Ingenieurs Geologische Kring
Netherlands Section of Engineering Geology
Secretaris: Dr. J.J.A. Hartevelt
Postbus 63, 2260 AB Leidschendam (the Netherlands)
Postgiro: 3342108, t.n.v. Penningmeester Ingeokring Delft.

INGEOKRING NIEUWSBRIEF

Lente - zomer editie

INHOUD
DUBBELE UITGAVE

Redaktie:

Drs. P.N.W. Verhoef
A.R.G. van de Wall
J.E. de Groot

INGENIEURS-GEOLOGISCHE KRING
NIEUWSBRIEF

Van de Redaktie

Voor U ligt het nieuwste nummer van de Ingeokring Nieuwsbrief. De dikte doet reeds vermoeden dat hier iets bijzonders aan de hand is. Dit is inderdaad een dubbel nummer. Dit als compensatie voor de niet uitgegeven puiblikatie van begin 1991. Daarnaast is dit misschien een compensatie voor de zogenaamde komkommer tijd in de kranten.

Zoals altijd begint dit nummer met een artikel van de heer Maurenbrecher, dit keer samen met de heer Kronieger. Verder wordt U door de heer Verhoef geholpen bij de keuze van nieuwe boeken in zijn boek besprekingen, wordt er verslag gedaan van de Ingeokring jaarvergadering en natuurlijk is ook de Symposium agenda weer aangevuld. In dit nummer staan ook enkele uitgebreide aankondigingen van congressen en symposia. Dit op verzoek van enkele lezers die graag meer informatie wilden krijgen.
Verder wil ik hier een speciale uitgave van de Nieuwsbrief aankondigen die eind september zal verschijnen. Deze zal in het teken staan van het EEG '91.

Correspondentie adres:

Redaktie Nieuwsbrief Ingeokring
Faculteit der Mijnbouwkunde en Petroleumwinning
Sectie Ingenieursgeologie
Mijnbouwstraat 120
2628 RX Delft
Nederland
Telefoon: 015-782543

INGEOKRING NIEUWSBRIEF

Engineering Geological Routes in The Netherlands
Instalment 2
Saturday in southern Limburg

edited by P.M. Maurenbrecher

This is the second of series of articles on engineering geological routes through The Netherlands. The first article published in the December 1990 issue of the IngeoKring Nieuwsbrief found us travelling back into time by following the A2 south from Amsterdam to southern Limburg. This second instalment describes the visits made the following day. Considering the guides had an extremely strenuous week behind them the Saturday tour went very well.

The programme for the day looked as follows:

Excursion programme 11 august 1990

7:30 - 8:30	Breakfast at the hotel, **we leave at 8:30 sharp** for the ENCI quarry.
9:00 - 11:30	Visit to the ENCI quarry (Maastricht). Cement factory and quarry. host: Mr. Poesen. Written contribution by P.M. Maurenbrecher with text provided by P. van Rooijen.
12:00 - 13:00	Quarry Hoorensberg (Valkenburg), underground limestone quarry. Written contribution by D.G. Price.
13:00 - 14:00	**Lunch** at the restaurant Sprookjesbos (= *Fairy tale forest*).
14:00 - 14:30	Bus drive over the terrace remnants of the Maas river from Maastricht to Gulpen. Written contribution by R.R. Kronieger.
14:30 - 15:00	Panorama from the Gulpener berg (Gulpen). Written contribution by R.R. Kronieger and verbal contribution by M. van den Berg
15:30 - 16:30	Visit to the quarry Sigrano (Heerlen) and the sieving plant. Written contribution by R.R. Kronieger, host: Mr. Scheeringa
17:00 - 18:00	Visit to the quarry Nagelbeek (Nagelbeek). Written contribution by R.R. Kronieger and additional "visual" contribution by R.G.D. (Geological Survey)
19:00 - 20:00	**Dinner** at the hotel.
20:45 - 22:00	Visit to the Museum of Natural History in Maastricht. host: Mr. D.Th. de Graaf

The guides and contributors were:

Geological Survey:	Meindert van den Berg
Technical University Delft:	Rene Kronieger Michiel Maurenbrecher Prof. David Price

PART 1 Southern Limburg the Engineering Geological Scene from the Bus: A Route Description

by R.R. Kronieger

How to fill the Saturday

The general approach of this excursion is to show you some interesting points of the geology of south Limburg, especially were it is related to construction on, in and with the geological materials available. A short introduction in the geology of the area was given in the December issue of the Ingeokring Nieuwsbrief. However due to the restricted time available only some striking sites can be visited. To reach those sites we have to do some touring (fig 1) having a view at the scenery and the influence of geology on this scenery. At the sites we will sometimes have a look at, in or under the geological strata. The excursion guide is composed as a general route description with some shorter articles attached to highlight individual stops (Parts 2 to 6). Elements of the routing have been underlined so you can find were you are. The geological units have been printed in italic, generalized topics are printed in bold.

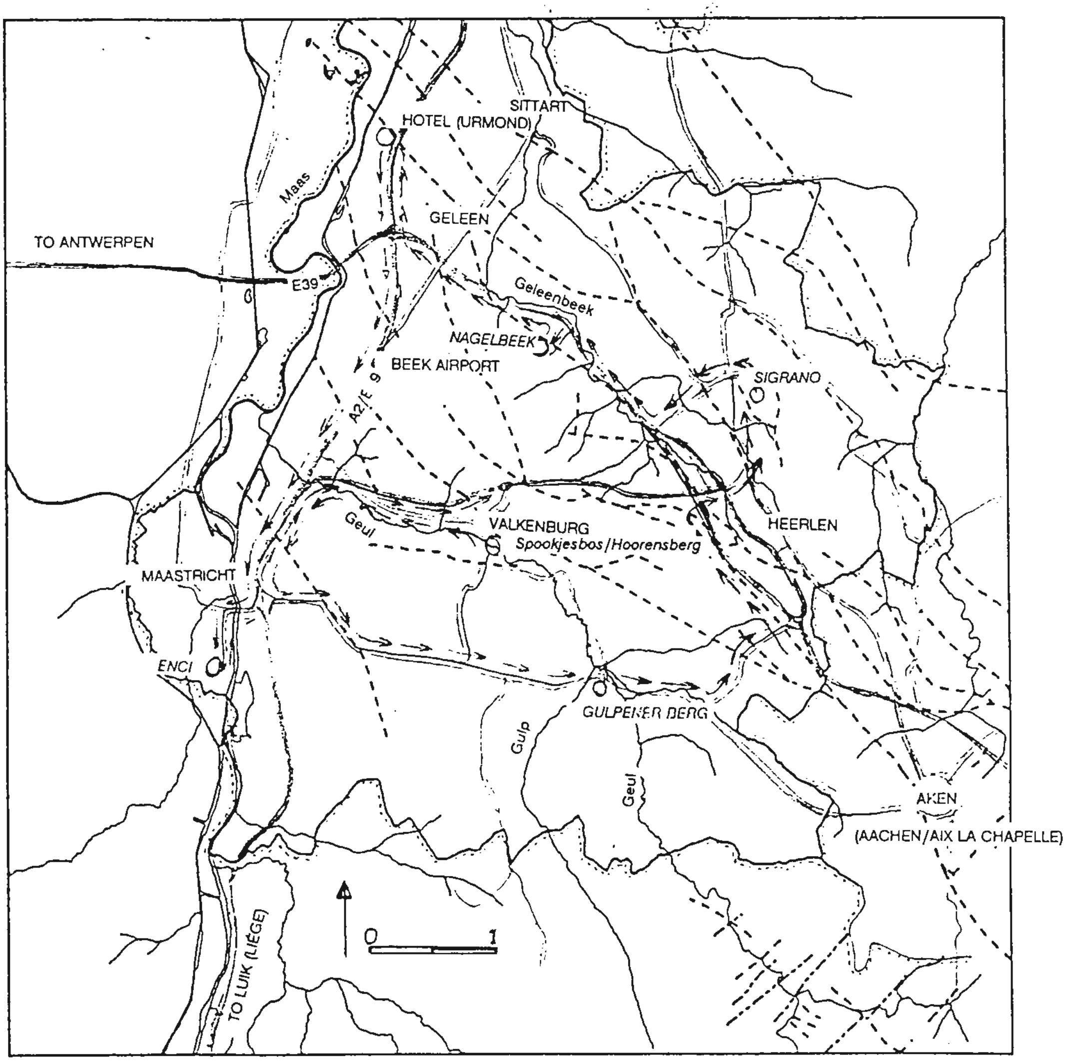

Figure 1 Route Map through southern Limburg

Urmond-Maastricht Road

From the hotel the bus takes us to the ENCI quarry were we will visit the cement factory and its excavation into the Maastrichtian limestone. The bus will take the A2 highway south to Maastricht which leads us over the northern part of the loess plateau. Airport 'South-Limburg' is constructed on a thick *loess* sequence on top of gravels. Future extension of the airport capacity will involve the use of loess as fill material for a small valley to be crossed by the new runway. Shortly after passing the airport we descend into the valley in which the city of Maastricht is situated. This valley is eroded by the river Maas in several stages... more on that later. Crossing the river Maas in Maastricht we drive along the older river bed to the **ENCI**. On our right side already some outcrops of *the Maastrichtian* appear. The steep cliff just before the plant begins is the type section of the Maastrichtian! The limestone, as is the case generally in southern Limburg, overlain by gravels and loess. The ENCI and its geology is described in Part 2.

Snow White and the Seven Dwarfs?

From the deepest excavation in the area we leave along the same route to the resort town of Valkenburg-on-the-Geul. The small town lies in a river valley cut into the Maastrichtian limestone by the Geul river. The purpose of the visit is to have a look at an underground limestone quarry, **the Hoorensberg Mine**. Please leaf to the Part 3 for more details especially with regard to the safety regulations. The visit to the mine is followed by lunch in the Sprookjesbos (Fairy Tale Woods) Restaurant on top of the entrance to the mine. Notice the antropogeneous rock-type exposed. Please do not whack it with your hammer, unforeseen effects may take hold of you!

Old River Routes

Leaving the lunch site above the underground excavations in the Maastrichtian near Valkenburg we return to the city of Maastricht to start the route showing us in more detail how the geology of the overlying strata. the highway is constructed on the loess cover in one of the small rivers called the Geul. The forested area to the south (left) covers the river embankment in the Maastrichtian limestone. Locally some exposures are visible. Cover consists of a loess cover underlain by gravel units and an Oligocene sand unit. Several steps in the topographical profile indicate **Maas river terraces** remnants of older Maas bedding. The background of the genesis of the Maas terraces is given in Part 4. The knowledge of this genesis appeared to be of grave importance to the understanding of the different gravel compositions beneath the loess cover and their liability for excavation.

The river terraces names were derived from villages situated on such a terrace. In former times most of these terraces were agricultural units centred around these villages and separated by the terrace rims. The route from Maastricht was chosen as it passes perpendicular to the terrace rims so that with increasing elevation their succession into history can be followed. Figure 2 shows the route followed relative to the Maas River terraces. Only where the difference in level between the terraces is sufficiently high they can be traced in the terrain (see elevations Figure 3. Where a terrace rims is approached the road is partly build on a embankment and passes then through a roadcut onto the next terrace.

