Newsletter

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Glacial Soils

No.23 Autumn 2015

Colophon

Ingeokring, founded in 1974, is the Dutch association of engineering geologists. It is the largest section of KNGMG (Royal Geological and Mining Society of The Netherlands). Ingeokring also forms the Netherlands National Group of the International Association for Engineering Geology and the Environment (IAEG).

*With **over 150 members** working in different organisations, ranging from universities and research institutes to contractors, from consultancy firms to various governmental organizations, Ingeokring plays a vital role in the communication between engineering geologists in The Netherlands.*

The objective of the Newsletter is to inform members of the Ingeokring and other interested parties about topics related to engineering geology, varying from detailed articles, book reviews and student affairs to announcements of the Ingeokring and current developments in the field of engineering geology. The Newsletter wants to make engineering geology better known by improving the understanding of the different aspects of engineering geology.

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Subscription to the Newsletter

Each member of the Ingeokring receives at least once a year a new edition of the Newsletter. Membership fee for the Ingeokring is **€18; student membership fee is €9.** Other membership alternatives can be found at:

http://www.ingeokring.nl/pages/membership.php

Issue

Geotechnical Engineering on a Geological Foundation: Unforeseen ground conditions or not?

Winter 2014-2015 (**150** copies)

Cover photo

Courtesy from dr. P.N.W. Verhoef (Boskalis)

Guidelines for authors of Newsletter articles and information about advertising in the Newsletter can be found at the inside of the back cover.

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Letter from the Editorial Board

Carolina Sigarán-Loría

As a team, this Editorial Board find this appointment with this Newsletter a great opportunity to remain close to the diverse Dutch community of geological engineers. This Newsletter serves as a bridge to transmit professional experiences (in The Netherlands or elsewhere) and provide others with technical or scientific articles on specific relevant projects we deal with through our profession. It also provides an overview of the latest postgraduate topics at TU Delft; summaries from fieldtrips, workshops or any other activities organized by Ingeokring.

This Newsletter aims to promote and encourage colleagues disseminating technological activities and research. Suggestions to improve the format, content and quality of this Newsletter in the future are welcome.

In this number we provide some articles on “Glacial Soils”, topic from the Ingeokring Symposium held last Autumn 2014.

Looking forward your contributions,
sincerely yours,

Dr.ir. C.Sigarán-Loría; Witteveen+Bos, TEC
Dr.ir. E. Rosenbrand; RHDHV
Dr.ir. L. van Paassen; TU Delft

Uncovering submerged landscapes in the North Sea: artwork or hard work?

Sytze van Heteren *(TNO Geological Survey of the Netherlands, Utrecht, the Netherlands)*

Glacially deposited sediments are common in the northern part of the Dutch North Sea, but rare near the present-day shoreline. They were formed at times of lower sea level than today, when lowlands occupied an area extending from the Strait of Dover to the current shelf edge next to the Norwegian Channel. From an engineering geological perspective, these glacial sediments pose specific challenges, primarily because of their heterogeneity. To understand this heterogeneity, simple analysis of available borehole information is not enough. It is necessary to consider this information within the context of bathymetric and seismic data that provide better coverage of the relevant areas.

As part of ongoing 3D geomodeling efforts at the Geological Survey of the Netherlands, more than 11,000 borehole descriptions are being combined with a full-coverage bathymetric grid, about 50,000 km of shallow seismics, and tens of thousands of km2 of industrial 3D seismics. The 3D seismics in particular are very useful in the reconstruction of incomplete, presently drowned landscapes that were home to early man at various times during the past million years. From this latter perspective, the North Sea can be considered as a richly filled treasure trove with its cover slightly opened. The boreholes and seismics provide a fascinating but highly incomplete view of the buried treasures, which are increasingly disturbed by human activities.

To reconstruct this drowned lowland, and thus to better understand the subsurface heterogeneity, a geomodeling workflow has been developed in which point, line and full-coverage data are combined. The analysis of existing maps and written documents on glacial, fluvial and coastal history is instrumental in building a conceptual framework. It establishes spa-

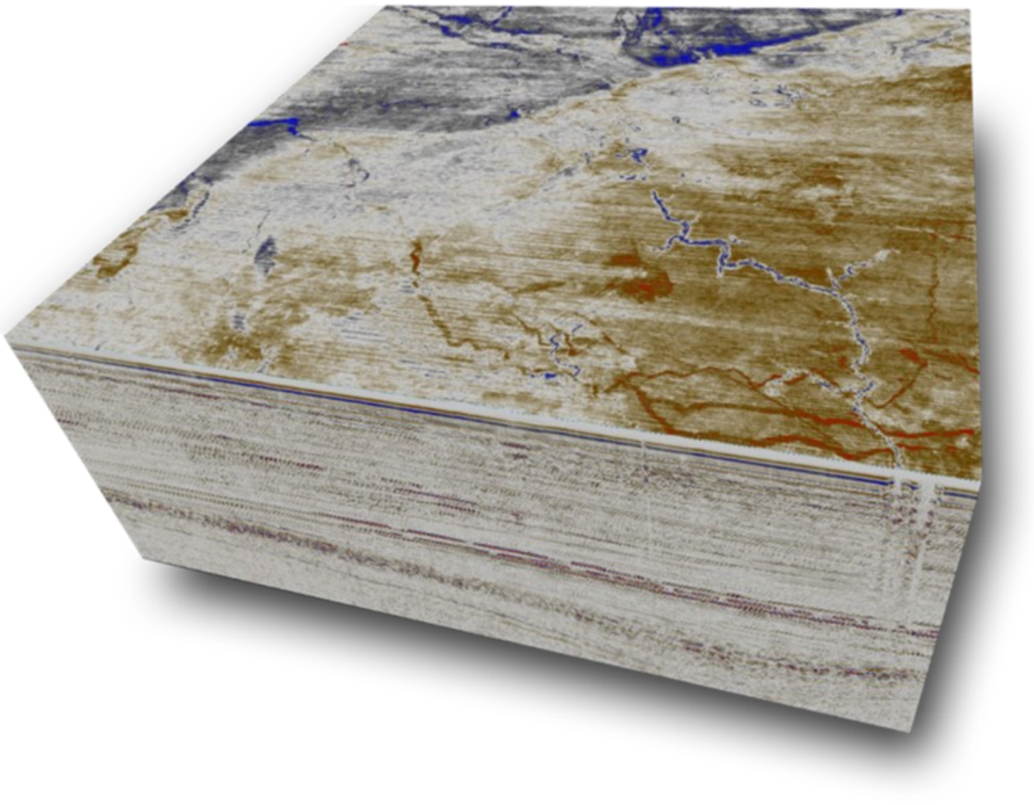

Figure 1: *3D seismic cube showing an early Holocene coastal-lowland landscape with meandering channels, reminiscent of the present-day coastal zone near Rotterdam.*

tial relations between units in the overall layer succession. This succession is far from simple, especially in formerly glaciated areas. In a second step, seismic data ground-truthed with borehole descriptions are used to identify 2D and 3D patterns of varying detail, representing elements of different depositional environments. Features thus identified may have familiar patterns that can be linked easily to processes responsible for their formation. In some cases, though, such features have unfamiliar shapes that can only be understood when geologists from different backgrounds work together. The interpretation and mapping of patterns may be hampered by limited spatial resolution or by the superposition of complex shapes. The higher the data density, the more likely it is that lateral variability resulting from architectural elements such as channels can be identified. When all patterns are combined, it is possible to reconstruct past landscapes across vast areas.

Engineering geologists may profit from such reconstructions because they visualize and quantify geotechnical heterogeneity. Given the near-absence of measured data on geotechnical parameters, it is essential in desk studies preceding infrastructural and other construction projects to use geological and geophysical information to its fullest extent. When such information is translated into applied indicators with an associated uncertainty, decision making (site selection, survey plan) can be optimized. This optimization will save both time and money.

