{14}C Dating Centre, at the Department of Physics and Astronomy, for radiogenic dating and measurements of cosmogenic isotopes. This proximity has facilitated a number of interdisciplinary research activities.

4. Staff and culture

In accordance with AU staff policy DG believes that freedom with responsibility provide the bast conditions to develop and thrive, in their own work as well as for the benefit of department, university and society. We are proud to make a difference for society through our research and teaching, in accordance with our vision and mission. Not only does DG provide important new insights into the basic knowledge of the Earth system and its dynamics, we also strongly work towards filling society's needs, among others in relation to clean water, energy, geo-hazards and understanding the consequences and risks of climate change. Over recent years DG has worked towards building a common platform for appreciating our duty to society.

Ensuring common values and culture as well as mutual respect among all staff members and students, in a working environment consisting of three locations and different groups working besides each other, is an on-going process. All staff members have the opportunity to meet at a monthly social get-together in the "Faculty club". Experience has shown that it facilitates both improved working relations as well as instigates new ideas for teaching and research. We include students in DG culture through the student organisation IGOR, which meet regularly with the HoD and the secretariat leader. Within our means we give the optimal working conditions for students by improving and expanding study space and by keeping AV equipment in teaching rooms updated. DG hosts an annual late summer's party for all staff members and students, as well as a Christmas dinner for staff. Once a year staff is invited to a one-day thematic excursion to geologically interesting sites/relevant institutions in Denmark for all staff to indulge in their shared interest.

We are a small organisation, which encourages the direct influence of employees and students individually, or through representatives in different fora. We are therefore further enhancing transparency by ensuring that responsibilities are clearly defined and that information is easily accessible (see Appendix A about the various committees and their charge). In response to the Problem Analysis from ultimo 2014 it is a focus point how to delegate responsibility to staff for optimal workflows, and how to involve the relevant staff to make the best decisions for DG development and the staff well-being. It is an on-going process of mutual exchanges to arrive at the best practices.

We have mandatory staff development dialogues (SDD) once a year, and strongly encourage all staff to participate positively.

In order to ensure a high information flow we have introduced the following actions:

- Joint meetings 4-6 times a year for all staff
- Bi-weekly online newsletter with a success rate of more than 60% of staff reading the news.
- Newsletter to students 2-4 times a year with news from DG
- Weekly morning briefings

Recruitment and gender strategy

The Department of Geoscience is committed to recruiting and retaining the highest quality researchers and staff to work in a culture that supports diversity and equality at all stages of employment, from recruitment to retirement. Diversity can be understood, for example, in terms of gender, nationality and age distribution. The benefits of a diverse workplace include increased adaptability, creativity and productivity, more skills (e.g. language and technical) and experiences, and more effective communication. The selection and appointment of new staff is a critical stage in determining the Department's quality and composition, particularly when considering gender balance.

Our recruitment strategy has three stages:

- Identifying the need for a new employee and writing a suitable job description that communicates the necessary skills, using non-discriminatory, gender-neutral language;
- Advertising the position internationally and sourcing potential candidates in venues that ensure a diverse applicant pool;
- Reviewing applications and taking steps to remove unconscious bias, such as including both men and women in the selection process and on the candidate shortlist.

In commitment to our gender balanced recruitment strategy The Head of Department and the steering committee assume responsibility for gender equality of the Department:

- We will review our recruitment process continuously to eliminate bias in the hiring process;
- We will remove obstacles that prevent students wanting to pursue careers in research from doing so – for example, the causes for the so-called 'leaky pipeline';
- We will provide mentoring and coaching to graduate students, postdoctoral fellows and junior professors contemplating academic or industry careers in the geosciences.

5. General goals, international position, and positions of strength

General goals. DG is a very internationally oriented with a significant number of staff recruited from abroad, many foreign students and with extensive international collaborations. DG has retained most of the classical geoscience disciplines in new and modern disguises and scopes, and added the newer disciplines of geophysics and geochemistry with gradually increasing weight. The trinity of geology, geophysics and geochemistry is required in a modern geoscience Department, which - together with excellent facilities and technical and administrative staff - makes DG the ideal world for geoscience research and education and cross disciplinary and international collaborations. The equality of the trinity components means that some educational pathways come with geology, geophysics or geochemistry flavours. We anticipate that some geochemistry flavoured masters will contribute to branding the Aarhus Geoscience educations. Externally imposed limitations on BSc enrolment constrains education expansion to geophysics, which has not been dimensioned. Besides answering to the call of society for technically oriented geophysical masters, this expansion can ease the pressure on the imposed BSc quota of 45, provided a new BSc entry in geophysics is established. This is in fine alignment with the huge potential for expansion within the Water research area and for increasing synergy within Deep Earth Systems. The research areas below represent core competences and strongholds of DG. They have different strengths, and it is our strategy to develop these further and increase their visibility in general.

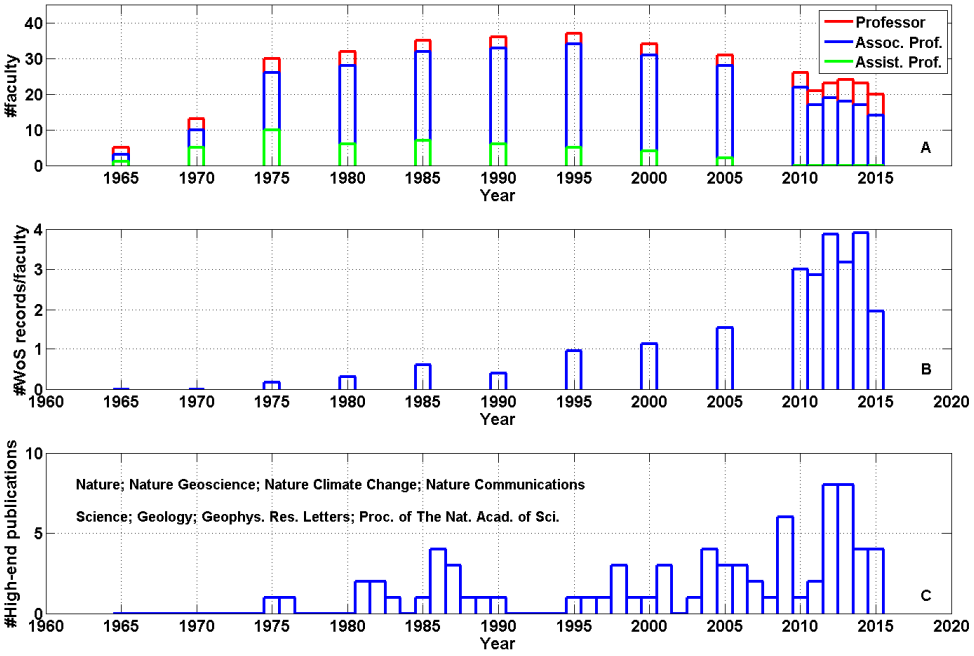


Fig 1.
A: Number of faculty as a function of time.
B: Number of WoS records per faculty as a function of time. Year 2015 is incomplete.
C: Number of publications in high-end journals. Year 2015 is incomplete.

Position Research. The average research impact of DG was low in the past, but with significant variations between disciplines; some have been very productive by international standards, and others have published only little in peer reviewed journals. A cultural change and new recruitments have improved research performance since 1990, when the average number of Web of Science (WoS) records and citations started to increase (Fig E1, E2, Appendix E). Besides the increased volume of research output this illustrates how the research publication channels of DG staff have changed from (typically local) low-impact literature or reports not recorded by WoS to international, peer reviewed journals.

The significant change in research impact is also apparent from the growth in citations in general (Fig. E2, App. E) and through the increasing number of publications in high-impact journals (Fig 1 C; Fig E3, E4, Appendix E). This has also been registered in the global National Taiwan University (NTU) Ranking, which exhibits a steep increase through the years 2011-2014 (Table E1, Table E2, Appendix E). While the significance of the absolute value of the NTU Ranking must be interpreted with caution between different departments, it is apparent that most of geoscience departments exhibit a rather constant NTU impact, while DG exhibits a significant impact growth. This positive development must have been caused by the recent growth in the bibliometric parameters on which the NTU index is based (productivity, impact, excellence) (Fig 1 B & C).

Present Research Areas: DG is internationally strong and/or has a significant potential/wants to increase its international strength through recruitment and/or reorganisation within the following research areas:

Climate & Environment: The understanding of human impacts on geo- and ecosystems through time is crucial for sustainable exploitation of geological resources. In particular, the understanding climate change driven by complicated non-linear feedback mechanisms requires long time series of multiple proxies recorded in geological archives. DG has a long history of achievements in the area of reconstructing past environmental changes spanning most geographical regions across the globe with special focus on the Artic. The cornerstones are a suite of marine and terrestrial palaeo-archives, glacial processes and environments, and solar dynamics investigating ocean-atmosphere-cryosphere interactions; sediment generation and re-distribution by water, wind, and ice; shaping the surface of the Earth surface by erosion and deposition; sea ice development; dynamics of glaciers and ice sheets; formation of soils and vegetation dynamics; and the interactions between humans and the environment. The strengths of this research reflected in its high international impact include expertise in marine and lacustrine cores analysis, micropalaeontology, sedimentology, glacial geology, geomorphology, isotope and trace element geochemistry, luminescence dating, cosmogenic isotopes, seismics, and numerical modeling. The area contributes to the Arctic Research Centre and has strong links to archaeology through the STAR network and numerous research projects.

Water: Availability of clean water to sustain human existence is the major global challenge immediately and in the future. Exploitation of groundwater and its interaction with surface water at the catchment scale has therefore been a DG key research area for more than two decades. DG hosts the world's largest hydrogeophysics group developing mapping and modelling methods key to management of groundwater resources, estimation of their vulnerability to anthropogenic pollution and saltwater incursion in coastal regions. Mapping of landfills and contaminated groundwater flows are amongst the competences. The group explores advanced methods for better integration of hydrogeophysics and groundwater modelling. The group is highly productive and successful with numerous significant international collaborations and large national research projects. Activities (via research groups in the US) regarding subglacial hydrogeological systems and permafrost in Antarctica point to a clear synergy potential with the flagship Climate & Environment. Many of the hydrogeophysics tools are also applicable to mineral exploration, and synergy with the flagship Energy & Natural Resources is obvious. The area is characterized by one large and closely cooperating group, mainly externally funded.

Energy & Natural Resources (not water): Fossil energy and mineral resources are required to sustain human existence now and in the foreseeable future. Shale gas is a relatively clean alternative to coal and oil. The importance of geothermal energy research, in which DG has a unique position, is witnessed by several operating plants in Denmark and many in Europe. Reservoir characterization is the common denominator of the number of subsurface applications (energy, water and CO2 storage). Almost all of the classical geoscience disciplines and in particular basin analysis, structural geology, sedimentology, petrology, geophysics, and stratigraphy are involved. Most activities, not least education, revolve around the seismic method of subsurface imaging, which is uniquely represented at DG, and which is the essential pivotal point of many high-profile external research collaborations together with GEUS. The strong societal dependency and the demand on candidates are at present not reflected in public funding opportunities. The fossil and mineral areas are governed by a relatively small number of large, private (multinational) companies from which funding can be achieved, subject to fluctuations in the world economy. Funding continuity therefore has been difficult. Mærsk Oil and Gas is funding a 5-year Chair in Basin Analysis.

Deep Earth Systems: Were it not for the geoscience disciplines probing the deep interior of the Earth, humanity would know rather little of the physical state and internal structure of Earth, e.g. the crustal roots supporting all mountain ranges, the formation of hydrocarbon rich sedimentary basins like the North Sea, and the mechanics of the great engine driving plate tectonics and the associated hazards of volcanism and earthquakes. At DG the two corner stones of the flagship Deep Earth comprise i) the Niels Bohr centre with world class geochemical analytical facilities probing the minerals of magmas and other rocks and materials, and ii) deep geophysics providing orthogonal constraints on the deep structure through remote sensing using gravity, heatflow and wavefields. These geochemistry and geophysics tools provide extremely useful connections to other areas at ST and across AU faculties. For example, the metal-free cleanlab and associated mass spectrometers have built bridges to Arts (the UrbNet centre at Archaeology) and Health, and DG's arctic seismic equipment (shared with GEUS) and associated technical support is one of a kind and much coveted by external collaborators.

Geochronology: Establishing chronologies for events recorded in sedimentary deposits is of critical importance to our understanding of the history of our culture, our species, our biosphere and our planet. This is especially true of the last 2.8 million years (the Quaternary) – the period of most relevance to our present climate and to the evolution of our species. Two of the most important dating methods for interpreting the Quaternary sedimentary record are represented in DG: i) cosmogenic dating and ii) luminescence dating. The new Cosmogenic Dating Laboratory is a collaborative facility with the Department of Physics and Astronomy. This laboratory is very well equipped and the staff has significant previous experience. AU's Nordic Laboratory for Luminescence Dating is, together with its close collaborator (DTU Nutech's Luminescence Laboratory), a well-established world leader in the area. It has unrivalled analytical facilities and is largely responsible for the three major technique developments of the last 15 years. As a result it has a very strong publication record, and is very much in demand from international visitors and users of the method.

Position education. DG has one BSc entry in Geoscience, and three MSc educations: Geology, Geophysics and Technical Geology (Civil Engineering). The number of enrolled BSc-students has varied significantly over the years, but seems recently to have stabilized around 50 BSc/year (Fig. 2).