Part of the A2 highway within the city limits of Maastricht is constructed on one of the youngest Maas river terrace, *the Oost-Maarland terrace*. From the A2 we deviate to the East in the direction of Margraten. Just before the traffic lights a slight rise in the road indicates that we traverse onto a small sliver of *the Gronsveld terrace*, one of the **'middle' terrace set**. From the traffic lights onwards we traverse the terrace of *Caberg* and *Rothem*. The location of the rims of these Maas terraces is not very clearly exposed since their height differs only a few metre which is masked by the loess cover.

The jump to the **'high' terrace set** however can be noticed quite clearly since the difference in level between the terrace groups is about 50 metre. On the terrace rim north of the road (on the left hand side) a church is build and south a castle has been build from the Maastrichtian limestone which is underneath. The terrace rim can be followed for it is heavily wooded. In the terrace rim to the *St.Pieterberg terrace*, a wine cellar is constructed. Near its entrance on the left side of the road (north) the terrace gravel is exposed in the embankment. covered with loess is exposed. The terrace rim here is sufficiently high to facilitate access to the Maastichtian limestone and some large limestone quarries are situated in this rim.

Driving further we pass the rim to the *St.Geertruid terrace* near the village of 'Cadier en Keer'. The road leads us then in a straight line towards the village of Margraten. The next terrace on which the road passes is the *Valkenburg terrace* which

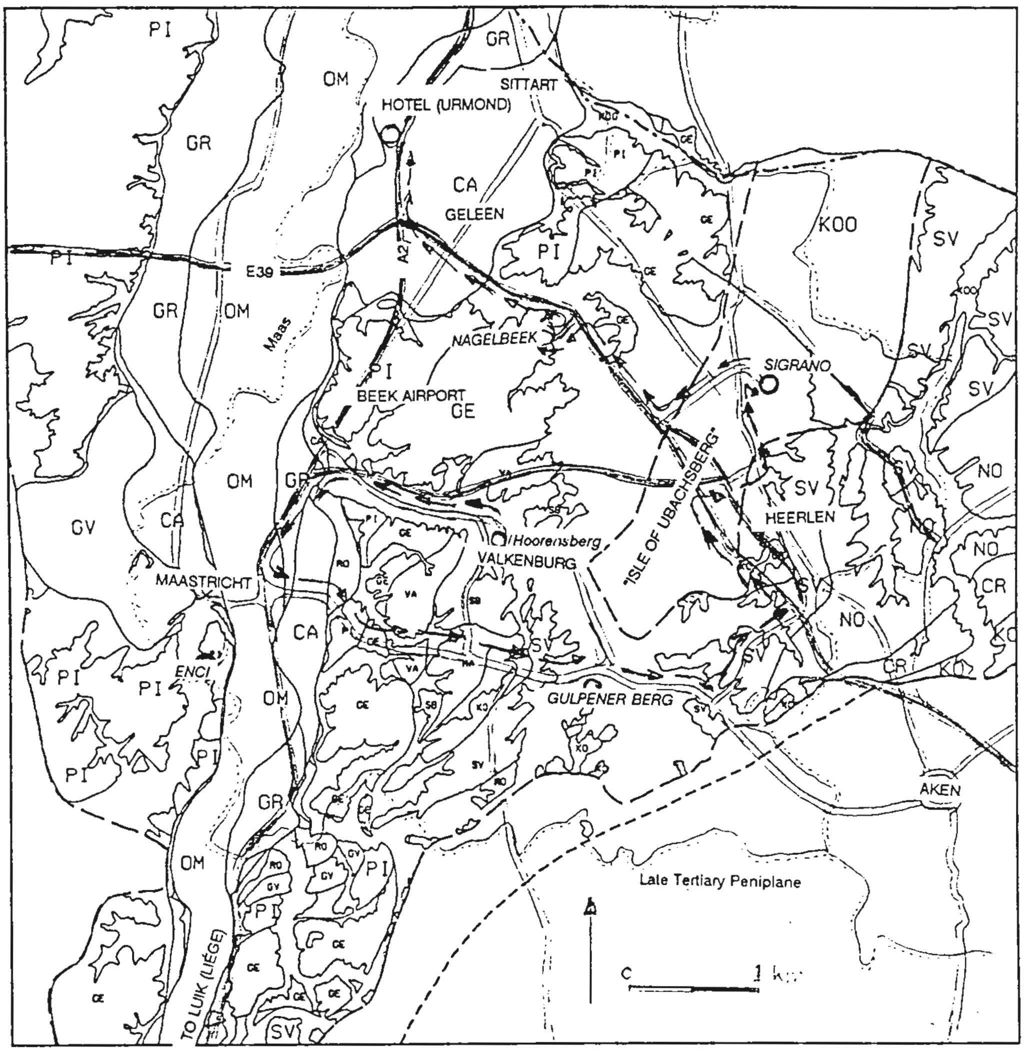

Figure 2: Gravel Terraces of the River Maas with route super imposed (Scale same as Figure 1).

Code	Name	Elevation m	%qtz	age my	Age name	Climatic Period(s)
OM	Oost-Maasland	35-42		0-0.1	Holocene-late pleistocene	Weichselian
GR	Gronsveld			0.12-0.14	Middle-Pleistocene	Eemian-Saalian
CA	Caberg	39-48	18	0.25-0.28	"	Saalian
RO	Rothem	60-65	25	0.31-0.45	"	Holsteinian-Cromerian
GR	's-Gravenvoeren			0.5-0.55	"	Cromerian
PI	St. Pietersberg	99-102	-	0.6-0.72	"	Cromerian
GE	St. Geertruid	109-118	32	0.85-1.08	Early Pleistocene	Bavelian-Menapian
VA	Valkenburg	110-128	32	1.16-1.33	"	Waalian-Eburonian
SB	Sibbe	140-145	33	1.39-1.44	"	Eburonian
MA	Margraten	150-160	40	1.52-1.59	"	Tiglian
SV	Simpelveld	160-170	40	1.75-1.85	"	Tiglian
NO	Noorbeek			1.92-1.95	"	Tiglian
CR	Crapoel			2.01-2.07	"	Tiglian
KO	Kosberg	170-189	65	2.11-2.25	"	Tiglian-PreTiglian
KOO	Kieselooliet	210	80	2.26>	Pliocene-Late Miocene	Reuverian-Susterian

Figure 3 Listing of principal Maas River Terraces shown in Figure 2

6

starts just outside the village, followed by the *Margraten terrace*. The rim of the latter terrace lies near the entrance of the American Military Graveyard. The village of Margraten forms the centre to this terrace. Just after leaving the village we pass the waterdivide between the 'east' and older Maas riverbed. The terrace sequence starts here at 160 metre with the *Simpelveld terrace* which was the youngest deposit from the 'East Maas', left after the break through in an more northerly direction. Older terraces indicating the predecessing riverbed are situated on higher levels, *the Noorbeek, Kosberg and Crapoel terraces*, and are only locally present.
The steep valley where the township of Gulpen is located, results from the erosion of the Gulp and Geul river. We will have a look at a profile through the 'east' maas river bed and its terraces from the **Gulpener berg** This remnant hill is covered with Simpelveld terrace gravel under a loess cover. Base rock here is formed by the Gulpen Limestone of Campanian/Maastrichtian age. Due to tilting older formations upto Santonian age form the pre-quaternary base going to the west. The oldest exposed rocks are of Carboniferous age, they are exposed by incision of the Geul river. One can observe that the main traffic arteries make use of the geology induced morphology.

High and Dry: Isle of Ubachsberg

Looking east from the Gulpener Berg the profile of a transverse valley can be seen with its matched terraces deposited by the Maas river during its "eastern" period. To the south-east the former river embankment covered with forrest can be seen. The topsoil here, covering the limestone, is an in-situ weathering product, several meters thick, consisting of almost entirely clay and flint. On the horizon to the east, the river terraces in elongated stepped profile can be seen. To the north-east the 'Isle of Ubachsberg' is the remnant of the northern bedding of the 'east' Maas river bed. All the terrace deposits have been used as a local source for gravel, however their extend and quality nowadays do not meet the requirements for economical exploitation.

Kunrade Limestones & Faults

From the view point on the Gulpener berg we drive to the east in the direction of the city of Vaals. The part of the excursion leads us through the valley of the Sinselerbeek, which eroded through the loess cover into the Campanian sandunit (Vaals formation) underneath the Maastrichtian limestone. As we cross the Sinselbeek creek heading north we ascend the steep embankment leading towards, again, the Simpelveld terrace. The drive along the highway to Heerlen further terraces of the 'East Maas' are passed again. The highway crossing at the turning north onto the A76 is located on the *Simpelveld terrace*. When we pass a small bridge crossing the highway we are on the *Kosberg terrace* again. The roadcut is made into the old northern embankment ('Isle of Ubachsberg') into the underlying limestone.

Unique in The Netherlands: A Road Cut

Along the roadcut of the A76 (to your left) an exposure of the eastern facies development of the *Maastrichtian limestone*, the ***Kunrade limestone*** is exposed. The map in Figure 4 indicates the facies boundary. Unfortunately it is not possible to stop here, but from the bus the layered appearance of this limestone unit clearly can be seen. The hardground units from the Maastrichtian still prevail but between them the Kunrade facies contain sandy units instead of pure limestone . Research by the Engineering Geology Section at Delft University of Technology on changes of strength properties related to the facies change is given in Figure 5. Cover of the limestone in this area consist of loess at the top, overlying Pliocene gravels and sands (*Kiezelooliet formation*).

Just a kilometre after the roadcut the terrain to the west (left) a marked step in the terrain, parallel to the highway, can be seen. This is caused by one of the NW-SE trending faults, the Kunrade fault, which places Kunrade limestone (Cretaceous) against Tertiary sand unit near surface. However the area is covered with Loess so the fault is not plain visible, but a profile across the fault shows an estimated offset of the base of the sand (Tongeren formation) of 100 metre. Sedimentation and regional scale tectonics in the southern part of Limburg were mainly influenced by three major structural area's. The massif of Brabant in the west, the massif of the Ardennes in the south and the Central graben in the north-east. The Hercynian folding phase at the end of the Carboniferous left in Limburg a remainder consisting of the Waubach anticline and probably the Vise-Puth anticline. The generation of NE-SW trending faults (e.g. the Feldbiss fault) culminated in the carboniferous into a horst and graben structure. At the end of the Cretaceous the block north-east of the Feldbiss fault was uplifted and erosion took place. The Alpine tectonics during the Tertiary again activated the large NW-SE faults. One of them,the

Feldbiss fault, became the borderfault of the Central graben. The last major tectonic Alpine effect was the tilting of the Limburg area to the NW causing the river Maas to seek a more north-easterly bedding.