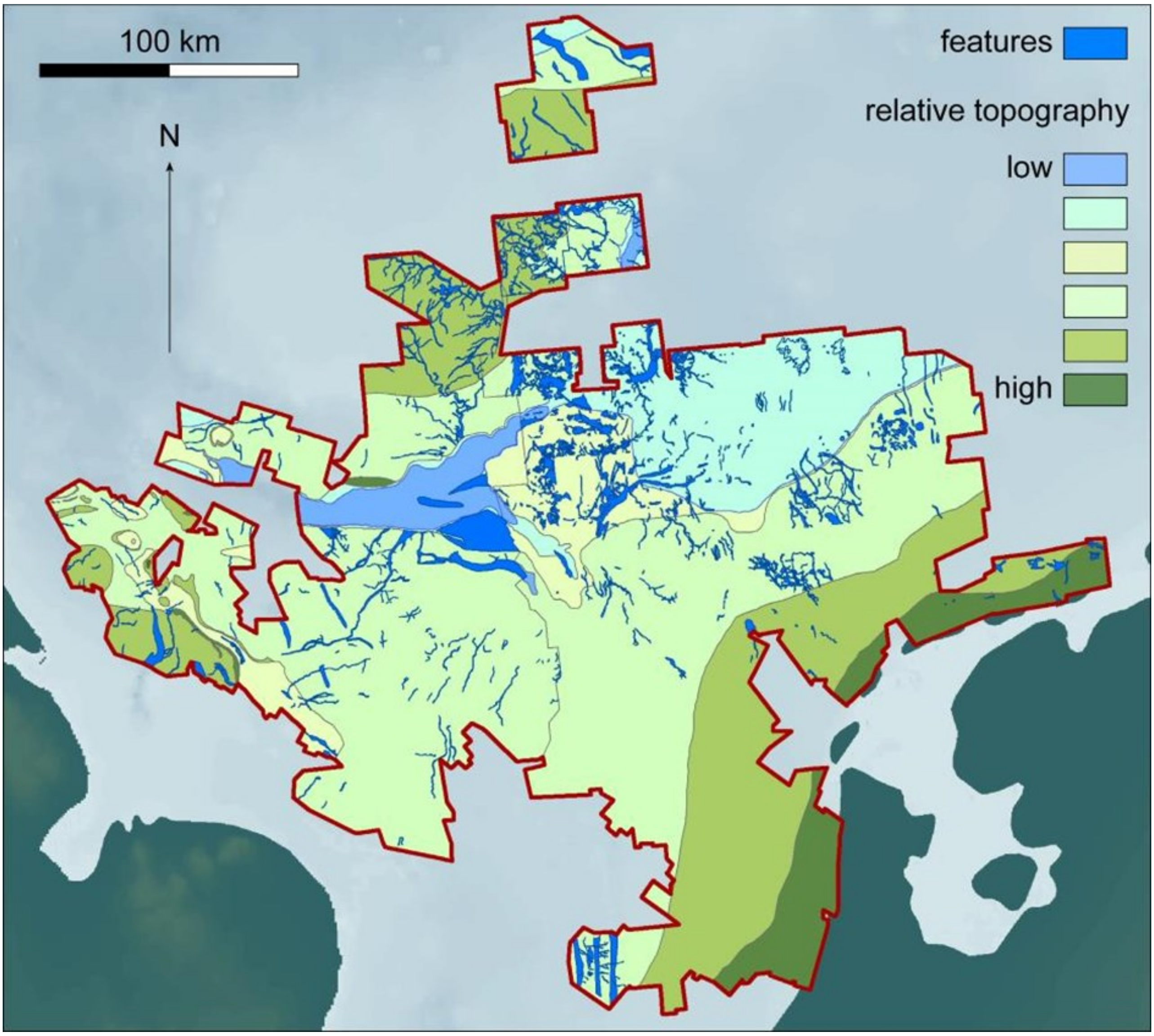

Figure 2: *Former rivers, lakes and estuaries (blue) still recognizable in the North Sea subsurface.*

Implications of past glacial processes on geotechnical design in the Netherlands; a selection from engineering practice

Esther Rosenbrand *(Royal Haskoning DHV, Nijmegen, the Netherlands)*

In his talk, Oscar Mooijman from Royal Haskoning DHV shared with the audience three examples from his experience of engineering on ground that has been affected by past glaciations. Prior to this, Oscar provided the audience with some background on himself and on the effect of Ice Ages on the Dutch subsurface.

Oscar graduated on the detection of abandoned mineshafts in Limburg and went on assignment for DHV Consultants in Brazil. Subsequently, he worked with Fugro on geotechnical monitoring projects and later on as a geotechnical consultant. He has been working as a geotechnical consultant at Royal Haskoning DHV since 2007 where he has amongst other things worked on a variety of infrastructure projects in the North of the Netherlands.

The subsurface of the Netherlands shows clear marks of past glaciations. During the last ice age, the Weichselien the Netherlands was a polar desert, similar to what can be found in Antarctica today (Figure 1).

Remnants of (polar) crescent sand dunes can still be found in the topography of the Gelderse Vallei area (between Amersfoort and Wageningen) today.

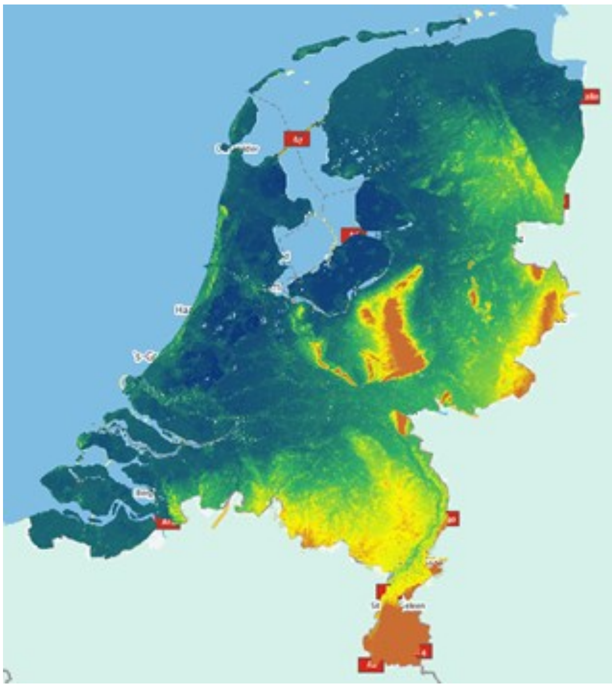

Figure 2 Topography of the Netherlands (from www. ahn.nl) showing the areas above sea level (yellow and red) in the northern half of the country are the result of glacial processes

Figure 1 Polar sand dunes in Antarctica (http:// kawelchinantarctica.blogspot.com/)

During the penultimate ice age, the Saalien, land ice covered the Netherlands from the North to the 'Haarlem -Nijmegen' line. Ice pushed ridges formed as soil collapsed and squeezed out along the edges of fast-advancing ice-tongues affecting the topography of, amongst others, the Veluwe area as we know it today (Figure 2). During the second to last ice age, the Elsteriën, land ice reached only the north of the Netherlands and resulted in the creation of glacial tunnel valleys both on land and in what is now the North Sea (Figure 3). The present-day topography does not show any signs of buried glacial tunnel valleys.

The first example related to deposits from the late Pleistocene/early Holocene, the Kreftenheye/Boxtel Formation. The project concerned a pile foundation in Rotterdam on these Pleistocene sands. A new high rise building was to be founded on piles next to an existing municipal monument (Figure 4). There was a fear that, if the piles were driven down to the same sand layer as the piles on which the existing building was founded, the concentrated load on piles below the new building would lead to differential settlement, caused by consolidation

Figure 3 Glacial tunnel valleys

of the underlying “Kedichem” clay layer. This might cause the existing building to tilt towards the new building, leading to rotations and damage. To avoid this, the piles for the new building were driven deeper down, to the 2nd sand layer.. The second example concerned the foundation for flats in Arnhem. This project is situated on the toe of an ice pushed ridge from the Saalien (Figure 5). A 25 by 25 m grid for CPT’s proved insufficient to characterise the variability in the subsurface. The layers of clay and loam were over consolidated and folded with layers of sand; therefore geological insights were valuable in designing and interpreting the site investigation.

The third example concerned the glacial tunnel valleys from the Elsteriën. A bridge was to be founded partially on the (suspected) slope of a glacial tunnel valley. The glacial tunnel valleys are filled with overconsolidated clay, locally referred to as ‘Potklei’. The higly variable ground conditions in glacial tunnel valleys resulted in a mixed foundation of end bearing piles and shaft friction piles. In combination with variable ground conditions under the pile tip this resulted in relatively large differences in load-displacement characteristics over the 4 bridge supports (Figure 6). Load transfer between the supports was however limited and did not however lead to significant extra requirements in the construction design of the bridge.

Overall this talk showed how important it is to consider the location of a project and the geological history of the site. In all three projects, DINOLoket provided a valuable insight into the local subsurface conditions.

Figure 4 Design of piled foundation of the high rise building ‘de Coopvaart’ in Rotterdam had to take into account the potential differential settlements of the neighbouring municipal monument due to consolidation of the underlying Pleistocene clay layer,.

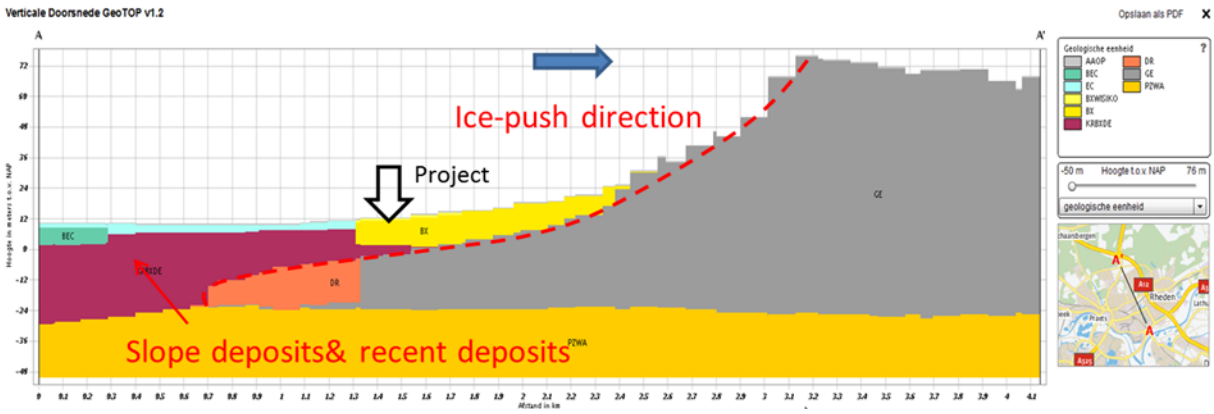

Figure 5 Project was located in the toe of an ice pushed ridge.