According to the external panel for educational affairs DG has a unique and useful brand of candidates: The geology candidates are very well equipped in geophysics and quantitative methods, and the geophysicists (and less the technical geologists) have a broad geology background underlying their strong quantitative competences. Candidates are coveted by both industry and the public sector. Unemployment rates are low. Nevertheless, the MSc in Geology and Technical Geology have been dimensioned. The Geophysics MSc is however untouched, and this fact together with the demand for the candidates urge DG to expand into this area through strengthening of the geophysics education and targeting recruitment for the MSc program in geophysics nationally and internationally. This is further discussed below.

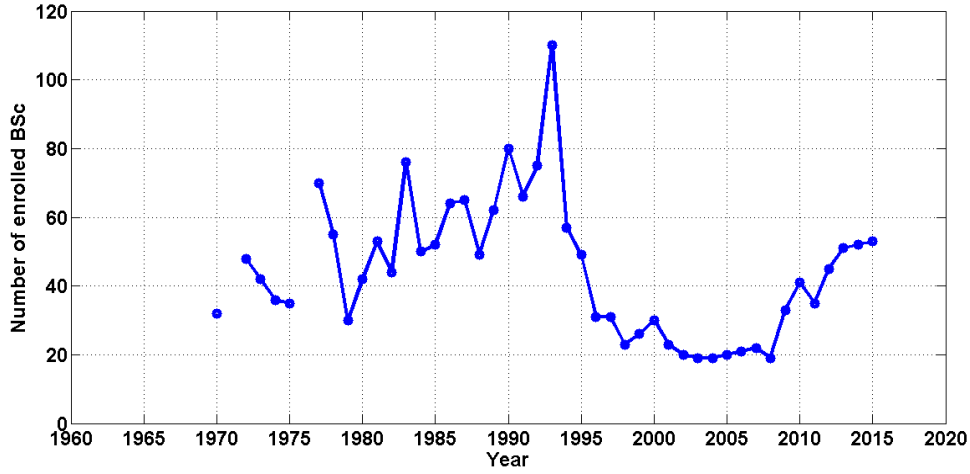


Fig 2. The number of enrolled BSc students over the years. Enrolment has been c. 50 for three years.

Position Talent. DG has an international environment for young talents of geosciences. PhD students and postdocs are recruited nationally and internationally with very close to equal gender distribution for PhDs and an overweight of males amongst postdocs. The international esteem of the PhD-education is very good. The PhD candidates compete successfully for postdoc positions at internationally esteemed institutions or are employed in private and public companies and organisations before or shortly after thesis defense. International recruitment of postdocs yields many well-qualified applicants. Figures F1 and F2 (App. F) show enrolled and produced PhDs and the postdoc population as a function of time.

Position Industrial collaboration. The areas Water and Energy & Natural Resources are responsible for the majority of industry collaborations. Water has a long history of significant, centre-size private and public funding. Energy & Natural Resources have had more sporadic funding mainly related to hydrocarbon exploration, mineral resources and geothermal energy; the latter area has had substantial funding in the 1970s, early 1980s and also recently.

Important and growing external cooperations

Individual researchers at DG has many and diverse external cooperations. The Hydrogeophysics Group and NLL at Risø alone can muster enough to fill several pages. Below are listed some long-standing cooperations of major importance at the departmental level and also for illustration some newer ones that testify to the development of the Department.

GEUS: There is a deep and longstanding tradition for cooperation between GEUS and DG at the individual researcher level (projects and shared laboratory facilities) and in teaching and supervision of MSc and PhD-

students. The section of GEUS located in Aarhus moves into the 8000 C campus in 2015. This section is specialized in hydrogeological research and geological modeling and will contribute significantly to the water environment of 8000 C. A further strengthening of the geo-environment at 8000 C occurs when parts of Marine Geology at GEUS (13 positions) also move into 1110 during the coming years. It is our intention to make the best of this strengthening of the geoscience environment in 8000 C.

Geocenter Danmark: DG is a member of Geocenter Danmark, a cooperation between the geo environments at De Nationale Geologiske Undersøgelser for Danmark og Grønland (GEUS), Institut for Geovidenskab og Naturforvaltning (IGN), Geologisk Museum ved Statens Naturhistoriske Museum (GM), samt Institut for Geoscience ved Aarhus Universitet (DG). Each year the Geocenter funds projects for more than 10 Mkr out of the portfolio that was created as a consequence of forming the Geocenter. DG only joined the Geocenter Danmark cooperation later. DG has no part in the seed money for the Geocenter Denmark cooperation, which is composed of saved rent following the resettlement of the Copenhagen geo-institutions under the same roof at Øster Voldgade 9. The bench fee for DG would be in the neighbourhood of 1.7 Mkr, a sum which it is impossible to free during the prevailing economically starved conditions. The funded projects are very important to the cooperation between the member institutions. The funding is used as seed money for initiatives which have the potential to draw larger funding from external sources.

Department of Physics and Astronomy: The Department of Geoscience and the Stellar Astrophysics Centre (SAC; DNRF Centre of Excellence) in the Department of Physics are expanding collaborations into a number of critical areas of Earth and planetary science. Among these are studies of the changes in solar radiation and their influence on Earth's climate. Key to these investigations are high-precision measurements of rare isotopes created by cosmogenic ray spallation, i.e. 14C and 10Be, in rocks, sediments and ice cores. Faculty in Geoscience are leading experts in this field and collaboration with stellar physicists at SAC is expected to strengthen further with the establishment of a research "node" in Geoscience during the second phase of DNFR funding of SAC. Geoscience has also recently initiated new collaborations with SAC researchers searching for exoplanets. Among the questions of mutual interests are the origin of life and its detection not only in our solar systems, but beyond. We are also mutually interested in the causes and consequences of plate tectonics operating on rocky planets and how one can detected such activity on extra-solar planets such as Kepler-10b? Researchers in Geoscience are and will continue to play a crucial role in this work to investigate our own planet's geological history, and working with our astrophysics colleagues to link these findings to the formation and evolution of exoplanets. An outstanding questions for all of us is – Is Earth's evolutionary path to a habitable world unique or the inevitable fate of any rocky planet orbiting as we do around our sun?

Collaborations with archaeologists in the School of Culture and Society is also vibrant and growing stronger. These are coming about because of DG's expertise in geomorphology, soil science, geochemistry and geophysics, and the growing importance of these fields in archaeological studies. The Danish Interdisciplinary Centre for Plasma Mass Spectrometry (DK-ICPMS) is playing a central role in these collaborations, providing powerful and unique analytical tools to characterize and trace archaeological materials. Presently, DG faculty are involved in the DNRF-funded Centre for Urban Network Evolutions (UrbNet) and AU-supported Climate, Culture and Catastrophe network (C3NET). Important to DG's educational and research mission is the new B.Sc. degree program in Geoarchaeology spearheaded by DG faculty as part of the AU-supported Science and Technology in Archaeological Research (STAR) network. STAR aims at initiating high profile applications to integrate new palynological, geochemical, geophysical

and dating methods in archaeological research. The combined AU expertise within such cooperation is unparalleled nationally and has major international potential. Finally, we see great potential in the fields of medical and forensic geology in collaboration with colleagues Health and Medical Science utilizing our expertise in petrology and geochemistry.

Geomicrobiology: Another area for synergy and growth in Geoscience that contributes to ST's overall research portfolio is in the area of geobiology. Geological and biological processes are inexorably linked and several of our faculty are fully engaged in research that bridges across these fields. One cannot study long-term climate change without understanding the role of biological processes in chemical weathering of rock formations, sequestration of greenhouse gases, and transport of toxins in surface and groundwater systems. The mass spectrometry facilities coming online in Geoscience will provide our faculty and students with new research opportunities in the field of geobiology. Moreover, we hope these efforts will forge even closer ties with the Center of Geomicrobiology (Bioscience) lead by Prof. Bo Baker Jørgensen in the coming years.

Alken Enge: Interpretation of the taphonomy of archaeological finds is strongly dependent on expertise in sedimentology

6 SWOT analysis

Strengths • Cutting edge research in specific areas • International faculty • Strong integration between numerical and observational approaches • Accredited geophysics MSc program • Extensive experience from Greenland and the Arctic • Research collaboration with private and public sectors • Excellent basic infrastructure (labs, offices, workshops etc.) • Excellent technical and administrative personnel • World-class research platforms within geochemistry and geophysics • Comprehensive and well-reputed international education / many international students • Excellent student environment • Good match between education and future job profiles • Member of Geocenter Danmark	**Weaknesses** • Diverse research profile • Marginal critical mass in some research groups • Too little internal collaboration • Too little external funding • Too few postdocs and PhD students • Research platforms challenged by funding rates • BSc applicants have heterogeneous skills • High drop-out rates (BSc studies)
Opportunities • Strengthen research profile through recruitments • Strengthen internal collaboration through recruitments • Strengthen multidisciplinary research • Outreach – increase interest in geoscience • Nurture the high-school course 'Geoscience A' • Increase number of BSc applicants • Increase volume in the geophysics MSc • Make geochemistry more visible • Global challenges within environment, water, energy and climate change • Closer cooperation with Engineering, Physics and Astronomy, Computer Science, Chemistry, Bioscience, Environmental Science, Agro ecology and Geomicrobiology	**Threats** • Dimensioning og Geology MSc • Only very few exchange students can be accepted into the Geology MSc program because of dimensioning. • Failure to achieve growth in research funding • Recruitment of students and staff is strongly competitive • New drop in student intake

Of particular significance we highlight:

- Strengths: the existence of some researchers/groups, which rank amongst the best world-wide within their areas and the excellent basic infra-structure
- Weaknesses: diverse research profile and too little internal cooperation
- Opportunities: recruitment of talent and increasing potential for interdisciplinarity. The global challenges are in principle gefundenes Fressen for Geoscience.
- Threats: dimensioning, inability to recruit talent and a new drop in student intake. Needless to say, DG is extremely aware of these factors.

7 Strategy 2016-2020

General

Belonging to the top 50 of geoscience departments worldwide and contributing to resolving threats to the immediate and deep future sustainability of life in the Earth system require high performance within relevant research and education. The climb up the ranking latter has gained momentum with the generation change, which allowed for recruitment of productive younger staff at the Assoc. Prof. level. However, every Department probably wants to climb so a successful landing in top 50 will require systematic work. This means, for example, recruitment of more mature and internationally reputed scientists with a well-established record at the Professor level. Here the different Centres of Excellence provide possibilities, and the strategy therefore is much concerned with the possibilities of successful CoE applications. In the process of carefully recruiting new staff members also the Assistant Professor segment must be considered. At present a new age-hump is emerging around 40+ reflecting successful recruitment of highly qualified Assoc. Profs. The age segment 30+ typical of Assist. Profs. is, however, absent in the staff.

A - Flagships

The flagships below **have high priority and can contribute to ST's profile**. The first three overlap with the present research areas of Section 5. The last one is an extract from in particular the Deep Earth Systems research area that demonstrably does appeal across disciplines.

- Climate & Environment: The extreme societal interest, the strength of individual researchers, technical staff, laboratory facilities, as well as the broad interest in this area across ST are an excellent background for growth in research and education in this area. Integrating the forces internally at DG to achieve the optimal research thrust and exploring potential synergy effects at the ST level will, in the context of a shared societal relevance, further improve opportunities to attract substantial external funding and produce internationally ground-breaking achievements. Realization of the growth potential requires strengthening of the climate/environment-related scientific staff at DG and identification of shared foci.

- Water Resources: The extreme societal interest, strong linkages to industry and stakeholders, the strength of the individual researchers, technical staff, and experimental facilities, and the broad interest in this area across ST are an excellent background for growth in research and education. The growth and expansion potential is huge. Strengthening the coupling between geophysical mapping, groundwater modelling/soil and water geochemistry can open an entirely new high-impact research area. Realization of the growth potential requires a strengthening of the scientific staff at DG with a view to avoiding complementing competences already existing at ST. This is in line with the strategy to increase the volume of the Geophysics MSc.

- Energy & Natural Resources (not water): Transformation of the energy supply from fossil to sustainable energy sources and technologies requires research and technical developments. DG's unique and strong research position in geothermal energy and its basis regarding geological energy storage (wind and solar energy etc. to heat) will be further developed through the involvement of more staff members, increased cooperation with other ST research groups, and by continued and increased external funding. Regarding fossil energy, the Danish Hydrocarbon Research and Technology Centre (DHRTC) presents a

10 years funding opportunity. DHRTC has set up a local focal point (secretariat) at AU. The cooperation with private oil and mineral exploration companies will be systematised. Education in the seismic method of subsurface imaging is essential. The above areas will be strengthened by the Mærsk Chair in Basin Analysis (externally funded), an Assist. Prof. in basin analysis, by the newly recruited assoc. prof. in sediment geology, and by the P-cable 3D seismic equipment.

- Physics and Chemistry of Earth Materials are the focus of many initiatives and programs within DG. Among them are the Niels Bohr Professorship in Geoscience, Centre of Earth System Petrology and new Danish Interdisciplinary Centre for Plasma Mass Spectrometry (DK-ICPMS). DK-ICPMS has brought to ST state-of-the-art mass spectrometry facilities enabling precise and accurate determination of trace metals and their isotopes in geological, archeological and biological materials. These facilities will be used by DG researchers to determine the elemental and isotopic composition of earth materials to establish their age and origin. The new ST synergy initiative in Materials at Extreme Conditions (MAT-X) also will have direct impacts in this area drawing ST geoscientists, material scientists and astrophysicists into closer collaboration on problems of planetary formation and evolution. DG's high pressure – temperature experimental laboratory is being re-established to support this new research initiative. Efforts are also underway to upgrade critical analytical instrumentation (i.e., electron microprobe) and to provide new ways to support and invest in our core laboratory facilities required for so much of DG's research activities – present and future.

