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Van de Redaktie

Voor U ligt het laatste nummer van de IngeoKring Nieuwsbrief van 1990. Wellicht heeft U het gevoel dat er dit jaar toch wat weinig nummers in Uw brievenbus zijn gevallen. Inderdaad is er een nummer minder uitgekomen. Dit doordat wij helaas hebben moeten constateren dat de herhaalde oproepen tot het insturen van kopij niet het beoogde effect hebben gehad.
Dit is zeker niet het gevolg van een verminderde aandacht voor de Ingenieursgeologie. Integendeel er is een duidelijke opleving te bespeuren, niet alleen op geotechnisch gebied maar ook op het gebied van milieu en het onderwijs. Dit laatste moge blijken uit het groeiende aantal studenten dat voor Ingenieursgeologische richting kiest. Er is zeer zeker genoeg potentieel voor deze mensen. Het is echter wel van groot belang dat zowel het bedrijfsleven als de overheid op de hoogte blijft met het vakgebied en de mogelijkheden van de Ingenieursgeoloog. Leden zouden hier een bijdrage kunnen leveren door het inzenden van artikelen voor de Nieuwsbrief.

In deze Nieuwsbrief wordt begonnen aan een nieuwe serie artikelen over ingenieursgeologische routes door Nederland. De Nieuwsbrief bevat tevens een abstract van een litteratuurstudie naar de Permeabiliteit van rockjoints. Daarnaast zijn er twee Symposiumrapporten met dezelfde titel. Laat U niet misleiden, de inhoud is anders!. De traditionele bijdrage van Drs. P.N.W. Verhoef is helaas niet aanwezig, dit als gevolg van zijn werkzaamheden in het buitenland. Ook is er een interview met een Student uit Tanzania die in Delft aan het I.T.C. studeerd. Zeker voor de studentleden zal het interessant zijn om dit stuk te lezen.
Achterin tenslotte is een Ledenlijst afgedrukt. Het is de bedoeling dat deze wordt gecontroleerd op de juistheid van de gegevens.

DE REDAKTIE WENST U EEN VOORSPOEDIG 1991

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Engineering Geological Routes in the Netherlands
Instalment 1
Introduction to the post 6th IAEG congress tour

A new series of articles will be published on engineering geological tours along major routes in the Netherlands.The first four instalments are based on the post 6th International Congress of the IAEG tour through the Netherlands starting after the last session of the conference on the Friday afternoon of 10th August,1990. The tour headed south along the A2 ending at Urmond in South Limburg. The second day the tour visited six major attractions in South Limburg, of which the remainder of the A2 towards Maastricht is not considered as one of the attractions. The Sunday the post conference tour headed North approximately following the Maas and visiting many attractions along the way. The Geology increasingly became younger. The final day, the Monday the route headed straight towards the young peat deposits of North Holland and ended in the youngest deposits of the Netherlands, in Flevoland.

Several people contributed towards collecting and writing articles for the series, all helping also to organise what was a very informative long weekend. These are ir. Meindert van den Berg, Drs. Rene Kronieger, Professor David Price and Ir. H.J. Winkels. Further contributions have been made by others; these contributors are all acknowledged in the articles as they appear.

Instalments subsequent to the IAEG post-congress tour will appear: one article is on a DIG (TU Delft/ ITC Dispuut IngenieursGeologie) excursion to Groningen. As excursions occur efforts are now made to describe the geology along the route. Contributions from others who may have written a guide in the past are welcome to add their guide to the series on "Engineering geological routes in the Netherlands".

Winding into history along the A2 from the present to 60 million years in the past

by P.M. Maurenbrecher

Amsterdam is young. It is built over deposits which are not much older than the oldest buildings over them. These Holocene deposits sound like a travel brochure for ferry crossings to England; the Calais deposits, the Dunkirk deposits all part of the Vecht's and Amstel's efforts before urbanisation to feed the marshes and tidal flats with sediment and organic matter to elevate the land above the sea. It has since sunk as the weight of buildings and mans efforts to keep the place drained has caused the underconsolidated sediments to compact. There are almost fifteen meters of very low density silts, clays, peats fine sands, soft clays and peat before a sand layer appears which represents an older landform during the last glaciation. On this landform flowed an ancient tributary River "Y" (*IJ*) of the Rhine which eroded meander channels in them before the sea levels rose as a result of glaciers melting to the north. The sea continued to fluctuate as we go back into time as softer clays divide this first sand layer with deeper sand layers starting again at 20 metres depth. Your congress centre, The Rai, would have its piled foundations going down to this layer. In some places in Amsterdam 40 meters may have to be penetrated before you will find a bearing layer as many of the River Y's channels are infilled with soft clays and loose silts and sands. The older buildings which charm the tourists (and do not go unnoticed by us Dutch either) have a vast forest of 15 meter deep tree trunks beneath them. They remain preserved and do not succumb to 'negative skin friction'as long as the groundwater remains high, hence the critical balancing act being played out by keeping Amsterdam's basements and streets clear of water but making sure not to drain too much.

It's only a short distance to the elevated motorway (piles down to at least 20 metres) and we travel a little way due east before heading south along the A2, Holland's most trafficked road. We may find ourselves in several "*files*" as the Dutch call their traffic congestion. Hence read on... there is plenty of time. We travel south towards the town of Utrecht and its famous Dom, a landmark that has endured now over six hundred years despite being separated from the end nave as a result of fire destroying the nave's centre part. The route follows the Amsterdam Rhine Canal. The canal in turn follows the Vecht, a smaller tributary of the Rhine flowing from the south. There is a lake complex to the east known as the Loosdrechtse Plassen (*plassen* can mean anything from what little statues in Brussels do (Manneken Pis) to puddles in Dutch). These were formed mainly by man; they were Holland's principal energy source until coal from the mines in Limburg late last century substituted this source: peat. Thick peat deposits. Now these "scars" are recreation areas and nature reserves. They have risen to the level of national monuments because of their unique landscape. Will the scars we create today follow the same path? No one seems to think so. (The bus presumably now erupts in heated discussion, the heat more to do with standing still as a portion of the Netherlands's population- it seems like the whole of the Netherlands is on the road- must have decided to choose this very evening, why always on a Friday evening, to go on vacation with their caravans to France. I can think of nothing worse then spending a vacation in some camping ground with a caravan. Anon, the writer, remains anonymous to avoid heated discussion on caravan vacations.)

Beyond the Loosdrechtse plassen is high ground; above sea level. These are the heaps of sand and boulder clay bulldozed by the Saalien glaciation of over 70,000 years ago leaving behind clays containing boulders transported all the way from Scandinavia.

To the right (west) are the flatlands much of which was under water until 1860 when steam pumps drained the Haarlemmer Lake. Part of this lake is now occupied by Schiphol Airport.

Just past Utrecht the A2 crosses over the main east-west road of the Netherlands, the A12 and continues over the Dunkirk fluvial/deltaic sediments laid down by the tributaries of the Rhine. Just beyond Nieuwegein we encounter our first main Rhine tributary, the Lek River. The other principal tributaries are the IJssel which branches off towards the northwest skirting the ice-pushed ridges along their northern flank flows into IJssel Lake, the old Zuider Zee (South Sea) and the Waal the largest tributary which we cross after another 25 km further along the A2. The geology remains Dunkirkian. The area is known as the Betuwe which is known for its fruit orchards. A second east-west road, the A15 we cross before crossing the Waal onto the island of Bommelerwaard. It is an island as after only another 10 km we meet yet again another major river. This time It is not a Rhine tributary but the Maas River which started of as the Meuse in France, flows as the Meuse through Belgium until it reaches the southeastern extremity of the Netherlands at Maastricht. There-after it becomes the Maas and for a short length also forms the border with Belgium. For that part of Belgium it is also known as the Maas as the Walloon (French speaking) and Flemish (Dutch speaking) border in Belgium meets the Netherlands at the same point where the Meuse/Maas enters the Netherlands.

About 10 km east of the bridge a short channel connects the two great rivers. Further down stream the major confluence occurs in a wild marshland area known as the Biesbosch; hence the island of Bommelerwaard.

The young deposits and rivers congregating in this area can be mainly attributed to the fact that the whole route we are following to Limburg follows a basin which is subsiding along the graben of a major rift fault system. If time allows (you would not have read this far because the bus was not held up by the *files*) we can take a detour as we pass 's-Hertogenbosch (pronounced *sairtochenbos* the *ch* as in the Scottish pronunciation of *loch*) provincial capital of Brabandt. 's-Hertogenbosch is near the centre line of the rift graben so that Pleistocene deposits extend to 200 metres depth and the underlying Tertiary sediments extend beyond 500 metres depth. The detour is to view the still active Peelrand fault. The fault forms the first fault of many on the north eastern flank of the graben. Evidence for the fault can be seen at Uden. To reach this we drive east to Oss along the A50 then at the Oss by-pass we drive down country roads for 10 km to Uden. At Uden we follow the road to Veghel which first by-passes Uden to the east. Along the turn-off to Volkel and the military cemetery on the left is where the Peelrand fault forks to the northwest into two faults. It runs parallel to the road up to the railway track, where after it trends south east as the road makes a wide bend to the east. At Uden the oldest Pleistocene formation (Tegelen) on the north eastern side is faulted against the youngest (Twente) on the south western downthrow side. To the east are fluvial deposits of the Veghel formation and the general low lying area of the Peel which has inland peat deposits from the Eemian interstadial of 70 000 years ago.

We head then along the road to the town of Veghel from which the name of the above formation is taken. There we turn left along the Zuid-Willemsvaart the main navigation route from 's-Hertogenbosch to the Belgium canal which connects the Maas further upstream with the port of Antwerpen. The land now rises towards a watershed that approximately follows the Belgian-Dutch border to the south. The rise in land is the result of glacial wind blown sands piling up against the rise of the Brabant-London Massif which has not been effected by the rifting skirting its eastern flank. The sands blew in from the north picked up by arctic winds as they passed over the glacial deposits derived from the high ground east of Utrecht. The nutrient of the ground is less than in the fluvial flat lands and hence much of it is forested.

If there was too little time to visit Uden the bus would have continued along the A2 (N2) from 's-Hertogenbosch to Eindhoven. The geology again is the same as described above along the Zuid-Willemsvaart canal. The terrain passes a ridge of dune sand which trends SW-NE to the north of Eindhoven and can be found on normal route maps "Lieshoutse*heide*" near the Zuid-Willemsvaart and "Sonse *Heide*" east of Best along the N2 to Eindhoven. "*Heide*" means heath and suggests high sandy ground covered with heather. Much of this terrain persists round Eindhoven "Oirschotse*heide*", and further SW Oostelbeerse *Heide* etc all the way into Belgium. Further parallel ridges exist towards Tilburg as well as to the south of Eindhoven though the SW-NE trends seem less obvious as stream erosion dominate the landform in this area. Eindhoven is a company town. Philips has their headquarters here; it also started here 100 years ago and supplied electric lamps then to light up the Winter Palace of the Czar of Russia. The football club of Eindhoven is called PSV: Philips Sport Vereniging and it supplies players to the Dutch national team.

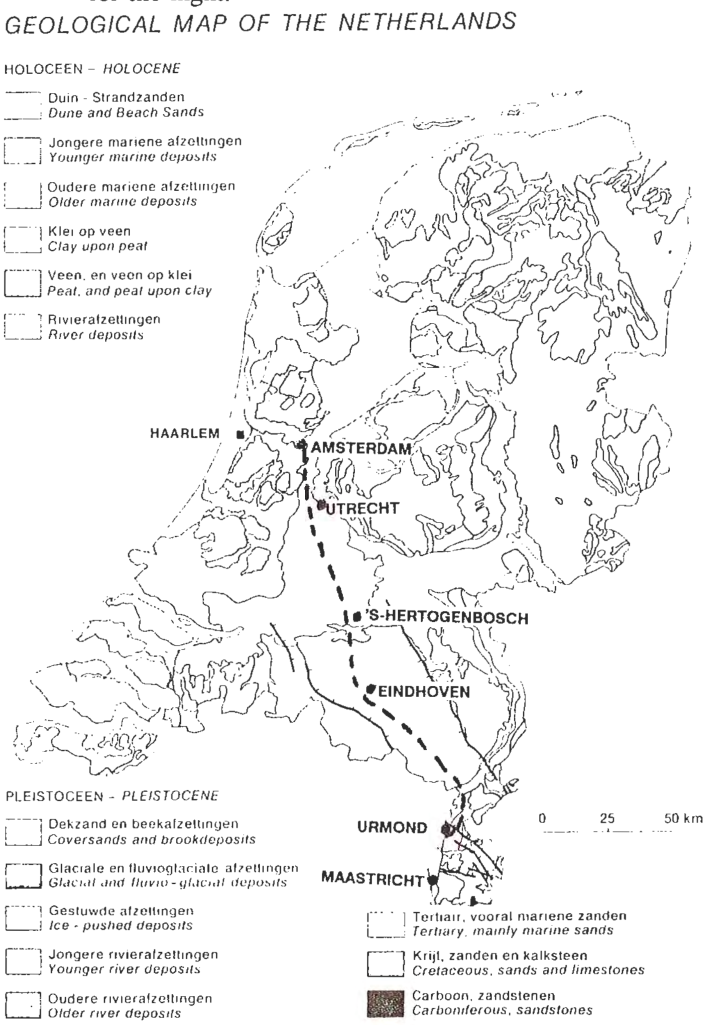
The sands continue up to and past Weert where the Zuid Willemsvaartroute joins the A2. The road approaches a large power station the Claus Centrale, which derives its cooling water from the River Maas. The River Maas has followed a circular bend of radius 50 km with Eindhoven at its centre and so now it is tangential to the SE radius flowing towards the NE in a large broad valley whereas at 's-Hertogenbosch it was tangential to the northern radius flowing west. The Maas has been considerably widened caused by gravel exploitation from the gravels the river has transported from its source quartz and granite rock in the Ardennes and the Vosges.

Crossing the bridge the A2 follows the Maas upstream which unbends almost into a straight line south. The terrain remains slightly undulating, all the way to our hotel at the Sittart junction. On the right can be seen the dyke which contains the elevated Juliana canal; the navigation channel of the Maas along this stretch which rejoins the river just north of Maastricht, "the Juliana Haven". The ground cover is becoming less sandy as distance has sorted the glacial sand winds from the north so that finer sands and silts make up the soil cover. This soil offers more nutrient and in this area is ideal for asparagus cultivation. Asparagus features locally on every menu during May and June. The Quaternary here does not dominate as it did up to now, monopolising only the narrow (7 to 15 km wide) isthmus of Dutch land that extends from the Belgium border along the Maas in the west and to the border with Germany on higher ground in the east. The higher ground becomes Tertiary sands of the Miocene famous for the huge open pit brown coal mines further east.

Shortly we reach the Van Der Valk hotel with its large incongruous Tucan bird sign. We have travelled up to thirty million years. Tomorrow a further ten minutes drive you rise into the Cretaceous limestone plateau landscape of south Limburg. Across the road is the northern end of a large chemical complex of the DSM. DSM has its origins in geology; *De Staats Mijnen* meaning The State Mines. Part of the complex exists over the now discontinued Maurits Mine. The mines obtained Carboniferous coal which had replaced peat as the main energy source in the Netherlands during the nineteenth century. In 1973 the last mine was closed; coal by that time had been replaced by a cheaper cleaner source of energy: the vast natural gas fields of Slochteren in the northern extremity of the Netherlands. The Staats Mijnen had been diversifying into chemicals. Less labour intensive then the mines the miners had to find work elsewhere. Many were employed in the then fledgling automobile industry of the DAF car factory at Born situated just to the north at the narrowest section of the isthmus. Since 1976 the DAFs became Volvos.