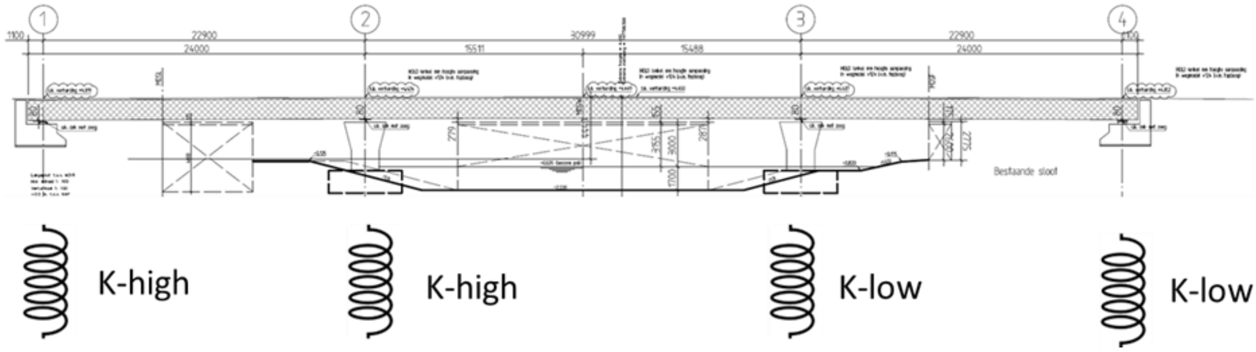

Figure 6 Variability in the stiffness below the bridge foundations.

Offshore ground investigation of glacial deposits

Peter Verhoef *(Boskalis Westminster, Papendrecht , the Netherlands)*

The central theme of the presentation given is that inclusion of knowledge of the geology into the design and interpretation of ground investigations will help to develop more realistic ground models and much better judge and estimate the risk involved in the ground conditions of a project.

Compared to civil engineering projects carried out on land, not only is the seabed subsurface hidden from direct observation in offshore projects, but also the seabed itself. Information about the seabed surface and subsurface for offshore projects comes from remote sensing techniques (hydrographic and geophysical surveys) and by sampling and probing of the ground (geotechnical surveys).

Information on the local geology can be obtained by accessing the data provided by national geological surveys on the internet. In many cases digital geological maps, including offshore marine geological maps can be downloaded and used. During the tender phase or while preparing a dredging work, it is often worthwhile to visit the site area for walk-over surveys to examine the coastal geology, perform engineering geological surveys and take samples.

Glacial deposits are the result of complex processes. The more knowledge we get about present day glacial systems, which are studied in depth nowadays in relation with climate change, the more we realize how difficult it is to interpret ancient glacial deposits. Due to this complexity there are often many soil related uncertainties to deal with in engineering projects. This may discourage people, but it is stressed that by making use of the excellent textbooks (such as Benn & Evans 2010) and review papers available a feel for the variability and architecture of glacial deposits can be obtained. And it is this insight in scale and nature of compositional variation that is exactly what is needed to assist the development of engineering ground models for a project and estimate the risk involved.

The quality and amount of the geotechnical information for dredging projects coming to tender varies quite a lot. In the presentation, examples were given of dredging projects situated in the Baltic Sea region (Figure 1). The site investigation information of these projects varies considerably, from minimal: a set of cross sections through Scandinavian penetrometer logs for one project to abundant: a very sophisticated state-of-the-art ground model based on an extended geophysical and

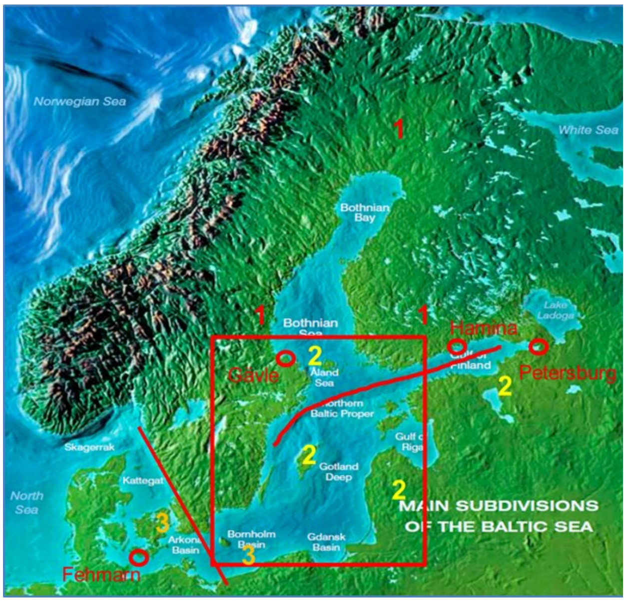

Figure 1. The projects discussed during the lecture are situated in the Baltic area. The Baltic and Botnian Sea are depressions related to faulting activity that started late in the Precambrian period. Tuuling et. al. (2011) provides a good overview of the geological history of the Baltic sea. Important fault lines and a main subdivision in age of bedrock are shown on the map: 1) Precambrian shield rocks; 2) Late Precambrian early Paleozoic rocks; 3) Cretaceous Limestone cor Chalk.

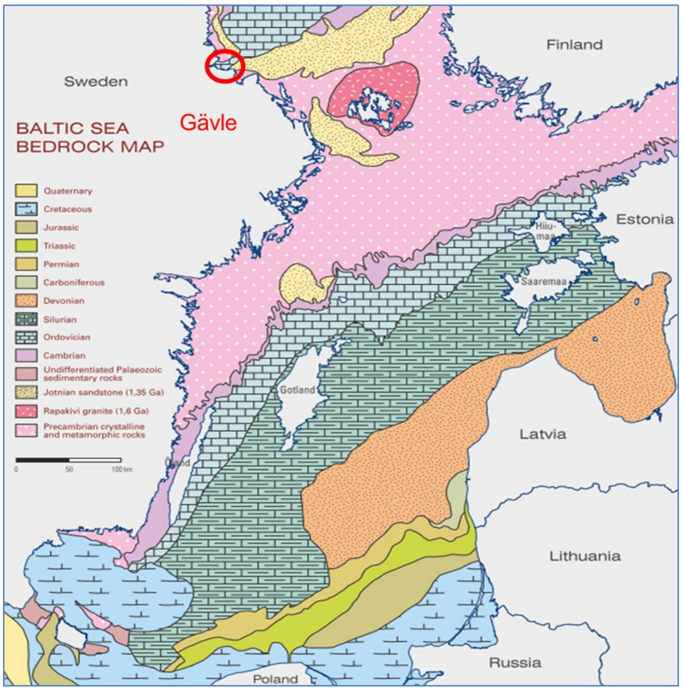

Figure 2: Geological bedrock map of the Baltic Sea (Tuuling et.al. 2011). Gavle harbour is positioned parallel to the late Precambrian fault system, Ordovician age limestone bedrock underlying glacial moraine with high boulder content had to be dredged in the access channel deepening project which was executed in 2012-2014.

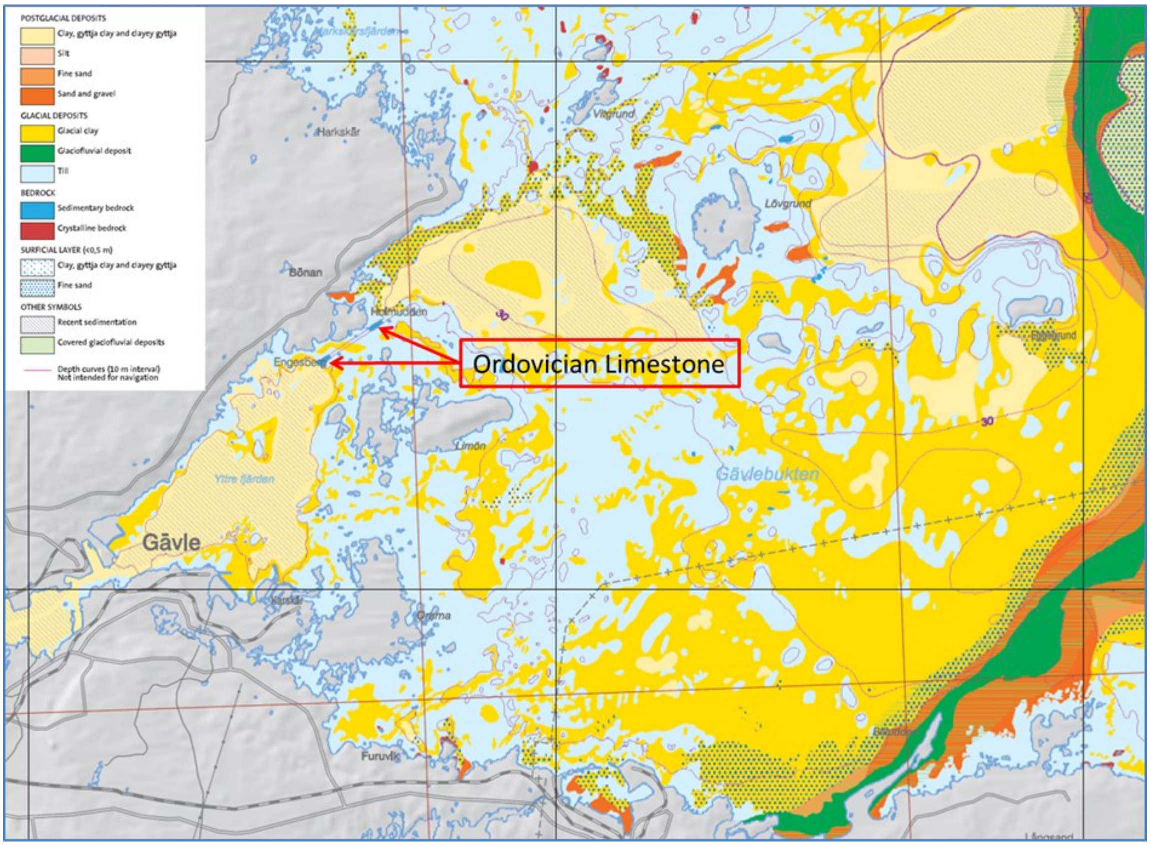

Figure 3: Gävle project. Occurrence of sedimentary bedrock indicated on the digital marine geological map of the geological survey of Sweden. This was good information, obtained early in the tender period, of the nature of the bedrock to be dredged in the entrance channel. http://www.sgu.se/en/products/maps/map-generator/

Figure 4: Gävle project. During the additional offshore ground investigations walk-over surveys were done along the coast using the geological maps. Locations were found where the red coloured limestone could be sampled for testing. Note the moraine boulders of hard crystalline rock which cover the limestone bedrock.

geotechnical ground investigation program. However, for all projects discussed it proved very helpful that site visits were made, samples were taken and additional ground investigation programs were executed, both onland and offshore.