B - Talent

The strategic goals, critical factors of success, measures, and initiatives are outlined in the strategy card in Appendix G.

It is the departments focus to develop an internationally competitive and challenging environment for the education of talented young scientists with interest in basic as well as applied geoscience research. The following strategic goals have been identified::

1. Increase the quality in PhD education and postdoctoral research.
2. Stimulate a vibrant research environment for young scientists.
3. Recruitment of the most talented PhD students and postdocs.
4. Increase focus on strategic research and the education of industrial PhD students and postdocs.
5. Guidance from PhD study to career.
6. Gender equality also at postdoc level.

C - Research

The strategic goals, critical factors of success, measures, and initiatives are outlined in the strategy card in Appendix G.

It is our strategic goal to rank among the elite of geoscience departments worldwide, also in respect to research. This high performance in research involves the three factors: productivity, impact, and excellence. The NTU ranking measures exactly this, and in the absence of more transparent bibliometric indicators we here formulate our performance goal based on this index. From Table 1 App. E it is apparent that some departments abroad with whom we share some foci (Oslo, Bergen, Stockholm) have a higher NTU ranking than DG. Other similar departments (Kiel, Lund, Uppsala, Melbourne AU) perform comparably to DG. Being disguised in a department with many other disciplines like forestry, geography, fishery etc., and with

the Geological Museum and The Niels Bohr Institute also contributing to the Geoscience subject at Copenhagen University, the particular contribution of KU Geoscience, with whom we are most comparable, remains obscure. Oslo, Bergen and Stockholm have different foci, but are relatively homogeneous departments. Considering the growth rates of WoS records and citations and not the least the increasing success with getting published in high-end journals, we believe that we can achieve a NTU-ranking better than 50 at the latest in 2020.

The strategic goal of excellence in research involves ensuring recruitment of talented researchers, increasing research funding, developing strategic partnerships, and pooling resources by increasing focus.

The following strategic goals have been identified:

1. Increase performance in research,
2. Strengthen interdisciplinary research
3. Increase visibility and leadership in national and international research
4. Strengthen the strategic research, and visibility in society
5. Strengthen research infrastructure
6. Improve gender balance

D - Education

The strategic goals, critical factors of success, measures, and initiatives are outlined in the strategy card in Appendix G.

Geoscience is applied natural science and intrinsically interdisciplinary, wherefore a broad, interdisciplinary bachelor education is required. The specialized MSc educations and PhD projects are closely integrated within the research environments.

It is a strategic focus to develop and highlight internationally competitive education programs that address global challenges of key societal relevance with specific emphasis on the *Environment, Climate, and Natural resources,* such as energy, minerals, and clean drinking water.

High performance in education involves being attractive to students, having a low dropout, producing employable candidates, i.e. candidates must be able to contribute critically to the competitiveness of private and public companies and organisations.

The tight coupling between geology and geophysics in DG's educations has been highlighted by the external panel for educational affairs as an asset that distinguishes DG from competing geoscience Departments at DTU and Copenhagen. It is a strategic focus of the Department to further develop this coupling.

The geophysics MSc program is not dimensioned and these candidates are in demand, wherefore expansion here is a strategic goal. This is realistic as DG, contrary to Copenhagen, has an accredited MSc program in geophysics. The geophysics education programs at DTU and the Niels Bohr Institute have a different focus (space, atmosphere, planets) with a relatively sparse geology curriculum.

Geochemistry (the chemistry and physics of earth materials) has always been inherently present in the geology BSc, MSc and PhD programmes. With the advent of the metal-free clean lab facility and the laboratory for cosmogenic isotope sample preparation and associated analytic facilities at IFA, the geochemistry weighting at DG increases strongly and move into another league. It is our strategy to use this momentum to enhance the difference between DG and competitors by adding a geochemistry flavour to some of the educational pathways.

Existing links to archaeology will be strengthened by the upcoming strong contribution of DG-researchers to the redesigned bachelor education in archaeology (the STAR cooperation), an important reinforcement of natural sciences awareness in interdisciplinary contexts.

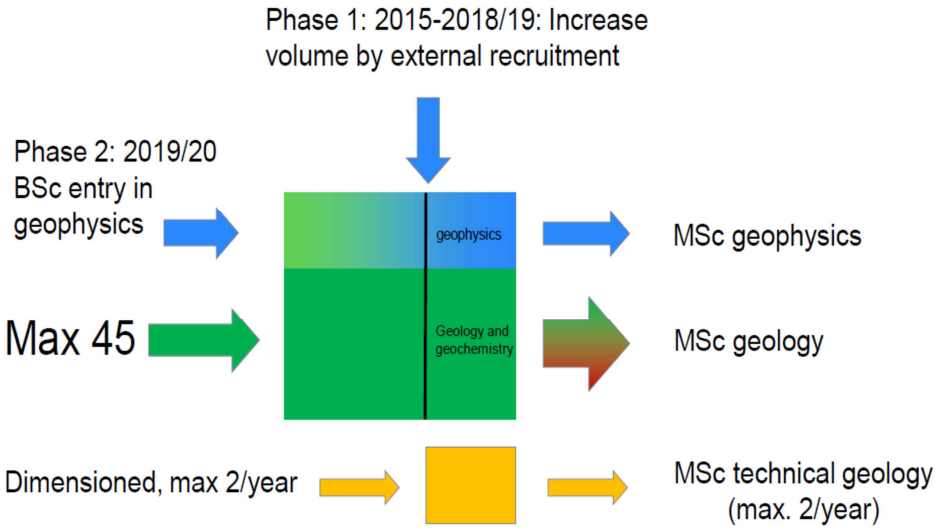


Figure 3. The main educational pathways of the Department and the time line of the strategic goal of increasing the volume of the MSc in Geophysics. The Geology MSc is at present dimensioned at 45 in 2020. Technical Geology receives engineers from AU and abroad, but is severely limited by dimensioning of the MSc enrolment.

The following strategic goals have been identified:

1. Enhance the coherence and progression of the education programs
2. Strengthen the integration of supporting disciplines at the BSc and MSc levels
3. Sharpening and increasing the awareness of the competence profiles of the candidates
4. Increase the volume of the geophysics MSc program and investigate the potential for opening a bi-lingual (Danish-English) BSc-entry in geophysics (possibly by 2019/20)
5. Further develop geochemistry in the geoscience education
6. Increase the number of applicants at the BSc level
7. Reduce drop-out/ensure that the unavoidable drop-out is as early as possible

E - Consultancy Services

DG performs only little public sector consulting, but is ready to increase the volume should this be desirable.

F - Industrial collaboration

The strategic goals, critical factors of success, measures, and initiatives are outlined in the strategy card in Appendix G.

Many of the research areas within the geosciences are naturally linked to vital areas in society. Examples of these are water, climate and environment, fossil and geothermal energy, and minerals. The former will normally be managed by governmental organisations while the latter are managed by industry. Approaching these two regimes are fundamentally different but the research goals are the same.

The overall strategy for DG is to focus on developing research partnerships with industry and by this apply to the numerous funding programs allocating funding for joint public/private research. These funds are extensive on both the national and the EU scale and they fit naturally within the DG research areas.

Development of joint proposals is done in two ways 1) yearly invitations to alumni to discuss their problems and needs with the DG faculty and 2) DG faculty learning to use their network to identify industry partners to make joint projects.

At DG the area of "Climate and Environment" traditionally has not worked systematically with public and private companies, but this can change in collaboration with other ST departments, for whom this has fallen more natural.

The strategy for "Water" will focus on international collaboration as the "home-market" is expected to shrink in the future due to the ending of the national groundwater mapping program.

The areas "Energy & Natural Resources" and "Deep Earth" are per definition international, although there are a few domestic players such as Mærsk Oil and Gas and Dong Energy that need to be approached further.

The following strategic goals have been identified:

1. Develop the extensive network of alumni employed in the public and private sector with a view to nursing existing and new industry collaborations.
2. Identify new areas where joint industry-academic research can be further advanced and create societal value.
3. Increase awareness of industry collaboration amongst the DG staff.
4. Implement "career awarding" measures for industrial collaboration

8 Action Plan

A - Action plans for Flagships

Implementation of the flagship goals will be supervised, coordinated and monitored by DG's steering committee, in close concert with the respective researchers.

The following actions have been identified:

1. Climate & Environment: Identify a societally relevant focus to which all DG staff members included in Climate & Environment can subscribe. Application for CoEs at first opportunity. Strengthen the climate-related part of the DG group. One resource in 2016 (see recruitment plan App. I).

2. Water: Identify synergy possibilities with other ST departments. Exploit new synergy created by housing of GEUS West and Bioscience on campus 8000 C. Further strengthen international collaboration and research. Strengthen the DG water group. Two resources (hydrogeophysics and hydrogeology), one in 2016 and one in 2017 (see recruitment plan App. I)

3. Energy & Natural Resources (not water): Recruit the Mærsk Chair in Basin Analysis (externally funded) and the Assist. Prof. in Basin Analysis. Outline plan for industry cooperation by making use of Scientific Coordinator. Produce project proposals for the DHRTC cooperation. Further develop cooperations within geothermal energy.

4. Physics and Chemistry of Earth Materials: Develop an economically sustainable organisation of the metal free clean facilities. Assimilation of the Niels Bohr Professorship in 2018 requires two ressources in 2018. Make sure new CoE is ready to take over when Niels Bohr Professorship terminates.

Action plans for Present Research Areas:

The present research areas of DG (Section 5) do not map 1-1 into the flagships of interest beyond geoscience. Therefore follows here the action plan for the present research areas not covered by the flagships.

Deep Earth: Ensure active participation in the national instrument pool "Danseis". Increase synergy within the Deep Earth group. Strengthen the geophysics part of the Deep Earth group by two resources, one in 2016 and one later (see recruitment plan App. I). This is in line with the strategy of increasing the volume of the Geophysics MSc programme and of preserving the important Geophysics MSc accreditation. This will pave the road for CoE initiatives emerging from the geophysics part of Deep Earth.

Geochronology: Outline a plan for creating a dating centre/centre of excellence within or related to geochronology. This includes defining the PI. The components of the CoE could comprise: 1) The laboratory for thermoluminescence dating at Risø, 2) the AMS facility at Physics and Astronomy, 3) The Cosmogenic nuclide laboratory at DG, 4) the ICPMS facility at DG. Application at first opportunity.

B - Talent

The general action plan is outlined in the strategy card in Appendix G.

Implementation of the goals for talent development described in section 7b will be supervised, coordinated and monitored by the Department's PhD Programme committee. Adjustments in the action plan will be possible through evaluation of feedback received from students, their supervisors, postdocs and other staff members. Concerning PhD studies the implementation will be coordinated with the Graduate School of Science and Technology (GSST) at AU. Concerning postdoc development this will be done in cooperation with the Department's Research committee. The following actions have been identified:

1. Develop new PhD courses, possibly in cooperation with other PhD schools and GSST. Work began in June 2015 and continues. First courses will be held in fall 2015. Holding international PhD courses will improve quality of the education and spotting of external talents (goals 1 and 3).
2. The quality of supervision will be secured by requiring that all permanent VIPs follow supervision course(s). Feedback on the supervision quality will be given to the supervisors from the PhD responsible officer and at MUS with the HoD. Data are collected from interviews with PhD-students and questionnaires (all anonymized) as well as from publication statistics for the PhD students (goal 1).
3. Supervisor will at an early stage help the PhD student to establish international contacts and stimulate cooperation with other students and staff. To further expose PhD-students and postdocs they are required to give internal and external seminars. Contributions to the geoscience seminar series and the yearly Geoscience Day will be mandatory (goal 2).
4. DG will seek to establish joint PhD programs with other high-rank geoscience PhD schools. This will improve spotting of talents from outside the department. Furthermore, the Department will work with GSST to ease the admission procedure to avoid loss of talented applicants to competing institutions (goal 3).
5. Attract external PhD and postdoc funding from new sources using the Scientific Coordinator. In this process, strengthen focus on strategic research (e.g. via annual departmental workshop on strategic research), and strengthen contact to industry (e.g. via alumni workshop) to better market the industrial PhD study (goals 3 and 4).
6. Urge GSST to make student and supervisor courses in career planning and mentoring for any type of research career. Supervisor will use this to mentor career planning for PhD students (and postdocs) (goals 5 and 6).
7. Improve gender balance for postdocs through guidance and the use of mentoring systems helping more female PhDs to stay in science. In accordance with DG's recruitment and gender strategy search committees must actively strive to also identify qualified potential female applicants for junior positions (goal 6).

C - Research

The general action plan is outlined in the strategy card in Appendix G.

Implementation of the research goals will be supervised, coordinated and monitored by DG's steering committee, in close concert with the Research Committee.

The following required actions have been identified:

1. Increase performance in research by focussing on productivity, impact, and excellence. DG monitors research publication and citations/H-index of each VIP and advise VIPs how to achieve goals. All VIP must be part (PI or co-applicant) of min. 1 application/year. VIP must actively seek international

collaborations which facilitate access to international (incl. Horizon2020) funding. The strong research leaders will be encouraged to lead, or participate in, applications for centres of excellence or similar large-scale funding. Hiring of new scientific staff will focus on the candidate's potential for strong research performance and ability to attract external funding.