For those who would like to stretch their legs; a short walk through the small town of Urmond will take them to the Juliana Canal. The town is on the slopes of the terrace of Caberg which drops to the lower and younger terrace of Gronsveld. Urmond, the travel books say, is the archetype Maas village; steeps narrow streets, has a walled hill, an old church dating back to 1793, a 1803 windmill, public hand-pumps, a skippers house, miners dwellings (for the miners who worked in the Maurits Mine) and evidence that it was populated 5500 years ago. Once on the dyke of the canal you can watch the last rays of the evening sun which must have just set somewhere along the northwestern horizon lighting the high ground of the Belgian Limburgseheide underlain by Miocene sands and the very ancient pre-Cambrian quartzites of the London-Brabant massif.

Just a kilometre to the north is the Heerlerheide fault, part of south western flank of the graben extending up to and past 's-Hertogenbosch. The fault system forms part of a rift complex extending well into the northern limits of the North Sea, passes through the Netherlands, winds its way along the Rhine towards Switzerland, then through France along the Rhone valley and into the Mediterranean through Sardinia and the Sicilian Channel ending up beyond the Gulf of Sirte in the desert wastes of the eastern Sahara. We hope for our guests that it remains dormant for the night.



The A2 route from Amsterdam to Urmond.
The route is superimposed on the Rijks Geologische Dienst - Netherlands Geological Survey postcard map.

Geological History of South Limburg: "From 290 million years into the past to the present"

by R.R. Kronieger

The field trip began with the promise of from the present into 60 million years of history. The exposed geology of South Limburg is somewhat older: it goes into the Carboniferous. Owing to the brief period in this area there is no time to see the small disused quarries exposing the Carboniferous sandstones in the Epen Dal (Epen Valley). The combination of the strata rising towards the south and the river Geul eroding through the younger overlying strata has, by chance, allowed the Netherlands an exposure into Carboniferous. The Geul is on the border with Belgium, and it is less then a stone's throw away from the quarries.

Up to 1973 coal was mined from the Carboniferous. The Maurits Mine, now in the DSM chemical complex (opposite our hotel) is the most westerly of an almost continuous mining complex running up the German border about 20 km to the east.

Hence something about 300 million years ago to the present:

The Carboniferous

The geological history of Limburg starts 280 million years ago with the deposition the Viseen as the Lower Carboniferous is locally known. This formation outcrops just outside the southern border with Belgium. The oldest rocks of the Viseen, the Dinantian, consist of dark massive limestones. They are frequently used as doorsteps. These limestones were generated in a shallow shelf sea which covered northern England, the North Sea and the northern Netherlands. The Caledonian mountain range which existed to the north supplied very little sediment so the main deposits were formed in the basin itself consisting of carbonates with fossil fragments. At the southern border of this sea the forming of a new orogeny the Vosges and middle Germany introduced arkosic and sand like material towards the end of the Viseen. Viseen material in Limburg is only known from mining and from drilling.

Its is upper part of the Carboniferous, the Namurien, that can be found in the Heimansgroeve (*groeve* = quarry) in southern Limburg. This period was subject to tectonic uplift causing rapid sedimentation as characterised by the formation of alluvial fans which migrate to the north as the land-sea boundary was displaced in a northerly direction. This regressional regime is further characterised by an increase in sand content and the appearance of fresh water fossils. The regression caused plant material to grow and accumulate in peat-layers. These are the predecessors of the West-Phalien coal-layers.

Tectonic activity increases resulting in an orogeny extending from Eire to the Ukraine. This cause locally folding, uplift and normal faulting. The Namurien can be seen as an interstage between the sea-formed Viseen and the land-formed West-Phalien. The end of the Namur is characterised with the forming of a border basin along the mountains now stretching from Eire to the Ukraine. Subsidence in this basin was matched with sediment input of clay and sand derived from Eire-Ukraine mountains and plant material growing in the lowlands. Short transgressive phases in this period were marked by a change of fresh-water faunas to salt-water faunas.

The end of the Carboniferous is marked by an intensivation of the folding and forming of thrusts with a displacement of at least 100m. This was detected in the area around Aken. The tectonic activity caused gentle open folding of the strata around Heerlen.

The Permian

In the Permian the climate was of a arid type. The late Carboniferous orogenesis still influenced early Permian sedimentation of coarse sands in alluvial fans. In the Upper-Permian a sea arm of the Russian sea transgressed over Holland, but Limburg remained above the sea level in an erosive regime.

The arid climate resulted in evaporating of this sea arm forming the salt-deposits of the Zechstein. This forms the cap rock of the Dutch gas fields. Limburg remained in that time on the edge of the mainland, resulting intransgressional and regressional cycles.

Subsidence of the central graben in the north of Limburg started.

The Triassic

In Lower Triassic times Limburg is again the stage of deposition of coarse material from the Mid-European mainland. Several hundreds of meters of white to red sandstones of the Buntsandstein (Bunter sandstone) were deposited. The mid-Triassic sea transgressed to the north but did not reach Limburg. All of the sediments eroded in later stages with exception of the sediments in the subsiding central graben.

The Jurassic

During the Jurassic the land-sea geography show a likeness with their recent position. The Atlantic and the North Sea existed much as it is today but NW Europe was probably an island area. During this period Lias sediments were probably deposited throughout Limburg which were subsequently eroded. Only those sediments deposited over the subsiding central graben have remained intact. During the middle Jurassic regression takes place in the north of the Netherlands. In Limburg erosion removes Triassic and Jurassic sediments. This process continued during the Lower and Middle Cretaceous, while in the north sedimentation occurred concurrently.

The Cretaceous

Sedimentation in Limburg starts again with transgression of the sea to the south in a warm climate. The oldest Cretaceous sediments show that Limburg was at that time a coastal area with sand dunes and shallow seas in which glauconitic sands were deposited (Vaalser Groenzand). The input of terrain material diminishes and becomes pure marine carbonate sedimentation resulting in the white Gulpen limestones (fine calcarenites). The material became coarser grained and the input of silica probably resulted in flintstone layers (the exact origin of the flintstones is still a major discussion point). The bulk of carbonate material became what is now the Maastrichtian limestone. This limestone has two facies types ; the Maastrichtian *tufkrijt* (tuff-like limestone) and the Kunrader limestone. The difference is thought to lie in a different development of the sedimentation cyclothems. This process resulted from normal fault movement, causing erosion of the Vaalser groenzand from the higher blocks onto the lower ones.

The glauconitic material can be found in the softer beds in the Kunrader facies. The input of

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this and more clastic material was restricted to a small area along the fault zone where there was sufficient subaquatic relief. The sedimentation is thought to be periodic, which is reflected in sedimentation cyclothems. The sedimentation cyclothem starts with a basal conglomerate, due to the fault movement the Kunrader facies shows a softer layer without flint but increasing carbonate content from 65 to 80% CaCO3 under the top layer. This top layer consists of a carbonate (95% CaCO3) hardground with reduction of the bioturbation in comparison to the Maastrichtian *tufkrijt*.

Outside the deposition area of this clastic material the "normal" cyclothem evolution continued and the cyclothems are completely carbonatic with an increase in CaCO3 from 85% to 98% in the top. Halfway the cyclothem the flintstone layers occur. The dominant fossils in the Maastrichter *tufkrijt* are Echinocorys and Belemnites, in the Kunrader they are Turritelles.

A large thickness variation in the limestones across some faults point to syn-sedimentary movements. The movements can still be associated with those which caused the late Carboniferous compressional regime trending in a NW-direction. The movements changed in the Cretaceous into an expansion of the crust along faults with a direction perpendicular to the older fault system. Parts of the original horsts in the Central Graben subsided whereas new horsts appeared so that islands were formed where they crossed the older horsts. The subsidence resulted in a step-like deepening of the graben structure towards the NE. Today its width is about 20 km and on the other side the Cretaceous lies at a depth of 800 m. The Carboniferous coal measures is reached for mining between 300 and 500 m depth before the major rift fault of the Feldbis downthrows the Carboniferous effectively out of reach for mining. The coal measures are considered the main source rocks for the oil and gas fields further to the north of central and the north Netherlands and the North Sea.

Tertiary Sediments

The limestone sedimentation continues up to the Lower Tertiary. Sedimentation ends in the Middle Palaeocene with clays and sands. From then on up till the Lower-Oligocene erosion results in peneplenisation and karst processes in the underlying limestone. For the last time transgression takes place in the Oligocene in the form of a shallow sea. On the main land the Alpine orogenesis starts with the uplift of the Alps. This uplift results in the deposit of Middle and Lower Oligocene sands. Regressional phases are indicated by brown coal layers and fresh water fossils like turritelles (a snail). The thin brown coal layers (e.g. Frimmersdorf) merge in Germany to minable deposits (Koenigdorf horizon). Leaching of the sands by humic acids from these brown coal layers generates pure white quartz sands.

Regression becomes dominant in the Miocene, but sedimentation of a shallow sea and coastal zone environment continues. The basin subsidence of the North Sea which started in the upper-Miocene continues into the Pliocene. Uplift of the Ardennes sand, the *Rheinische Leisteen gebergte* (Rhine shaley mountains), causes alluvial fanning of the *kiezelooliet* ("oolite" gravels) on the Oligocene sands. Especially in the Central Graben (north of Geleen-Brunssum) thick layers were deposited together with sands (*Zanden van Schinveld*) and clay (*Klei van Brunssum*).

The next phase of sedimentation is caused by the uplift of the Ardennes resulting in older erosion products in the East-Maas gravels. Continuation of the uplift causes the river to abandon it's path and seek a more westerly direction to it's present bedding. The erosion of the Maas replaced the gravels and the underlying formations became accessible in the river valleys. Not influenced sediment is the flint-eluvium along the southern border and the *kiezelooliet* ("oolites" gravels) on the Isle of Ubachsberg.

Sedimentation became dominant again in the Saalien and Weichselien (Wurm) glacials. The aeolian sediment is probably due to saltation clouds of wind eddy lifted sediment which is then deposited in the lower parts of the topography in wind shadows. The material is probably selected from the Oligocene and Miocene sands by the wind in a dry and cold climate.

Quaternary

The Quaternary is what gives South Limburg its present landscape. A plateau consisting of the southern two-thirds of Cretaceous limestones and the northern third of Miocene and Oligocene sands which has been incised by first a wayward River Maas flowing northeast along it southern flank towards Aken anc He:erlen depositing as it incised the plateau a series of gravel terraces. Tilting of the plateau caused the Maas to shift its course to its present almost straight north course through Limburgs geographical isthmus. Again it did meander leaving a series of younger terraces as it excavated its way through the western plateau. The Maas collected a few tributaries, on the west side the Jeker and on the east more numerous, redistributing much of the earlier terrace deposits; the Geul, the Gulp, the Geleen Beek and in the far east with Germany the Wurm which flows into the Roer which reaches the Maas in Middle Limburg at Roermond. All these have done much to give Limburg its plateau landscape with its deep valleys. One such deep valley at Epen reaches the Carboniferous. To soften the action of rivers a mantle of loess was laid over the land during the glacials. It is the loess gives this land its nutrient; the large and elegant farmhouses testifying to wealth from agriculture.

Quaternary top layer in south Limburg

With exception of some steep valley sides where rock is exposed there are only four types of ground which form the top layer in the southern part of Limburg. These four types are 1) loess, 2) "*verweringsleem*", (weathered clay) 3) flint-eluvium and 4) local sediments deposited by brooks and small rivers.

Loess

Loess is a fine grained rock, with a grain size between clay and sand. It consists for at least 70% of grains with a diameter between 2 and 50 mu, 10% sand and 15% clay (O.S.Kuyl '80).
Above a diameter of 50 mu abrasion in relation to saltation is the dominant process in aeolian transport. Small flakes about 2 mu are generated on collision with other grains or the ground. Investigations by the RGD (Dutch Geological Survey) have concluded that quartz-grains with a diameter less than 50 mu float in the air, the major grain size distribution cannot be a result of wind induced abrasion. Therefore the Loess is thought as a product of aeolian sorting of an already fine grained source material. They further suspect that Loess's origin to be the fine grained Miocene and Oligocene Sands and thus of local origin.

A greater part of southern Limburg was covered with Loess. It's western boundary is formed by the river Maas, the demarcation between the "*dekzanden*" (cover sands) and the Loess. The Loess was deposited during the glacials on a sterile permafrost. This cause features such as cryoturbation and polygonal earths. The aeolian origin of the Loess is probably from with westerly winds since the layer thickness on west-orientated slopes is largest. Only the higher parts of the then existing landscape remained without loess coverage, for the dust clouds moved probably through the valleys. This explains the large variation in thickness (from 0 up to 8 metres). Very thick layers were deposited on the old river terraces of the Maas.

At a later stage parts of the Loess was eroded by streams in the valleys and by sheet erosion on the steeper slopes. Additionally solifluction has played a role in redistributing of the Loess. During the warming following the last glaciation monotypical woods started to form, with mainly "*Lindebomen*" (lime trees). Around 4500-3000 B.C. heavy erosion started caused by felling of these woods. On the remaining loess area's agriculture is until now common. Due to all these natural and man-aided influences there is in Limburg however no loess on the surface in its original state.

The loess in Limburg can be divided in three major parts. The Upper and Middle Loess are of Weichselien age , the Lower loess is of Saalien age. The boundary's are dated on 28000 B.P. and 50400 B.P. The top of the Upper Loess has a lower carbonate content.

The boundary between the Upper and Middle loess forms the so-called Kesselt-earth a humus-rich layer on top of a cryoturbatic horizon. The Kesselt-earth is of interstadial origin. The boundary between the Middle and Lower Loess is formed by the Eem-horizon. Its an interglacial formed earth with grey polygon stripes. Typical in this earth are iron and manganese nodules.

It follows that Upper Loess in Limburg was deposited in a cold-dry climate with mainly an aeolian sedimentation. The Middle and Lower Loess show solifluction processes typical for a cold humid climate. Both climates are comparable with contemporary tundra environment. By determining the heavy mineral content of the Loess it is possible to divide the Limburgian Loess from its equivalents in the provinces of Gelderland and Overijssel.

Since in the Loess steep to vertical slopes remain erosion by wind and water often generated deep gullies. In former times these gullies were often used as roads or that these gullies started along paths where the vegetation protection was removed by the road traffic. These roads form today the characteristic " *holle wegen* " (hollow roads) in Limburg.

Verweringsleem (Clay from weathered limestone).

This type of earth is generated by erosion of limestone. E.g. Kunrader and Gulpen limestone contain 30% clay and sand which form the sticky *"leem"* (loam) after solution of the limestone. Large parts of this earth were also covered in a later stage by Loess. Areas where this earth is exposed were cultivated at a later stage then the Loess areas. The influence of erosion was also greater since this earth was exposed on steeper slopes. Also the *"verweringsleem"* area is characterized by erosion gullies and *"holle wegen"*. Where this top layer couldn't stop water seepage to the underlying limestone, solution erosion developed karst features which in turn collapsed to cause local subsidence. These sites form the present *"droogdalen"*, (dry valleys) which were not the result of erosion by continuous flowing brooks.