The conclusion of the presentation was that even when extensive offshore ground investigation is done, continuous effort to understand the local geological situation is needed. Many of the questions on the ground conditions for dredging works are related to the 'meso-scale' (1 to 100 m). Onshore walk-over surveys or more extensive investigations (like test pits) can assist in understanding the soil deposit types to be dredged in the project.

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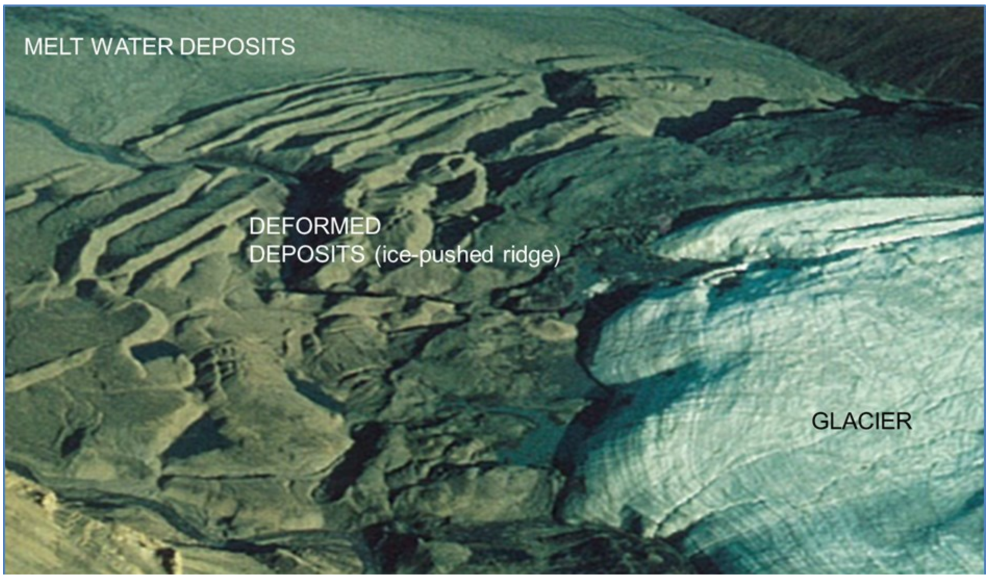

Figure 5: Fehmarnbelt project. On the southern side of the tunnel project the sedimentary deposits are highly deformed. A photo of the effect of ice-margin deformation is given in Benn & Evans (2010). Ice-pushed sediments extend in front of the ice margin. Meltwater creeks run out of the glacier, feeding meltwater deposits.

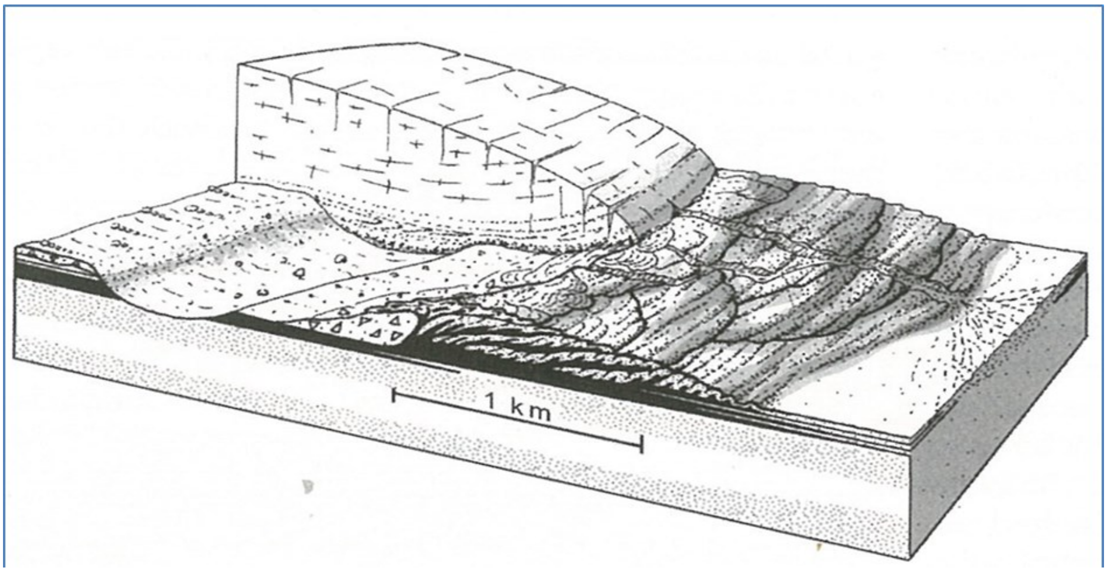

Figure 6: The weight of the glacier results in a stress differential which leads to shear deformations pushing soil from underneath the glacier towards the margin. (Benn & Evans (2010).

Figure 7: On the south east coast of the island of Fehmarn (Germany), glacial deposits are exposed. Deformed meltwater deposits, containing an erratic block, are overridden by a glacier as indicated by the basal till (ground moraine) layer.

Figure 8: Exposure of meltwater deposits deformed by a glacier. The ground moraine has been taken up in the deformed meltwater deposits.

Figure 9: Detail of figure 8, showing the knife-sharp boundary ofthe ground moraine overlying glacial basal till.

Prestigious Chinese award for Ingeokring Honorary Member Dr. Niek Rengers

***Communications, Faculty of Geo-Information Science and Earth Observation** (University of Twente)**

The People's Republic of China has given its 2014 International Science and Technology Cooperation Award to Dr Niek Rengers (former Vice-rector of ITC). This is the highest prize for foreign individuals or organizations in the field of science and technology and honours the significant contributions Dr Rengers has made to China's social and economic development. The prize was awarded by President Xi Jinping and Premier Li Keqiang in a solemn ceremony held on 9 January 2015 in Beijing.

Figure 2: Mr. Tang (University of Chengdu) and Dr. Rengers

Dr Niek Rengers, is an expert of engineering geology, geo-disaster risk assessment and management, retired associate professor of the ITC (University of Twente) and Delft University of Technology, the Netherlands. He is also former Vice-rector of the International Institute for Aerospace Survey and Earth Sciences (ITC) and past president of the International Association of Engineering Geology and the Environment and was board member of the Federation of International Geo-engineering Societies. He also served as an editorial member for several international journals. He published about one hundred research papers and (co-) authored several books.

Figure 1: After award ceremony

Introduced by the Ministry of Land Resources of the People's Republic of China, he started the collaboration with Chinese scientists in 2006. With his theoretical background and experience in Europe and Latin America, he helps China to establish a geological disaster risk assessment system, which produces huge mitigation benefits. He spared no effort to cultivate a large number of outstanding young Chinese talents and trained more than 10 young teachers, and 20 master and PhD students. With his support, the secretariat of the International Association of Engineering Geology and the Environment (IAEG) was transferred to China. And now the vice -president and the secretary-general of IAEG are Chinese scholars. This greatly enhanced the Chinese influence and position in the field of engineering geology in the international academic community. He also made an important contribution to the study and prevention of geological disasters in China.

About the Prize

The International Scientific and Technological Cooperation Award of the People's Republic of China is a national science and technology award established by the State Council. It is given to foreign scientists, engineers, experts or organizations, which have made important contributions to China's development through bilateral or multilateral scientific and technological cooperation. This year eight international scientist were awarded with this prestigious prize.

*Source: http://www.itc.nl/Pub/News-overview/in2015/in2015-january/Prestigious-Chinese-award-for-Dr-Niek-Rengers.html

Figure 3: Dr. Rengers, visiting Professor at Chengdu University

PhD abstracts from 2015

Transmission of climate, sea-level, and tectonic singals across river systems (2015-03-11)
Author: A. Forzoni
Promotor(s): Luthi, S.M., Storms, J.E.A.
Keywords: sediment flux, catchment modeling, fluvio-deltaic stratigraphy.
This thesis investigates the impact of climatic, tectonic, and sea-level changes (external forcing) on river systems (source-to-sink) and how these changs are recorded in the stratigraphic record. It describes a newly developed numerical tool (PaCMod) to simulate the complex fluvial system sediment flux response to external forcing on a geological time scale. Numerical modelling simulations, combined with field data indicated that the late Quaternary evolution of the Golo River system (France) was controlled by a complex interaction of sea-level and climatic forcing. Stratigraphic analysis in the Panther Tongue delta (Utah) showed how different parts of an ancient shoreline reacted differently to the same changes in external forcing, which consequently, have a different stratigraphic expression along depositional strike.