2. Strengthen interdisciplinary research by encouraging increased collaboration with other departments at AU. Subject-focussed, interdisciplinary workshops at faculty or university level is an avenue which must be pursued. Funding possibilities must be investigated using ST Scientific Coordinators.
3. Increase visibility and leadership in national and international research. Encourage researchers to take an active part in large-scale international projects. The scientific staff must work actively on increasing visibility through participating in international meetings, signing up for international review panels, convene sessions at large international conferences and organise workshops etc.
4. Strengthen the strategic research and visibility in society by strengthening contact to stakeholders (governmental and industry). An annual departmental workshop on strategic research will have the purpose of exchange of knowledge and experience.
5. Strengthen research infrastructure by increasing departmental focus and by attracting the (external) funding of instruments and technical staff; specific areas of focus have been identified.
6. Improve gender balance through guidance and the use of mentoring systems helping more female early-stage researchers to stay in science. Search committees must actively strive to also identify qualified potential female applicants for positions.

D - Education

The general action plan is outlined in the strategy card in Appendix G.

Implementation of the education goals will be supervised, coordinated, and monitored by the Department's steering committee, in close concert with the Education Committee.

A number of actions will ensure meeting the general and more specific strategic goals. These comprise:

1. Implementation of educational paths ("Elephant tracks") by fall 2017. These tracks define coordinated pathways through the educational jungle. The working track titles are *Energy, Deep Earth, Water and Environment, Ice and climate*. Some tracks are weighted towards a geology, a geophysics, or a geochemistry flavour suited for the respective master programs. The goal is more efficient teaching, better coherence of progression, and sharpened competence profiles. The work has been in progress since fall 2014. This measure will work towards the strategic goals 1, 2, 3, 6, 7.
2. Increase the volume of the Geophysics MSc program and investigate the potential for opening a new BSc entry in geophysics, possibly by 2020 (goal 4). The action is twofold: i) Use the strategic recruitment funds of ST towards developing more systematic recruitment tools of students from targeted universities/regions in Europe and overseas. This may include entering a joint degree program with selected universities and establishing formal and durable contacts. ii) Adjust BSc program. Those MSc in Geology working with basin analysis acquire skills, which - for all practical purposes - make them geophysicists, particularly from an industry perspective. The overall goal of the actions is to increase the geophysicist volume and visibility sufficiently so that by 2020 it is realistic to open a new bi-lingual BSc entry in geophysics parallel to the BSc geoscience entry. This work starts immediately (August 2015). The bi-lingual aspect will require synchronous bi-lingual development of the general mathematics/physics/statistics/chemistry courses at ST. Deep geophysics recruitments will ensure that

the MSc geophysics accreditation prevails.

3. Already existing, strong recruitment efforts directed towards high schools continue and are further developed. The goal is 70 BSc applicants by 2020. With an imposed BSc dimensioning of 45, we can look forward to sorting students by qualifications. Investigating the possibility of making the BSc geoscience education bilingual (Danish & English) continues in cooperation with ST's pro-dean of education. This works toward goals 3, 6, 7.
4. A mentoring system involving permanent faculty members will be (has been) implemented in order to assist undergraduate students with any matters related to the course of their studies. Mentoring entails steady contact with the students, most frequently during the 1st study year, gradually reducing during the 2nd and 3rd year. Both group sessions and individual meetings are envisaged. Focus is on securing the best possible conditions for the students to succeed, or to advise upon a decision to change the area of study/education. Mentoring will reduce dropout rates and ensure that the unavoidable dropouts occur early (goal 6). Implemented from august 2015.
5. Educate the VIP-personnel in e-based learning activities through courses offered by the Centre for Science Education, AU. The VIP-staff will take part in a series of short training courses during 2015 and 2016 that focus on increasing the pedagogic standards and creating a learning environment that deepens the students' engagement in the learning process. This measure works towards most strategic goals.
6. A yearly alumni event will facilitate the contact between MSc students and different private and public companies and organisations. First event will take place in the fall of 2015. Goal 7.
7. Contribute (~30 ECTS) to the upcoming revised bachelor in archaeology. This initiative is seen as a strengthening of the ties to humanities and the fundament for future interdisciplinary research.

E - Consultancy Services

Our action plan is to contribute where it is relevant and possible. DG will participate in the relevant ST board.

F - Industrial collaboration

The general action plan is outlined in the strategy card in Appendix G.

Implementation of the industrial collaboration goals will be supervised, coordinated, and monitored by the Department's steering committee, in close concert with the Committee for Industrial cooperation.

The plan of action within industrial collaboration has several elements. However, the key element for success is the DG faculty and its ability to deal with innovative research and at the same time address the desires of the value driven industrial partners. The action plan therefore is as follows:

1. Educate the faculty to work with industry partners while maintaining their integrity as researchers. This is to a high degree a management task and it should be an element at every faculty meeting. The steering committee will also go into dialog with individual faculty members and help them exploit the possibilities.
2. Develop simpler and less bureaucratic procedures for establishing collaborations. This is a management task and need discussion in the research board and the steering committee. One key element is to use standard and simple contract templates and have simple rules for overhead.

3. Develop new industrial partnerships. Within water there are numerous partnerships and these can be used as examples for the other parts of DG. Increase collaboration with other ST departments and use them as icebreakers for new industry cooperation.
4. Nurture the network between industry and faculty by arranging a yearly workshop for alumni. DG wants to create a framework where industrial problems and research/innovation can meet DG researchers and develop new joint projects. First event is planned to take place in the fall 2015. If successful the workshop concept will be expanded to industry partners in general and not only alumni.
5. Monitor and identify research funding from various sources with focus on industry close research and innovation. These significant funds are spread out on a number of funding agencies. The DG Scientific Coordinator will have this as one of his working areas and he will work closely with DG faculty and management to follow potential funding possibilities and establish contact between industry and relevant faculty. Implemented immediately (August 2015).
6. Establish closer collaborations between industry and DG faculty to implement research into their production and customer service. Many of these industries do not monitor the research and innovation environments and they can potentially loose technologies that can create significant value. The personal networks initiated during workshops for alumni will be the driver for this task.

9. Appendices

A - Organisation

Committees	Charge
Steering committee	Provides advice and co-management in the context of the overall economy and development of DG at monthly meetings
Department Forum	The overall purpose of the forum is: • Ensure idea development quality, transparency and legitimacy in all decisions on academic issues • To ensure DG's academic and social identity and coherence • Head of Department must ensure participation on academic matters in the broad sense through continuous and timely involvement. Head of Department must therefore discuss major issues within research, talent development, knowledge exchange and education with the Department Forum • DG Forum can comment on all academic issues of significant importance to DG and has a duty to discuss academic issues, as Dean or Head of Department shall submit • Institute Forum has the right to speak to the Dean Four yearly meetings
Liaison committee	• Reporting about department economy • Expected and/or planned changes in staffing at the • Skills development projects envisaged launched across DG • Local management of employment within the inclusive labour market • Questions regarding the streamlining and/or changes relating to DG • Better use of resources in connection with the purchase/operation of equipment/instruments across the • Local implementation of personnel policy • Activities of both professional and social , including local rules and welfare schemes • Orientation points from HSU and FSU • Follow-up psychological work • Absence • Mutual information 4-6 yearly meetings
The occupational health and safety committee	The committee must handle occupational health and safety issues in the workplace and prevent new problems. Highlighted examples of different themes which will be given the most attention, depending on the circumstances: Psychological work environment, such as:

	• Preventing and alleviating stress • Promoting well-being • Bullying and harassment Physical work environment, such as: • Office layout • Impact from substances and materials Four yearly meetings
Research committee	Acts in an advisory capacity for the head of department as regards developing the departmental research strategy and in relation to research-related questions. • Discuss and advise on the formulation of major academic initiatives/project ideas. • Coordinate and advise on major research applications and external funding possibilities. • Discuss possible initiatives to strengthen external and internal collaboration. • Discuss recruitment plans and initiatives, and advise in connection with tenured appointments of scientific staff. • Discuss and advise on internationalisation initiatives, including initiatives in relation to strengthening the international impact and visibility of the research. • Help single researchers in application writing and research strategy. Monthly meeting
PhD programme committee	The committee discusses matters related to PhD studies at the departmental level and forward their recommendations to the Head of PhD School. PhD students are excluded from participating in any items on the agenda that pertain to personal issues, such as the evaluation of incoming applications. The academic staff members of the programme committees evaluate incoming applications and submit their recommendations to GSST. Programme committee members from the academic staff take part in qualifying examinations and thesis assessments
Committee for Industrial Collaboration	The aims and objectives are to significantly increase dialogue and collaboration with the private business sector. • Setting annual targets – in collaboration with the departmental management – for the extent and nature of business collaboration at DG or centre. • Regularly describing DG's or centre's positions of strength that are relevant to the business sector.

	• Providing access for enquiries from companies, the Dean's Office and the Faculty Secretariat regarding activities related to business collaboration. • Mapping and contributing to the initiation of collaboration with companies that can have an interest in DG's or centre's academic profile (both major companies and SMEs). • Providing management information to the Faculty Business Committee and the Faculty Management Team in connection with enquiries, including a brief annual report of the individual committee's work. Four yearly meetings
Education/studies administration committee	The committee shall advise the person responsible for education in developmental and practical aspects related to education and training and assist in the preparation of material for departments, study committees and advisory board, in the following areas: • development of courses, and professional and competence profile • pedagogical and didactic development of teaching • quality assurance and quality development of education and training • ensuring that education and training are conducted in line with the university's quality policy with the following specific tasks: • assist in the preparation of proposals for course descriptions and curricula • continuously evaluate course offerings, including the need for new training initiatives • establish courses offered three semesters forward • ensure that courses offered are composed so that for each student a coherent and scientifically relevant training is created that meets the requirements for progression and the desired competence profile • ensure the professional relationship between Bachelor's degree and Master's degree that naturally belong together • comment in credit and exemption cases • ensure that all teachers have the information about the course portfolio that is needed to achieve academic context and progression of the individual program • contribute to the quality of education and training, including the development of new teaching and testing methods • review teaching evaluations as they are published online, in order to propose concrete follow-up and general measures to strengthen education and training • assist in the follow-up study environmental studies • help ensure the program's social relevance, including through dialogue with the advisory board

	• comment on matters referred by the study board, department, or deanery
Daily management	Provides advice and co-management of the daily operations of DG at short, weekly meetings
Laboratory committee	Adhoc meetings when relevant topics are presented
IT committee	Adhoc meetings when relevant topics are presented
PR committee	Adhoc meetings when relevant topics are presented

B - Physical environment

DG is located at three separate addresses:

- Høegh- Guldbergs Gade 2, 8000 C, building 1670: the majority of staff is placed here, incl. administration, most laboratories, and workshops.
- HydroGeophysics Group (HGG): C.F. Møllers Alle 4, building 1120, 8000 Aarhus C. This address also holds its own electronic workshop.
- Nordic Laboratory for Luminescence Dating, DTU Nutech byg 201, Risø Campus, Frederiksborgvej 399, 4000 Roskilde

Being at three different addresses gives some challenges in connection with internal collaboration and development of a common culture

In addition the Department takes advantage of a number of field stations. Previously field stations in Mønsted, Klima and Rønbjerg were available; now only the field station at Rønbjerg remains and the Department is seeking new options for field-based courses.

The new AU research vessel *Aurora* is also a central element of two courses at the Department of Geoscience.

C - Staff composition (categories, age profile, etc.)

Source of finance	Professors	Associate professors	Assistant Professors	Scientific assistants	Postdocs	PhD students	Technical AC-TAP	Technical staff TAP	Administrative staff
Annuum	7	15					4	10	3 + 1 (HoD)
External	1 (Niels Bohr)		2	3	13	20	7	1	2

Table C1. number of employees in the various categories 2015

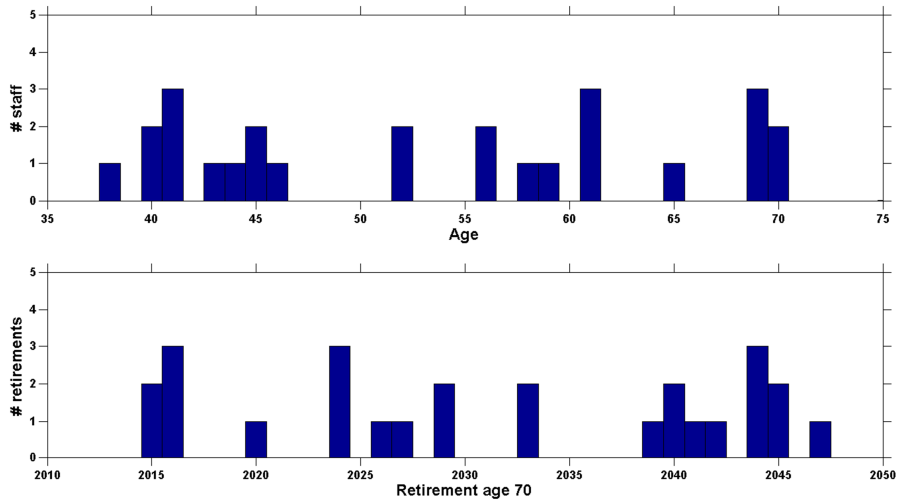


Figure C1. Age distribution of scientific staff 2015 –

D - Infrastructure

Overview of larger experimental facilities at the Department of Geoscience,					
Instrument	***Model***	***Use***	***Purchased***	***Responsible person***	***Location***
Microprobe	*JEOL JXA-8600 Superprobe*	Qualitative, semi-quantitative and quantitative analyses of major elements in minerals and other solids, incl. glass and cement (in situ).	Approximately 1980-1990, upgraded 2011	Thomas Ulrich, Christian Tegner, Thorsten Nagel	1674-141
X-ray fluorescence (XRF) core scanner	*Itrax, Cox Analytical Systems*	Qualitative detection of elements from Al to U in sediment cores, available x-ray tubes are Mo or Cr. X-ray and RGB images as well as magnetic susceptibility.	2012	Trine Ravn-Jonsen	1672-030
Powder X-ray diffractometer (XRD)	*Panalytical X'Pert Pro PW3050/60*	Identification of crystalline materials or clay minerals. Clay minerals (<2µm) are concentrated before measurement using a sedimentation process. Clay is analysed in 3 steps: Untreated, after ethylenglycol treatment and again after heating to 500°C.	2006	Trine Ravn-Jonsen	1674-141
Sedimentation cylinders and pipettes	*"Andreasen"*	Sedimentation analysis (Stoke's Law) of samples <0,063 mm. Used for particle sizing of very fine material or as the preparatory step for XRD analysis of clay minerals.	1970-1990	Charlotte Rasmussen	1672-034
Titrator	*Titralab, Radiometer auto burette ABU900, TIM900 titration manager*	Measurement of alkalinity.	1996	Bente Rasmussen	1674-138
CNS Analyzer	*Elementar Vario MAX CNS*	Measurements of carbon (TC and TIC/TOC), TN (Dumas combustion method) and TS.o	2012	Bente Rasmussen	1674-138
Spectrophotometer	*Perkin-Elmer lambda 1 UV-VIS*	Measurement of phosphate.	1983	Bente Rasmussen	1674-138
Laserdiffraction	*Sympatec HELOS: VIBRI/GRADIS module for (coarse) dry measurements and QUIXEL module for (fine) wet measurements*	Determination of particle size distribution using diffraction patterns from laserlight. Available lenses: R1 (0.18-35.0 µm), R4 (1.8-350.0 µm) and R7 (18.0-3500 µm). Quartz flow-cells for wet measurements: 2 and 6 mm. Limited number of classes (31).	1997	Bente Rasmussen	1674-132
Particle shape	*Sympatec Qicpic*	Particle size (0.02-20mm)	2013	Charlotte	1672-032