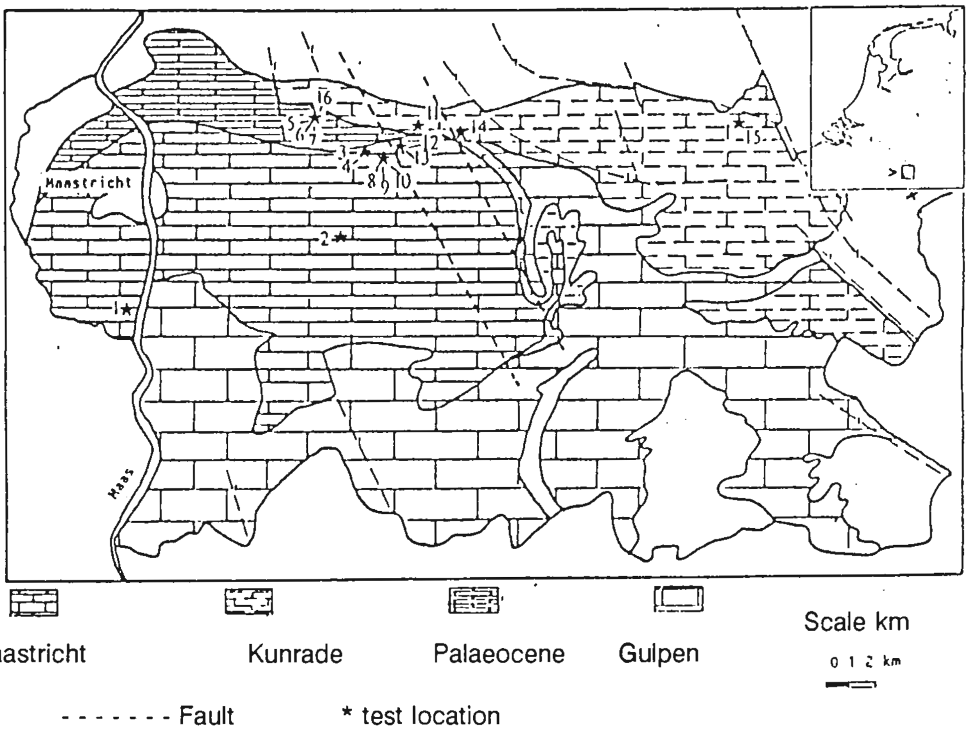

Figure 3 Limestone types in southern Limburg (Kronieger,1989)

SW 1	2	3-10	11-13	14-15 NE
MAASTRICHTIAN FACIES		<------------------------------->		KUNRADE FACIES
		✱20-21.4 ▼12-30 □17 ▲11.6-15.8 ↔0.2-0.5 ↕3.2-3.7	✱19.3-19.7 ▼14.2-28.4 □18 ▲11.6-15.8 ↔0.2-0.5 ↕3.1-3.7	✱18.5-23.6 ▼13.4-53.4 □7-21 ▲9.5-23.7 ♦90-98 ↔0.15-0.6 ↕1.3-3.6
✱13.2 ▼2.6-2.8 □48 ▲0.82-0.95 ♦95 ↔0.22 ↕0.2-0.25	✱11.0-12.8 ▼1.4-4.2 □47 ▲0.16-0.35 ↔0.1-0.14 ↕0.14-0.55	✱13.0-15.8 ▼0.8-4.2 □27-43 ▲0.2-1.5 ↔0.1-0.34 ↕0.1-2.1	✱12.4-14.4 ▼0.3-22 □28-45 ▲0.1-0.7 ♦94 ↔0.1-0.2 ↕0.2-0.3	Hardground
Chert Concretions			♦50-80	

✱ Dry Density kN/m³, □ Porosity %, ♦ $CaCO_3$ content %, ▼ UCS MPa (Unconfined compressive strength) ▲ E-modulus GPa, ↔ Poisson's ratio, ↕ Brazilian Tensile Strength MPa

Figure 5 Spread of geotechnical properties of south Limburg limestones

Costa de la Plata Limburg: silver sand beaches

Some of the *Tertiary sand units* between the Cretaceous and the Quaternary are mined in open pits . In order to have a look at them we leave the highway near the town of Heerlen to visit one of these quarries, the **quarry Sigrano.** In several quarries the sands of the *miocene Heksenberg formation* are excavated for they consist of an almost pure quartz sand, only with small intercalations of browncoal (Morken, Frimmersdorf layers). The sands are locally known as "Silver Sand" because of the white glare they produce in the sunlight. At Sigrano part of the quarrying is by dreging so that a lake with white sand beaches leading up to white sand cliffs exists. This is a popular recreation spot for bathers, nudists (bring your binoculars!) and cross country motorcyclists. The brown-coal layers gain in thickness towards the east; across the Dutch-German border they are extensively opencast-mined by huge rotating bucket excavators to supply the German electricity generating industry. Locally in the top of the sand unit a sandstone makes life difficult for the extraction of the sand research of the section of Engineering geology revealed UCS strengths ranging upto 10 Mpa in these quartz cemented sandstone layers. This material has been traced as buildingstone back to even the 'Dom-church' at Utrecht. Please refer to the Part 5 on the Sigrano quarry for the visit in the quarry.

Pleistocene Loess & Gravels, Miocene Sands

After our visit to the quarry we return again to the A76 highway and cross the Benzenrade fault on our way to the Nagelbeek quarry. Again this is a NW-SE trending faults related to the Central graben structure in the North. As we drive onto the highway we again enter the realm of the Maas terrace deposits, they are however now covered underneath a thick (upto 15 metres) loess cover. Along the highway they are eroded due to the incision into the tertiary by a small brook, the Geleenbeek. The quarry Nagelbeek offers us an insight to the sequence from the miocene sand unit (the *Heksenberg formation)* we saw earlier at the quarry Sigrano, the terrace gravels (the *St.Geertruid terrace)* and Pleistocene loess cover. The (engineering) geology and use of the materials excavated in the quarry are described in the appendix F on the **Nagelbeek quarry**.

Leaving the Nagelbeek quarry to the hotel we use again the highway A76 and pass unseen the *St.Pietersberg* and *Caberg terrace* covered with loess.

Part 2 - ENCI: First Netherlands Cement Industry

by P.M. Maurenbrecher

The A2

Back to the A2. The route which started yesterday in Amsterdam we follow today almost to its conclusion as it crosses together with the Maas into Belgium. In fact the A2 is also European Route E9. This continues to Luik (Liège) and onwards through the Ardennes along the north-south border between Luxembourg and Belgium towards France. The geology not only becomes much older, it also holds some hidden surprises. The surprises were for the foundations of the piers of the viaduct which bridges the roads and the River Amblève at Remouchamps. Remouchamps is renown for the underground Devonian limestone caves and subterranean rivers.

The next junction is the E39 (in this part of The Netherlands roads have a more European significance) which connects Aachen -the road signs use the Dutch spelling of "Aken"-, (the centre of civilization in western Europe during the Holy Roman Empire, where Charlemagne was born and had his palace, Aix-la-Chapelle) just across the border to the East with the port of Antwerpen to the West. Antwerpen is Belgium's great port and on the river Schelde. The Schelde is the last main river to make up the delta of the Netherlands as its estuary in the south western extremity of the Netherlands. Together with the Maas it drains the whole of Belgium.

Already at the hotel we were very near to our 60 million year goal. The Heerlerheide fault upthrows the Cretaceous close to the surface near the Hotel. The road now gradually climbs up the Cretaceous plateau passing up through increasing older terraces of the Maas. At the top is the airport of Beek, which is better known for keeping flight paths in control as the skies above are one of Europe's highest density airliner cross roads. Beek occupies much of the northwestern part of the south Limburg's plateau; they want to occupy more for a second runway.

The A2 now drops down a steep gradient back towards the Maas valley where it joins the valley of the Geul. We pass Maastricht to our right, then finally exit the A2 to approach Maastricht from the south by crossing over the Maas for the third time since leaving Amsterdam. We follow the Maas upstream along its west bank to the remnants of the Cretaceous plateau in this remaining corner of the Netherlands. Just before the border, a few hundred meters to the south we have arrived for our first visit: 60 million years exposed at The ENCI and its St. Pietersberg.

The ENCI

ENCI means Eerste (First) Nederlandse Cement Industrie was established in 1926. It is owned by Belgian and Swiss holding companies specialized in cement. It also supplies nearly 80% of all cement needs for The Netherlands. This guide will refrain from divulging too many statistics, that pleasure we leave to our hosts at the ENCI. Behind the ENCI is a vast quarry. It has exposed the Maastrichtian, the local Maastricht formation and its underlying upper section of the Gulpen formation. More of the Gulpen will be soon exposed as the ENCI has received a concession to excavate deeper to ensure The Netherlands retains its first (and almost only) cement industry. Environmental concern has though made greater stipulations; the ENCI must determine the effects on the aquifers surrounding the quarry as they are also digging still deeper below original groundwater levels. Groundwater in Limburg is the principal drinkwater resource, especially the groundwater from the Cretaceous limestone aquifers.

This is no easy job. The limestones appear to be uniform calcarenites. They are certainly more uniform than other sediments. When it comes to predicting groundwater flow and aquifer parameters such as permeability, transmissibility and storage, simple sand aquifer modelling we are used to in the dune areas of the coast of Holland do not apply.

The Hydrogeology

Piet van Rooijen writes from the local survey of the RGD (State Geological Survey) at Heerlen:

The chalk forms the major aquifer in the southern part of Limburg and yields about $30x10^6$ m^3 of drinking water a year. A typical feature of the chalk is the drastic reduction of the permeability of the rock as a whole with depth. This is caused by both the reduction of both frequency and aperture of the fissures and fractures in the rock with increasing depth. Near the chalk surface, permeability values of 1 - 10 m/day and beyond may occur, whereas the flow of groundwater on a depth of 30 to 50 meters in the chalk may only depend on the primary, intergranular permeability which may reach values of 0.01 or 0.02 m/day. In the ENCI quarry, chalk is presently being mined to a depth of 25 m above sea level, which is more than 50 metres below the original top of the formation. Over the ages, a slow process of solution along minor fissures in the chalk has increased the permeability and levelled the groundwater table between an average of 53 metres above sea level near the Jeker River in the west and an average of 44 metres above sea level at the River Maas just east of the quarry. Recent excavations in the chalk below this stable water table locally reduced the groundwater level to between 25 and 30 metres above sea level. This forced the groundwater, flowing towards the excavations, to make use of the deeper levels of the chalk, where fissuring is scarce and solution has hardly increased the permeability. Obviously, this results in high gradients of the water table immediately around the deeper pits and a relatively low water inrush.

Plans have been made to increase the mining depth to 5 metres above sea level. Presently, the hydrogeological consequence of these plans in and around the quarry is a subject of investigation. As yet, only a minor increase of groundwater inrush due to a deepening of the excavation level is anticipated. It is only in zones of major fractures or faults that an important additional inflow of groundwater appears to occur.

Table B1 summarises the main formation found in the ENCI quarry. All formations bar the "cover ground" are in the Maastrichtian. The "dry" calcarenites are grouped into a formation called the Maastricht (not to be confused with "Maastrichtian") and the remaining calcarenites, the Lanaye and older are part of the Gulpen Formation. The general geology is shown in section in Figure B1 with an exaggerated vertical scale.