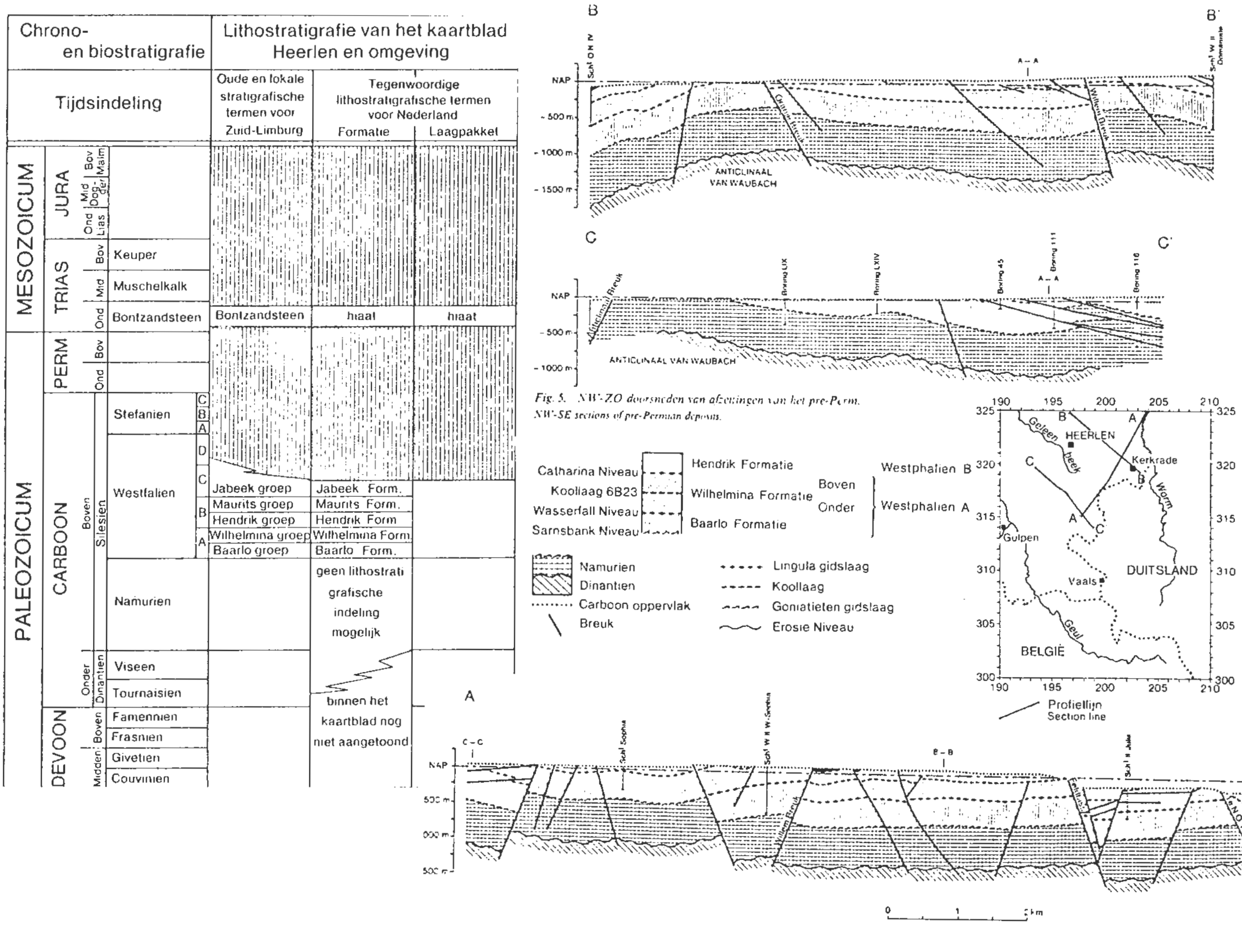
Flint-eluvium

The highest areas along the valleys of the small rivers Geul, Gulp and Voer were never covered by the Loess. Originally the exposed rock was a flint-rich limestone. In situ solution of the the limestone generated an earth rich in loam, clay and sand with a high percentage of flint. The flint is often found still in its original layering. The volume reduction is about 60% and the process is still going on. This earth type is unsuitable for agriculture and the original forest covering it was therefore never felled. Since it was never influenced by man it is an earth in its original state which is exposed in the Vaalser, Vijlener and Epener Forests.

Deposits by small brooks and rivers

From a geological view these valleys were at first so steep that they were erosion sites The Loess which was deposited in these valleys was eroded so gravel and sand remained. The valleys became at that time infertile. Locally little moors lay at the origin of peat outcrops. But when mankind started with the felling of the forests about 4500 B.C. on the fertile hills the small brooks and rivers became sedimentation sites. Their valleys were filled with fertile deposits, the loess and **verweringsleem** from the hills. The valleys were cultivated and were necessary drained for agriculture.

Between 30,000 and 10,000 B.C. landslides locally displaced thick layers of loess and *verweringsleem* into the abandoned river valley of the "East Maas".



Stratigraphical table of pre-Cretaceous and sections through South Limburg (*RGD Rijks Geologische Dienst - Netherlands Geological Survey publication "Toelichting bij de Geologische Kaart van Nederland 1:50.000; Heerlen (62 W oostelijke helft, 62 O westelijke helft) Figures 4, 5 & 6*)

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DEADLINES

Despatch by Symposium Organiser of second Bulletin with request for Abstracts	30 June 1990
Final date for receipt of Abstracts by Symposium Organiser	30 November 1990
Notification of acceptance of Paper with instructions for preparation	31 January 1991
Despatch of third Bulletin with registration details and information on technical excursions	28 February 1991
Receipt of early registration with discounted fee	31 October 1991

DATES LIMITES

Envoi du second bulletin demandant les résumés	30 juin 1990
Date limite de réception des résumés par le secrétariat du symposium	30 novembre 1990
Notification d'acceptation des exposés et directives pour la préparation	31 janvier 1990
Envoi du troisième bulletin avec détails d'inscription et informations sur les excursions techniques	28 février 1991
Date limite pour la réception de l'exposé complet en vue d'une étude critique et inclusion dans les comptes rendus du symposium	30 juin 1991
Réception des inscriptions à tarif réduit envoyées tôt	31 octobre 1991

ASSOCIATED CONFERENCE

The Sixth Australia-New Zealand Conference on Geomechanics is to be held at the University of Canterbury, Christchurch, from 3 to 7 February 1992. The theme is "Geotechnical Risk - Identification, Evaluation and Solutions". Delegates to the Sixth International Symposium on Landslides are invited to attend, and a discounted combined registration fee will be available.

CONFERENCE ASSOCIEE

La sixième conférence Australie/Nouvelle-Zélande sur la géomécanique aura lieu à l'université de Canterbury à Christchurch du 3 au 7 Février 1992. Le thème en est 'Risques géotechniques-Identification; Evaluation et solutions'. Les délégués du Sixième Symposium International sur les Glissements de terrain sont invités à y prendre part et pourront joir d'un farif spécial pour les inscriptions combinées.

Symposium Convenor:

David H Bell
Geology Department
University of Canterbury Christchurch, New Zealand
Phone (64-3) 642-717 or 667-001
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THEMES

General:
- G1 Landslide investigations
- G2 Stability analysis techniques
- G3 Stabilisation and remedial works
- G4 Landslide hazard assessment

Specialist:
- S1 Seismicity and landslides
- S2 Landslides and reservoirs
- S3 Open-pit mine slopes
- S4 Slope instability in tropical areas

THEMES

Généraux:
- G1 Investigations sur les glissements de terrain
- G2 Techniques des analyses de stabilité
- G3 Stabilisation, mesures préventives et mesures pour remédier aux glissements de terrain
- G4 Evaluation des risques de glissements de terrain

Spécialisés:
- S1 Séismicité et glissements de terrain
- S2 Glissements et réservoirs
- S3 Pentes avec mines à ciel ouvert
- S4 Instabilité des versants en zones tropicales

SESSION FORMAT

General Reports on each theme will be presented by a keynote speaker, and this will be followed by Panel Reports which review the Papers accepted for the Symposium under that theme. Up to 1.5 hours will be allocated for chaired discussion of each theme by the Symposium participants, with priority being given to written questions or contributions directed to the authors of papers. Facilities will be available for presentation of individual papers by Poster Display.

ORGANISATION DES SESSIONS

Les rapports généraux sur chacun des thèmes seront présentés par un conférencier et seront suivis par les rapports de la commission qui juge les exposés concernant ce thème qui auront été acceptés pour le symposium. Une heure et demie sera allouée aux participants du symposium pour des discussions organisées sur chaque thème, la priorité étant donnée aux questions ou contributions écrites adressées aux auteurs des exposés.
Des facilités seront offertes pour les exposés individuels qui devront être présentés sous forme d'affiche.

TECHNICAL EXCURSIONS

Pre-Symposium Field Seminar:

A one-day field seminar will be held on Saturday 8 February 1992 at Queenstown, a popular and readily accessible tourist resort some 350km southwest from Christchurch. The seminar is concerned specifically with the stability of large schist-derived landslides, some of which form parts of the reservoir slopes for Lake Dunstan, a hydro-electric storage that is scheduled for filling before the Symposium. Opportunities also exist for social and leisure activities in Queenstown, with the option of a day-long technical/scenic coach tour to Christchurch on Sunday 9 February.

Symposium Tours:

Wednesday 12 February 1992 is scheduled for various half and full-day technical excursions to landslide sites in Christchurch and surrounding parts of Canterbury. Non-technical excursions will also be offered for participants and accompanying persons.

Post-Symposium Excursions:

A range of 4 to 10-day technical excursions will be offered to landslide sites in New Zealand and eastern Australia, and these will also emphasise scenic and historic aspects of the areas visited. Landslide sites will include slope movements in soft-rock terrain, regolith failures, and large-scale seismically-triggered mass movements. Positions on post-Symposium technical excursions will be available subject to minimum and maximum numbers.

I.S.L. 1992 - CHRISTCHURCH

Preliminary Application Form
Bulletin d'Inscription Préliminaire

Surname / Nom ______________________

Initials / Initiales ______________ Prof/Dr/Mr/Ms

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PLEASE REGISTER MY INTEREST FOR:

Dans la liste suivante cochez ce qui vous intéresse (mark with ✓)

Symposium registration / Inscription au symposium ☐

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ISL Proceedings only / Seulement les comptes rendus ☐

Post-Symposium Technical Excursion / Excursions techniques postérieures au symposium ☐

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Probability of attending the symposium / Probabilité de participer au symposium 100% ☐ 50% ☐

Are you interested in presenting a technical stand / Etes-vous intéressé au montage d'un stand d'exposition ☐

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Theme / Thème G1 ☐ G2 ☐ G3 ☐ G4 ☐ S1 ☐ S2 ☐ S3 ☐ S4 ☐

Tentative Title / Titre proposé ______________________

____

Number of accompanying persons / Nombre de personnes vous accompagnant ________

A VIEW ON PERMEABILITY

Jenco de Groot[1]

A consideration based upon the literature study on permeability of rock joints and fractures in relation to surface roughness and aperture.

Permeability measurements

Lab and in situ permeability measurements differ completely from conditions and testing approach and as a result they end up with different permeability values. What is the difference between these tests and how can they be correlated?

Rock joint permeability theory

Rockjoint permeability is a complex parameter which can be measured in the laboratory by letting water flow through a single joint. For doing research on it it is essential to know about different flow types because each flowtype is represented by a different formula for the hydraulic conductivity and so for the permeability. Examples of different flowtypes are: hydraulic rough, hydraulic smooth, laminar both par allel or non parallel flows. Their boundary conditions in respect to the friction factor (f) are related to the relative roughness (k/dh) and the Reynolds number (Re). Hydraulic flow regions according to Louis are given in figure 1.

The Missbach law, a generalized form of Darcy's conductivity law, describes these flow types with different n values. n = 1/2 and n = 4/7 for hydraulic rough and hydraulic smooth flows, while n = 1 for both laminar flow types. The Missbach formula:

$$\overline{v} = -k\{\nabla\phi\}^n$$

$$\begin{pmatrix} Vx \\ Vy \\ Vz \end{pmatrix} = -K* \begin{pmatrix} \delta\phi/\delta x \\ \delta\phi/\delta y \\ \delta\phi/\delta z \end{pmatrix}^n$$

The relative roughness, the surface amplitude as a fraction of the hydraulic diameter, is linear dependent on the aperture. Together with the Reynolds number it determines which flow type most probably will exist, so which permeability will occur.

Table I Equivalent hydraulic conductivities (from Louis (3)) NB Dh=2b

Hydraulic zone	Hydraulic conductivity (L/T)	Exponent (x)
1	$\frac{g b^2}{12\nu}$	1.0
2	$\frac{1}{b}\left[\frac{g}{0.079}\left(\frac{2}{\nu}\right)^{1/4} b^3\right]^{4/7}$	4/7
3	$4g^{1/2}\log\left[\frac{3.7}{k/D_h}\right]b^{1/2}$	0.5
4	$\frac{g b^2}{12\nu(1+8.8(D_h)^{3/2})}$	1.0
5	$4g^{1/2}\log\left[\frac{1.9}{(k/D_h)}\right]b^{1/2}$	0.5

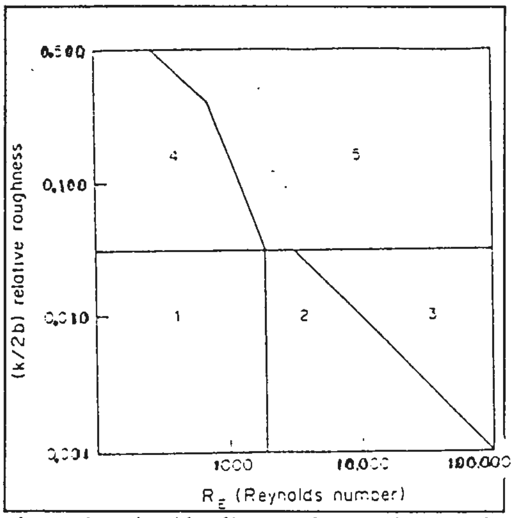

Figure 1 Hydraulic flow regions, after Louis (1)

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[1] Kolk 28, 2611 KD Delft, tel: 015-120712

Apertures according to Brown

Brown (2) defines three different joint apertures, i.e. the mean, the mechanical and the hydraulic aperture. These apertures are mathematically related but the fluid mechanics are only based upon the hydraulic aperture. This is also the the aperture which results from the permeability test, based upon the Missbachlaw.
When using in situ aperture measurements, estimations for the mean and / or the mechanical aperture can be made. However it is important to convert this aperture to the hydraulic one, for permeability calculations.

Field Approach

In situ different tests excist in order to get an impression of the permeability of the rock mass. Applicated tests are: pump tests, tracer tests, falling head tests, rising head or auger tests and most widely used in rock formations, especially when dam constructions are concerned, the packer or Lugeon test.
The tracer test is not a quantitative test, it's result only indicates or discriminates for several flow paths. The other tests have a quantitative result which most of the time consist of a flow rating (volume of water per time unit) and a related change in the piezometric level or comparratively in the overpressure.
Dependent upon the test which is performed, the results are converted by *(semi) emperical* formulas to a *'bulk permeability'*

Discrepancy between laboratory and in situ approaches

In theory the conditions are ideal. The aperture distribution, the Reynolds number, so the velocity, density , hydraulic diameter and dynamic viscosity are known. The Reynolds number combined with the relative rougness k/dh, which is also known,
result in the flow condition, i.e. laminar parallel or non parallel, hydraulic rough or smooth, etc.
Each flow condition is described with different formulas for the friction factor f, the velocity so the permeability times the gradient to a certain power (Missbach law) and the piezometric head as a function of the radius. The friction factor, in general f(Re,k/dh), is an important dimensionless factor. It determines the drop in piezometric head ($\nabla\sigma$) when flowing over a distance (∇x) along the joint surface with average velocity <u> and a hydraulic diameter Dh.

In reality the situation is different. Under laboratory conditions one can simulate the theory quite accurate because parameters as the Reynolds number and the relative rougness can be measured. Then then the flowtype, as a function of the radius, is known.

On the other hand in the literature studied, these factors, even in the laboratory, were not measured but simply assumed to lie within the range of a linear flow. The results showed that this was allowed in most cases (Raven and Gale, waterflow in a rock fracture (3)).