determination		and particle shape (0.06-20mm) by use of dynamic image analysing. Examples of parameters available for evaluation: Feret diameter, sphericity, aspect ratio, convexity, fibre length, fibre diameter and others. Unlimited number of classes.		Rasmussen	
Ring shear apparatus	*VILLA GEOTEKNIC*	Mechanical experiments with continuous deformation of unconsolidated (soft) sediments.	2001	Jan Piotrowski	1672-032
Sieving machines	*Pascall inclyno*	Used for separation purposes and to determine particle size for various experiments. Used with 20 cm or 8 inch sieves (Endecott); sizes normally 0,032-16mm. Brass or steel.	Ca. 1970-1980	Bente Rasmussen, Charlotte Rasmussen	1674-114, 1672-046
X-ray fluorescence (XRF)	*Philips PW 2400 spectrometer and PW 2510 sample changer*	Quantitative and semi-quantitative analyses of major and trace elements in rocks and sediments.	Ca. 1996	Andrew S. Murray	Risø
Temperature logging equipment		Winch, wire, probes.		(Bente Rasmussen, Trine Ravn-Jonsen)	1672-120
Thermal conductivity devices		Divided bar, needle probe.		(Bente Rasmussen, Trine Ravn-Jonsen)	1672-120
Rock preparation devices		Crunchers, grinding equipment, saws, Wilfley table etc.		Various people	1672-042, 1672-046, 1672-047
Hydrometric devices		Instruments for quantifying stream runoff.		Keld R. Rasmussen	1674
Shallow geophysical mapping		SkyTem and other electromagnetic devices.		Simon Ejlertsen	1120
Metal-free Cleanlab "class 100" (ISO class 5)	*Nu plasma*	Multicollector ICPMS.	2015	Rasmus Andraesen	1674
Seismic processing and interpretation lab				Egon Nørmark	1671
Electric workshop				Per Trinhammer	1674
Metal workshop				Per Trinhammer	1674
Micropalaeological sample preparation		HF-laboratory for pollen, foraminifers, coccoliths etc.		Kirsten Rosendal	1674-234
Cosmogenic isotope lab		Sample preparation for Be and Al determination, quartz separation etc.		Birte Eriksen	1674-238

Luminescence dating lab		Sample preparation, HF-lab (dark room), material dating.		Vicki Hansen	Risø

E - Benchmarking

Table E1. National Taiwan University (NTU) Ranking. Subject Geoscience. Measures research impact.

Geoscience	2011	2012	2013	2014
DTU	171	187	137	190
KU	37	51	53	37
DG Aarhus	124	138	88	72
Oslo	52	58	50	41
Bergen	45	50	48	45
Stockholm	35	32	33	32
Lund	93	77	77	65
Uppsala	156	137	142	142
Kiel	62	63	72	89
Bonn	163	155	134	136
Ruhr, Bochum	232	247	236	268
Cambridge, UK	11	12	17	12
Newcastle, UK	145	121	114	124
Melbourne, AU	77	69	69	69
UC, Davis, USA	51	52	52	57

From the NTU webpage (http://nturanking.lis.ntu.edu.tw/Default.aspx):

The NTU ranking system is designed to assess academic performance for research universities by using objective indicators to evaluate their achievements in scientific research. It ranking system evaluates the performance of scientific papers, and the indicators are designed to compare both the quality and the quantity of scientific papers in each university.

The ranking system evaluates and ranks the scientific paper performance of the top 500 universities worldwide. Three criteria represented by eight indicators are used to assess a university's overall scientific paper performance: *research productivity* (accounting for 25% of the score), *research impact* (35%), and *research excellence* (40%) (Table 1).

The emphasis on current research performance makes the NTU ranking system more objective than traditional indicators such as a university's reputation reflected by peer reviews, or the number of Nobel laureates affiliated with that university, which tend to favour universities with longer histories or universities in developed countries. The ranking system employs quantitative data extracted from Science Citation Index (SCI) and Social Sciences Citation Index (SSCI) to evaluate the scientific paper performances. Today, publishing in international academic journals has become the predominant mode of

scientific research output. Statistics on the articles published in international academic journals provide an objective representation of each university's research performance.

Table E2 The NTU Criteria and Indicators, and Their Respective Weightings, Used for the Overall Performance-Based Ranking in 2014.

Criteria	2014 Overall Performance Indicators	Weighting	
Research productivity	Number of articles in the last 11 years* (2003-2013)	10%	25%
	Number of articles in the current year (2013)	15%	
Research impact	Number of citations in the last 11 years* (2003-2013)	15%	35%
	Number of citations in the last 2 years (2012-2013)	10%	
	Average number of citations in the last 11 years* (2003-2013)	10%	
Research excellence	h-index of the last 2 years (2012-2013)	10%	40%
	Number of Highly Cited Papers* (2003-2013)	15%	
	Number of articles in the current year in high-impact journals (2012-2013)	15%	

Figure E1. Number of records per year in Web of Science. All peer review articles.

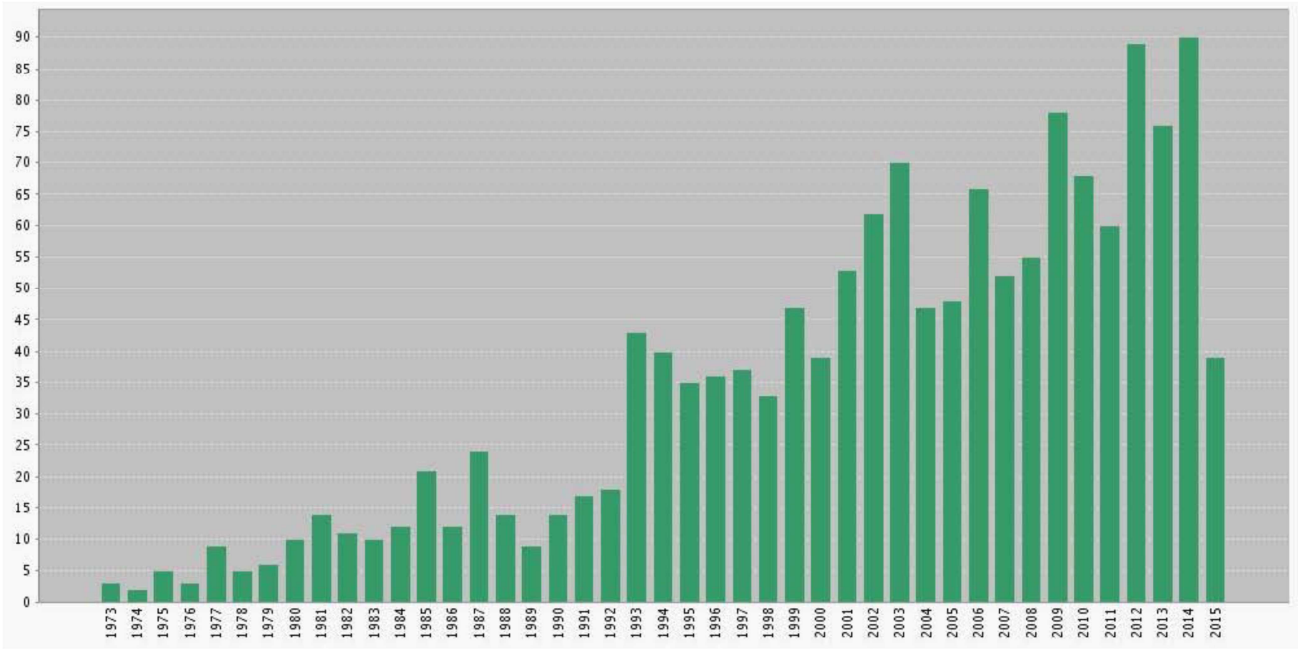


Figure E2. Number of citations per year in Web of Science. All peer review articles.

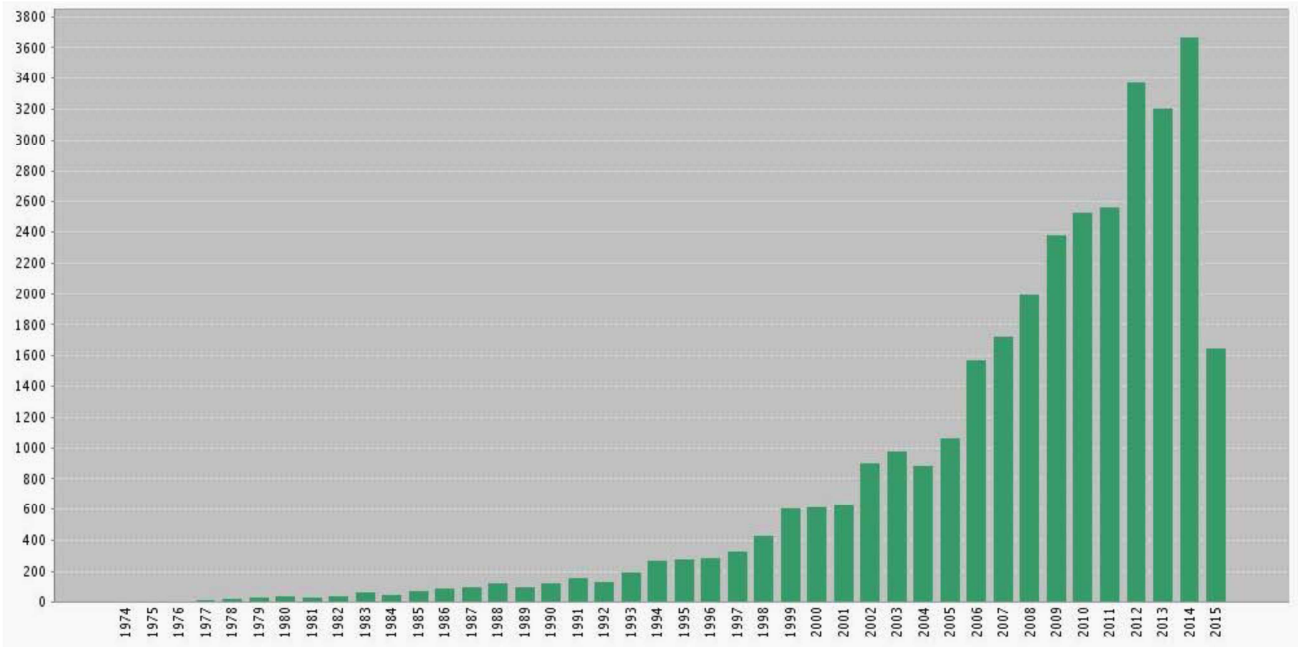


Figure E3. Number of high-end publications per year measured by WoS records. The publications comprise Nature, Nature Geoscience, Nature Climate Change, Nature Communications, Science, Geology, Geophysical Research Letters.