The permeabilities in Table B1 are from recent tests performed by TU Delft student Kees Waverijn in engineering geology for his master's project. He spent five month's at the ENCI to determine the hydrogeology in the quarry. When ever the drilling machine wasn't drilling blasting holes it was drilling holes for Kees; observation standpipe holes, holes for variable head permeability tests, and holes for pumping tests with and without observation wells. The sketch map of the quarry , Figure B2, shows the general piezometric levels of the ground water in the

Depth m NAP	Formation Name	$CaCO_3$ %	Description	Permeability Range m/day (note $1.16x10^{-5}$ m/d = m/s)				Hydrological description
				high	low	aveg	std	
100 to 87	**Loess, Gravel Oligocene sand**		Cover ground.					Dry with some perched water tables. doline depressions in surface congregates water
87 to 80	**Meersen**	95	Coarse grained calcarenite with numerous *stringy* layers. Fossil debris layers. Dolines up to 80m ϕ often 4 to 10m ϕ					Doline acts as conduit for infiltration, ponding can be due to clay infill. 35% area covered by doline karstification
80 to 68	**Nekum**	98	Coarse grained calcarenite with *stringy* layers, underground building stone room and pillar mines. Few flint stones, fossil debris layers					Dry, except for infiltration along fissures causing red iron oxide staining. Doline karstification extends into the top of this formation.
68 to 48	**Emael Schiepersberg** **Gronsveld**	96	Alternating coarse and medium grained layers. Upper section coarse grained fossil debris layers with hard limestone containing ϕ 100 to 600mm flinstone cobbles					Dry, except for infiltration along fissures causing red iron oxide staining.
48 to 33	**Lanaye**	97	Medium grained calcarenite. Conspicuous layers 0.1 to 0.6m thick at 0.3 to 1.5m spacing containing blue grey flint-stone cobbles & boulders of 100 to 1200mm ϕ	.46	.04	.13	.08	Wet calcarenites starting at 45 m seepage along fissures & flintstone bedding planes
				based on 27 tests				
33 to 23	**Lixhe 3**	88	Fine grained calcarenite, numerous dark blue-black & grey abstruse shaped 100 to 800mm ϕ flintstone cobbles and boulders in layers	.07	.016	.045	.017	as above *the high permeability values probably due to faulting
				, based on 6 tests				
				2.05	.016	.29	.66	
				with extra test*				
23 to 18	**Lixhe 2**	88	Fine grained calcarenite with layers of abstruse shaped 10 to 300mm ϕ flintstone cobbles	.03	.012	.019	.009	as above. *Note only five tests of which two gave high values again probably due to faulting.
				limited number*				
				1.27	.012	.076	.48	
18 to 5	**Lixhe 1**	88 & 71	Fine grained calcarenite, with very abstruse shaped dark blue-black flintstone cobbles of 10 to 100mm ϕ, irregularly distributed in layers					Probable reduction of permeability due to reduction in micro fissuring associated with flintstone beddding & less potential karstification
5 to -20	**Vylen**	71 & 61	Fine grained, with depth increasingly glauconitic calcarenite irregular $CaCO_3$ content. Few flintstone but silicic acid enrichment					Does not daylight.probably subject low solution action owing to low permeability, slow groundwater flow rates & less $CaCO_3$ for karstification.
-20 to -35	**Zeven Wegen**	85	Fine grained calcarenite, few dark blue-grey flintstones					As above
below -35	**Vaalser Greensand**		Fine grained clayey (smectite) glauconitic sand.					Consisdered as an aquiclude despite described as "sands"

Table B1: Formations at the ENCI

quarry. Figure B3 is an example of drawdown ellipses observed after pumping for 5 hrs in one of the pumping tests. The long axis drawdown favours a jointing/ fissure pattern striking approximately from NW to SE, a typical polar diagram is given in Figure B4. These are parallel to the main graben faults; the Feldbis and the Heerlerheide and perpendicular to the faults observed in the quarry generating a second set of fissures approximately perpendicular to the first. This may indicate that the earlier fissures are more continuous and therefore older and that the faulting seen in the quarry came later so that the fissures they generated were made discontinuous compared to the earlier.

Various methods were used to analyze the pump tests all having to assume that the ellipses were near enough circles. The results show permeabilities similar to that of the variable head tests (0.5 m/day). In addition the transmissivity 35 m^2/day and storage coefficient of $4x10^{-5}$ are indicators that the calcarenite aquifers of the Cretaceous in South Limburg are a limited resource. As Piet van Rooijen suggests most of the water extracted has to come from wells intersecting major open faults which have a large surface area to tap water from the less pervious calcarenites.

The above is only a glimpse on a project which has also looked at changes in water levels in the quarry as a result of allowing water to pond at the base of the quarry floor and changes with respect to temperature and rainfall. Kees was unlucky or in fact lucky; the study coincided with a mild winter producing early summery weather, hence wintry near freezing, low evaporation conditions or heavy prolonged rainfall conditions just did not occur. Other aspects looked at inflow rates into the quarry. These are difficult to measure as quarry plant tend to damage weirs painstakingly built to measure flows along the water channels draining the quarry floors to the collecting ponds. There is enough work here for years to come!

Other engineering geology aspects

Engineering geological studies were also carried out previously to examine the strength and deformation properties of the calcarenites. Professor David Price will be only to willing to describe this work he carried out during students field work early in the 1980s.

Other significant incidental aspects of the ENCI of interest to engineering geological are properties of the calcarenite with respect to making of cement. Of concern to the ENCI is not only the carbonate content of the calcarenite (it drops with depth- see table) but also the water content. The low permeability means water is retained requiring more fuel to dry the rock before processing. The flintstones are very numerous with depth, though as the table shows their number reduces as the ENCI penetrates beyond the Lixhe formation. The flintstone, locally known as "silex" is used to grind the cement klinker in the rotary kiln. It's otherwise run to spoil and used in the quarry as a temporary paving for access roads.

The final aspect is the reinstatement of the quarry once a section of it and eventually the entire quarry when the concession runs out. Much of the reinstatement has already been achieved in which the ENCI prides itself for receiving in 1988 a high European commendation. It is the southern area known as the "Observant" because of its fine views over the Maas. Fine views? In winter possibly as the trees are so numerous. Its on a spoil dump. One would hardly notice it was man made and that the ENCI complex was so near.

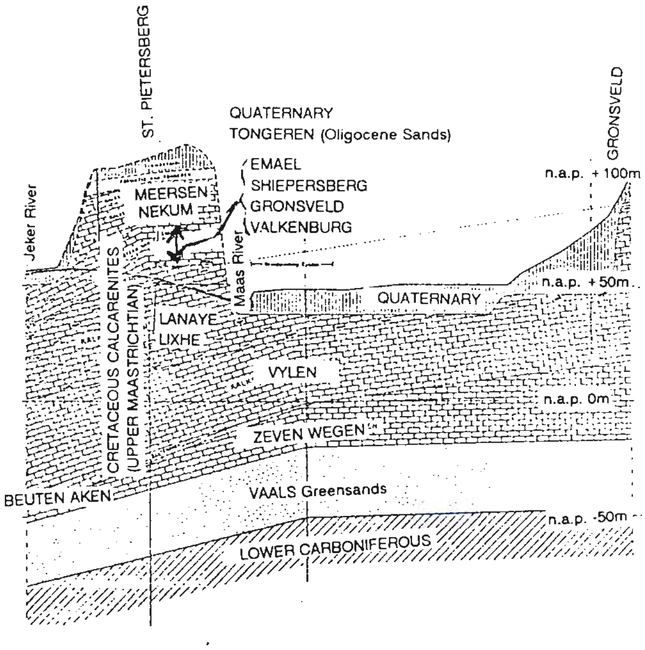

Figure B-1 Geological crossection; West to East: Jeker, St. Pietersberg/ENCI, Maas, Gronsveld Cretaceous plateau scarp.

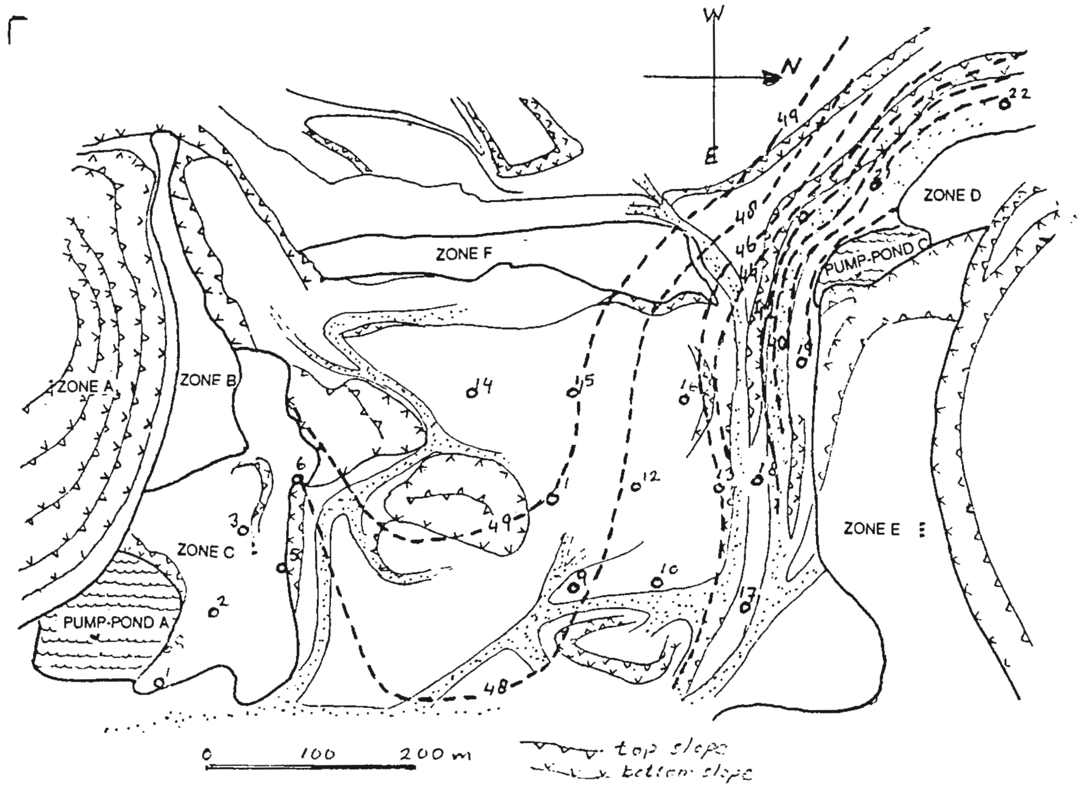

Figure B-2 Sketch map of ENCI quarry lay-out. *Zone A: Overburden spoil, landscaped, Zone B & C quarry floor, Zone D flintstone spoil, Zone E Present overburden spoil dump, Pompvijver A: collecting pond for surface water Zone A,B & C. Pompvijver C collecting pond for NW quarry area including and beyond Zone D. Zone F: present exploitation. Contours: phreatic levels of groundwater. Numbered circles: groundwater observation open boreholes.*

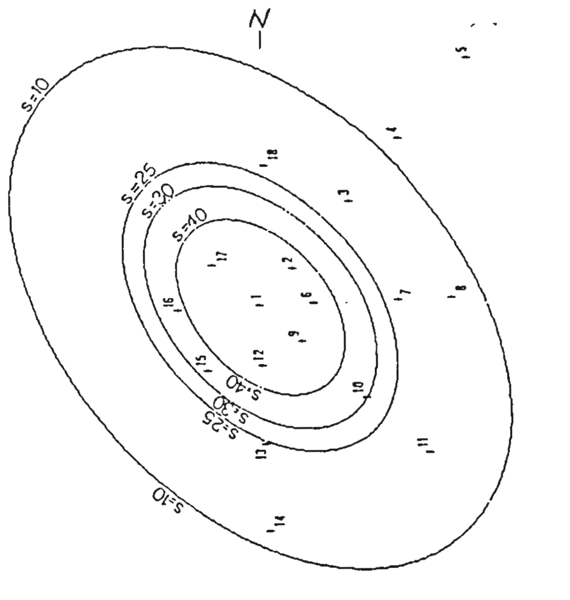

Figure B-3 Drawdown ellipses approximating drawdown of groundwater after 5 hours pumping.