In situ the problem is much more prominent because in general the geometry is unknown or at least for a great part. This results in a model of it. Next to this it's very difficult to get reliable values for the aperture and the relative roughness because of an unknown variation along the jointplane. Another point is the persistence combined with the different joint sets. Because these significantly problems a lot of assumptions have to be made. One should keep in mind very well that ***'the permeability'* of a rock mass does exist but it is impossible to be measured accurately, only the order of magnitude might say something!**

Given permeabilities are always based upon assumptions such as:
- a geometry with three jointsets with known orientation and with hydraulic diameters d1, d2, d3 and spacings s1, s2 and s3 (see de Wit (4))
- a linear flow (n=1 in the Missbach law)
- infinite persistence

Recommendations

concerning roughness

Research should be done in order to find a correlation between the practical JRC (Barton's joint rougness coëfficient(6,7,8) and the more theoretical relative roughness (k/dh).

concerning Lugeon tests

Research should be done in order to find a permeability value out of a lugeon value. The aim is to transform a lugeon value (liter/(min.*m*10 atm)) to a permeability value

(m/s). In his 'Bestimmung der wasserdurchlÄssigkeit von kluftigem fels'Rissler (6) corrects the piezometric borehole level for losses due to friction with the pipewalls, the depth at which the horizontal joint is situated, the change in diameter of the pipe and the borehole and the energy loss when the flow enters the joint, i.e. changes 90 degrees in flow direction.
Concerning the Lugeon test this should also be corrected for the wateroverpressure at the surface, 10 atm is about 100 m. The best way of doing it is to test on a single horizontal joint with a very high persistence and of which the aperture is rather constant and known. When assuming the cubic law, the hydraulic conductivity is now already known before even testing, $K = d^2/12$ pg/n [L/T]. The testing result can know be correlated with the known value.
It might also be tested on a small laboratory scale similar to Gale and Raven (3) with a fixed aperture and a strong waterpump with manometer. This test might also be applicated further for examining different flowtypes as a function of the radius.

literature

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Imperial College of Rock Mechanics Rept, No.10 september 1969

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Fluid flow through rock joints: the effect of surface roughness
Journal of Geoph. Research, vol 92 no B2 february 1987

(3) Raven K.G. and Gale J.E.
Waterflow in a natural rock fracture as a function of stress and sample size
Int. Journ. of Rock Mech. and Min. Sciences, vol.22 no.4 august 1985

(4) de Wit R.G.
De invloed van discontinuïteiten op de grondwaterstroming in de kalksteen formaties van zuid Limburg
Memoirs of the centre for engineering geology in the Netherlands No.64september 1988

(5) Dierx H.A.L.
De lugeon proef onder de loupe genomen
Delft University of Technology, The Netherlands march 1982

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(7) Barton N., Bakhtar K.
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(8) Barton N., Bandis S., Bakhtar K.
Strength, deformation and conductivity coupling of rockjoints
Int. Journ. of Rock Mech. and Min. Sciences, vol 22 No 3 june 1985

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The shear strength of rock joints in theory and practise
Rock Mechanics 100 1-54 1977

Preliminary Announcement

5TH INTERNATIONAL CONFERENCE ON UNDERGROUND SPACE AND EARTH SHELTERED BUILDINGS

INTRODUCTION

The Netherlands National Research Centre for Innovative use of Underground Spaces, NOVA TERRA, as organisers, invite authors to submit papers relevant to the themes chosen for the 5th International Conference on Underground Space and Earth Sheltered Buildings. The venue will be Delft University of Technology. The university will be celebrating its 150th anniversary in 1992 and are pleased to have a conference that will interest numerous disciplines many of which can be traced to the different faculties at Delft.

Coincidently 1992 has been earmarked by the European Community as the year to further their ideal of unity between member nations by creating one European customs union and hence allowing unrestricted movement of goods and people across the members' borders. The conference will devote themes to this effect in connection with unified codes of practice and unified legal procedures, laws and ordinances. The objectives of the conference themes would be to discuss such unification not only as an ideal for European unity but also for increased international unity.

The Netherlands has a long tradition in international rules and law. An early exponent of this tradition is Hugo Grotius, born in Delft, 1583, who set up proposals for maritime law in his book 'Mare Liberum', amongst many other works nearly four hundred years ago. The spirit of his book is still recognised by most maritime nations today. Further international cooperation received a significant boost almost 90 years ago with the construction of The International Court of Justice, located in The Hague, near Delft, culminating in 1945 in the United Nations.

Stichting NOVA TERRA

P.O.Box 695
2501 BM The Hague
The Netherlands

Telephone: (31-70) 364 5264
Telefax: (31-70) 360 7063

CONFERENCE THEMES

Two principal themes of the conference will aspire to the spirit of 1992 and the earlier spirits of Hugo Grotius and the International Court. The remaining three themes could be considered to evolve logically from the initial two themes.

The themes and their objectives are:
Themes 1 and 2, **'Existing Codes of Practice'** and **'Existing Procedures and Ordinances'** respectively will be held to discuss their commonality, their differences and their shortcomings at local, regional, national and international level. The codes, procedures and ordinances with respect to underground space and earth covered buildings can cover aspects of construction, design, safety, comfort, utilisation and planning.

Theme 3. **'Marketing of underground space and earth sheltered buildings'** will look at underground structures and earth covered buildings with respect to the following questions:
a. What are present and projected applications?
b. Who are the specialists and contractors?
c. What is the demand?
d. What are human prejudices against occupation?
e. How and to what extend is promotion achieved?
f. Who is the competition?
g. What are the environmental advantages and disadvantages?
h. What is the short term and the long term return on investments, in commercial terms and in terms of environmental conservation?

Themes 4 and 5, **'Soft ground underground spaces'** and **'Hard ground underground spaces'** respectively will look at recent developments.
a. construction methods,
b. structural design,
c. construction influence on neighbouring structures and environment,
d. monitoring and predicting of short and long term behaviour,
e. special problems and research trends (such as for underground chemical/nuclear waste disposal or techniques for lighting/daylight penetration) in The Netherlands and other countries having high density populations in soft ground areas such as in delta, fluvial or lacustrine deposits and,
f. similarly such trends in underground spaces in hard ground.

PROGRAMME

As it will be for many delegates' families summer vacation a special programme has been organised for partners (it depends which one is attending the conference) and their children. August can be a warm month, if the sun shines, and there are extensive beaches along the North Sea coast. Many activities are possible and there are numerous museums, many specially tailored to keep the kids entertained. There are many outings organised to the windmills, the canal boats of Amsterdam, the dykes, the cheese market of Edam or Gouda, castles with moats and dungeons used by river pirates or fairy tale castles. The week is too short to see all of Holland, small as this country may seem. Conference delegates are also promised an entertaining time.

The conference activities will start with registration at the conference centre, The Aula of TU Delft, Mekelweg 5, from Saturday afternoon and evening of 1st August 1992. The Sunday will be reserved for excursions and a buffet welcome reception.

From Monday, 3rd August to Friday, 7th August 1992 sessions are planned to cover the themes of the conference. The sessions will first consist of joint keynote sessions in which invited speakers who are specialists in these fields will give their views on the major themes. The keynote sessions will be followed by parallel sessions. These sessions will be devoted to delegates who would like to present and discuss papers they have submitted.

In addition to the sessions there will be a trades exhibition, poster presentations, a Wednesday afternoon excursion and a Wednesday morning workshop entitled **'What can X tell Y (X -> Y) about Underground Space and Earth Sheltered Buildings?'**

Where X and Y are part of a matrix consisting of, X, an Architect, an Engineer, a Geologist and a Legal expert, and Y are architects, engineers, geologists and legal experts. As long as the Xs do not have to inform their own profession then three parallel sessions held four times is sufficient to inform one-another of eachothers interests.

During the week a number of evening activities are planned: a reception and dinner in old Delft, a concert evening and a farewell diner. During the conference ample time will be given for delegates to visit the trades exhibition and poster presentations. Buffet lunch will be provided at the conference center.

Three Dimensional Computer Graphics in Modelling Geologic Structures and Simulating Geologic Processes, October 7-11, 1990, Freiburg [BRD]".

Symposium Report by Rene Kronieger[1]

The symposium focused on the role of three dimensional computer graphics in geology and geophysics, with emphasis on modelling and visualising complex geologic structures. Attention will also be given to the use of dynamic graphics displays of two and three dimensional simulation models of geologic processes, including fluid flow and evolution of sedimentary basins.

I INTRODUCTION

The symposium itself was held at the university of Freiburg and consisted of some 35 oral presentations, demonstrations and panel discussions. During the day a poster session was realised in the entrance hall. Themes ranged from 3D hardware and techniques, 3D modelling, geological process simulation in 3D and 3D applications for use in economic geology (petroleum and mining) distributed over four days.

The oral presentations of 20 min. were held mainly in the morning sessions, the afternoon was used for program demonstrations by manufacturers and universities,and ended with a 40 min lecture annex program demonstration followed by an panel discussion. A short presentation of these oral presentations is given in this paper. Names and Institutions are mentioned to inform the reader about who's who and where in the world of 3D-modelling. Longer elaborations of the speakers can be found in the symposium proceeding by **Pflug,R. & Bitzer,K. (ed) 1990,** *Three-dimensional Computer Graphics in Modeling Geologic Structures and Simulating Geologic Processes*. Freiburger Geowiss. Beitr., Bd2, [ISSN 0936-6571], DM 22,=

Demonstrations included static as well dynamic displays on graphics workstations mainly provided by Silicon Graphics, IBM and Digital. However also single workstations of Intergraph and Stardent were presented. On these program demonstrations and panel discussions Robert Hack will elaborate further in the associated article [B] under the same title in this volume.

2 DAY I - 3D HARDWARE

After a short introduction by **Dan Merriam** [Wichita State Univ.] on the 3D subject **Flynn**, [Silicon Graphics Inc.], gave insight in the structure of a modern computer or "graphical engine".

It should be capable to handle 3D solid state graphics work in real time and needing a 30000 times larger capacity (100 Mips) than in 2D graphic applications. The main difference is the graphical processing hardware between the CPU and the Image to enhance applications like colour, solids, perspective, depth cueing, transparency and movement (10 frames/sec). A usual graphical workstation can only handle 3D static images. The graphics computers needed to display 3D movement make use of an 64 bit pipeline architecture where only the database is done by the CPU and the transversion/transformation, scanning/conversion and display is done by the graphical processing hardware. A demo was given displaying in real time the assessment of a borehole which could be displayed unfolded or e.g. going down the tube and a demo of fluid flow modelling in real time of a reservoir.

The next theme by **Schaeben** adressed the problems in modelling geology from sparse data, erratic regional distributions and uncodified geology.

This is the reality in the practice of modelling geology, additionally features like faults, folds and surface families etc. will generate discontinuity problems which are the benchmark test for the software. Polynomial B-splines in 2 directions are used to model these surfaces in 3D space in general followed by interactive modelling steps to refine the model.

The B-spline theme was picked up by **Fisher** [Intergraph Corp.] who introduced terms as non-rational B-splines (NURBS) and fuzzy data which both became the hot irons for discussion during this session.

It was also emphasized the basic idea of an computer

[1] T U Delft, Faculty of Mining and Petroleum Engng, PO Box 5028,2600 GA Delft. Tel: 015-785192 Fax: 015-784891

generated model with interactive editing, but added the possibility to combine different datasets to create a model.

A more philosophical approach by **Raper** [Birbeck College,UK] underlined the basic thinking for these systems.

It should adress the description of the reality by surfaces and volumes, rather than to produce nice pictures (visualisation). There should be topological based inter- relationships (functions) for model/data handling.

The chinese speaker **Huang** [LIAD,Nancy] dealt with the conversion of a 3D grid into triangulated surfaces (T-surfaces), needed to model planar objects in space.

This seemed a generally accepted approach to model a surface from sparse data. However modelling discontinuities with this approach seemed the major problem to solve now. His talk was in fact a precursor to the **GOCAD** system.

The **GOCAD** program seems to be very fast and user friendly and was presented by prof. **Mallet** [LIAD,Nancy].

With use of GOCAD **Mallet** modelled a 3D model of a saltdome within 15 min, including intersections of layers, faults introduced by their throw vector, movement of the blocks along a fault and real time modelling of surfaces to fit new data.

Luthi [Schlumberger] presented software which could simulate cores from somewhere in a geological structure.

Geological structures like fractures, faults, folds (recumbent, isoclinal, complex, normal etc.), discontinuities, cross bedding or combinations could be visualised in synthetic cylindrical solid core samples as drilled through the sequence. The program was also used to model geology back from real borings, however the scale problem does not relieve them to use field mapping (medium scale) and seismic sections (large scale).

Before lunch **Guiglielmo** [Univ of California, Santa Cruz]]gave a dia presentation on 3D strain analysis around the emplacement of a pluton.

Simulation of strainfields in 3D especially helped in the understanding of deformations in triple points generated by pluton interaction. Also the strain history could be modeled and resulting lineament maps (e.g. mineral or foliation) could be produced by the software.

The programme of the day ended by **Preuss** [Landesamt fur Bodenforschung of Niedersachsen] giving a demonstration how they used the profile approach to generate geological maps.

Their approach consisted of an semi Artificial Intelligent shell around a GIS (2D data handling), IVM (contouring and interpolation) and a DBMS. Data was derived from boreholes, raster images (DTM and scanned maps) and vector data (existing sections and contour maps). Produced were maps and sections anywhere in the structure.

2 DAY 2 - 3D MODELLING

Day 2 started with a lecture by **Siehl** [Bonn] on possibilities of geological modelling and production of daylights of the geology through intersection of the assembly of geological surfaces with a digital terrain model (DTM).

Surface modelling was done by using bivariate quadratic B-splines associated with irregular triangles, the vertices of which are adjusted to the areal distribution of data points. The example was an anticline structure of triassic strata in lower Saxony near Hildesheim.

Barchi [Univ di Perugia] presented the research on an area located in the central Apennines.

It consisted of a structural complex geology (three thrusts and an graben structure) in an elevated terrain on both sides of the Ancona-Anzio line. Using standard map analysis techniques a better understanding of the geometry of the tectonic features was gained. The regional trends of several tectonic phases could be deduced. The basic approach using DTM and griding of the geology as used by Siehl seemed to work here also.

Hay [Univ of Colorado,Boulder] used volume calculations in a mass balance reconstruction of the Molasse basins and Alpine uplift.

By estimating the erosion and back calculation in a 50 km2 grid across the alpine region, steps in the sediment production were related to the uplift and proved that flexural response to loading was not instantaneous. Maps were generated which showed the alpine topography before erosion. However not all geological parameters were considered and the result therefor should be an estimate.

A geothermal anomaly in northern California was modelled by **Burns** [Los Alamos Nat. Lab]. This anomaly was to be used as energy source.

A geothermal transport model was made to visualize influence of lithology, fault systems, permeability anisotropy (texture) unto depths of 6 km's. The GIS system was enhanced with a vector field in which the texture of the grains to facilitated the calculation of a permeability tensor. The use of a Cray, FEM models for heat-mass transport and available 2D,3D software was necessary to finish the project in 12 months, as was required and transverse slices through the system were produced.

This representation was followed by an video on the continental deep drilling (KTB) near Gottingen giving insight into lithosphere dynamics (plate tectonics).

After coffee the modelling session was resumed by **Turner** [Colorado School of Mines] demonstrating the GSIS approach to model ground water flow in Nevada, for waste disposal.

Two flow regimes had to be considered where the regional flow could transport unwanted material through the mountain range out of the valley. The core of GSIS consists of a database in which geology, hydrogeology, soils, vegetation, climate etc. is recorded. A 3D graphical interface is used to approach the data to construct a conceptual model which can

18

be edited until a satisfactory ground water model is accepted. Several cyclic edit and check procedures form a scheme in which available software like Oracle, Intergraph, Lynx and Dynamic Graphics play a role.

Modelling was resumed by **Wold** [Univ of Colorado,Boulder] using the concept of Hay to match the coastlines of Africa and south America.

A bathymetric development of the rift valley by back stripping of sediment load and isostasy revealed that stretching of the coastline of south america was needed to make the fit.