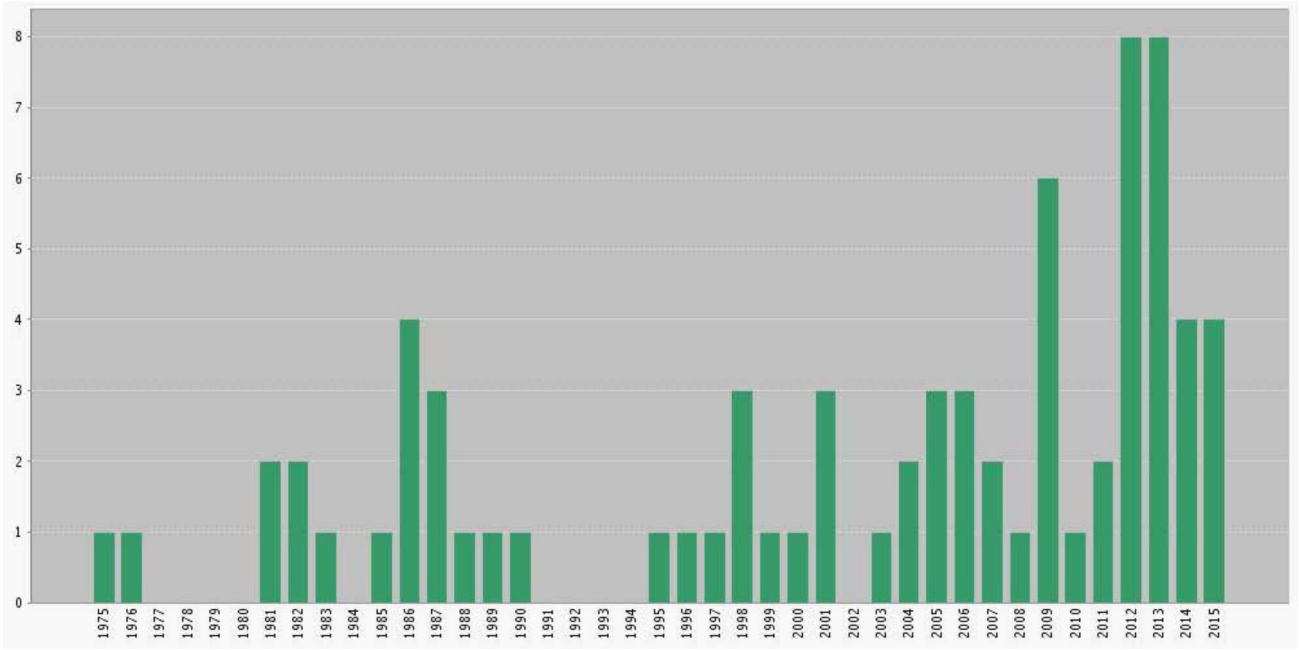
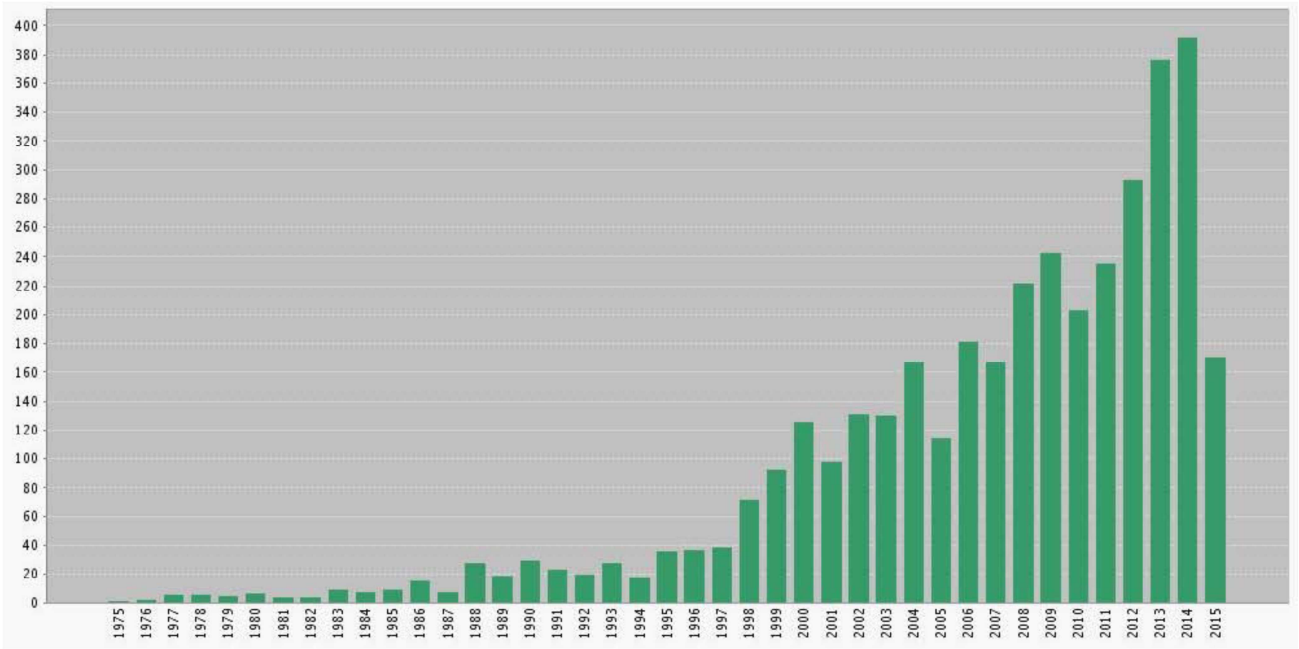


Figure E4. Citations of high end publications from WoS.



F - Department analysis

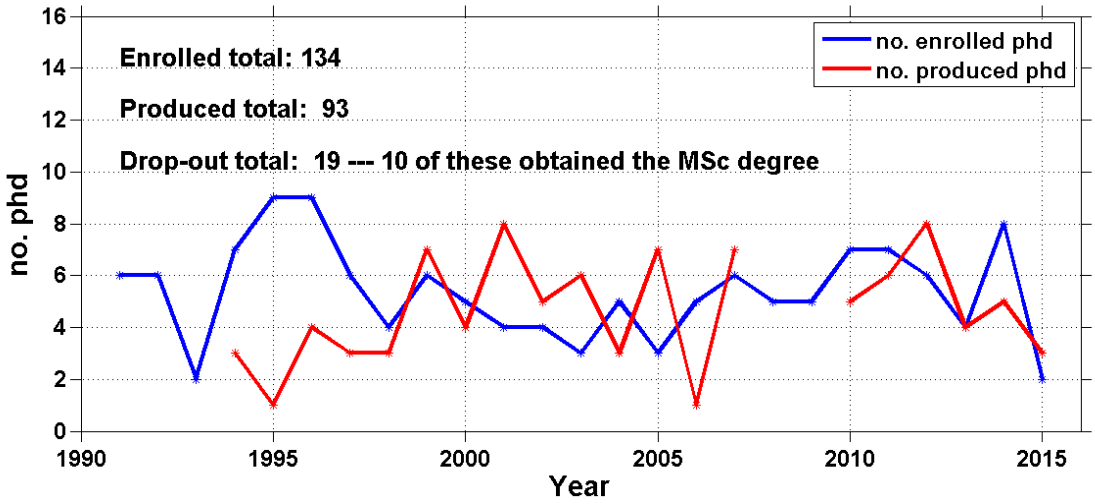


Figure F1. Number of enrolled and produces phd-students as a function of time.

The average enrolment is 5.6 phd/year and the average production is 4 phd/year. This corresponds to an average PhD-population of 20-25. If each of 20 staff at all times had 1 successful 4-year PhD-student, the yearly enrolment and production should equal 5 and the all-time PhD population should be 20.

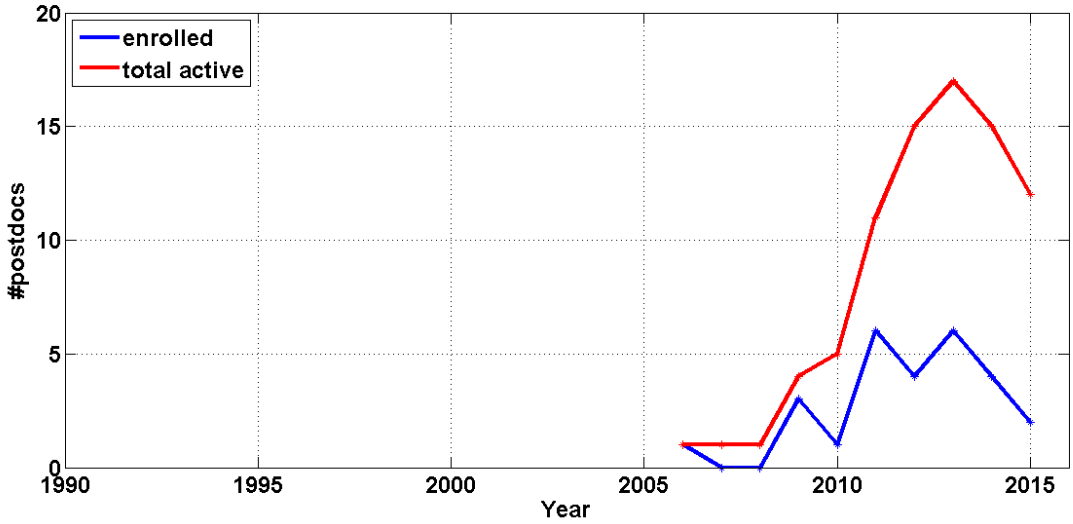


Figure F2. Population of postdocs as a function of time and yearly new enrolments. Year 2015 is incomplete.

G - Strategy cards: Department of Geoscience

Vision	To belong to the top 50 of Geoscience departments worldwide and to contribute to resolving global and national threats to the immediate and deep future sustainability of life in the Earth system.				
Mission	We perform basic and applied research, consultancy of governmental organizations and research-based teaching at the highest international level with a clear view to the demands of society. We collaborate with the best international researchers and research groups as well as rising academic environments, and with private and public companies and organizations. We are committed to recruiting and retaining the highest quality researchers and staff to work in a culture that supports diversity and equality at all stages of employment, from recruitment to retirement within a departmental atmosphere of ambition, mentoring and team spirit.				
Stakeholders	Society, private and public companies, students.				
Outcome areas	**Research**	**Talent development**	**Education**	**Public sector advice**	**Industrial collaboration**
Strategic focus areas	• Increase research performance in • Strengthen inter-disciplinary research • Increase visibility and leadership • Strengthen strategic research • Develop research infrastructure • Gender balance	• Quality in PhD education and postdoc research • Recruitment of talented PhD students and Postdocs • Guidance from a PhD to a settled career • Gender equality	• Society and the job market • Quality, flexibility, and efficiency of our educations • Applicants • Internationalization	• • •	• Faculty and management awareness of industrial collaboration among faculty • Innovation, cooperation, and knowledge exchange with companies and public institutions
Strategic requirements	Excellence in research, teaching, innovation, networking and communication				
Values	freedom with responsibility, a departmental culture of diversity and equality at all stages of employment, mentoring				

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Research				
Increase research performance	Increase the impact of national and international research publications	Increase the number of research publications (on average, per VIP) in international, peer-reviewed journals	Increase DG's average publication rate by 25% within 5 year	2016: Analyse bibliometric data 2017: Analyse bibliometric data 2018: Analyse bibliometric data 2019: Analyse bibliometric data 2020: Analyse bibliometric data
			Each VIP should publish on average (lead or co-author) at least 3.8 publications/yr averaged over 5 years.	2016: Discuss publication strategies 2017: Discuss publication strategies 2018: Discuss publication strategies 2019: Discuss publication strategies 2020: Discuss publication strategies
		Increase H-index and citations of staff members	Increase H-index by 2.5 per 5 year for each VIP	2016: Publish in cross-disciplinary high-impact journals 2017: Publish in cross-disciplinary high-impact journals 2018: Publish in cross-disciplinary high-impact journals 2019: Publish in cross-disciplinary high-impact journals 2020: Publish in cross-disciplinary high-impact journals
	Increase the number of externally funded projects	Increase the number of competitive research applications.	Increase number of successful research applications by 30% within 5 years	2016: Analyze application statistics 2017: Analyze application statistics 2018: Analyze application statistics 2019: Analyze application statistics

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Research				
				2020: Analyze application statistics All VIP without external funding (PI or co-PI) must be part of min. 1 application/year
		Attract international funding	Attract min 2 Horizon 2020, ERC or other large national/international grant (individual or consortium) within 5 years	2016: Submit at least one international (or national) individual/consortium) grant/year on average 2017: Submit at least one international (or national) individual/consortium) grant/year on average 2018: Submit at least one international (or national) individual/consortium) grant/year on average 2019: Submit at least one international (or national) individual/consortium) grant/year on average 2020: Submit at least one international (or national) individual/consortium) grant/year on average
	Establish a DG centre or excellence or similar	Submit at least one international (or national) individual/consortium) grant/year on average	Submit at least two centre applications per cycle	2016: Encourage applications 2017: Encourage applications 2018: Encourage applications 2019: Encourage applications 2020: Encourage applications Identify and strengthen existing strong groups/leaders, e.g. through professorships Attract new strong VIP who can build up strong groups

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Research				
	Establish new strong pilot centres	Prioritize and strengthen research sectors/areas around specific, chosen themes	Apply for at least two new pilot-type projects per year (averaged). Top 50 NTU ranking by 2020	2016: Encourage applications 2017: Encourage applications 2018: Encourage applications 2019: Encourage applications 2020: Encourage applications Interdepartmental brainstorm meetings on new research initiatives
Strengthen the interdisciplinary research	Further increase collaboration with other disciplines	Publish more papers with researchers from other departments and research areas	Increase the number of publications with more than one area by 30% within 5 years	2016: Encourage interdisciplinarity 2017: Encourage interdisciplinarity 2018: Encourage interdisciplinarity 2019: Encourage interdisciplinarity 2020: Encourage interdisciplinarity Organize meetings/workshops with potential collaborators Seed money from department/ faculty for collaboration
Increase visibility and leadership in national and international research	Lead or participate as partner in international (e.g. EU) projects	Strengthen the international profiles of research leaders	Obtain invitations to give key-note presentations	2016: Promote staff actively 2017: Promote staff actively 2018: Promote staff actively 2019: Promote staff actively 2020: Promote staff actively Active promotion of colleagues for international awards