On the interaction between a Tunnel Boring Machine and the surrounding soil (2015-01-08)
Author: D. Festa
Promotor(s): Bosch, J.W., Broere, W.
Keywords: tunnelling, soft soil TBM interaction, settlement, monitoring
The thesis investigates the mechanical equilibrium of a Tunnel Boring Machine (TBM) driving in soft soil. The interaction between the TBM-shield and the soil is also investigated. The analysis is based on monitoring data gathered during the construction of the Hubertus tunnel in The Hague, Netherlands. The monitoring activities during tunnel construction are discussed in detail. Special care is given to explain how the recorded data can be processed in order to verify a number of physical processes induced by the TBM-shield advance. TBM-data (machine data) and soil monitoring data (from inclinometers and extensometers) are examined. A kinematic model of TBM-shield behaviour is constructed from theoretical and geometrical considerations. The consequences of driving a TBM-shield in a curve are highlighted and validated against the TBM monitoring data. It is demonstrated how the kinematic model can provide the displacement history of the soil induced by the TBM-shield. Stresses, forces and moments acting on the TBM are covered in detail. Active and passive forces are combined and the equilibrium of the TBM-shield is considered by means of a purpose built numerical model. It is discussed which model features produce favourable conditions to the achievement of static equilibrium and which others may still hinder it. A quantitative assessment of the influence of the tail-void grouting is undertaken and uncertainties regarding the soil stiffness are discussed. It is observed that a considerable amount of the total tunnelling induced soil displacements occurs during the phase of temporary support. It is also demonstrated that the pattern of the induced displacements is more articulated than assumed in the volume-loss scheme.

Three-dimensional inversion of inductions logs in real-time (2015-03-19)
Author: S. Bensdorp
Promotor(s): Van den Berg, P.M., Fokkema, J.T.
Keywords: induction logging, inversion, electromagnetics
In petroleum production and exploration, having good information about a hydrocarbon reservoir is paramount to successful exploitation. A popular tool is to probe the electric conductivity in a well to obtain direct information of the well surrounding. As wells are nowadays mostly horizontally drilled, this information is becoming more important. In this thesis, we describe how we can model electromagnetic fields in boreholes in a fast and efficient way. These models are used to rapidly predict responses from projected wells in reservoirs models. Moreover, this fast model makes it possible to do real-time inversion of the measured magnetic fields. We describe an inversion algorithm adapted specifically to the circumstances as found in the borehole measurement setup. Our research shows that with this algorithm the conductivity surrounding the measurement probe can be reconstructed with reasonable fidelity in a short time frame. This gives a drilling operator the possibility to place the well in an optimal position, both from an economical as well as a safety perspective.

Experimental and numerical study of heat flow under low-enthalpy hydrothermal conditions (2015-02-09)
Author: S. Saeid
Promotor(s): Hicks, M.
Keywords: Geothermal
Energy and its management and environmental impact constitute one of the most important issues in the 21st century. Since fossil fuels are environmentally hazardous and sooner or later are going to be depleted, there is a pressing need for alternatives. Renewable energies, such as solar, wind and geothermal energy are vital sources of energy that are clean and abundantly available. Wind and solar energy sources, in spite of their several advantages, are naturally intermittent. They might not be available at times of peak energy demands and abundant at times of no demand. On the contrary, geothermal energy is available at all times. This makes geothermal energy sources a plausible alternative to fossil fuels. Several types of geothermal energy sources are available, including high, intermediate, and low-enthalpy which have different applications. In countries with low thermal gradients and relatively high permeable aquifers, such as the Netherlands, geothermal energy can be used for space heating using hydrothermal heating plants. A prerequisite to safe, economic and viable geothermal systems is a good understanding of the geology and the physical processes in the subsurface. In a hydrothermal system, heat conduction and convection takes place in a rather highly disproportionate geometry.

This combination of physical processes and geometry make numerical analysis of such a system complicated and resource-consuming. Hence, in developing numerical tools for geothermal systems, important efforts are devoted to tackling the discretization of two main issues: geometry and heat convection. Deep geothermal systems consist of very slender boreholes embedded in a large soil mass. This geometrical peculiarity exerts an enormous computational burden, as a combination of very fine elements (cells) and coarse elements (cells) is normally needed to discretize the physical domain. For three-dimensional systems, this normally requires hundreds of thousands to millions of elements, necessitating parallel computing using multiple processor computers and making the CPU times unrealistic for engineering practice. Additionally, heat flow in a hydrothermal system involves density and viscosity variation with temperature, and thermal dispersion. These phenomena make the problem non-linear and must be well understood and taken into consideration in optimizing a geothermal system. In this thesis, these physical and geometrical issues have been studied experimentally and numerically. The objectives of this thesis are: 1. To investigate the variation of the formation fluid density and viscosity, with temperatures typically existing in hydrothermal conditions. 2. To investigate thermal dispersion due to heat flow in a porous domain. 3. To establish a discretization technique that covers all important features of the hydrothermal system geometry and physical processes, and, at the same time, is computationally efficient such that it can be run on a normal PC (500 MHz, 4GB RAM). 4. To formulate a prototype model for a preliminary estimation of the reservoir lifetime by knowing its porosity and initial temperature for different design parameters, namely, discharge, well spacing and injection temperature. The outcome of the experimental-numerical study in this thesis emphasizes the significance of several manmade and physical parameters on the system's lifetime. In conducting a viable design study of a hydrothermal system, these parameters need to be carefully evaluated. The proposed prototype model can be utilized in the preliminary phases of a project, from which the project lifetime and consequently the cost and the amount of the extracted energy, can be estimated.

Turbid flows and their deposits on slopes with minibasins: a modelling approach (2015-01-19)
Author: X. Wang
Promotor(s): Luthi, S.
Keywords: turbidity currents, turbidites, passive margin, minibasin, flow-deposit interaction, compensational pattern

Passive continental margins display a great diversity of seafloor bathymetries induced by gravity driven extensional faulting and compressional folding, as well as diapiric movements of salt or mud. In many diapirically controlled settings, slope bathymetries are complicated and characterized by numerous ridges, trenches and minibasins such as in the Gulf of Mexico and offshore West Africa. These bathymetries play a significant role in controlling turbidity current behavior, the resulting sediment distribution and the internal architecture. Numerous researchers have investigated the influence of pre-existing or developing minibasins on the behaviour of turbidity currents and the resulting depositional systems using seismic data, analogue field outcrops, and laboratory and numerical experiments. The classic fill-spill model was proposed to describe the depositional process in linked intraslope minibasins in the Gulf of Mexico. However, due to the inherent limitations of present-day geophysical techniques and the limited exposure of field outcrops, the small-scale internal architecture and stacking pattern of such confined or semi-confined turbidite systems are still not well understood. The objective of this thesis is to better understand the interaction between flow, sediment and topography, and attempt to develop conceptual models for the changes in sediment dispersal and stacking patterns in diapirically controlled minibasins on passive margins. In order to achieve this, we combine laboratory analogue modelling of intraslope minibasins with numerical flow simulations of multi-event turbidity currents. Previous studies on salt tectonics show that minibasins can be bounded by fold-and-fault systems or are sitting above allochthonous or autochthonous salt bodies. Gravity gliding explains well the typical structural zones (extensional, transitional and compressional) of passive margins, and therefore, in our studies, we conducted analogue tectonic sandbox experiments in which the deformations are driven gravity gliding. Sand and silicone putty are used to represent the prekinematic sediment and salt respectively. The experimental results from different setups show that three types of minibasins are formed and distinguished according to their boundary contact relationships: MB1 (no contact with the silicone layer), MB2 (the silicone layer as the basin base) and MB3 (the silicone diapir as the basin flank). The resulting topographies are scanned with a laser beam from which a digital elevation model is obtained. One topography that is considered most realistic is selected and upscaled to dimensions that typically occur in nature. Furthermore, a channel is added on the shelf and the shelf break to serve as point source for the flows. Subsequently, a numerical flow simulation ("FanBuilder", Groenenberg et al., 2009) is employed to model multi-event low-density turbidity currents that flow from the incised channel down into the minibasins on the continental margin. A series of sets of parameters within ranges expected to occur in nature were compiled from literature study and used for the flow simulation experiments. Multiple flow events (non-equilibrium and equilibrium flows) from the same point source were run whereby the deposits were stacked on top of its predecessor. The resulting stratigraphy is then analyzed in 3-D, typically in a series of strike and dip sections. The experimental results of a series of numerical simulations are compared and discussed in terms of flow evolution, flow-deposit interaction, and internal architecture and stacking patterns. In our models, the turbidity currents show a behaviour that can be divided into three phases: the ponding, the fill-and-spill, and the trapping stages. A significant grain-size partitioning happens at the early fill-and-spill stage, with the coarser grains getting trapped in the up-dip minibasin and finer grains transported by the spillover flows further downslope. Significant deposition in the minibasin takes place on the counterslope after the first minibasin depression. The flow pathway and evolution depend much on the flow volume reaching the up-dip minibasin, the remaining accommodation space, and the topography geometry and gradient. The deposits can smooth the gradient of the counterslope, allow more spillover, but they can also make the bounding ridge grow and move upstream and thereby restrict the flows to the minibasin. Overall, the turbisoftware ("FanBuilder", Groenenberg et al., 2009) is employed to model multi-event low-density turbidity currents that flow from the incised channel down into the minibasins on the continental margin. A series of sets of parameters within ranges expected to occur in nature were compiled from literature study and used for the flow simulation experiments. Multiple flow events (non-equilibrium and equilibrium flows) from the same point source were run whereby the deposits were stacked on top of its predecessor. The resulting stratigraphy is then analyzed in 3-D, typically in a series of strike and dip sections. The experimental results of a series of numerical simulations are compared and discussed in terms of flow evolution, flow-deposit interaction, and internal architecture and stacking patterns. In our models, the turbidity currents show a behaviour that can be divided into three phases: the ponding, the fill-and-spill, and the trapping stages. A significant grain-size partitioning happens at the early fill-and-spill stage, with the coarser grains getting trapped in the up-dip minibasin and finer grains transported by the spillover flows further downslope. Significant deposition in the minibasin takes place on the counterslope after the first minibasin depression. The flow pathway and evolution depend much on the flow volume reaching the up-dip minibasin, the remaining accommodation space, and the topography geometry and gradient. The deposits can smooth the gradient of the counterslope, allow more spillover, but they can also make the bounding ridge grow and move upstream and thereby restrict the flows to the minibasin. Overall, the turbidite system undergoes a sequence of progradation followed by aggradation and retrogradation. A sequence of coarsening- and thickening-upward trends is dominant in the down-dip minibasins, while the upper minibasin shows different sequences at different locations. The group depocenters in three minibasins all migrate towards upstream longitudinally and to the minibasin center laterally, which results in a back-filling stacking pattern. Some supportive evidence from published literature has been found to validate our main results. Recommendations for future research include seismic or outcrop studies, syn-tectonic sedimentation experiments, and numerical simulations of high-density gravity flows.