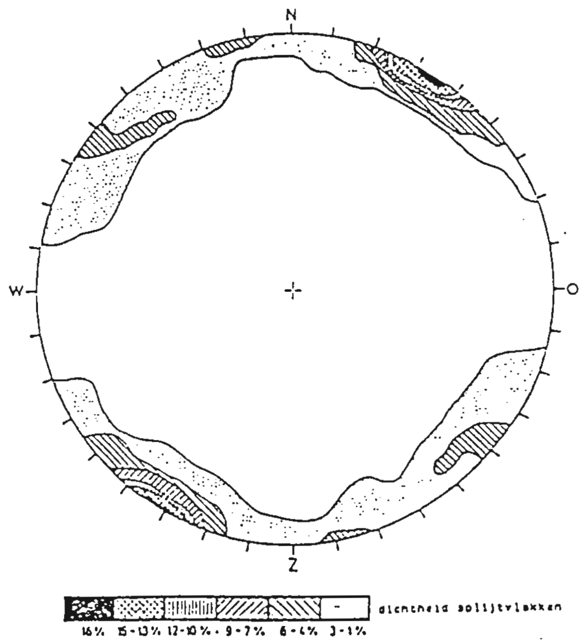

Figure B-4 Typical polar plot of fissures in Gulpen formation. Long axis of drawdown ellipse, figure B-3, compares well with strike of fissures.

Part 3 - Visit to the Hoorensberg Mine, Valkenburg.

by Prof. D.G. Price

The Maastrichtian rocks of the Upper Cretaceous of the Province of Limburg consist of calcarenites and calcilutites with bands of flint and "hard ground". Apart from the thin layers of "hard ground" the rocks are weak and highly porous and particular layers are generally free of joints and have almost imperceptible bedding. These layers have been worked for very many years (the earliest workings are believed to be Roman) as a source of building stone. The extraction has been by underground mining using a room and pillar technique. The rocks have been sawn out using steel saws, chisels and wedges to give large blocks, which were cut into smaller building stone sizes on the surface. Table 1 gives the horizons that were worked and some rock mechanics properties of the rocks.

The abandoned mines are present under quite large areas of Limburg, mostly in the vicinity of the cities of Maastricht and Valkenburg. In both areas the abandoned mines have been used for shelter in times of war, for mushroom growing and are now mostly used as tourist attractions. Many of the mines are decorated with paintings and sculptures.

The mines are generally stable but there have been instances of partial or total collapse. Research is being undertaken by the section Engineering Geology of Delft University of Technology to establish a means of evaluating mine stability. Some details of this are given in the paper by Bekendam and Dirks presented in theme 5.3 in the Proceedings of the Congress.

The Hoorensberg mine is one of the mines which has been surveyed in the course of this work. A stratigraphical column showing the strata within which the mine has been excavated and a plan showing the results of a mine survey is given in fig. C-1.

The general problems of mine surveying and assessing stability will be described in the course of the visit.

The mine to be visited links with another much larger mine in which it is quite easy to get lost so participants are asked to keep close to the guide. Safety helmets will be provided and must be worn during the visit.

Stratigraphic unit	Lithology	Geotech-zone	Mine Zone	Dry Unit Weight (kN/m^3)	Porosity (%)	Unconfined Compressive Strength (MPa)		
						Dry	Sat.	Nat.
Meersen		A	■	13.2	46-50	2.6-2.8	1.7-1.9	1.3-1.9
		B	■	12.9	46-50	1.5-2.5	1.3-1.7	1.2-1.7
Nekum		C	■ ■ ■	12.6	47-51	1.9-2.5	1.0-1.6	1.3-1.9
Emael		D	■	12.8	45-51	1.5-1.7	0.5-0.9	0.5-0.7
		E	■	12.8	49	2.7	2.1	2.3
Schiepersberg		F		13.5	49	4.2	2.0	2.3
Gronsveld		G		<--------- Not Tested --------->				
Valkenburg		H		14.8	32-36	4.0-8.0	2.0-2.8	2.7-3.3

Approx. scale 0 ⌊—⌋ 4m --------Hardground ------Flint Sat. = saturated, Nat. = at natural moisture content

Table C-1 Some geotechnical properties of the stratigraphical units of the Maastrichtian

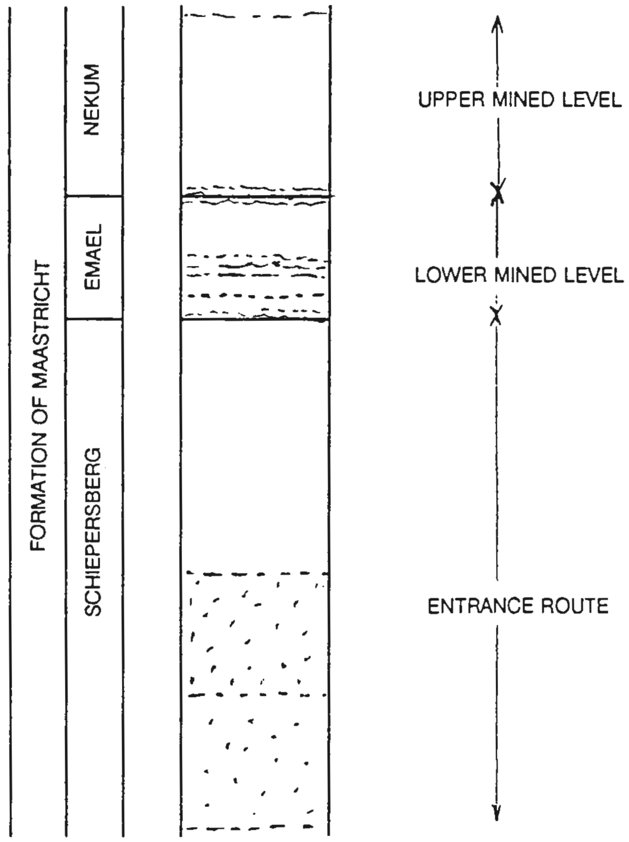

Figure C-1 The stratigraphy of the Hoorensberg mine

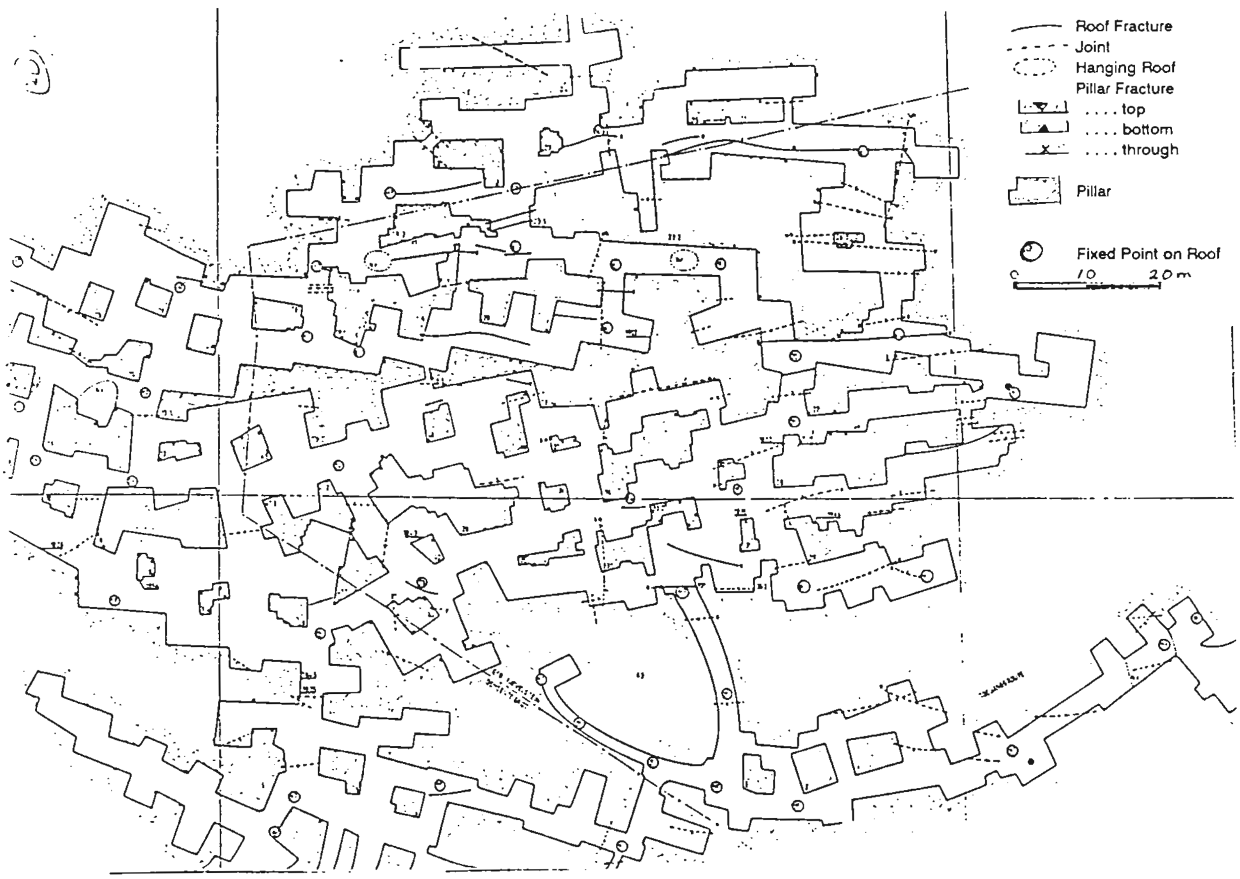

Figure C-1 Plan of the Hoorensberg Mine at the "Sprookjesbos", Valkenburg

Part 4 - The Maas river terraces.

by R.R. Kronieger

The Maas deposits are found over much of southern Limburg. The spread of these deposits is caused by Alpine tilting of the foreland of the Ardennes during the Pliocene. The tilting **predeced the Maas river terrace deposition;** material was deposited as an alluvial fan over the Limburg area. The Pliocene and Pleistocene sediments contain for that reason clay, sand and gravel partly derived from this fan. Besides the well rounded, bleached flint pebbles the gravel contains also pebbles which originate in the Paris basin. These consists of typical rocks, such as Jurassic Limestone and Kiezelooliet *"pebble oolites"*. The last gave this gravel deposit its name, the *Kiezelooliet Formation* (Formation of Waubach). The lithology of the rocks indicate that they were deposited before the Alpine uplift of the Ardennes. In the area south of the Central Graben, erosion by subsequent river removed the Kiezelooliet gravel from large parts of Limburg.