Williams [Univ of Tennessee, Knoxville] demonstrated an approach to model thrust sheet development.
Initially a pancake model was deformed in the associated similar and concentric folding regimes of the thrusting region. To model the strain development, globes were introduced as markers undergoing the thrusting, using non-rational non-uniform B-splines.

The morning session was closed by a GOCAD demo by **Mallet** [LIAD,Nancy] showing the capabilities of the software to interpolate between 5 drillings generating a NURB surface and the construction of an plane from three non matching cross sections.

The after lunch programme consisted of a lecture/demo by **Art Paradis** [Dynamic Graphics Ltd.] on voxel programming.
The software Interactive Volume Modelling (IVM) produces property distributions in 3D space within e.g. each geological layer (stratiform gridder) using a minimum tension surface algorithm. Demo's of IVM visualized 3D seismic velocity files, influence of layer permeability on steam injection of oil reservoirs, reservoir engineering (saturation and pressure development within the layered reservoir), pollutant distribution etc. Demo's were continued by showing ozone development in real time above the US and salinity/temperature variations within certain water bodies in Chesapeake bay and the influence of storms on this system.

Panel discussions revealed the intricate relationship of geometric modelling (CAD type) and property modelling (geostatistical) and also that the geometric model development is based on a geological history (which may be altered).
Answers to questions like what do we need, what can we get, can it handle fuzzy data, what is the error propagation etc. were posed. Kelk (BGS) described how the geologist's approach was infact an continuing improvement of the initial model and questions the possibility for the computer to do so.
However no clear questions or answers were given, the panel discussion revealed a fuzzy zone between users and software developpers.

3 DAY 3 - 3D PROCESS SIMULATION

On day 3 several presentations on simulations were given. Three families of software with topics as sedimentation (SEDSIM,SEDVIEW), meteorologic and geologic (GEO3VIEW) were presented and/or demonstrated. The SEDSIM group around **Harbaugh** [Stanford Univ.] demonstrated the facilities and boundary mechanisms of the SEDSIM software set.

SEDSIM is a dynamic 3D simulation of geologic processes that can simulate creation of sedimentary basins. The software is modular build and has among others interconnected models for simulation of sediment transport and deposition by waves (Martinez), compaction (Wendebourg), sealevel changes and isostatic compensation, delta propagation (Harbaugh). Also synthetic petrophysical and seismic logs as well as hydrocarbon migration can be generated.

Slingerland [Penns. State Univ.] demonstrated a simulation of water circulation models underneath tropical storms in the Gulf of Mexico.
From the wind circulation pattern, current patterns along the shoreline, were derived that related to sedimentation and erosion of the sea bottom and the deposition of 'event' beds. A video showed the vectors displaying air and water velocities in the approach of such a storm. A geomorphological simulation of floods in the Colombia river 1500 years ago is presented by Craig. The expansion of the Ice sheet blocked part of the drainage resulting in a lake 600 m deep and holding 25000 km3 water. 100 years later the ice dam failed rapidly and the lake emptied in about 10 days, as much as 100 of these floods occurred, carving large scour channels in the plateau basalts and left a 40 m thick deposit with boulders of 1m diameter 10 km downstream. The video presentation gave several dynamic 2D flood expansion stages and a 3D streamvelocity vectorfield model within the topography where velocities in excess of 30 m/s were calculated.

Davis [Kansas Geol. Surv.] used the approach of regionalisation to analyze large data sets (W-Kansas, 7000 sq mi, 2079 selected wells, 28 variables) since it took too much time to calculate each node.
Probability determined of the kridged variables were accepted to a certain set. These sets with thus probabilistic determined node elements and boundaries were then combined to give maps indicating the probability that a data point had variables meeting the probability criteria of a set (1 variable) or class (more variables).

The group around **Pflug** [Univ. Freiburg] demonstrated their software on 3D-visualisation of geologic processes and structures.
Especially dynamic ground water flow around dams, effects of grouting schemes and related watertable fluctuations down stream were contained in their demo. The Pflug group cooperated with Mallet (GOCAD) and Prakla-Seismos (COMSEIS) to make a Unix X-windows based system for manipulation of views in 3D. The approach started from contoured data and gridded data and connected serial sections by triangulation and rendering into surface models. By use of their inhouse developed orientation dialcontrol, manipulation

of the structures like rotation with associated light cueing in real time looked user friendly to visualise complex geologic structures ranging from thin sections unto large folds.

Something alike was the 'cockpit' software developed by **Tipper** [ANU, Canberra] in which the view point (screen) could actually move into the 3D structure.
His lecture dealt with implementation of a finite difference approximation technique on a triangular mesh to simulate a potential driven flow. The simulation consists of a stochastic modelling of a sedimentation system combined from erosional and depositional events. The model is characterised by an event pattern depending on space and time, governed by probability distributions regulating the frequency and duration of the events. it resulted in a model generating landform development or basin filling.

4 DAY 4 - 3D AND ECONOMIC GEOLOGY

Day 4 was dedicated to economic geology and 3D applications herein. The morning sessions before coffee dealt mainly with the approach to some case studies.

Case studies ran from hydrocarbon reservoir modelling (**Lasseter**,Techlogic Inc.), lignite mining (**Peschel**,Univ Greifswald), sulphide ore mining (**Sides**, SOMINCOR) and coal mining (**Dann**, Ruhrkohle AG). An additional case was given by **Prissang** [FU Berlin] on deposit modelling with use of variable octree elements in 3D.

After coffee geostatistical modelling of geological layers were treated on subjects like geostatistical optimization in underground mining (**Houlding**, Lynx Geosystems Inc.), the survey design of the Channel tunnel (**Chiles**, Bureau des Recherches Geol. et Minieres, Orleans).

An application of a rock-CAD modelling system was given by **Saksa** [Saanio & Riekkola Engng. Inc., Helsinki]
The model was used for site investigation prior to the construction of a nuclear power station. However the system was mainly used for visualisation of the rock mass with respect to the fault sets in the underground. The basic system handled different rocktypes, fractured zones and hydraulic models. Especially the knowledge on geologic sequences (intrusions) had to be build into the modelling tool.

A program demonstration was given by Stardent Systems on 3D visualisation.
The A(pplication) V(isualisation) S(ystem) was developed as a tool for relative computer illiterates. The software works modular, software can be implemented in the data processing flow, and designing the routing of data between these software blocks is like making a flow chart, with user-defined software in the boxes. Data processing consists of two cycles, a computational and visualizing cycle, which can be viewed and rendered in a later stage. The AVS was demonstrated on a stardent computer with 4 parallel processors to enhance dynamic graphic response.

What's in for the engineering geologist ?

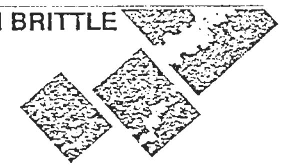
Well at first the knowledge that DOS based computer systems and programs were totally lacking in this field of geology. Correlation, visualization (rendering and contouring), geostatistics, modelling, all these approaches that connect basically the unevenly distributed data sets we normally get from geology or engineering cases, are performed on UNIX based workstations. Simply because these machines break the 640 Kb limit and have therefor a better performance in data handling, computing and displaying for editing. The latter is of importance to the input from us into the model. Also workstations, UNIX and software are better suited for networking since front-end and back-end processing are not necessary limited to one machine. The price of workstations (4-10 mips) and the 386-33 Mhz machines is nowadays in the same order of magnitude. The software shown can model many aspects in geology starting from interactive displaying and correlation (GOCAD, Intergraph) unto geological and basin modelling (SEDSIM), geophysical modelling (COMSEIS) or geostatistical modelling (LYNX) in ore bodies. Saltdome simulation, dam and grouting screen simulation, groundwater flow simulation, 3D contouring of properties, all seems to be there. Problems lie more likely in the price of the software than in the performance. Surprisingly no contributions from the Netherlands were there, no university or company (user or software) was represented in the field. One may wonder if lack of sufficient variation in topographical height forces our thinking into 2D (GIS), but we have to remember that 3D space applies also to depth.

Delft, 22 october 1990

Other Dutch visitors:
R.Hack(ITC); J.Herbschleb(GeoCom); J.Lyklama(TNO); H.Poelen(KSEPL); F.Schokking(RGD); W.Zijl(TNO).

DTM = Digital Terrain Model.
GIS = Geographical Information System.
GSIS = Geo Scientific Information System.
IVM = Interactive Volume Modelling.
DBMS = DataBase Management System.

FRACTURE PROCESSES IN BRITTLE DISORDERED MATERIALS
June 19-21, 1991



Noordwijk, The Netherlands

PRELIMINARY REGISTRATION FORM

In order to aid preliminary planning, the organizers would be grateful if intending participants would, without obligation, complete and return this form as soon as possible.

O I am planning to attend

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Name: ______________ Title: __________

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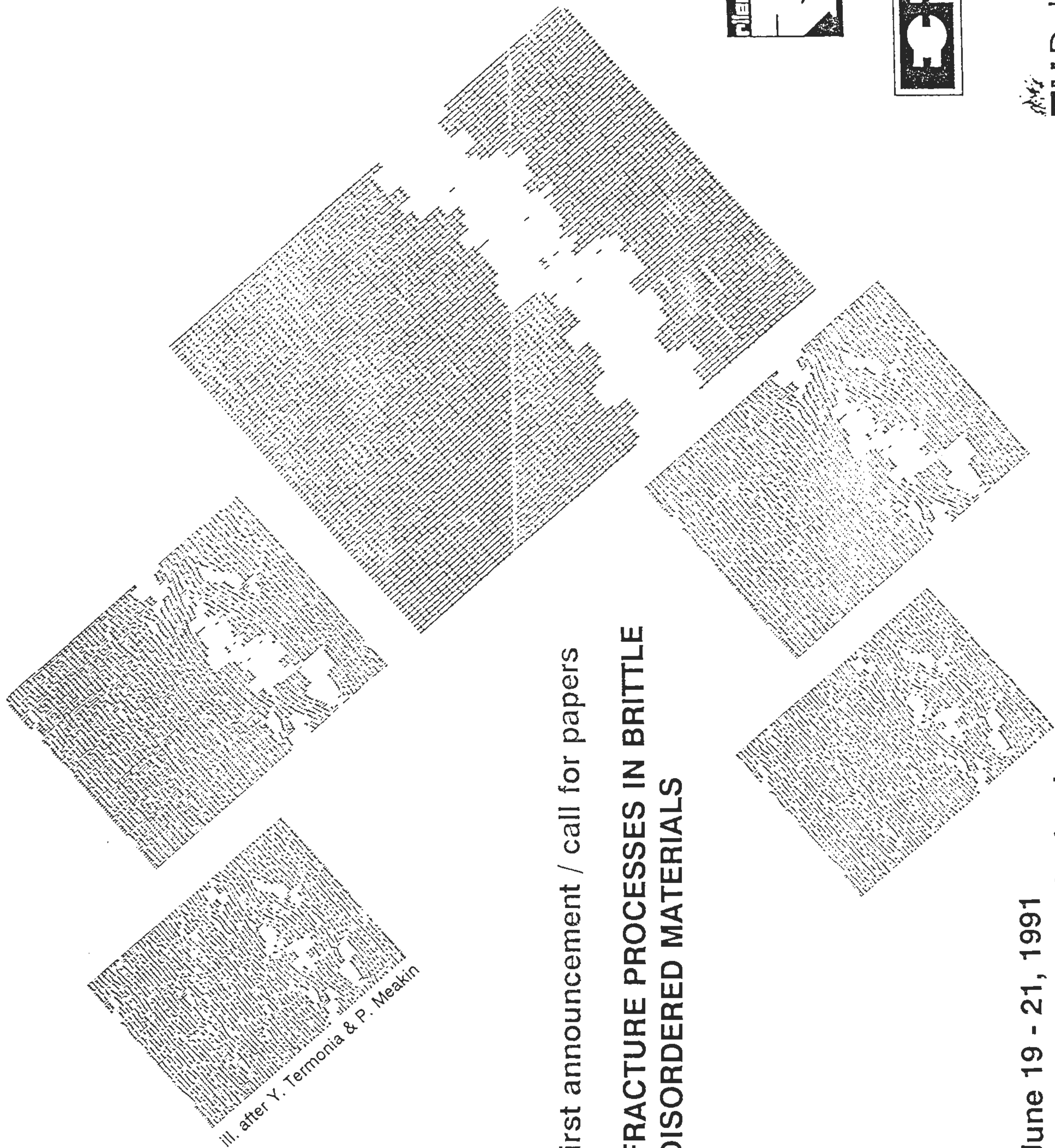

first announcement / call for papers

FRACTURE PROCESSES IN BRITTLE DISORDERED MATERIALS

June 19 - 21, 1991
Noordwijk, The Netherlands

FRACTURE PROCESSES IN BRITTLE DISORDERED MATERIALS (CONCRETE, ROCK, CERAMICS)
June 19-21, 1991

Sponsored by:
The International Union of Testing and Research Laboratories for Materials and Structures (RILEM)

Co-sponsored by:

The European Group on Fracture

Delft University of Technology

TNO Building Research (formerly TNO-IBBC)

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F.H. Wittmann, Switzerland

Theme

Fracture processes in brittle disordered materials are extensively studied worldwide, and rapid advances are made in the field. The predictive power of fracture models that were developed in the past is however not yet sufficient to warrant a fool proof application of fracture mechanics principles in practice. A salient feature in the fracture of brittle disordered materials is the size effect. Furthermore, different loadings (e.g. fatigue, long term loading, dynamic loading) may have a pronounced influence on the fracture process. The experimental validation of the models is under development, and gradually the geometry dependency of the outcome is better understood.

Localization of deformations seems to be the final stage in a fracture process. Similar phenomena are observed in tensile and compressive fracture. Yet the two fields are separated: tensile fracture is studied in the field of fracture mechanics, compressive fracture is of much interest to continuum mechanics specialists.
Since recently, fracture processes are studied in the physics community as well. Fracture is regarded as a growth process, and the aim of the physicists is to arrive at a universal fracture law for disordered materials.

The aim of this conference is to bring together specialists from fracture mechanics, continuum mechanics, material scientists specialised in rock, concrete and ceramics, and physicists to discuss the salient problems of fracture processes in brittle disordered materials. Progress in either of these fields is rapid, much on the advent of the introduction of numerical techniques. Researchers working in different areas are sometimes not aware of parallel research in other fields. Therefore it is felt that the conference may serve as a discussion forum for researchers from the above mentioned specialisms.

Specific topics:

- *Fracture mechanics modelling of failure processes*
- *Continuum mechanics based approaches*
- *Damage and Micromechanical modelling*
- *Rate effects, fatigue and sustained loading*
- *Structure and non-linear behaviour of heterogeneous materials*
- *Numerical modelling of failure processes*
- *Fracture mechanics test-methods for concrete, rock and ceramics (destructive, non-destructive)*
- *Applications of fracture mechanics*

Call for Papers

Abstracts (500 words) on the above topics are invited by July 1st, 1990. Notification of acceptance will be given by October 1st, 1990, at which stage recommendations concerning the format of the papers will be sent to the authors. Completed manuscripts are required January 1st, 1991 in order to ensure production of the Proceedings before the Conference. Abstracts should be sent to the Conference Secretary

Mrs. R. Komen-Zimmerman
Congress Office ASD
P.O. Box 54
2640 AB Pijnacker
The Netherlands
Tel. 31 (1736) 5356 / Fax. 31 (1736) 2242

Location

The Conference will be held in Hotel Oranje, Noordwijk, The Netherlands. Noordwijk is a nice seaside resort at the Dutch west coast, close to Leiden and Amsterdam. Schiphol Airport, which has frequent connections to almost anywhere in the world is only 30 mins by car. Noordwijk can also be reached by public transportation.