Displacement pile installation effects in sand (2015-01-06)
Author: A. Beijer-Lundberg
Promotor(s): Van Tol, A.F.
Keywords: piles

Installation effects govern the post-installation behaviour of displacement piles in sand. These effects are currently not completely understood. Suitable experimental techniques to model these installation effects include field, laboratory and experimental models. In the current thesis, a small-scale laboratory model is used to investigate the installation effect of displacement piles in sand, to complement a numerical study of the same subject. The current knowledge of installation effects is initially discussed. The distribution of shaft friction, resulting from cyclic loading, and the effect of initial relative density on the installation effects are of particular interest. Aims and scope for the current thesis are subsequently discussed, and consist of investigating the effect of installation mode (continuous or incremental installation) and the effect of the initial relative density of the soil before installation. The experiments are carried out in the geotechnical centrifuge, and considerable effort is taken to ensure that the similarity between the scale model and the prototype. This concerns the model itself, the size of the soil grains, as well as the boundaries of the soil container. This process is guided both by theoretical and empirical consideration. The experimental model is then elaborated. This includes the geotechnical centrifuge, as well as the electrical and communications system installed to drive electric control motors and transmit measurement and control data. The model control system is described, including the computer programs that control the model tests. Deformation measurements are carried out by an in-flight camera. The deformation measurements are subsequently analysed with a series of computer programs to adjust for lens distortion and to retain displacement increments with a Particle Image Velocimetry (PIV) program. The soil sample preparation procedure is described, including preparation at different initial relative densities.The small scale model pile is described. This model pile included horizontal contact stress and axial stress measurement sensors that were included in the small membranes inside the model pile. The model pile was analysed with a FE-program to estimate the effect of the loading conditions. Calibration was carried out in custom-made calibration equipment for the horizontal stress sensors and the axial stress sensor.The experimental measurement results consisted of stress measurements and deformation measurements. The stress measurements consisted of the horizontal contact stress and the axial stress, as well as the ratios between these. The deformation measurements were presented as displacement paths in which the soil displacements were analysed, as well as incremental strains. The interpretation of the measurements focused on the effect of initial relative density and the effect of load cycles. The initial relative density was shown to have a large influence on the horizontal contact stress during installation and during extraction of the pile. The deformation measurements showed a similar influence in which the denser soil samples exhibited more horizontal displacement. The effect of incremental installation was analysed in the stress and deformation measurements, and indicates that the compaction of the soil during cyclic loading results in lower horizontal contact stress. The measurements were compared to numerical models that display a similar result, resulting in more confidence in the current theory of installation effects that is included in empirical design methods.

Surface-wave separation and its impact on seismic survey design (2015-04-09)
Author: T. Ishiyama
Promotor(s): Mulder, W.A.
Keywords: surface wave, near surface, noise attenuation, data acquisition, survey design

Surface waves in seismic data are often dominant and mask primaries in land or shallow-water environments. Separating them from the primaries is of great importance either for removing them as noise for reservoir imaging and characterization, or for considering them as signal for near-surface characterization. However, their complex properties, such as dispersion, multi-modality and spatial variability, make the surface-wave separation significantly challenging in processing. To address the challenges, we introduced a method of 3-D surface-wave estimation and separation using a closed-loop approach. The closed loop contains a relatively simple forward model of surface waves and adaptive subtraction of the forward-modelled surface waves from the observed surface waves, making it possible to evaluate the residual between them. In this approach, the surface-wave model is parameterized by the frequency-dependent slowness and source properties for each surface-wave mode. The optimal model parameters are estimated in an iterative way such that the residual is minimized and, consequently, this approach solves the inverse problem. Through synthetic and real data examples, we observed that this method successfully estimates and separates out the surface waves from the seismic data to consequently obtain the subsurface signals. We also observed the method's wide range of applicability to undersampled, asymmetrically sampled, irregularly sampled and blended seismic data. This suggests the possibility of relaxing requirements for survey parameters in terms of surface-wave separation and, therefore, offers flexibility as well as potential effort reduction with respect to seismic surveys. Seismic survey design corresponds to choosing a set of survey parameters that enables imaging and amplitude-versus-offset applications of target reflectors with sufficient data quality under given economical and operational constraints. However, surface waves are often dominant in the seismic data, as already mentioned, and the effectiveness of surface-wave separation or removal significantly affects that of the subsequent steps for target reflectors. Therefore, they impose additional requirements on the survey parameters for acquisition so that those allow for effective surface-wave separation in processing. We should understand how the application of surface-wave separation affects the choice of survey parameters and the resulting data quality. For this purpose, we discussed the relationship between the survey parameters and the resulting data quality in order to find the essential types of survey parameters and their optimal values for a required data quality in the context of surface-wave separation. For 3-D seismic surveys, the relevant survey parameters are the four spatial sampling intervals and apertures of the template geometry. Two of the four spatial coordinates specify the spatial sampling of the basic subset, and two other coordinates specify the spatial redundancy of the basic subsets, i.e., the fold. The signal-to-noise ratio of the data sets after surface-wave separation serves as an attribute or measure representing the resulting data quality. We carried out a case study, applying surface-wave separation and signal-to-noise ratio estimation to several data sets with different survey parameters. The case study led us to conclude that the spatial sampling intervals of the basic subset are the essential types of survey parameters. The resulting data quality is related to the spatial sampling intervals and follows a trend curve, in which finer spatial sampling intervals improve the resulting data quality until it levels off on a plateau. The shape of this trend curve depends on the method of surface-wave separation. Given this impact of surface-wave separation on survey design, it should be included in the design, next to its intended application for reflection imaging or amplitude-versus-offset analysis. We then discussed the relationship between the survey parameters and the resulting data quality in the context of reflection imaging and amplitude-versus-offset applications. We also carried out a case study for this purpose using the so-called focal-beam method to several data sets with different survey parameters. Through the case study, we observed that the spatial sampling intervals and apertures of the basic subset are the essential types of survey parameters for reflection imaging, and that all the four spatial sampling intervals and apertures of the template geometry are essential for amplitude-versus-offset applications. A noteworthy conclusion is that suitable spatial sampling intervals for surface-wave separation also suffice for reflection imaging and amplitude-versus-offset applications. Therefore, for survey design, the spatial sampling intervals of the basic subset should be determined first for a required signal-to-noise ratio as needed for surface -wave separation. The other survey parameters should be considered next for a required resolution and prestack amplitude fidelity as required for reflection imaging and amplitude-versus-offset applications.

Basal Reinforced Piled Embankments (2015-07-01)

Author: S.J.M. Van Eekelen
Promotor(s): *Van Tol, A.F.*, *Bezuijen, A.*
Keywords: piled embankments, geosynthetics, arching, Concentric Arches model, geosynthetic reinforcement, geoengineering, geotechniques, road construction, infrastructure, design guideline