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Research				
				e.g. AGU fellow, various medals etc.
			Obtain invitation to be co- or lead author of major international review papers	2016: Promote staff actively 2017: Promote staff actively 2018: Promote staff actively 2019: Promote staff actively 2020: Promote staff actively Participate in organising international conferences
Strengthen the strategic research	Establish internationally-renowned research infrastructure	Increase visibility to society and industry	Increase the number of strategic projects by 30% within 5 years.	2016: Industrial collaboration committee 2017: Industrial collaboration committee 2018: Industrial collaboration committee 2019: Industrial collaboration committee 2020: Industrial collaboration committee Establish new contacts to industry and government organisations
		Identify possible stakeholders		2016: Networking and alumni 2017: Networking and alumni 2018: Networking and alumni 2019: Networking and alumni

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Research				
				2020: Networking and alumni Give presentations at end-user conferences
Develop research infrastructure	Establish internationally-renowned research infrastructure	Develop existing laboratories and other facilities	Efficient laboratory facilities	2016: Ensure funding and relevant upgrading of staff 2017: Ensure funding and relevant upgrading of staff 2018: Ensure funding and relevant upgrading of staff 2019: Ensure funding and relevant upgrading of staff 2020: Ensure funding and relevant upgrading of staff Long-term plan for further external funding of laboratory facilities and staff
				2016: Continued focus on infrastructure 2017: Continued focus on infrastructure 2018: Continued focus on infrastructure 2019: Continued focus on infrastructure 2020: Continued focus on infrastructure
		Use departmental infrastructure in national and international research projects	Increase the number of papers based on AU/departmental infrastructure by 30%	2016: Necessary and sufficient technical assistance 2017: Necessary and sufficient technical assistance 2018: Necessary and sufficient technical assistance 2019: Necessary and sufficient technical assistance 2020: Necessary and sufficient technical assistance

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Research				
Gender balance	Increase the number of female permanent VIP	Everything else being equal DG must choose a female scientific staff member	Growing number of female postdocs and permanent scientific staff.	2016: Active use of mentoring 2017: Active use of mentoring 2018: Active use of mentoring 2019: Active use of mentoring 2020: Active use of mentoring
				2016: Use search committees 2017: Use search committees 2018: Use search committees 2019: Use search committees 2020: Use search committees
				2016: Engage “Talent” groups 2017: Engage “Talent” groups 2018: Engage “Talent” groups 2019: Engage “Talent” groups 2020: Engage “Talent” groups

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Talent development				
Quality in PhD education and postdoc research	High-quality PhD education	PhD projects must be of high quality.	Min. 3 articles published in journals with IF > 2 per PhD. The articles should be published within 2 years after the defense.	2016: Analyze PhD bibliometrics 2017: Analyze PhD bibliometrics 2018: Analyze PhD bibliometrics 2019: Analyze PhD bibliometrics 2020: Analyze PhD bibliometrics Supervisors report publication statistics for the PhD student to the head of the PhD Programme. Anonymized results will be reported regularly.
		Broad spectrum of scientific PhD courses must be available.	Geoscience offers 2-4 PhD courses per year (possibly together with other PhD schools).	2016: Arrange PhD courses 2017: Arrange PhD courses 2018: Arrange PhD courses 2019: Arrange PhD courses 2020: Arrange PhD courses New courses will be developed. Work began in June 2015 and continues. First courses will be held in fall 2015. The PhD Programme Committee will be flexible in acceptance of individually designed courses.
		Supervision must be of high quality.	All supervisors attend supervisor courses as son as possible.	2016: Supervisors attend PhD supervisor course 2017: Supervisors attend PhD supervisor course 2018: Supervisors attend PhD supervisor course

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Talent development				
				2019: Supervisors attend PhD supervisor course 2020: Supervisors attend PhD supervisor course Permanent VIPs will follow supervision course(s) at AU or elsewhere. Anonymized data will be collected from PhD students to monitor quality in supervision.
		Exposure to broad teaching experiences.	During part B all PhD students must teach exercises, labs and field courses.	2016: PhD-students teach 2017: PhD-students teach 2018: PhD-students teach 2019: PhD-students teach 2020: PhD-students teach PhD students are offered teaching at both basic and master level.
	Create and stimulate a vibrant research environment for young scientists	Knowledge exchange among students, senior staff and international scientists.		2016: Mentoring of PhD-students 2017: Mentoring of PhD-students 2018: Mentoring of PhD-students 2019: Mentoring of PhD-students 2020: Mentoring of PhD-students Supervisor will at an early stage help to establish international contacts and stimulate collaboration among

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Talent development				
				Geoscience PhD students (and staff). This will be monitored via the annual MUS with the PhD student.
		Improving visibility of PhD and postdoc project research.	All students must present their research at least twice annually, externally and internally.	2016: Presentations at Geoscience Day/seminars 2017: Presentations at Geoscience Day/seminars 2018: Presentations at Geoscience Day/seminars 2019: Presentations at Geoscience Day/seminars 2020: Presentations at Geoscience Day/seminars Supervisor will stimulate student to present scientific work, e.g. by facilitating their students (post docs) to visit universities/groups in the supervisor's network where they present their work. This would probably also increase the number of external postdocs coming to DG to present their work. This will be monitored via the annual MUS with the PhD student.
Recruitment of talented PhD students and Postdocs	Increase the number of best qualified PhDs and postdocs	Financing	External funding must be attracted to support at least 1 PhD per VIP, 0.3 postdoc per VIP. This goal should be reached within the strategic period (2016-2020).	2016: Obtain funding for PhD projects 2017: Obtain funding for PhD projects 2018: Obtain funding for PhD projects 2019: Obtain funding for PhD projects 2020: Obtain funding for PhD projects Attract external PhD and postdoc funding from new

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Talent development				
				sources using the Scientific Coordinator. Work will begin immediately. Work with GSST toward making PhD positions more attractive than postdocs for prospective supervisors.
		Talents must be spotted at an early stage of education to increase the number of best-qualified applicants.	All project holders must proactively seek talents.	2016: Contact relevant Geoscience PhD schools 2017: Contact relevant Geoscience PhD schools 2018: Contact relevant Geoscience PhD schools 2019: Contact relevant Geoscience PhD schools 2020: Contact relevant Geoscience PhD schools Establish joint PhD programs with other high-rank geoscience PhD schools. Invite post docs from the network to come and present their work at IG.
		Admission procedure must be flexible and fast.		2016: Review admission procedure 2017: Review admission procedure 2018: Review admission procedure 2019: Review admission procedure 2020: Review admission procedure Work with GSST to decentralize procedures for admission and co-financing (to reduce risk that best qualified candidate accepts other offer).

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Talent development				
	Increase the number of industrial PhD students	Better marketing of the industrial PhD study	Identify companies that will collaborate on this	2016: Contact potential companies 2017: Contact potential companies 2018: Contact potential companies 2019: Contact potential companies 2020: Contact potential companies Market the study at the annual alumni workshop. Work with GSST to develop and implement marketing strategy.
	Increase the number of industrial PhD students	Strengthened focus on applied research	One proposal per year in applied research	2016: Workshop and active search 2017: Workshop and active search 2018: Workshop and active search 2019: Workshop and active search 2020: Workshop and active search Attract external PhD and postdoc funding from new sources using the Scientific Coordinator. Annual departmental workshop on strategic research (together with "Research" and "Industrial cooperation").
		Qualified guidance for any type of career (academia,	90% of PhDs and postdocs obtain tenures within 5 years of completing their programme or employment	2016: Mentoring of PhD-students 2017: Mentoring of PhD-students 2018: Mentoring of PhD-students

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Talent development				
		industry, or state agency).	outside academia.	2019: Mentoring of PhD-students 2020: Mentoring of PhD-students Urge GSST to make student and supervisor courses in career planning and mentoring for any type of research career.
Guidance from a PhD to a settled career	Strengthen guidance of PhD students and Postdocs toward professional careers	More female PhDs must be encouraged to continue as postdoc.		2016: Mentoring of PhD-students 2017: Mentoring of PhD-students 2018: Mentoring of PhD-students 2019: Mentoring of PhD-students 2020: Mentoring of PhD-students Active use of mentoring for female PhD students.
Gender equality	Increase the number of female postdocs.	Qualified female postdocs must be attracted.		2016: Use of search committees 2017: Use of search committees 2018: Use of search committees 2019: Use of search committees 2020: Use of search committees Search committees must actively strive to also identify qualified female applicants for young scientist positions. This will be monitored by the HoD.

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Education				
Society and the job market	Sharpened, and increased awareness of, the competence profiles of the candidates	Employer awareness of 8. contents of educations 9. our new candidates Student engagement in personal profiling and alumni activities.	# alumni participating at annual meeting. # last-year MSc/PhD students taking part in the alumni day. # candidates in job after 6, 12 and 18 months.	2016: Geoscience Alumni Day 2017: Geoscience Alumni Day 2018: Geoscience Alumni Day 2019: Geoscience Alumni Day 2020: Geoscience Alumni Day The “elephant track” model is profiled externally - as details settle 2015-17. Annual alumni day.
Quality, flexibility, and efficiency of our educations	Enhanced coherence and progression of the education programs Strengthened integration of supporting disciplines at the BSc and MSc levels Reduced drop-out, ensuring that	Didactic coupling of core courses and supporting courses. Student awareness of this coupling First-year-student awareness of required skills	# VIP participating in CSE-course # hours of VIP 1. teaching effort 2. mentoring effort Progress parameters relating to elephant tracks, to be defined #students participating in mentoring	2016: Cooperate with ST Learning Lab 2017: Cooperate with ST Learning Lab 2018: Cooperate with ST Learning Lab 2019: Cooperate with ST Learning Lab 2020: Cooperate with ST Learning Lab Two CSE courses (~half of VIP staff each) on e-learning. “Supporting course in focus” (Calculus, physics, …); Course teacher meets with 5-10 geoscience-VIP, 1-3 hours. Mentoring program, pilot project fall 2015, involving

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Education				
	unavoidable drop-out is as early as possible.	and study efforts. Elephant Track model develops 1. Clear profiles 2. Good didactic integration Tractable VIP load	Student feedback on mentoring Drop-out statistics # drop-outs providing farewell-feedback	external consultation on best practice etc. and internal evaluations. Careful design and exposure of the "elephant track" model
Applicants	BSc: 1. Increased number of applicants. 2. Clarification of feasibility regarding opening of BSc in geophysics. MSc: Increased enrolment in the geophysics program.	Awareness and appreciation of geo-educations among potential applicants. Stationary or relaxed "dimensioning".	# applicants at Geology BSc and Geophysics MSc Qualification profile of applicants Statistics on outreach to high schools and media.	2016: Market educations 2017: Market educations 2018: Market educations 2019: Market educations 2020: Market educations The "elephant track" model is profiled externally - as details settle 2015-17. Establishing of an "Outreach advisory board" of high school teachers, skyping 4 times per year.
International-	Attracting many	International	# foreign student applicants	2016: Market Geophysics MSc

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Education				
ization	well-qualified foreign full-degree geophysics students. Clarification of feasibility regarding bi-lingual BSc-entries (Danish-English)	applicants' awareness and appreciation of the MSc geophysics program. Bi-lingual versions of suitable supporting courses.	#qualified/#non-qualified foreign applicants. # ECTS earned abroad by Danish students. # ECTS earned at DG by foreign students.	2017: Market Geophysics MSc 2018: Market Geophysics MSc 2019: Market Geophysics MSc 2020: Market Geophysics MSc. International accreditation. Long-term development of international recruitment, via best-practice development at AU. Long-term work on possible bi-lingual BSc entries in synergy with similar efforts at ST.

Focus areas	Strategic goals	Critical success factor	Goals	Initiative 2016-2020
Industrial collaboration				
Faculty and management awareness of industrial collaboration among faculty	Make industrial collaboration an integrated mechanism in the research and development and development process	Identify funding bodies (national and international) that include industry participation	DG should submit 5-10 applications in the next 5 years with industry partnership included	2016: Organization of possible collaborators. Workshop. 2017: Organization of possible collaborators. Workshop. 2018: Organization of possible collaborators. Workshop. 2019: Organization of possible collaborators. Workshop. 2020: Organization of possible collaborators. Workshop. Compilation of relevant application calls where industry partnership is required (scientific coordinator) Create a database of existing industry collaborations at DG to be used as a starting point for new collaborations
	Simplify the bureaucratic process when establishing industry related projects	A defined set of rates for DG services and laboratory costs	Standard and simple contracts for industrial collaboration in place by mid 2016	2016: Development of standard contracts 2017: Development of standard contracts 2018: Development of standard contracts 2019: Development of standard contracts 2020: Development of standard contracts With help of relevant support from e.g. TTO produce a template for contracts that is applicable (with minor changes) to various kinds of collaborations.