Continuation of tectonic uplift and sea level fluctuations caused new incisions of the river Maas in the Kiezelooliet formation and the underlying limestones. Now a more defined river, called the **'East-Maas'** found its way in the Limburg area flowing from Maastricht in easterly direction between the Ardennes and the 'Isle of Ubachsberg' to merge near Duren with the River Rhine. In its valley several matched river terraces mark several incisions in the same river bed. On +190 m lies the oldest terrace, the *Kosberg Terrace*. It contains erosion products of the Ardennes derived from the Devonian sandstones, pyrite-quarzites and conglomerates. This marks the incision phase of the river during the early Alpine uplift of the Ardennes. A second terrace (*Simpelveld Terrace*) on + 165 m shows lithology types in the gravel that originated from the deeper, central part of the Ardennes, the Massif of Rocroi and therefore contain higher metamorphic rocks, mostly diabaas, porphyry and dyke material. Also gravels derived from the Carboniferous limestone in the vicinity of Namen and Vise have been identified. Research confirmed that nearly all Maas river terraces could be differentiated, based on height above sea level, lithological content and quartz content. The Maas River catchment is shown in Figure D-1 showing the source areas of several rocktypes found in the Maas gravels.

The direction of flow of **the present Maas river** was displaced by late alpine tilting in an increasingly northern-easternly direction. The break through its northern embankment near Maastricht was dated 1.7 million years ago. The older sets of gravel terraces were subjected to erosion by a new drainage system consisting of the Geul and Gulp streams which connect to the Maas. A new set of terraces were generated while the river cut deeper into the Maastrichtian. However the river did not succeed to erode it former northern bank completely; today it still exists as the 'Isle of Ubachsberg'. South to this 'Isle' we find 'East-Maas' terraces, but on its northern side the terraces after the break through can be found. There are three main sets of gravel terraces related to the change in bedding from the Maas river from the Pleistocene onwards. Two major sets are recognized in relation to the River Rhine gravel terraces, a 'high' terrace set at 110-160 metre above sea level and 'middle' terrace set at 30-65 metre above sea level. The 'low' terrace group reflects the Holocene bedding of the Maas. The terrace structure of the Maas riverbed can be traced downstream to the rim of the Central Graben structure, there they end in a terrace overlying approximately the northermost fault of the graben southern downthrow fault zone.

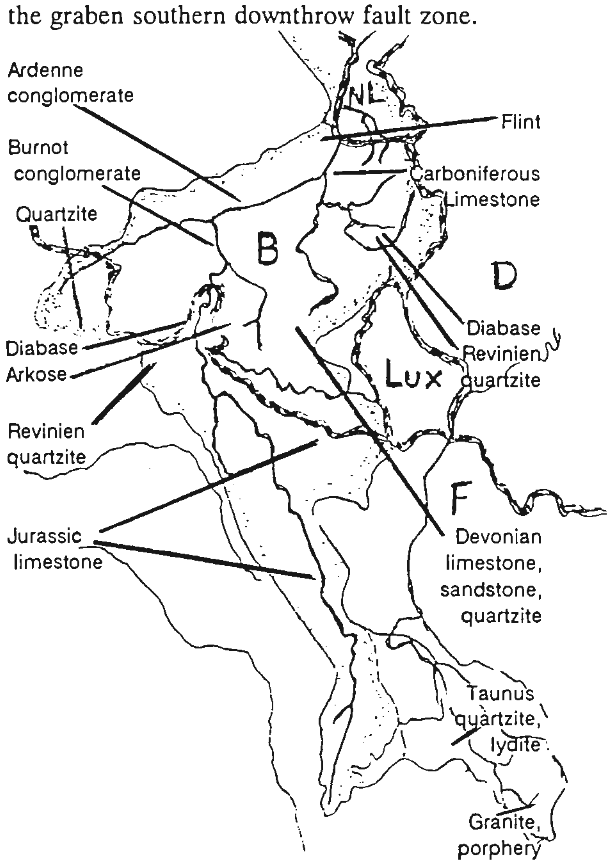

Figure D-1 Maas River Catchment source areas of south Limburg gravel litholigies.

Part 5 - The Sigrano Quarry

by R.R. Kronieger

Silver geology of South Limburg:

Under the thin cover of loess the Miocene "Silver Sands" Formation of Heksenberg is exposed. The sands have a marine to continental origin and consist of fine to medium coarse quartzitic sands with a grey to white colour. Browncoal layers of Morken and Frimmersdorf are exposed at the moment. The sands have generally a low iron content and are used in the glass industry. Locally the sand is overlain by the yellow-white sand of the formation of Vrijherenberg. Both sand units are middle Miocene deposits. Thickness of the exploited sand unit varies between 6 and 50 metres. In the quarry a fault places both formations at the excavation level. (Fig. E-1)

Exploitation:

Above the groundwater level the sand is excavated with shovels, under water excavation a suction dredger is used. In both cases the sand is transported to dewatering basins within the dry part of the quarry. After drying, the sand is transported by conveyor belt to the sieving & sorting plant. A schematic view of this installation is given in fig. E-2. In part A of the scheme removal of coarse and fine fractions, organic materials, iron etc. is achieved by washing and dry sieving. Part B of the scheme shows the subdivision of the bulk sand by hydrosieves into four basic grainsize fractions, which are stored in dewatering silos. The requested grainsizes are mixed and then dried in a fluidized-bed gas oven to a moisture content of 0.1-0.02 %. (part C). Additional milling in a ball-mill with Al-oxide grinding balls (part D) produces very fine grainsizes.

Use of the quartz sand:

The sieved sand fractions are used in various industries: foundry, glass and brick manufacture, concrete and construction, chemical, glue and paint manufacture. The milled sands are used in the production of glass fibre, paint, enamel, glaze, isolation materials and abrasives.

Facts:

Exploitation: 1970-
Concession: 120 hectare
Volume excavated: 4 milj.ton
Production: 180.000 ton/yr
Available: 4.5 milj.ton