A basal reinforced piled embankment consists of a reinforced embankment on a pile foundation. The reinforcement consists of one or more horizontal layers of geosynthetic reinforcement (GR) installed at the base of the embankment. The design of the GR is the subject of this thesis. A basal reinforced piled embankment can be used for the construction of a road or a railway when a traditional construction method would require too much construction time, affect vulnerable objects nearby or give too much residual settlement, making frequent maintenance necessary. The GR strain needs to be calculated to design the GR. Multiplying this GR strain by the GR stiffness gives the tensile force, which needs to be smaller than the long-term GR tensile strength. The GR strain is calculated in two steps. Calculation step 1 divides the load – the weight of the embankment fill, road construction and traffic load – into two load parts. One part (load part A) is transferred to the piles directly. This part is relatively large because a load tends to be transferred to the stiffer parts of a construction. This mechanism is known as 'arching'. The second, residual load part (B+C) rests on the GR (B) and the underlying subsoil (C). Calculation step 2 determines the GR strain on the basis of the result of step 1. Only the GR strips between each pair of adjacent piles are considered: they are loaded by B+C and may or may not be supported by the subsoil. The GR strain can be calculated if the distribution of load part B+C on the GR strip, the amount of subsoil support and the GR stiffness are known. An implicit result of this calculation step is the further division of load part B+C into parts B and C. Several methods for the GR design are available, all with their own models for calculation steps 1 and 2. The methods give results that differ immensely. The Dutch CUR226 (2010) and the German EBGEO (2010) adopted Zaeske's method (2001). However, measurements that were published later (Van Duijnen et al., 2010; Van Eekelen et al., 2015a) showed that this method could be calculating much higher GR strains than those measured in practice, leading to heavier and more expensive designs than necessary. The objective of the present study was to establish a clearer picture of load distribution in a basal reinforced piled embankment and, on that basis, to develop and validate an analytical design model for the geosynthetic reinforcement in a piled embankment. The results were described in five papers published in the international scientific journal 'Geotextiles and Geomembranes'. Those journal papers can be found in Chapters 2, 3, 4, 5 and Appendix A of this thesis (Van Eekelen et al., 2012a, 2012b, 2013, 2015a and 2011 respectively). Chapter 2 presents a series of twelve 3D experiments that were carried out at the Deltares laboratory. The scaled model tests were carried out under high surcharge loads to achieve stress situations comparable with those in practice. A unique feature of these tests was that load parts A, B and C could be measured separately, making it possible to compare the measurements with calculation steps 1 and 2 separately. In these tests (static load, laboratory scale), smooth relationships were obtained between the net load on the fill (surcharge load minus subsoil support) and several measured parameters such as load distribution and deformation. Consolidation of the subsoil resulted in an increase in arching (more A) and more tensile force in the GR (more B and more GR strain). The measured response to consolidation depends on the fill's friction angle. A higher friction angle results in more arching during consolidation. One of the major conclusions based on the test series was that the load on a GR strip is approximately distributed as an inverse triangle, with the lowest pressure in the centre and higher pressure close to the piles. This conclusion was the basis for the remainder of this doctorate study and the development of the new calculation model. Chapter 3 considers calculation step 2. This chapter starts by comparing the measurements in the experiments with the calculation results of step 2 of the Zaeske (2001) model, which uses a triangular load distribution on the GR strip and considers the support of the subsoil underneath the GR strip only. It was found that Zaeske's model calculates GR strains that are larger than the measured GR strains (approximately a factor of two for GR strains larger than 1%). Chapter 3 continues with the suggestion of two modifications to Zaeske's step 2. Firstly, the load distribution is changed from a triangular to an inverse triangular load distribution. Secondly, the subsoil support is extended from the support by the subsoil underneath the GR strip to the subsoil underneath the entire GR between the piles. The new step 2 model with these modifications produces a much better fit with field measurements than Zaeske's model. Chapter 4 considers calculation step 1, the arching. Additional tests were conducted for this purpose, varying factors such as the fill height. This chapter gives an overview of the existing arching models and introduces a new model. This Concentric Arches model (CA model) is an adaptation and extension of the models of Hewlett and Randolph (1988), and Zaeske (2001), which have been adopted in several European design guidelines. Some countries use piled embankments without GR. Introducing GR changes the load distribution considerably. A major part of the load is then exerted on the piles and the residual load is mainly exerted on the GR strips between the piles, with the load being distributed approximately as an inverse triangle. Chapter 4 explains the development of the load distribution as a result of continuing GR deflection; new small arches grow within the older larger ones. Smaller arches exert less load on their subsurface. This idea is related to the concentric arches of the new model, which gives an almost perfect description of the observed load distribution in the limit state situation. Furthermore, the new model describes the influence of the fill strength and embankment height correctly. Chapter 5 compares the existing, and the newly introduced, design models with measurements from seven full-scale projects and four series of scaled model experiments. Two of these seven field projects were conducted in the Netherlands and they were carried out in part for this doctorate research. One of the four experimental series – the one presented in Chapters 2 and 4 – was conducted specifically for the present research. The other measurements were reported earlier in the literature. The calculations were carried out using mean, best-guess values for the material properties. The calculation results from the CA model match the measurements much better than the results of the arching models of Hewlett and Randolph (1988), and of Zaeske (2001). The results of the CA model are also the closest match with the results of the 3D numerical calculations, as described in Van der Peet and Van Eekelen (2014). These authors also show that the new CA model responds better to changes in the fill friction angle than any of the other models considered. When there is no subsoil support, or almost no subsoil support, the inverse triangular load distribution on the GR strips between adjacent piles gives the best match with the measurements. When there is significant subsoil support, the load distribution is approximately uniform. This difference between the situation with or without subsoil support is understandable when one considers that most load is attracted to the construction parts that move least. In the cases with limited subsoil support, the load distribution that gives the minimum GR strain should be used to find the best match with the measurements. The GR strain calculated with Zaeske's model is on average 2.46 times the measured GR strain. The GR strain calculated with the new model is on average 1.06 times the measured GR strain. The calculated GR strain is therefore almost a perfect match with the measured GR strain. The new Dutch CUR226 (2015) has therefore adopted the model proposed in this thesis.

Abstracts from Geo-Engineering MSc thesis candidates for the best thesis award 2015

Influences of ice lens formation in a silty soil

T.J.H. Van den Bosch

Artificial ground freezing (AGF) has been applied over 150 years for mining, and was adopted for civil engineering purposes more than 30 years ago. AGF is used as a construction method to provide structural support and to exclude groundwater. Due to 9 percent volumetric expansion of pore water during freezing, soil experiences primary heave. In fine-grained soils, due to formation of distinct ice lenses, soil heave may occur. This secondary heave may contribute significantly to the total heave. After thawing, favourable effects of the freezing process may turn into unfavourable soil conditions due to reduction in strength properties and thaw settlements.
The primary thesis objective is investigating one-dimensional ice lens growth and its influence on physical and mechanical properties and deformation of a silty soil. To focus on important aspects only, three secondary objectives were formulated, being establishing an overview of literature, designing test equipment and performing lab tests on frozen soil. Freeze-thaw cycles (FTCs) consist of three phases: initiation phase, preservation phase and degradation phase. In the initiation phase a temperature gradient is introduced, initiating heat extraction. The temperature within the sample starts to drop now. At the end of this phase thermal equilibrium is established, which is maintained during the preservation phase. Between the frozen and unfrozen zone lies the frozen fringe, which is partially frozen soil with reduced permeability.
Water from the unfrozen zone can flow through this zone, until it freezes. Here ice crystals may form distinct layers, known as ice lenses. The lens thickness can increase as long as the frozen fringe supplies groundwater. Two theories exist regarding moment of ice lens initiation: a pressure- and a temperature-based theory. During thawing phase, pore ice melts and water is released by the thawing soil. In fine-grained soils, drainage of excess pore water is limited by the permeability, resulting in excess pore pressure. Therefore, effective stress and shear strength may be reduced after thawing. Soil tends to reach a residual void ratio that is approached after a number of FTCs. The result is densification of loose soils and loosening of dense soils. Remarkably, the particle rearrangement always causes an increase in permeability. With regard to changes in mechanical properties after thawing, different conclusions were found, sometimes even contradictory. This may be because of different researchers studied different soils and applied different test conditions. A lack in study is recognised on the difference between natural and reconstituted soils, between the same soil at different densities and between soil types. During FT tests on natural clay the inter-particle bonding was damaged and disappeared after five FTCs. As laboratory-prepared samples lack particle cementation, they are not as affected by FT damage. Triaxial test data for this project was not accurate enough for determination of undrained shear strength and permeability. By frost heave observations useful data was obtained.
For the frost tests Illite and K122 was used, given their high potential for ice lens formation. Frost heave progresses non-linearly, starting rapidly, but slowing down after a while. This is probably because of temperature boundary effects of the setup. With decreasing cold-side temperature, the frost heave increases. This is partially the result of a larger frozen zone, as seen on μCT scans. With this non-destructive method the internal rearrangement of the soil particles was monitored, revealing vertical cracking and expansion of existing cracks. Numerical test results show a linear relationship between sample height and frost penetration height and thus, primary heave. The secondary heave is not height-related, as lens growth is a distinct process dependent on time. Other test results show a non-linear relationship between sample height and time to establish thermal equilibrium.

Influence of capillary bridges on weathered tailings material

S. Carelssen

Weathering of tailings materials (mine waste) can affect the grain size and angularity of the grains. As a consequence, the angle of repose of such granular material and void volume (porosity) decreases, which potentially results is in the failure of a slope of such material (e.g. tailings dam). The decrease of the porosity may affect the permeability and increase the (volumetric) water content (W) of the material. The water content of a material influences the amount of capillary bridges that are formed in an unsaturated granular material. Most research has been done on the effects of these capillary bridges on the static shear strength.
In this thesis, the influence of the residual (dynamic) shear stress was studied with a newly built shear box test. The resulting Mohr Coulomb failure envelope suggests that for water content below the maximum value of the residual shear strength (W = 0:1), capillary bridges add to rigidity of the bulk material rather than adhesion in the shear band. This is rejected in an increasing angle of internal friction, while the cohesion is negligibly low. A peak in the cohesion at W = 0:1 suggests that capillary bridges are formed and pinched off continuously in the shear band, resulting in a maximum residual shear strength. Finally, for W > 0:1 both the angle of internal friction and cohesion are found to decrease signicantly.