Accompanying Persons Programme

An accompanying persons programme will be organized in conjunction with the conference.

Accomodation

Reservations at reduced price have been made at Hotel Oranje. All enquiries should be addressed to the Conference Secretary Mrs. R. Komen-Zimmerman (address, see above).

Three-dimensional Computer Graphics in Modelling Geologic Structures and Simulating Geologic Processes
October 7 - 11, 1990, Freiburg, Federal Republic of Germany.

Symposium report by Robert Hack[1]

I INTRODUCTION

The "Geologisches Institut" of the "Albert-Ludwigs" University in Freiburg organized a congress about 3-D computer graphics modelling of geologic structures and simulating geologic processes from 7 to 11 October 1990.

Series of presentations were given about the following subjects:
- application of 3-D modelling in geosciences
- modelling of 3-D surfaces
- modelling of 3-D bodies
- modelling of 3-D geological structures; dome structures, faulted and folded structures and various combinations.
- modelling and strain analysis on 3-D structures and faults
- 3-D modelling of groundwater/oil flow
- 3-D modelling and simulation of erosion and sedimentary processes
- 3-D modelling and simulation of sea-water flow, current and floods
- 3-D simulation of compaction and subsurface fluid flow
- 3-D modelling of reservoirs and mining applications

In some of the presentations as well as in special demonstration sessions, soft- and hardware of different manufacturers and developers was presented. A large screen projection facility was coupled to a computer which allowed for graphic computer-slide shows and also real-time graphic computer modelling and simulation during the presentations.

Four panel discussions were held about the following subjects:

- 3-D hardware
- 3-D modelling
- 3-D process simulation
- 3-D and economic geology

Various hard- and soft-ware companies had arranged for complete operational systems for demonstration purposes in an adjoining hall.

2 PRESENTATIONS

The amount of presentations and the range of subjects covered by the presentations makes it impossible to report on these in detail in this report. The abstracts of the presentations were published prior to the congress and can be borrowed from undersigned. The proceedings of the congress will be published.

An overview of the presentations which is certainly not complete follows below:

- Various new developments in mathematical handling of data, contouring and interpolation routines.

Interesting developments in B-spline contouring routines and conversion of 3-D into T(riangulated)-surfaces were presented. Use of these routines in real situations will have to prove their usefulness.

- Modelling of geological structures

Various authors presented modelling of geologic structures and/or 3-D bodies. Examples were given of modelling of oil and water reservoirs, ore bodies including mine infra-structure and various other geological structures. The most impressive presentation were those on the computer in real-time. Especially the presentations by Mallet using COCAD and showing the modelling of a salt dome intersected by a fault with a displacement along the fault made clear what the benefits of 3-D graphics can be. The demonstrations were done in real-time

[1] ITC, Int.Inst. for Aerospace Survey and Earth Sciences, Kanaalweg 3, 2628 EB Delft. Tel: 015-569226 ex 215 Fax: 015-623961

including triangulation of surfaces. Re-building of graphic images was virtually instantaneous.

- Process modelling

Dynamic graphics showed modelling of viscous flow, temperature gradient (steam flood sweep efficiency in oil reservoirs), and ocean research of temperature and salinity modelling. A presentation of SEDSIM (Sedimentary Basin Simulation) showed modelling of sedimentary basins especially for oil exploration.

- Borehole log modelling

Silicon Graphics gave a real-time presentation of the interpretation of a down-the-hole fracture log. Very impressive and very useful for everybody concerned with rock-fracturing (as is the undersigned). Without doubt the method will also be useful for other parameters measurable in a borehole.

- General ideas and modelling structures

Some presentations dealt with the general set-up of how a 3-D computer graphics simulation should be and which soft- and hard-ware should be developed. For the details is referred to the proceedings. Time will prove if the ideas are right.

3 SYSTEM DEMONSTRATIONS

3.1 COCAD

Demonstrations of the COCAD system were mainly given during the presentations in the main audience hall. The demonstrations in the adjoining hall were in general fairly chaotic and did not add much to the demonstrations given during the presentations. System seems to be very good and suitable for geologic modelling and oil industry. Compared to the other systems present the COCAD system is probably the most complete system for geological applications. For mining applications the system seems not particularly suitable. System runs under UNIX with X-windows on HP, Silicon Graphics, SUN, Mac II (A/UX), Dec, Apollo, Convex, Tektronix, IBM. Annual costs $20,000 commercial and $2,000 for research institutes.

3.2 Dynamic Graphics

Good working system particularly suitable for geological modelling, oil industry and other fluid flow modelling or simulation. Costs not available also reduction for research institutes and universities not known. System runs on Silicon Graphics workstations.

3.3 Freie Universität Berlin

René Prissang from the "Freie Universität Berlin" gave a demonstration of an octree encoded modelling system developed by this university. The system can be combined with a Lynx system and the combination will then be a very powerful tool for underground and surface mining and for engineering geology. System runs on SUN Sparc stations or on FAX. Source code can be made available and thus (theoretically) it is possible to run the program on any computer configuration.

3.4 Intergraph

A workstation of Intergraph was installed and the standard demonstrations were given. The full version of the Intergraph system runs at the moment only on an Intergraph workstation but in due time a version for Sun Sparcs will be available (first half 1991 ?). Stripped versions of Intergraph are available for PCs. The PC version is not able to model profiles and sections in a random direction, but the new UNIX version is said to be able to do so. Data files are compatible between PC and workstations which is likely to be very handy. A draw back of the system might be that it is a modular system were (some of) the modules have been developed by different persons or companies. This might weaken the integrity of the system.

3.5 Lynx Geosystems Inc.

The only system present during the congress specially developed for mining applications. Geological modelling is mainly done by hand and the 3-D solid modelling is facilitated by smoothing options. The concept not to do too much on automatic/mathematical 3-D modelling is attractive. All systems (and also most of the presentations) showed that (automatic/mathematical) modelling can give erroneous results when used on incomplete or none structured (fuzzy) data sets. Incomplete data sets are more or less common in geology. Geological interpretation is for a large part intuitive and/or based on experience (the geological model has to "look good" !). The Lynx system allows for this type of input without too much of hassle. The statistical handling of ore grades (or any other set(s) of parameter(s)) is done mathematically with incorporation of the geological model. The modelling of the mining infrastructure (stopes, tunnels, ramps, open pit benches, etc.) seems to be fairly easy. The Lynx system uses 2-D graphics display standard because Lynx is reluctant to start with 3-D graphics as long as there is no standard for 3-D graphics (see also 3-D hardware panel discussion). Combined with the octree code of the Freie Universität Berlin (see above) the Lynx system might be one of the most powerful for mining and engineering-geology. The Lynx system runs on UNIX based graphics workstations -code: Fortran 77 & C, graphics GKS-. During the congress a SUN Sparc station was used for demonstrations.

3.6 Prakla-Seismos AG

A demonstration of a 3-D reflection seismic system was given. Interpretation of 3-D seismic reflection surveys and correlation with well log information was shown. Although the system is specialized and not particularly suitable for general use in geological modelling its attractiveness is the data-handling. The amount of data from seismic reflection surveys is so enormous that most databases and programs can not handle them (or become irritatingly slow). The Prakla-Seismos system has solved this problem and the system is useful when large data sets have to be interpreted, for example for the interpretation of large numbers of cone penetration tests. The system runs on FAX/VMS and the interpretations are made on a workstation with two high resolution colour monitors.

3.7 Geological Survey of Germany

A 2-D (2.5-D) system for use on FAX stations. The well known overlay in 2-D of different data sets was demonstrated. System seems to be working good. Comparison of this 2-D system with the other full 3-D systems is not fair.

3.8 Silicon Graphics

A (hard-ware) system developed for graphical design. Doubtful if the system is already in an end-user state for geological applications. It seems that the system is still under development and that programs are not yet finished or operational (see also presentations and Dynamic Graphics above). Systems run on Silicon Graphics workstations.

3.9 Stardent

A Stardent parallel computer (4 parallel processors) was installed running under UNIX and the AVS operating system. Sedimentary Basin Simulation (SEDSIM), various image processing, numerical and statistical programs are available. Stardent company is interested in research contracts with universities and research institutes. Costs of hardware (4 processors, 64 MByte memory, 1.5 GByte disk, vector floating point processor 80 Mflops) with software more than $120,000 but large discounts on hard ware as well as on soft ware are possible for research contracts.

4 PANEL DISCUSSIONS

Panel discussions always seem to have as subject what do we have to do (or make or produce) or not to do (or make or produce) to keep or make everybody happy. The answer is nearly always in the style of the question what was first: the egg or the chicken ?

Normally the users do not know what they miss until it is being made; the producers do not no what to produce because the users can not say what they miss. This partly illustrates the discussions which were held in the large hall of the university in Freiburg.

The panels existed out of 4 to 6 persons and all participants of the congress could take part in the discussions or react on statements made by the panel. Such a large amount of people (up to about 150) taking part in a discussion reduced the effectiveness of a discussion and did not lead to firm conclusions.

4.1 3-D hardware panel discussion

Especially the hardware discussions suffered from the egg/chicken question. The following points are worth mentioning:

- When will expensive equipment be available (free or with substantial discounts) for universities and research institutes ? (no explicit answers from the manufacturers were given)
- An interesting discussion developed around the subject when the re-calculation of the screen should take place. Either the graphics should be calculated

separately from the data model with gain of speed for small editing on the graphics but loss of speed for the first image, or the graphics should be calculated with the data model which gains speed for the first display but looses speed during editing (the screen has to be completely re-built after every form of editing). Supporters of both opinions were found in both the panel and the audience.

- A standard for 3-D graphics should be fixed (everybody agreed but which standard was not discussed).
- Flyn from Silicon Graphics and panel member: New developments will be stereo-viewing (pair of glasses with built-in LCD displays), sound (related to parameters) and 3-D environment (electronic gloves in combination with stereo-viewing will allow for simulated actual touching of objects and modelling by hand). These developments which can be expected in the near(?) future, will change the world of the design or research engineer. The audience and probably the panel too were stunned and were without doubt having their (mixed) feelings over their future work environment.

4.2 3-D modelling panel discussion

Geological modelling is impossible now because geology is (partly) intuitive and based on experience. This can at present not be modelled and may be in the future artificial intelligence (AI) systems are able to produce decent geological interpretations.

4.3 3-D process simulation panel discussion

Lack of geological knowledge frustrates the development of 3-D process simulation. The panel and audience agreed. Some participants in the audience found that especially geomorphological processes are underrated in geological simulation. Others argued that present day geomorphology and geomorphological processes do not need to be the same as processes in the geological past. The amount of factors influencing geomorphological processes is likely to be so large that a decent historical modelling will never be possible based upon present day geomorphology. Moreover most of the geomorphological processes are not precisely known or not described quantitatively.

4.4 3-D and economic geology panel discussion

The mathematics of most geologists and geology related scientists are not up to a standard to properly use 3-D systems. More emphasis should be put to mathematics and computer sciences during their study. Not everybody agreed with this statement quoting that for driving a car you do not need to be a mechanic.

5 CONCLUSIONS

3-D computer graphics gives very impressive results. Without being a user of the system it is fairly difficult to find out how much work and time has been involved to obtain a particular result. Series of pre-calculated computer slides can have taken hours or days to produce and when viewed in minutes give the impression of a wonderful and easy to handle very fast system. Also it is unknown if the data sets and examples for real-time presentations have been selected to gain a maximum performance of the system whereas with a real data set the system becomes irritatingly slow and cumbersome.

Notwithstanding the above, the Freiburg 3-D congress offered the opportunity to see various systems working in real-time and allowed for comparison of systems. Concluding it can be stated that 3-D computer graphics will without doubt have a major future and will change the working environment of the geologist and related scientists completely.
Also for education the impact will be tremendous. Now it becomes possible to show geological processes and resulting (sub-) surface features simulated in real-time and in 3-dimensions in lecture-rooms.

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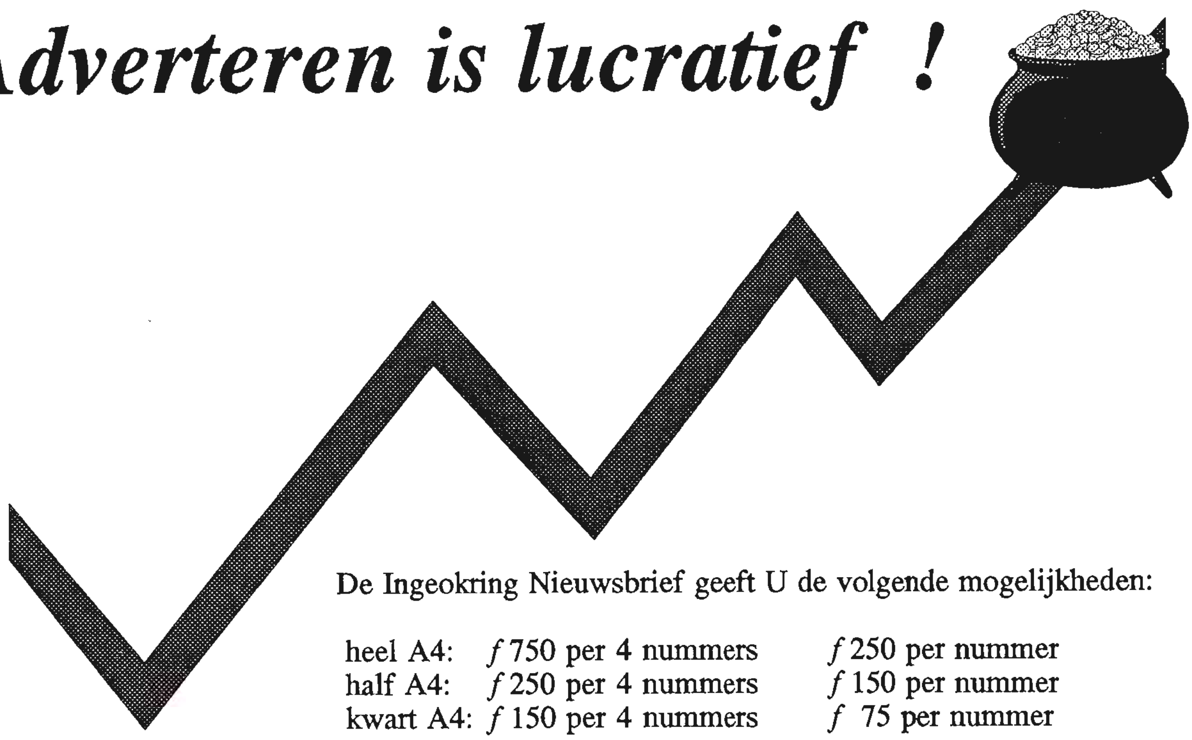

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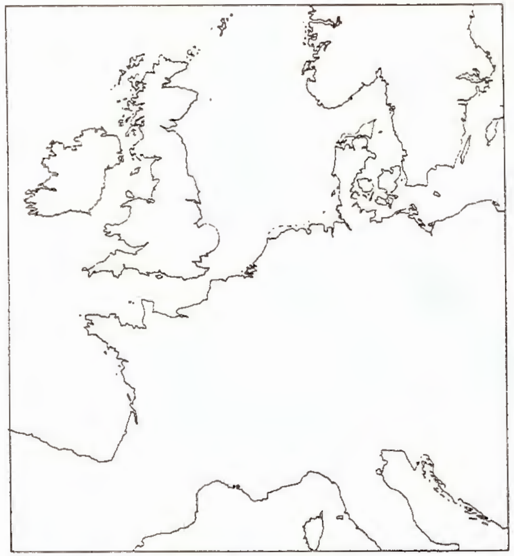

8th - 14th September 1991

SECOND BULLETIN

Symposium - The role of the Engineering Geologist in Europe.
Engineering Geology Fair.
Study Tour - Engineering Geology practice in North West Europe.