Innovation, cooperation and knowledge exchange with companies and public institutions	Outreach to the private sector	'Think out of the box' to potentially make aspects of 'basic' research to more applied research		2016: The committee of industry collaboration/relevant VIPs/scientific coordinator attend relevant conferences 2017: Same 2018: Same 2019: Same 2020: Same Attend a more industry-related conference
		Become aware of current challenges in different industries	3 visits per year by different major industries	2016: The committee of industry collaboration/relevant VIPs/scientific coordinator visit/invite relevant partners 2017: Same 2018: Same 2019: Same 2020: Same Invite/visit representatives from potential collaboration partners
		Actively showcase/promote DG's expertise		2016: Presentations at the Alumni Day 2017: Presentations at the Alumni Day 2018: Presentations at the Alumni Day 2019: Presentations at the Alumni Day 2020: Presentations at the Alumni Day
				2016: Promote DG nationally and internationally 2017: Promote DG nationally and internationally 2018: Promote DG nationally and internationally

				2019: Promote DG nationally and internationally 2020: Promote DG nationally and internationally Again the committee for industrial cooperation is the prime responsible for the initiatives
		Find out what the industry partners of other departments are, including DTI/DTU	Have at least 3 potential partner from 'non-traditional' geo-industries identified and approached	2016: The committee for Industrial cooperation 2017: The committee for Industrial cooperation 2018: The committee for Industrial cooperation 2019: The committee for Industrial cooperation 2020: The committee for Industrial cooperation Make this an agenda on one of the ST Industrial collaborations committee meetings
				2016: ST industry collaboration committee is active 2017: ST industry collaboration committee is active 2018: ST industry collaboration committee is active 2019: ST industry collaboration committee is active 2020: ST industry collaboration committee is active Compilation of active industry partners at faculty-wide level (ST industry collaboration committee)
	Create and maintain a network between faculty and alumni from the private and public sector	Identify alumni with jobs in sectors that could become project partners	Aim for an annual meeting with alumni from a broad area of industry/public sectors	2016: Alumni Day match making 2017: Alumni Day match making 2018: Alumni Day match making 2019: Alumni Day match making 2020: Alumni Day match making Organisation of alumni day and workshops where

		Active participation by faculty staff during alumni day		different industry topics will be discussed to find a match with research at DG Create a database on alumni and their job relations Keep active contact and inform alumni about DG (research) activities via e,g, Linkedin. Invite alumni to have an active role in student education by presenting lectures from the ‘business world’

H - KPI for Department of Geoscience for the period 2016 – 2020

The KPIs indicated below are agreed for the Department of Geoscience

Definitions: - VIP (academic staff) covers permanent VIP such as professor, professor with special responsibilities (MSO), associate professor, senior researcher, and senior adviser estimated in full-time equivalent (FTE) per year.
- *-marked KPIs are commonly agreed on by all the departments of Science and Technology

VIP FTE: 2013: 24,5
2014: 24
2015: 21
2016: 22
2017: 24
2018: 26
2019: 26
2020: 26

Objective	KPI	KPI goal (incl. % change p.a.)	KPI result	KPI objective
***1. Financing:** *Increased attraction of external funding*	Spending on external funding per VIP FTE	**2016: 37.799/22 = 1,72 mio.kr./VIP** **2017: 39.017/24 = 1,63 mio.kr./VIP** **2018: 40.817/26 = 1,57 mio.kr./VIP** **2019: 44.515/26 = 1,71 mio.kr./VIP** **2020: 46.000/26 = 1,77 mio.kr./VIP**	**KPI-basis: 1,40 mio.kr.** **2013: 1,348** **2014: 1,35 (32,446 mio.kr)** **2015 (FC3): 1,83 (38,377 mio.kr)**	External funds to cover fixed costs should be increased significantly. The calculation assumes that 20% of the increased sales are sent to ST and the rest is used for covering fixed costs. Number of researchers = 20.
***2. Publications:**	Number of peer reviewed	**2016: 5.60 Publications/VIP**	**KPI-basis: 2,90**	It is desirable that the volume of research in terms

Increased number of publications	publications per VIP FTE	**2017: 5.70 Publications/VIP** **2018: 5.80 Publications/VIP** **2019: 5.90 Publications/VIP** **2020: 6.00 Publications/VIP**	**2013: 2,90** **2014:5.58 (134 publications)** **2015: 5.45 (c. 120 publications)**	of number of publications increases. Only peer- reviewed publications are counted. No abstracts.
***3. Talent mass:** *Increased number of talents*	Number of talents (PhD, postdoc, assistant professor, researcher incl. tenure track and other VIP) measured in VIP FTE	**2016: 1.60 Talents/VIP** **2017: 1.70 Talents/VIP** **2018: 1.80 Talents/VIP** **2019: 1.90 Talents/VIP** **2020: 2.00 Talents/VIP**	**KPI-basis: 1.20** **2013: 1.20** **2014: 1.38 (33 talents)** **2015 (FC3): 1.67 (35 talents)**	It is desirable that more researchers are capable of supporting PhDs and postdocs. The increase corresponds to an increase in the population of 2 PhD/postdoc per year
EITHER ***4. a Education:** *Increased number of completed graduates*	Number of graduates from Bachelor of Engineering, Bachelor's and Master's degree programmes, and professional Master's degree programme measured as completed per 1 October each year per VIP FTE	**2016: 62 (2,82 grads/VIP)** **2017: 63 (2,63)** **2018: 65 (2,50)** **2019: 70 (2,69)** **2020: 70 (2,69)**	**KPI-basis: 1,41** **2013: 1,41 grads/VIP** **2014: 27 graduates (1,13 grads/VIP)** **2015(FC3): 39 graduates (1,86 grads/VIP)**	The numbers give the sum of BSc and MSc per year. MSc production is estimated from a regression of #MSc on the number admitted with six years' delay. BSc is the number admitted minus 25 % which is assumed to be dropouts.
***5. External**	Number of	**2016: 5.04**	**KPI-basis: 2,32**	Estimated 80 % of

collaboration: *Increased number of external collaborators on publications*	publications with external co-authors (= not employed by AU) on peer reviewed publications registered in PURE per VIP FTE C. 90% of publications are with external coauthors	**Publications/VIP** **2017: 5.13 Publications/VIP** **2018: 5.22 Publications/VIP** **2019: 5.31 Publications/VIP** **2020: 5.40 Publications/VIP**	**2013: 3,96** **2014: 4.88 (117 publications)** **2015: 4,90**	peer -reviewed publications are with external co-authors. This is already a high proportion. The increase is due to the increase in number of publications.
Department KPI 1 **6. Impact of publikations**	Number of average citations of all published papers	**2016: 18,0** **2017: 20,0** **2018: 22,0** **2019: 24,0** **2020: 26,0**	Total number of citations/published paper Found to be 16.56 for all geoscience publications up until 2013 2014: 16,6 2015: 16,8	It is desirable that the published research is relevant to others also.
Department KPI 2 **7. Elitist publications** Increase number of publications in high-end journals	Number of publications in high-end journals (Nature, Nature Geoscience, Nature Climate Change, Nature Communications, Science, Proc. Of the Nat. Acad. Of Sci., Geophysical Research Letters, Geology)	**2016: 7,0** **2017: 7,5** **2018: 8,0** **2019: 8,5** **2020: 9,0**	2000 1 2001 3 2002 0 2003 1 2004 4 2005 3 2006 3 2007 2 2008 1 2009 6 2010 1 2011 2 2012 8 2013 8 2014 4 2015 9	It is desirable and an expression of quality that the department that researchers are able to publish in top international journals.
Department KPI 3		**2016: 8**	Number enrolled AU students who spend at	It is desirable that students have the

8. International education Increase number of students going abroad		**2017: 9** **2018: 10** **2019: 11** **2020: 12**	least one quarter at a foreign university 2013: 3 in autumn 2014: 2 (goal was 2) 2015: 7 (goal was 5)	opportunity / see it as a benefit to include courses from other countries in the program.
Department KPI 4 **9. Internatio-nal/EU applications** Increase number of international research applications	# VIP involved in international applications	**2016: 11** **2017: 12** **2018: 13** **2019: 14** **2020: 15**	Number of researchers in international applications/networks 2013: 5 2014: 22 (mål 8) 2015: 12 (mål 10)	It is essential that researchers increasingly explore the possibilities of research funding from international sources.
Department KPI 5 **10. Focus on geophysics education** Increase number of students in the MSc geophysics programme	Number enrolled in the MSc geophysics programme Abroad: externally recruited Ingternal: recruited out of the enrolled 45 BSc	**2016:** **Abroad: 7** **Internal: 10** **2017:** **Abroad: 8** **Internal: 10** **2018:** **Abroad: 10** **Internal: 10** **2019:** **Abroad: 15** **Internal: 10** **2020:** **Abroad: 15** **Internal: 10**	2013: Abroad: 1 Internal: 4 2014: Abroad: 5 Internal: 2 2015: Abroad: 5 Internal: 11	This area is Geoscience's possibility to expand the field of education

I - Recruitment plan 2016-2020

Scientific staff:

General area	Flagship	Brief description	Level	Status	Financing
Hydrogeophysics	Water	Hydrogeophysics	Assoc. Prof.	Anders Vest	Department
Isotope geochemistry	Climate & Environment	Cosmogenic nuclides, AMS, climate	Assoc. Prof.	Mads F Knudsen	Department
Glacial/Quaternary geology	Climate & Environment	Glacial sedimentology, Quat. stratigraphy, AMS, OSL	Assoc. Prof.	Nicolaj K Larsen	Department
Sedimentary geology	Deep earth Systems/ Climate & Environment	Sedimentary processes and diagenesis	Assoc. Prof	Stephane Bodin, 2015	Department
Solid Earth geology	Deep Earth Systems	Metamorph petrology/structural geology	Assoc. Prof.	Thorsten Nagel	Department
Luminescence Dating	Climate & Environment	Geoscience applications of luminescence	Assoc. Prof.	Jan-Pieter Buylaert	Extern/Dept.
Spectroscopist	Chemistry of Earth materials	Technical specialt to run clean lab	AC-TAP	Rasmus Andreasen	Department
Scientific coordinator	All	Administrative specialist to coordinate research funding ect.	AC-TAP	Thomas Nielsen	Department (ST)
Marine geology	Energy and Natural resources	Basin Analysis/seismic data and well logs/DHRTC collaboration.	Assist. Prof.	In process	Department
Deep Geophysics	Deep Earth Systems	Quantitative modelling of mantle & lithosphere processes	Assist. Prof.	2016	Department (Ext.)
Paleoceanography	Climate & Environment	micropaleontology (surface)/ multiproxy methods/ geochemistry	Assist. and/or Assoc. Prof.	2016	Department
Basin Analysis	Energy and Natural resources	Hydrocarbon reservoirs and DHRTC collaboration	Professor	2016	Department (Mærsk Oil)
Hydrology and shallow	Water/ Climate & Environment	Interaction between surface and shallow groundwater (integrated	Assist. and/or	2016	Department

groundwater		modelling using hydrological and geophysical data types)	Assoc. Prof.		
Hydrogeophysics	Water/ Climate & Environment	Electromagnetic methods in shallow geophysics	Assoc. Prof.	2016	Department (Ext.)
Deep Geophysics	Deep Earth Systems	Seismology and potential fields	Assist. Prof.	-	Department
Geochemistry	Deep Earth Systems	Niels Bohr Professor	Professor	2018	Dept. (Niels Bohr)
Geochemistry	Chemistry of Earth materials	Cross-disciplinary geoscience/archaeology/health/...	Assoc. Prof.	2018	Dept. (Niels Bohr)

Technical and Administrative staff

Laboratory technician				2016	Department (ext.)
Seismic technician				2016	Department (ext.)
Retirements will be compensated for when required					

Comments to recruitment plan

The Department has seen a significant decrease in the number of faculty from c. 38 in the mid 90ties to 18.5 at the present day. This number includes three half-time positions in luminescence dating, hydrogeology and micropalaeontology. Counting some imminent retirements and the conversion of half-time positions to full-time positions the above recruitment of nine full-time faculty members means that the faculty will number 26 by 2018. We consider this a necessary and sufficient size of the faculty of a broad geoscience department. Of the new positions the Mærsk Oil Chair is externally funded, the hydro geophysics position is externally funded for a period of three years. Further external funding possibilities exist for Deep Geophysics via the DHRTC.

The recruitment plan reflects the strategy that the Department remains a broad geoscience department with most fundamental geoscience disciplines represented. The plan strengthens the field of "Water" with one hydrogeophysics position and upgrades a half-time position in hydrogeology to a full time position. The plan strengthens geochemistry with two full-time positions in 2018. This represents the assimilation of the Niels Bohr project. Basin analysis is strengthened by the Mærsk Oil Chair and the Assistant Professor position in basin analysis. The Deep Geophysics field will temporarily increase to three staff. With one position the field of micropalaeontology stabilises at two full positions. Given the previous recruitments, and considering the methodological and topical kinship between some existing and new staff, this means that the classical fields of sediment geology, micropalaeontology, climate/surface processes, structural geology, petrology, basin analysis, hydrogeophysics and deep geophysics are anchored in at least 3 permanent staff. With this plan the previously strongly represented fields of geomorphology/physical geography have taken on new guises through the existing fields/disciplines of quaternary geology, cosmogenic isotopes, thermochronology and numerical modelling.

The clean lab and associated instruments and technical and scientific staff is a world-class research platform. It represents a significant change of direction of the Department with even greater emphasis on geochemistry. This focus area generates strong synergies with existing disciplines, where geochemistry always has been important, and opens new avenues of interdisciplinary collaborations, which currently include Archaeology, material science (iNano, Chemistry), Health, and Physics & Astronomy.

Internally, the recruitment plan strengthens the synergy within Deep Earth Systems by recruiting a numerical modeller/geophysicist with emphasis on modelling of lithosphere and mantle processes. The expertise of the geochemists of the Niels Bohr group is measurement of isotopes and rare earth elements and thermodynamic modelling. The seismic tomography and potential field methods of experimental geophysics require interpretations to relate them to earth processes. Integrated modelling of mantle and lithosphere processes is the missing link between geochemical and geophysical observations and earth processes.

The important departmental strength of the Geophysics MSc accreditation is supported by the recruitment plan by ensuring continues existence of deep geophysics at the Department. Contrary to the MScs of Geology and Technical Geology, the Geophysics MSc is not dimensioned.