Immediate & long-term installation effects adjacent to an open-ended pile in a layered clay. An experimental approach

M.G. Ottolini

Floating piles in soft soil deposits primarily mobilize their bearing capacity by means of shaft resistance. The upper part of the pile triggers a downward traction on the pile shaft whilst the lower part mobilizes the shaft friction in the soil required for the pile bearing capacity. The transition between these two modes of shaft friction is often deemed as the neutral-plane. This plane, which is not at a constant level, assists in predictions of the (long-term) settlements of a pile in such a soil. Floating piles primarily occur in areas where stickier clay layers are overlain by softer clay layers, e.g. on the west-coast of Sweden or in the Kaspian Sea.

In the past, the response for the floating piles has been extensively described using the neutral plane approach. This approach requires a reliable prediction of the soil settlements, which in turn are affected by the pile installation effects in the soil. Additional experimental evidence on the soil behaviour during, directly after installation and in the long-term is required if advanced numerical methods are considered and current analytical design methods to be improved. A novel approach to retrieve this experimental data on immediate and long-term pile installation effects in the geotechnical centrifuge is developed. An axisymmetric experimental test setup allows for measurement of full-field displacement as well as pore pressures during and after installation. This setup uses an instrumented wall with 40 pore pressure transducers. Additionally, an image sequence taken with a machine vision camera is used to extract the soil displacements by application of Particle Image Velocimetry (PIV). Due to natural low contrast of the kaolin clay used for the experiments a novel method for the application of contrasting speckle material on a clay sample is developed. This method applies the contrast material on the surface of the slurry without the need of removing the transparent window of the strongbox. Therefore tracking of the material displacements during the consolidation stage and subsequent loading stages using imaging methods is facilitated.

The results of the experiments are generally in agreement with the framework reported in literature and indicate that pile installation effects, such as generation of excess pore pressure and change of the hydraulic conductivity in the soil due to remoulding, have an inuence on the development on the neutral plane and therefore the prediction of the response of floating piles. Additionally, the results can be used to benchmark numerical calculations with advanced constitituve models.

Earthquake induced liquefaction susceptibility of Carbonate sands. Experimental study: Cyclic behaviour of Carbonate materials used as hydraulic fills

K. Petropoulos

This research deals with the evaluation of earthquake induced liquefaction susceptibility of carbonate sands, used as hydraulic fill. Existing evaluation methods are based on in-situ penetration tests (CPT, SPT etc.) and on seismic case histories at sites where silica sands are predominant. These methods cannot be implemented on carbonate sands, due to their crushable nature. Very limited experimental research has been done to evaluate the seismic performance of this type of sand which is abundant in seismically active regions (e.g. Central America).

A series of isotropically consolidated undrained cyclic triaxial tests were conducted using a carbonate sand from Central America. The tested Central American carbonate sand is a poorly graded clean beach sand with highly angular grains. The performed test program was set to simulate a typical hydraulic fill structure. For this reason the carbonate samples were tested at three relative densities (20%, 50%, 80%), three effective confinements (50kPa, 100kPa, 150kPa) along with three cyclic loading scenarios represented by the *cyclic stress ratio* (CSR=0.2, 0.28, 0.32).

The evaluation of the liquefaction susceptibility was based on the excess pore-water pressure development during cyclic loading. Cyclic strength curves were generated by plotting the cyclic stress ratios (CSR) with the number of loading cycles until liquefaction (N_f). These curves were compared to those reported in the literature concerning both silica and other carbonate sands. Overall, the Central American carbonate sand was shown to be less susceptible to liquefaction than silica sands. While both density and confinement had a meaningful effect on its cyclic strength, the former was more influential. Furthermore, compared to Toyoura (silica) and two other carbonate sands, the density effect was less pronounced, whereas the effect of confinement was significant for all carbonate sands. No particle crushing effects were observed, due to the low imposed confinements encountered in a hydraulic fill mass.

Modeling MIC and Metal Precipitation with a 1D Reactive Transport Model

J. Zhou

This model includes a relatively wide range of processes, which enables a more comprehensive representation of complex interactions in the subsurface environment. In terms of biomass development, this model includes the sequential degradation of electron donors, sequential utilization of electron acceptors, kinetic biomass growth on module is constructed considering the time-scale of reactions, in which both kinetic reactions and equilibrium reactions are explicitly included. In the representation of transport process, only diffusion under fully saturated condition is considered, the physical transport medium properties in this model are interconnected with bio-chemical reactions. In a conclusion, this model has profoundly investigated these three dominating processes and their interactions.

Series of simplifications and assumptions were made. The biofilm dynamics are ignored which results the localized simulated biomass distribution. In terms of mineral precipitation, this model applies a uniform rate law for all minerals. It leads to a generic expression but also might oversimplify the kinetics regarding specific mineral precipitation processes. Although this model presents the possibility of the inclusion of gas phase, all simulations are implemented with the fully saturation assumption.and decay.

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The model has been verified using experimental data from two different experiments, and proven to be able to give accurate predictions. Nevertheless, the verification does not cover the entire model yet. The sequential degradation of electron donors, sequential utilization of electrons and the gas-liquid equilibrium modules have not been verified. Their effects on microbially influenced mineral precipitation are not investigated.

In the application of this model on microbially influenced mineral precipitation simulation, this model helps to predict the effects of varying boundary concentrations and varying distance on the spatial distribution of precipitated minerals. 1) In terms of mineral precipitation under double diffusion control, precipitation mainly occurs close to the low concentration boundary; 2) Precipitation position and magnitude are highly influenced by the solubility product of minerals.

The solubility product helps to study the competition for species among various minerals; 3) Microbial activities influence the concentrations of species and therefore drive mineral precipitation; 4) Although this research does not specifically investigate a microbially driven siderite precipitation strategy under sulfate reduction condition, it can be possibly achieved by preventing pH from reducing in the vicinity of iron surface.

Note: "Working abroad"

*Contribution from **Koen de Jong** (Witteveen+Bos)*

Approximately 2 years ago, my wife, daughter and I moved to Jakarta Indonesia for my work in the Indonesian office of Witteveen+Bos. Indonesia is a location with a lot of Dutch history attached to it and quite frankly, I was a little bit afraid when we boarded the plane that there would be some hostility against us since our joined history is not an especially glorious one. In addition to that, my first name does sound very familiar to Indonesian ears, and not in a good way.
I couldn't have been more wrong. We were welcomed in Indonesia as if we were long lost friends that finally managed to come back home, and the kindness of the Indonesian people will be among the best memories that I will keep from my years in Indonesia. To illustrate; when I introduced myself on the Banda islands (where some guy named Coen murdered the whole population), a very enthusiastic host said: "Aaah, Coen, that is a very good name ya, very Dutch!" and I got a double thumbs up. This scene automatically brings us to the nicest and most difficult aspect of working abroad: the cultural differences. When I first moved here, I expected it would take some months to really understand what a certain type of behaviour meant, or to read the state of mind behind the words. Actually, that was a massive underestimation, and to be honest, I am now quite sure that I will always need a 'cultural' translator. Many times after meetings I needed to ask my Indonesian colleges what the Client thought of our ideas, and whether the reaction was positive or negative. It adds to the fun of working abroad in an interesting way.
The past two years I have been working mainly on technical assistance during construction of 2 man-made islands in the Jakarta Bay. A very challenging project, since the subsoil consists for the first 10-15 m of very soft clays and silts, making the construction of the dikes

Figure 1. The projects

Figure 2: Common floods in Jakarta

on top of this layer very critical. Sufficient safety is required in all phases of the project; during construction, after the design life time, and also during possible seismic events. The amount of calculations required to establish that this goal is achieved is substantial. Luckily we have a good team of both international and local staff to assist in this job and the project is currently moving towards completion. The end of this project will however not be the end of our work in Indonesia; the country is developing at a rapid rate. Land reclamations and urban developments are all over the place and Jakarta is trying to solve its major problems with regard to flooding, traffic congestion, pollution and waste water treatment. There are large opportunities and equally large problems in this country, which make working here very dynamic and challenging.
By the time you will read this, I am already back in the Netherlands. Currently my house is full of boxes, my office full of the well known stress that precedes a major change like this, and my mind full of doubt whether I have thought of all paperwork and practical arrangements that are needed for a smooth transition.
When I get on the plane next week I will look back at a great time in Indonesia. I will leave the Jakarta that is so dreaded by the Lonely Planet, that floods a number of times each year, that does not have sewerage, that has smog that makes sunblock unnecessary even though it's in the tropics and has traffic jams that are legendary (for example: yesterday it took me 1 hour to move 150 m). But still I will miss it, Jakarta has a strangely relaxed atmosphere; it feels like a small village which somehow manages to contain 15 million inhabitants. It takes some getting used to, but when you're patient, you will be rewarded.

Notes for the authors

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  - Figures, drawings, and pictures should be produced in one of the common image formats: GIF, TIFF, JPEG.
  - Figures, drawings, pictures, and tables should be submitted separately; named and numbered in a logical order according to their placement in the main text. Submissions should be preferably in digital format. The print size should be selected by considering possible reduction for the final version.
  - Each article must include the author(s) name(s), affiliations and address, and a short abstract of preferably less than 100 words.

Advertising in the Newsletter

The Newsletter is distributed to the 160 members of the Ingeokring and several companies and institutes, active in the field of Geo-Engineering. The Newsletter offers the possibility to advertise and bring your company to readers' notice.

Advertisements, preferably in English, can be published either in black/white or in colour, A4 or A5 size. Rates are listed below:

Size	**Black/white**	**Full colour**
A4	€375 (2 issues)	€750 (2 issues)
A5	€225 (2 issues)	€450 (2 issues)

Advertisements should be sent to the editorial board (address provided at the inside of the front cover), preferably in high resolution digital image format (e.g. PDF, GIF, TIFF, JPEG).


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