Le Groupe de Géologie Appliquée de la Société de Géologie de Londres organise un Symposium, une Exposition de Géologie Appliquée et une Tournée de visites d'étude, regroupés sous le titre **European Engineering Geology '91** (Géologie Appliquée Européenne '91). EEG'91 fournira aux géologues et aux géotechniciens l'occasion de se rencontrer et d'étudier les similarités et les différences des problèmes, solutions et pratiques de géologie appliquée en Belgique, en France, en Allemagne, aux Pays-Bas et au Royaume-Uni; abordant les aspects techniques, professionnels et commerciaux.

SYMPOSIUM - Le rôle de l'Ingénieur en Géologie Appliquée en Europe

Un symposium d'une journée se déroulera le vendredi 13 septembre à Bruxelles. Les conférenciers invités de chacun des pays prenant part exposeront à grands traits les problèmes de géologie appliquée particuliers à leur pays et la manière de les aborder. Le congrès scientifique se terminera dans la soirée par une réception sans caractère officiel qui sera suivie par le dîner du symposium. Les présentations du symposium et un répertoire, pays par pays, des principaux contacts géotechniques seront publiés.

EXPOSITION DE GEOLOGIE APPLIQUEE

L'Exposition aura lieu à Bruxelles, les vendredi et samedi 13 et 14 septembre 1991. Elle fournira aux organisations et aux universités relevant de la géologie appliquée et de la géothechnique l'occasion unique de présenter leurs produits, leur services et leurs programmes.

TOURNEE DE VISITES D'ETUDE - Pratique de la Géologie Appliquée en Europe du Nord-Ouest

Les visites d'étude commenceront dimanche 8 septembre 1991 et comprendront des chantiers de construction, des laboratoires géotechniques, les Bureaux nationaux de Recherches Géologiques et les universités des pays prenant part.

EEG'91

For further information please complete and return this form. It does not commit you in any way, but will reserve a place.

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Weitere Informationen erhalten Sie, wenn Sie dieses Formular ausfüllen und zurückschicken. Sie gehen damit keinerlei Verpflichtung ein, reservieren sich jedoch damit einen Platz.

Please indicate your interest / Veuillez indiquer votre intérêt / Bitte kreuzen Sie Ihre Interessen an:

- ☐ Attend Symposium / Présence au Symposium / Teilnahme an Symposium
- ☐ Attend Symposium dinner / Présence au dîner du Symposium / Teilnahme an Symposiumsessen
- ☐ Attend Fair on 13th / Présence à l'Exposition le 13 / Teilnahme an Messe am 13.
- ☐ Attend Fair on 14th / Présence à l'Exposition le 14 / Teilnahme an Messe am 14.
- ☐ Exhibit at Fair / Présentation à l'Exposition / Auf der Messe ausstellen
- ☐ Advertise in EEG'91 publication / Publicité dans la publication EEG'91 / Werbung in der Publikation EEG'91
- ☐ Attend Study Tour / Participation aux Visites d'Etude / Teilnahme an Studienfahrt

D.I.G. Subsidence-excursion: A visit to the waterboard Eemszijlvest

A.R.G. van de Wall

On the sixteenth of october this year the Student chapter D.I.G. organized an excursion to Groningen to get an impression about the problem of subsidence in these parts of our country. The excursion included a visit to the Waterboard 'Eemszijlvest' in Groningen and a to the N.A.M. in Drenthe. The article on the geology in this edition was part of the documentation. The following article will deal with the visit to the waterboard.

Introduction

With all the discussions going on about the problem of subsidence, possibly due to gas exploration, the student chapter decided to organize an excursion and take a look for ourself. It also was a good opportunity for the foreign I.T.C. students to see more from the Netherlands and its geology and geomorphology. We must not forget that polders are a rather unique phenomena which most of these participants had not seen before. The travel to the waterboard led trough one of the Netherlands' biggest achievements in this area, the Flevopolders.(I will not discuss these here)
The following sectors will discuss the aspects of the waterboard.

I History

Waterboards have of course not existed always, long ago people protected themselves from the water by retreating themselves on mounds, heights in the landscape. Later more active methods were developed, for example the construction of dikes. Everyone living near such a dike had the responsibility for his 'own' stretch. Of course this could not continue like that for if one neglected his part, it made the whole dike more or less useless. Therefore an organization was established which was in charge of the maintenance of dikes and other connected matters: the Waterboard.

The waterboard is controlled by the province, but not financed. It is financed by those who own real estate in this area, proportional to the size of their properties. These people also elect the staff of the waterboard. This makes the waterboard an independent public authority.

The waterboard Eemszijlvest was established in 1986, and was a fusion of three smaller waterboards. This did not lead to any rigorous changes, for these three had their own independent water systems, which remained independent.The accompanying map (figure 1) shows the location of these three areas.

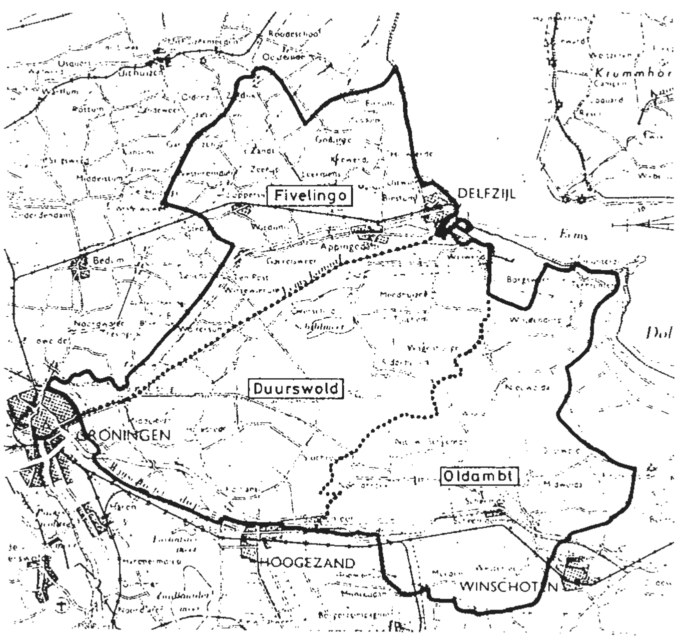

Figure 1 The three areas that are now combined in th Eemszijlvest.

II Tasks of the waterboard

The care of the water in the Netherlands is divided into different tasks: The control of the groundwater, the preparation of drinking-water, water quantity, water quality flood defence and waterways. The waterboard takes care of the groundwater control, the quantity and nowadays often also the water quality. To do so regulations have been developed: the 'Keur'.

III Practice of the waterboard

The height of the water is of course not constant; it changes continually due to the weather and the use of water. The task of the waterboard is to keep this level as constant as possible. The required level depends on the use of the nearest land, other uses of water and the number of watercourses. A problem that has to be solved is which lands must be taken together having the same waterheight throughout. Such a unity is called a polder.
Briefly said, the waterboard has to maintain the watercourses and the pumping stations. In the afternoon a look was taken at these maintenance works.

IV The influence of subsidence

From the title of this article it is clear that we didn't come all the way to Groningen only to hear about these things. So, we got to learn the influence of the subsidence and the measures to be taken.

Figure 2 shows the isolines of subsidence as registered by the N.A.M. A polder that lies in this area would sink at one side. It is clear that this could influence the groundwater regime. Lands could become to wet or to dry. Constructions could be affected.

the waterboard can take several measures to compensate the influence:
- Splitting up the polders into two or more parts with different water heights. This would ask for the installation of pumping stations and weirs.
- Enlargement of the watercourses in the direction with most subsidence,
- rebuilding of engineering constructions. This would ask for enormous investments.

An example of one of the remedial measures taken by the waterboard is the 'Damsterdiep' canal. The waterflow in this canal is opposite to the isolines. The waterboard has split the canal up into 4 parts by two pumping stations and a weir.

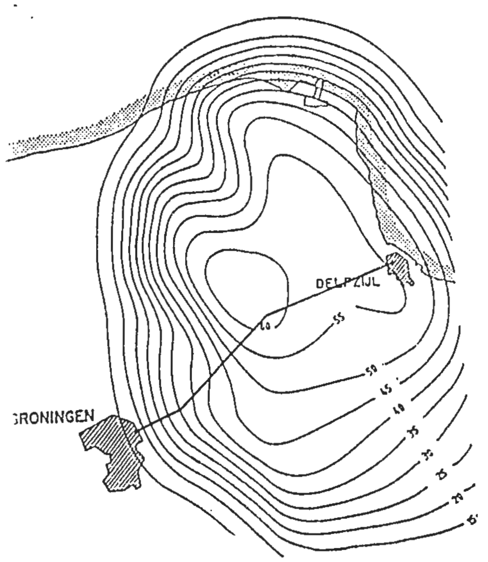

Figure 2 isolines of subsidence. (N.A.M.)

The disadvantage of this measure was the obstruction to navigation. Therefore liftlocks had to be installed, and the watercourses near the stations enlarged.

The question arises if all the stations installed the last few years have been necessary. After all, the prognosis for the maximum subsidence has been adjusted constantly and it didn't become bigger. At this moment it is expected to be 0.40 m in the year 2025; in the future it might even turn out to be less. At this moment stations that are already installed have often open docks and of some of the planned stations it is known that they won't be necessary for many years to come. One could wonder if all that money, we're talking about millions, can't be used for other purposes. After asking it turns out that most of the money comes from companies that might contribute to the subsidence. The attitude of the waterboard in this matter seems to be:'If it's there why not take it?'

V Direct influences on engineering structures

Direct influence of the subsidence on engineering structures does not seem to be of any significance.

As said before the prognosis of the maximum subsidence is at this moment 0.40 meter. This height difference is spread out over such a big area that no construction could be damaged. Even a railway, which has to be almost perfectly hori zontal doesn't seem to have any problems. One does not have to be scared for a sudden change in groundlevel. This could only result from a day-lighting fault. And the faults in this area can't reach the surface because the end deep in the earth in the salt layers.

What can be of influence is the change in the groundwater regime. If for example this level would drop the top of wooden foundation piles could get above the g.w.l. and thus suffer from rotting. Also drainage systems could stop working effectively. Of course it is very difficult to say what the direct cause for this kind of problems is. Let's just hope that the results of the symposium recently held on this subject in Delft will give a more clear view on the matter.

SPONSORING D.I.G.

Het Dispuut IngenieursGeologie viert dit jaar haar eerste lustrum. In het vorige nummer heeft U haar geschiedenis reeds kunnen lezen, alsmede haar doelstellingen:

1. Het behartigen van de belangen van de ingenieursgeologische studenten.
2. Het bevorderen van de sociale contacten tussen de ingenieursgeologische studenten onderling.
3. Het bevorderen van de sociale contacten tussen de buitenlandse ingenieursgeologische studenten van het I.T.C. en de ingenieursgeologische studenten van Mijnbouwkunde.
4. Het tot stand brengen van betere contacten tussen het bedrijfsleven en de ingenieurs-geologische studenten.

Om een goede uitvoering aan deze doelstellingen te geven heeft het dispuut geld nodig. Dit geld is voor een deel afkomstig uit de verkoop van truien en dassen en voor een deel uit het advertenties in dit blad. Dit is helaas vaak niet genoeg. Daarom wordt er gezocht naar bedrijven of andere instellingen die bereid zijn om het dispuut te sponsoren. Als tegenprestatie zal het dispuut bij een donatie van minimaal 100 gulden eenmalig een A4 advertentie in dit blad plaatsen.

INTERVIEW

Mr Hingira a civil engineer from Tanzania is doing his M.Sc. thesis in Engineering Geology at ITC Delft with a thesis on the development of a rockmass classification system for slope stability. In order to give some background information on his subject, interests, job and stay in our country, the editors were pleased to do this interview.

Brief historical background

Mr Hingira was born in Musona, Tanzania in 1959. He graduated from the University of Dar es Salaam in 1985, where he was awarded a B.Sc. degree in civil engineering with honours. After his graduation, he joined the Building Research Institute in Dar es Salaam as an assistant executive engineer. (research). He has undertaken various research projects at the institute, which were mainly dealing with the utilization of locally available geological materials for building purposes. His research work also included the development of construction techniques which could be applied easily, based on local and international standards available.
In august 1989, Mr Hingira was awarded the dutch fellowship to take part in the post graduate course in Engineering Geology at ITC Delft. This year his fellowship was extended and now he is proceeding for his M.Sc. degree.
In his country he is an active member of the institution of Engineers Tanzania and a member of the standardization committee of the Tanzania Bureau of Standards. At ITC Delft he is the current president of the student association board.

How did it come you came to Delft?

After working for more than four years, my government selected me to attend further studies so that I can broaden my knowledge. Among the alternatives was to join the Technical University Delft, but since the courses are conducted in Dutch I had to join ITC. There is a good number of Tanzanians who have already attended similar courses, so most of the Institutes are already known.

Can you tell something about your Msc. thesis?

The topic of my M.Sc. thesis is ' The Development of a Rockmass Classification System for slope stability analysis'. This seems to be a broad topic as there are many factors which have to be considered in the development of the whole system. We are working out, together with my supervisor Mr Robert Hack, to narrow the scope and deal with on aspect of the whole topic in more details.
The successful development of the rock mass classification system for slope stability (and other engineering geological purposes) analysis, will yield the following benefits:

to provide quantitative information for design purposes

to improve the effectiveness of site investigations by calling for the minimum input data as classification parameters

to enable better engineering judgement and more effective communication on a project.

Why did you choose this subject?

In my country the construction of high ways and trunk roads is one of the major engineering projects which are being undertaken. A great part of these roads pass through hilly and mountainous terrains, where big cuts and fills are inevitable. One of the major problems we are faced with is the determination of the stability of the created slopes.
As I just said, the development of a rockmass classification system for slope stability analysis is one of the basic tools in site investigation procedures, which can lead to better engineering design works.

Since you live for about two years far away from your family and friends, we wonder whether and if so in what kind of degree you consider our country as a different world?

It is true that I am missing my family very much. In most cases I communicate with them by means of letters and photographs. In few occasions talk to some of my relatives who have access to telephone services.
There is a remarkable difference between my

phone services.
There is a remarkable difference between my country and yours. You are living in the developed world while my country is still struggling to develop as much as possible. Definitely, the life system is quite different. The climatic conditions are quite different between the two countries, As you have summer and winter periods; we have dry and rainy periods. Most of our land is still very natural and attractive, such as our national parks as Serengeti, Ngorongoro, Mikumi, Tarangire, etc., mountains (Kilimanjaro) and beaches. I kindly welcome you to our country Tanzania so that you can explore its beaut on your own. I believe you will have a very pleasant and joyful time which you won't forget in your lifetime.

Thank you very much.

Tom Maase and Jenco de Groot.

OPROEP

Wellicht is het U opgevallen dat de Nieuwsbrief de laatste nummers steeds meer gaat lijken op een Delfts T.U. periodiek. Met uitzondering van een enkeling in het vorige nummer zijn allle stukken geschreven door mensen verbonden aan Delft. Dit zou toch een drang moeten opwekken om zelf ook wat in te sturen. Alle artikelen, casehistories of mededelingen zijn welkom.

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Nederland
Telefoon: 015-782543

INTERNATIONAL ASSOCIATION OF ENGINEERING GEOLOGY

INTERNATIONAL SYMPOSIUM ON URBAN GEOLOGY

Sfax (Tunisia)
May 6 - 11 1991

Bulletin N°1

organised by :
THE TUNISIAN ASSOCIATION OF APPLIED GEOLOGY

Symposium TAAG Secretariat :
Departement of Geology, Ecole Nationale d'Ingénieurs de Sfax
P/O. Box W -3038 Sfax - Tunisia

Telephone : (216) (4) 74 088
Telex : 40 982 TN
Telefax : (216) (4) 75 970

INTERNATIONAL SYMPOSIUM ON URBAN GEOLOGY

The Association Tunisienne de Géologie appliquée (ATGA), the Tunisian National Group of IAEG, takes pleasure in inviting you to attend the international symposium on Urban Geology.