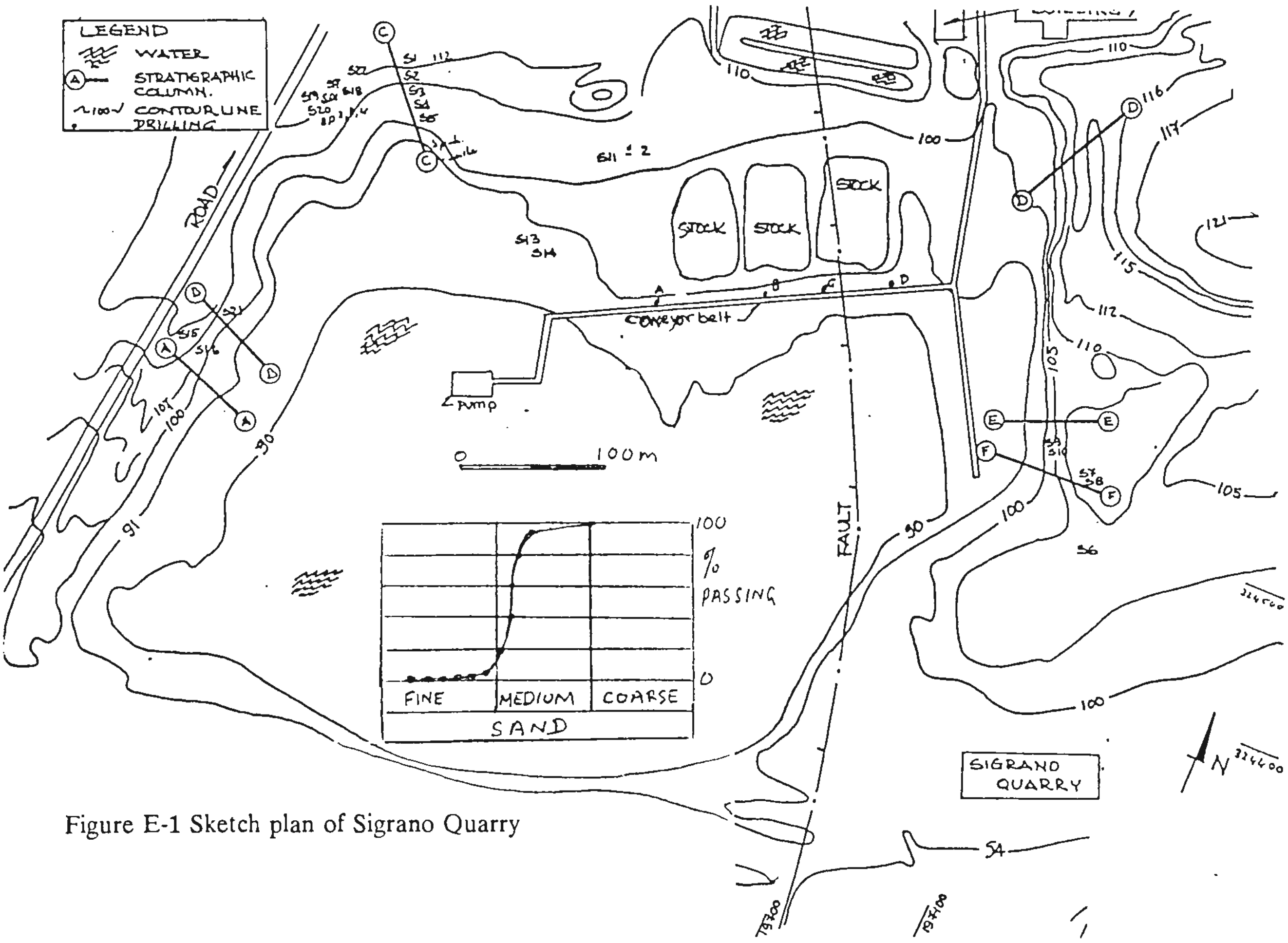

Figure E-1 Sketch plan of Sigrano Quarry

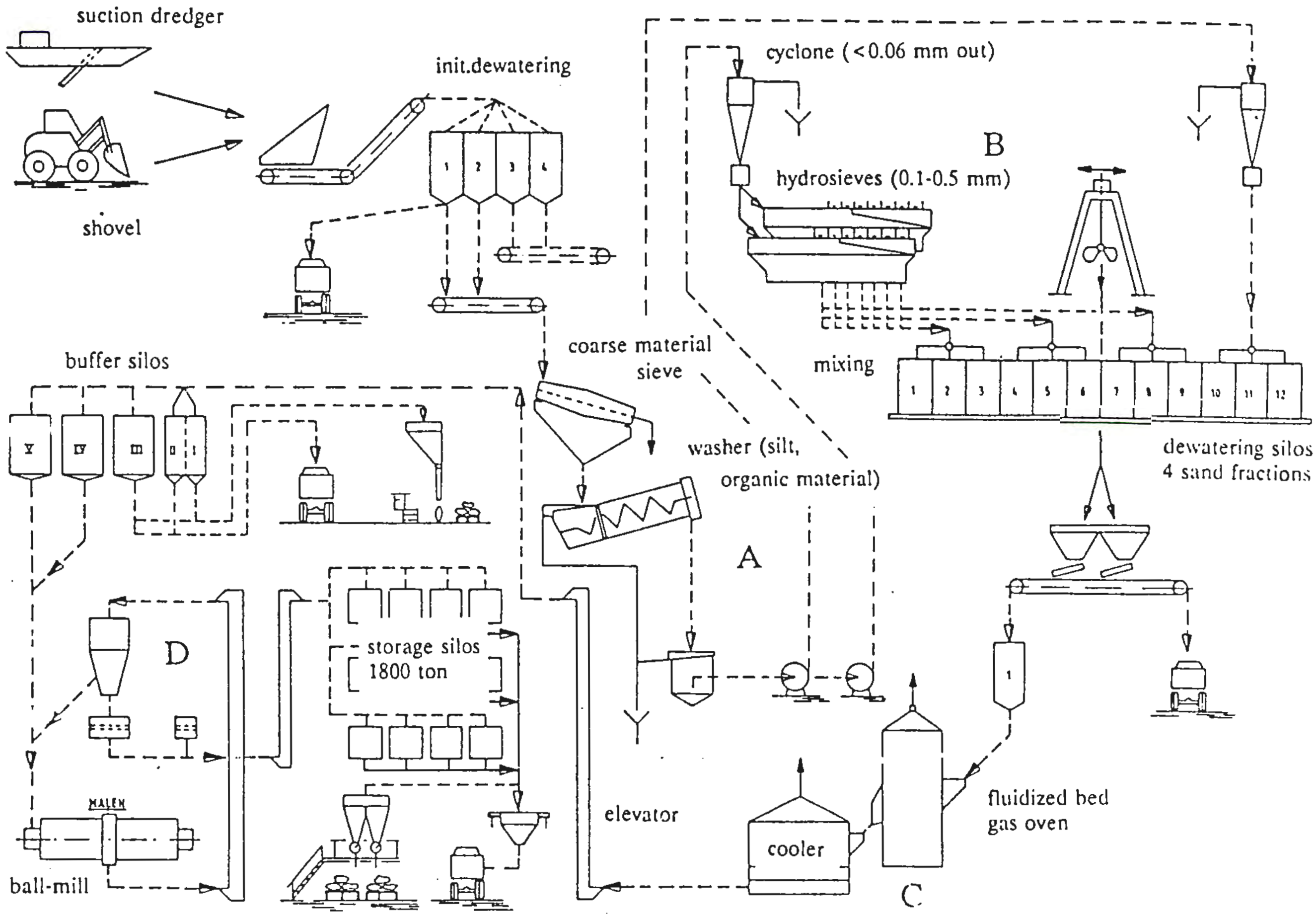

Figure E-2 Schematic diagram of Sigrano silver sands processing installation

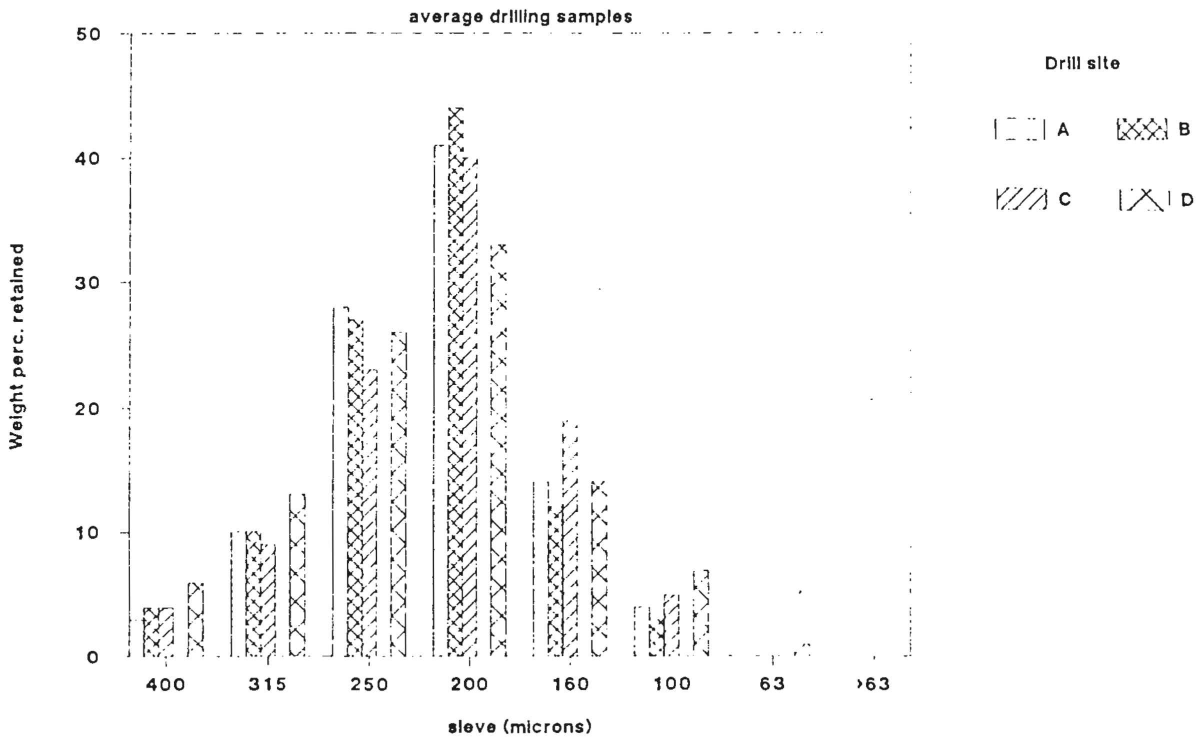

Figure E-3 Histogram of sand particle size distribution for four sample locations

Part 6 - Nagelbeek quarry

by R.R. Kronieger

Aeolian Geology: volcanic & glacial
At the floor of the quarry the groundwater level forms the lowest excavation level. As in the Sigrano quarry the sands of the formation of Heksenberg are excavated. The sands are deposited in a near shore sedimentary facies. On top of this sand unit a 15 metre thick gravel unit of the river Maas is exposed (fm of Sterksel, St.Geertruid terrace). The cover consists of a 6 metre thick loess deposit (Pleistocene). The loess unit can be subdivided in two major subunits, the Weichselian loess unit, yelllow-brown coloured , and the Saalian loess unit, brownish coloured. The Geological Survey subdivides the Loess deposit into the Upper, Middle and Lower loess. The Lower Loess complies with the Saalian, the Middle Loess with the lower Weichselien unto the Nagelbeek horizon, just above the Eltviller tuff layer (very thin, 18.000-21.000 yr), the Upper Loess complies with the upper Weichselien. The loess deposits here form part of the loess 'belt'. The Upper loess consists only of one unit and has the largest regional extension. This loess layer often is found to be decalcified up to depths of 3m below ground level. The Middle Loess shows several soil profiles with cryoturbated horizons.

Use of loess:
The loess is qualitative limited of use for brick industry. The large amount of cheap base material with a constant composition and the natural iron-carbonate blend speak in favour for its use, however a low clay content and sand content are unfavourable.

Exploitation:
All materials are excavated with use of shovels above the water table. - The carbonate poor loess results in a popular red coloured brick whereas the carbonate rich loess results in a yellow coloured brick. On the factory terrains a stockpile is kept. After mixing to required composition, water is added to make the loess sufficiently plastic for moulding into a brick shape. The brick mould is coated with a thin layer of sand which gives a typical 'sanded' brick. The drying takes place at about 80 degrees in two days. Since one of the clays is montmorillonite the bricks have to kept dry before firing, which takes about 5 days at a temperature of 1100 degrees. - The gravel is used as fill and in asphalt production. High silt content, organic plus iron-oxide coating and unfavourable lithological composition (high flintstone content) do not allow use in situations having motre critical standards requirements such as for concrete. The sand is used almost only for fill material. The high organic and iron content limits the use of the sand from this quarry.

The geology within the quarry has been earlier established by the geological survey (fig. F-1). Research by the section Engineering Geology of the TU Delft was focused on the basic index parameters of the sand, gravel and loess. The first deposits were investigated for use in road and embankment construction, the loess is investigated in relation to behaviour related to foundation, since this is the only site were the full sequence practically is accessible. Also the use of the overburden loess layer as a liner for use in the future of the quarry as a garbage waste dump site are still investigated.

Facts:
Use in local brick industry: 75.000 m^3/yr
Export to Belgium: 162.000 m^3/yr
Import Clay (no loess) Germany: 100.000 m^3/yr

Literature:
H.F.M. Linssen (1989) De Loessleem als Grondstof voor de Baksteenindustrie.
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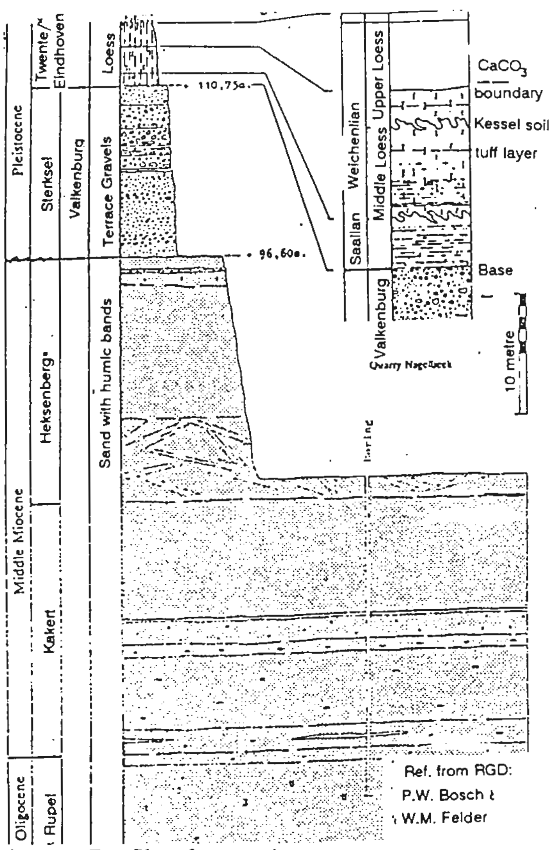

Fig. E-1 Profile of strata in quarry

Ranges of Properties of loess		
Type Test	Upper Loess	Middle Loess
Unconfined Strength kPa	125 - 416	115 - 435
Vane Shear strength kPa	62 - 208	39 - 680
Bulk Density kN/m^3	17 - 19	15 - 21
Dry Density kN/m^3	15 - 16	17 - 18
Liquid Limit %	23 - 30	26 - 33
Plastic Limit %	20 - 24	19 - 28
Plasticity Index %	3 - 9	4 - 7
Natural Moisture Content %	10 - 18	22 - 24
$CaCO_3$ content		
a. decalcified %	<1	n.a.
b. calcified %	5 - 10	10 - 16
Organic material %	<5	<2
Porosity %	36 - 42	6 - 20
Permeability m/s	$5x10^{-10}$	$15x10^{-6}$
Cohesion kPa	0.5 - 10	6 - 17
Angle of Internal Friction °	24 - 36	29 - 30
c_v at 50 kN/m^2	>100	
c_v at 100 kN/m^2	>100	
Optimum Proctor Density kN/m^3	17 - 18	17 - 18
Optimum Moisture % Conetnt	14 -17	14 -17

Figure E-2 Properties of the loess at Nagelbeek

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First announcement / **Call for papers**

ICUSESS '92

5th International Conference on Underground Space & Earth Sheltered Structures
2nd to 7th August 1992 Delft University of Technology, The Netherlands

The Netherlands National Research Centre for Innovative Use of Underground Spaces, the NOVA TERRA Foundation, invites authors to submit papers for the 5th International Conference on Underground Space and Earth Sheltered Structures. The conference will be held at Delft University of Technology from 2nd to and including 7th August 1992. The conference will be held in the English language. All abstracts and papers must be submitted in English. There will be no translation facilities at the conference.The aim of the conference is to develop discussion and exchange knowledge and opinion about all factors relating to the development and use of underground spaces and earth sheltered structures for living, working, recreation, infrastructure, industry and storage and as an aid to the environmental protection of the surface. The conference is open to all with interest in the use of underground space and it is expected that delegates will come from the fields of civil engineering, architecture, geology, planning, economics, politics, law, medicine and environmental science.