OBJECTIVES OF THE SYMPOSIUM.

Important spreading of the urbanisation, with the lack of real control, especially in the developping countries, creates a problematic environmental situation. Sites for the ancient Mediterranean towns have been relatively well chosen, but the recent urbanisation wave and increasing needs of new areas, has lead to citizens occuping zones considered before as risky.

The symposium provides an excellent opportunity for engineers, geologists, urbanists and scientists working in the field of Urban geology to exchange ideas, information and experiences and stimulate a greater understanding of Environmental geology and its application in the urbanisation domain.

THEMES.

1 - Geotechnical mapping and specific technics (drilling, data collection and treatment, remote sensing, geophysics, testing...).
2 - Hydrology in the urban areas (runoff and urbanisation, phreatic groundwater, modelling...).
3 - Important projects in urban areas (foundation, roads, dams...)
4 - Problems in engineering geology (soils problem, landslides...).
5 - Useful materials (inventory, exploration, mapping...).
6 - Waste disposal (domestic, industrial, mining...).
7 - Historic cases.

PLACE AND DATE

The symposium will take place in Sfax, the second town of Tunisia, from 6 to 11 May 1991, at the Ecole Nationale d'Ingénieurs de Sfax (ENIS). Participants will be welcomed as from Sunday 5 May, either at Tunis (the capital of the country), or at the aeroport of Sfax.

PREVISIONAL PROGRAMME

Technical sessions will take place during the first three days (i. e., 6, 7 and 8 May 1991). A technical tour (optional) is planned for the last three days.

A special programme is organized for accompagnying persons.

OFFICIAL LANGUAGES.

The official languages of the symposium will be English and French. No simultaneous translation will be provided. Papers and discussions have to be presented in French or in English.

CALL FOR PAPERS

Prospective authors who wish to submit papers are requested to submit a summary of their project to the secretariat of the symposium by 30 october 1990.

The authors should :

- write in French or in English;
- clearly indicate the N° of the theme, the name(s) of author(s) and the title of the paper.
- limit their summary to about 200 words typed in double space.

The selection of papers will be made by the scientific committee. The authors of the selected papers should submit the full and final text to the organizing committee by 28 February 1991 (papers must be preparated according to instructions to be given at a later date).

TRANSPORT, RECEPTION, ACCOMODATION.

Most of the airline companies pass through Tunis. The airport of Sfax is served weekly by direct flights from Paris, each Thursday and Sunday.

Sfax is connected to Tunis by a train three times a day; it takes approximately 4 hours to cover the 300 km separating the cities.

Tunisia is equiped with hotels of an international level. For Sfax, existing hotels offer a very avantageous services, with prices ranging between 10 and 50 Us $

Detailed prices and hotel categories will be provided in the bulletin N° 2

REGISTRATION FEES

The registration fee is as follows : (1 Tunisian Dinar ≈ 1 US $)

IAEG Members	150 TD
Students	75 TD
Granted Tunisian participants	25 TD
Granted Tunisian students	15 TD
Others	200 TD
Accompanying persons	100 TD

The registration fee includes :

- participation in the symposium;
- proceedings of the symposium;
- 3 lunches (served at the restaurant of the university);
- coffee breaks;
- welcome cocktail;
- closing dinner;
- transportation between Sfax hotels and ENIS.

The companion fee includes :

- special programme;
- lunches and coffee breaks;
- welcome cocktail;
- closing dinner.

The fee for the technical tour will be included in bulletin N°2.

FORMULAIRE D'INSCRIPTION PRELIMINAIRE/PRELIMINARY APPLICATION FORM
SYMPOSIUM INTERNATIONAL SUR LA/ INTERNATIONAL SYMPOSIUM ON
GÉOLOGIE URBAINE/ URBAN GEOLOGY

Sfax, Tunisie / Tunisia 06-11 Mai /May 1991

Si vous êtes intéressés par une participation aux travaux du symposium, prière de remplir ce formulaire, pour recevoir le Bulletin N°2, et le renvoyer, avant le 15 Septembre 1990 au :

If you are interested in attending the symposium, please complete this form to ensure receipt of Bulletin N°2 and return it by September 15 1990 to

Secrétariat du Symposium ATGA/Symposium TAAG Secretariat
Département de Géologie / Department of Geology
Ecole Nationale d'Ingénieurs de Sfax, B.P./ P.O. Box W
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Probabilité de participation au symposium/Probability of attending the conference : 100%.....................50%........................25%.........................0%................

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Je voudrais faire les suggestions suivantes / I would like to make the following suggestions :...
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Date...Signature...

BOOKREVIEW: ENGINEERING ROCK MASS CLASSIFICATIONS -

A Complete Manual for Engineers and Geologists in Mining, Civil and Petroleum Engineering

By Z.T. Bieniawski. 251 pp., John Wiley & Sons, New York - Chichester, 1989. Price: £ 43.65.

Bieniawski who can be considered as one of the pioneers in rock-mass classification has compiled this book about classification systems. A large part of the book consists of already previously published papers. Notwithstanding the great achievements in classification systems through the work of Bieniawski this book is disappointing. The claim in the sub-title - A Complete Manual for Engineers and Geologists in Mining, Civil and Petroleum Engineering - can not be fulfilled. Descriptions of systems are very brief. A critical evaluation of classification systems is missing although it is common knowledge that most of the classification systems have flaws sometimes leading to serious errors in the assessment of rock-mass quality. The geomechanics system of Bieniawski including modifications by other authors is described in reasonable detail, other systems are described briefly.

Chapter 1 and 2 describe general rock-mass parameters including a very short description of intact rock material and characterizing laboratory tests for intact rock. Also in these chapters a short to very short description is given of: site characterization, drilling programs and mapping, geophysical, geological data acquisition and presentation methods. Chapter 2 concludes with a description of rock-mass parameters and rock-mass discontinuities. All this in 28 pages! It is obvious that the amount of pages do not allow for much detail considering that virtually the whole of rock mechanics, mining engineering and engineering geology is included. Such a brief summary may lead unexperienced engineers to serious errors when they base their designs only on this book without realizing that shortcomings in the described methods and a critical evaluation of the methods are absent.

Chapter 3 describes early rock-mass classifications as Rock Load, Stand-up Time, RQD index and Rock Structure Classification. By "early" the author means the period in rock mechanics previous to geomechanics classification systems.

Chapter 4 and 5 describe the geomechanics rock-mass classification system and the Q-system respectively. The former is the system developed by the author. A critical evaluation of both systems is missing.

Chapter 6 briefly deals with the New Austrian Tunnelling Method, Size Strength Classification and ISRM. Descriptions are very short with a small amount of examples and no evaluation.

Chapter 7 consists of three case histories of classification systems used in tunnelling and comparison of the results. This chapter is the most interesting in the whole book but the amount of case histories is rather small.

Chapter 8 deals with applications in mining outlining the use of the different systems in a mining environment. Remarkable is that nearly all users of the geomechanics system referenced in this book have modified the geomechanics system in one way or an other to 'make' it fit better to their local circumstances.

Chapter 9 deals with other Applications. Other applications are: estimating rock-mass strength, rock-mass modulus, rock slope stability, rippability, dredgeability, excavatability, cuttability, cavability and unified rock classification system. In 26 pages describing the use of classification systems in the applications above leads to a very brief description and the result is not much more than a listing.

Chapter 10. Case history data base. This chapter consists of a database of case histories for the geomechanics and Q-system. Support measures installed in underground openings are not included and therefore an evaluation of the merits of the classification systems is not possible. Also the most reliable measurable parameter in mining and tunnelling, the 'stand-up time', is only listed for a small amount of cases.

The benefits of a rock-mass classification system are without doubt for underground mining and civil engineering tunnelling. Designing support measures and span widths is facilitated with the help of a classification system. The amount of case histories described in the literature is considerable and most rock mechanics engineers involved in mining and tunnelling are well acquainted with the different classification systems. For them this book will not hold much new but a compilation of different systems in one book can be useful. What is missing is a decent compilation of case histories and a critical evaluation of the systems.
Research of classification systems for slope engineering and estimating slope stability has only recently started. Reliable reference data and case histories published are minimal. This is reflected by the very small amount of pages dedicated towards this subject.
For other rock-mechanically related engineering applications the case histories and classification systems described in the literature are very limited. Consequently the amount of case histories and detail described in this book is limited. Foundation engineering is not dealt with at all. Strange is that also petroleum engineering, except in the title, is not referenced in the book. The book includes a reasonable amount of references per chapter and a bibliography of 10 pages but the index is only 3 pages.

The chapters 1 and 2 about rock mechanics in general, could have been better left out altogether. These chapters rather result in mis-understanding of rock mechanics than in its understanding. If instead more case histories and evaluation of systems had been included the book would have been of more value.
A book about classification systems would have been a useful contribution to the rock-mechanic engineer's library but this book is a missed opportunity. Although clearly written with an extensive amount of figures and tables it is not much more than a compilation of a series of already published articles. This is quite expensive for £ 43.65 (= Dfl 140.-).

H.R.G.K. Hack
(ITC, Int.Inst. for Aerospace Survey and Earth Sciences, Delft)

Ledenlijst 1990

Op de volgende bladzijden volgt een ledenlijst zoals deze momenteel bij de redaktie van de Ingeokring bekend is. Het doel van de publikatie van deze lijst is meerledig. Ten eerste is het de bedoeling dat de leden hun gegevens controleren en indien nodig wijzigingen of ontbrekende gegevens middels bijgaand formulier aan de redaktie doorgeven. Het mutatie formulier bestaat daartoe uit twee delen. Het eerste deel is voor mutaties betreffende het lid zelf. Het tweede formulier is voor het geval dat men aanvullingen kan geven wat betreft andere leden of voor het aanmelden van nieuwe leden en/of het verkrijgen van extra informatie omtrend de Ingeokring.
Een ander doel dat de Ingeokring probeert te bereiken is dat personen en/of bedrijven die gebruik willen maken van de diensten van anderen op deze wijze sneller contact kunnen leggen en zo mogelijke problemen beter kunnen oplossen.

De formulieren spreken voor zichzelf. De codes die moeten worden ingevuld zijn dezelfde als die vermeld in de ledenlijst. Bij deze lijst zit ook een uitleg van deze codes.

De redaktie wil op deze plaats ook een oproep plaatsen voor hen die zich verdienstelijk denken te kunnen maken voor de Nieuwsbrief.
Ondanks succesvolle wervingen is er nog plaats voor een of twee personen. Eenieder die bekend is met wordprocessors en desk top publishing en daarnaast ook bereid is stukjes te schrijven in de nieuwsbrief kan zich aanmelden door dit aan te geven op de mutatie formulieren in het daartoe bestemde vak 'redaktie'.

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EXTRA BIJZONDERHEDEN:

40

Conferences, Seminars and Symposia

1991

6-11 May	International Symposium on Urban Geology. Sfax, Tunisia. **Organisation:** International Association of Engeneering Geology. **Topics:** Geotechnical mapping and specific technics, Hydrology in the urban areas, Important projects in urban areas, Problems in engeneering geology, Usefull materials, Waste disposal and Historic cases. **Info:** Symposium TAAG Secretariat: Department of Geology, Ecole Nationale d'Ingenieurs de Sfax. P/O. Box W -3038 Sfax - Tunisia. Tel. (216)(4)74088; telex: 40 982 TN
12-18 May	Fourth International Symposium On Land Subsidence. Houston, Texas, USA. **Topics:** a.o. Case histories, Mathematical and egngeneering theory, analysis and modelling of subsidence phenomena, Subsidence impacts on environmental, social, economic and legal factors, relation of subsidence to other phenomena, New techniques and instrumentation for prediction and measuring subsidence. **Info:** I. Johnson, Chairman, FISOLS. 7474 Upham Court, Arvada, CO 80003 USA.
27 may-1 June	10th European Regional Conference. Florence, Italy. **Topics:** Deformation of Soils and Displacement of Structures. **Info:** Ing. G. Baldi, Secretary, Associazione Geotechnica Italiana, Viale Regina Margherita 183, 00198 Roma, Italy.
19-21 juni	Fracture processes in brittle disordered materials. Noordwijk, The Netherlands. **Topics:** fracture mechanics modelling of failure processes, continuum mechanics based approaches, Damage and micromechanical modelling, rate effects, fatigue and sustained loading, structure and non-linear behaviour of heterogeneous materials, nummerical modelling of failure processes, fracture mechanics test-methods for concrete, rock and ceramics, applications of fracture mechanics. **Info:** (for registration and papers) Mrs. R. Kommen-Zimmerman, Congress Office ASD P.O. BOX 54, 2640 Pijnacker, the Netherlands. tel. 31-(1736) 5356, fax. 31-(1736) 2242
21-22 june	International symposium on Mapping and Geographic Information systems. **Topics:** Exchange of experiences and the potential for standardizations. see also the ad in this paper. **info:** Ms. Dorothy Savini, ASTM, 1916 Racestreet, Philadelphia, Pennsylvania 19103 USA 215/299-5413; fax: 215/977-9679
26-30 August	9th Pan Am Regional Conference. Santiago, Chile. **Topics:** a.o. Geotechnical properties of soils of America, Special problems on foundations, Soildynamics, Nummerical Methods in Geotechnical Engeneering, Underground excavations in urban areas, Geotechnical

aspects of Tailing Dams, Earth and Rockfill Dams.
Most sessions willbe preceeded by a special lecture. A technical exhibtion in included to display equipment and techniques, as well as field- and laboratory intrumentation.
Info: Mr. Luis Valenzuela, Secretary, SOCHIMSYF,San Martin 352, Santiago, Chile.

8-14 September

European Engeneering Geology '91.
Brussels, Belgium.
Topics: 13 september: Symposium on the role of the engeneering Geologist in Europe. The engeneering problems in different countries and how these are addressed. Presentations will be published.
13,14 september: Engeneering geology fair; Exhibition for organisations and universities.
from 8 september: Study tour visiting active construction sites, geotechnical laboratories, national Geological surveys and universities in the participating countries.
Info: Mr D.R. Nurbury; EEg'91 Organising committe Secretary.
Soil Mechanics Associates; Hogwod Lane, Finchampstead, Workingham, Berkshire RG11 4QW U.K.

16-20 September

ISRM 7th International Congress on Rock Mechanics, Aachen, Germany.
Topics: Rock Mechanics and Geology; Stress-Strain Behaviour, Dynamic Behaviour and Water Permeability of Jointed Rock; Underground openings in Rock; Rock Excavation; Dam Foundations in Rock; Slopes.
Info: Deutsche Gesellschaft fur Erd- und Grundbau E.V., Kronprinzenstr. 35A, D-4300 Essen 1, Germany.

9-13 december

Ninth Asian Regional conference on soilmechanics and foundation engeneering. Bangkok,Thailand.
Topics: Development of theory and practice in geotechnical engeneering; Problematic soils and their engeneering behaviour; Soil-structure interaction, and foundations; Embankments, excavations and buried structures; natural hazards and environmental geotechnics; groundimprovement techniques.
Special emphasis will be placed on contributions dealing with practical applications.
Info: Prof. A.S. Balasubramaniam, Secretary,South East Asia Geotechnical Society, Asian Institute of Technology, P.O. Box 2754, Bangkok 10501, Thailand.

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10-14 februari

Sixth International Symposium on Landslides.
Christchurch, New Zealand.
Topics: Landslide investigations, Stability analysis techniques, Stabilisation and remedial works, Lanslide hazard assessment, Seismicity and landslides, Landslides and reservoirs, Open pit mmine slopes, Slope instability in tropical areas. Excursions related with the symposium are being orginized.
Info: see information- and subscription form in this newsletter.