The proceedings of the conference will fall under five main themes. These are:

1. **Planning** The use of underground space and earth sheltered structures within urban, national and environmental development planning.

2. **Design and use** Architectural and social design of underground space with regard to function, safety, natural light, comfort, health and utilisation, in accordance to specific uses and possibilities of underground space.

3. **Construction** General problems relevant to the construction of new underground spaces and the use of existing underground space and earth sheltered structures. Environmental impact of the construction process.

4. **Economy** The economy, marketing and financing of the use and development of underground space and earth sheltered structures, in particular in contrast to the continuing exploitation of surface space. The economy of mining/quarrying with a view to creating underground space.

5. **Law and politics** The present situation and developments in national and international law, standards and political opinion with regard to the use of underground space and earth sheltered structures. The use of underground space and earth sheltered structures as a factor in the development of policies for environmental protection.

Case histories relevant to one or a combination of the themes listed will be particularly welcome.

Submission of abstracts

Authors are invited to submit 5 copies of the abstracts (of not more than 300 words) of their intended papers as soon as possible, and no later than 1st. September 1991, to the Conference Bureau. Abstracts will be reviewed by qualified professionals engaged in the field covered by the conference under the supervision of the Scientific Committee. Authors of abstracts accepted will be informed by the Scientific Committee as soon as possible and not later than the 1st December 1991, of acceptance and sent instructions for the required typographical form of their paper. The arrival deadline for the submission in a camera-ready form is the 1st May 1992. All papers will be refereed.

Proceedings

The proceedings will be available during the conference. They will be edited by Prof.Dr.Lester L.Boyer of the Texas A & M University, USA. The proceedings will be officially published.

Reply Card

Please use typewriter or CAPITAL LETTERS

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I estimate my chance of attending the Conference as
__100% __50% __ 0

__ I will attend with ___ accompanying person(s)
__ I intend to submit an abstract
__ I would like to follow the post congress excursion
__ I will prepare __ poster(s) for the poster sessions
__ I would like to be kept informed on developments

Organisation of the conference

Sunday 2 August 1992

Registration and excursion.

Monday 3 August to Friday 7 August

Plenary sessions of the Conference. A half day technical excursion will be held on Wednesday 5th August 1992.

Keynote speakers will be invited to give "State of the Art" lectures relevant to each of the main themes. It is intended to allow selected authors to present their papers. All authors may present their papers as "posters"; poster sessions will be held at which authors will have the opportunity to discuss their papers with other delegates. There will also be time for questions and discussions within the plenary sessions.

Saturday 8 August

The Organising Committee intends to organise a post congress excursion for about 7 to 10 days to visit underground space sites throughout Western Europe. Those who would wish to participate in such an excursion should complete the box on the reply card.

Accompanying persons

There will be a touristic programme for accompanying persons.

General information

All correspondence should be sent to the Conference Bureau which is: Congress Office ASD, P.O. Box 54, 2640 AB Pijnacker, The Netherlands, Tel. 31 1736 95356; Fax 31 1736 92242. Per 6th May 1991: P.O.Box 40, 2600 AA Delft, The Netherlands; Tel. 31 15 120234; Fax 31 15 120250.

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please return to:

Congress Office ASD
P.O. Box 40
2600 AA Delft
The Netherlands

Date

August 2 - 7, 1992.

Location of conference

Delft University of Technology, Aula Building, Mekelweg 5, Delft, The Netherlands.

Registration fee

- if received before June 1, 1992
  Dfl. 1.150,--; ± $ 680,--.
- if received after June 1, 1992
  Dfl. 1.300,--; ± $ 770,--.

Hotel accommodation

Hotel accommodation will be available in The Hague and at prices ranging from Dfl. 260,-- for a double room and Dfl. 195,-- for a single room per day.

Second announcement

The Congress Second Announcement will be issued in October 1991, and will include full details and registration forms.

Authors - please note these important dates

Abstracts received after 1st September, 1991 will not be accepted. Authors will be notified of the decision of the Scientific Committee not later than 1st December, 1991. Complete camera ready papers should be submitted by 1st May, 1992.

ICUSESS '92 occurs during the 150th anniversary year of the University of Technology, Delft. The University is the principal sponsor for the conference through the faculties of:

* Architecture, Housing and Urban Planning
* Civil Engineering
* Mining and Petroleum Engineering

Please note:

The Nova Terra Foundation intend to establish through the European Community a European Underground Space Centre (E.U.S.C.). 1992 has, after all, been earmarked by the Community as the year to further their ideal of unity between member nations by creating on European customs union and hence allowing unrestricted movement of goods and people across members' borders. Hence in the spirit of 1992 an effort is made by the Nova Terra Foundation to establish a the E.U.S.C. to encourage more use of underground space for the whole of Europe.

We would be pleased if you would return the reply form even if you are unable to participate in the conference. We can then keep you informed of any new developments with regard to the European Underground Space Centre and provide you with relevant information.

ARMOURSTONE AND CRUSHED ROCK AGGREGATE RESEARCH IN THE NETHERLANDS[1]

Peter N.W. Verhoef
Delft University of Technology, Faculty of Mining and Petroleum Engineering, Section of Engineering Geology, P.O.Box 5028, 2600 GA Delft, The Netherlands

INTRODUCTION

The Netherlands is a small country, only 36158 km^2 in area and covered mainly by unlithified Quaternary deposits. Pleistocene sediments occur in the south and east and Holocene sediments in the western part of the country. Most of these sediments are deltaic river deposits from the rivers Rhine and Meuse grading to coastal and marine deposits in the west. The northern half of the country has been affected by glacial reworking during the Pleistocene, leaving till and stretches of ice-pushed ridges. Aeolic and periglacial sand deposits occur at or near the surface in the south and east. The western part of the country has peri-marine clay and peat sediments near the surface, which are transected by braided sandy river deposits. There the Pleistocene sand layers occur at depths of generally -15 m, where they form the first firm foundation layer for building structures. De Mulder (1990) gives an extensive summary of the engineering geology of The Netherlands.

Only in the extreme east and south, near the border of Germany (Winterswijk, Losser) and Belgium (Maastricht, Valkenburg) do rock quarries exist. Only the rock in the south is of major economic importance. It is weak, relatively pure, calcarenite of Cretaceous age which is used for cement production and has been used for building stone in the past (Price and Verhoef, 1988a,b). The quarry near Maastricht is the type locality of the Maastrichtian Period.
Apart from abundant sands, gravels and clays no rock construction materials are present in the country. The gravel deposits along the river Meuse have traditionally been the major aggregate source for concrete and bituminous concrete. The country, with nearly 16 million inhabitants, is very densely populated and considering the present environmental and urban and rural planning schemes, the gravel resources are expected to be depleted within the next 25 years.

Traditionally millions of tons of rock have been imported each year for hydraulic structures, road construction and railway ballast. These rocks come in by water or railway from Germany (quarries along or near the river Rhine) and Belgium. England, Scotland, Norway, Sweden and Finland are other regular suppliers of armourstone and rock fill. The quantity of imported rock required can only increase. Armourstone will continue to be necessary for coastal defence work and river and canal side protection. About one third of the country is below sea level, and level difference is expected to increase. The expected sea level rise has led to the development of new master planning schemes for coastal defence which will commence in the next century, just a decade after the finalization of the "Delta works", which aimed to protect the Dutch coast against storm surges by constructing numerous dams and increasing the height of dikes. The apotheosis of these works has been the Eastern Scheldt Storm Surge Barrier, which was finished in 1989. Rock is one of the major constructional elements in this structure.

Due to the depletion of gravel, crushed rock aggregate will increasingly be employed in Dutch concrete. Dutch engineers will be confronted with all the problems that can occur if different types of aggregate are used; they cannot rely any more on the luxury of using one, well known, type of aggregate. Up to now only contractors and consultants working abroad have had to deal with rock. A considerable knowledge of the design and construction of armoured defence structures does exist, but a lack of knowledge concerning rock as construction material is evident.

The above mentioned factors have led to a renewed interest in rock as a construction material in The Netherlands. The Road and Hydraulic Engineering Division of "Rijkswaterstaat", the Dutch Public Works Authority, is sponsoring a new rock aggregate research programme, in which other national

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organisations, like the Dutch Railway, have shown interest. This interest is further enhanced by the ongoing programmes in Europe (both West and East) for a unified system regarding design of ballast foundations and ballast aggregate standard tests. The 1992 release of the economic frontiers in the European Community has also led to the preparation of European Standards with regard to rock aggregate testing for various applications. Holland actively participates in these preparations. For some years the Dutch Civil Engineering Council (CUR) has cooperated with its English counterpart (CIRIA) in preparing a manual for coastal armour structures. Much of the research work on the design of the structures is done by the Road and Hydraulic Engineering Division of Rijkswaterstaat, together with Delft Hydraulics laboratories and the Delft University of Technology. Most of the work on exploration, production and quality of rock armourstone, rip-rap and aggregates is done by the Geomaterials Group at Queen Mary and Westfield College of London University, with up to now a minor contribution by the Delft University of Technology (Latham et al., 1990). The newly released French report on armourstone, "Les Enrochements" (1989), published by the "Laboratoire Central des Ponts et Chaussées" (LCPC), has given fresh impetus to this study. This report summarises the vast experience of the French in dealing with quarrying of armourstone blocks and design of structures. Notable advances have been made in the use of geophysical methods to predict block size distributions of a rock mass from borehole well-logging data. Both the UK and Dutch partners of the above mentioned research group are seeking closer cooperation with LCPC. Some of the work carried out by the Section of Engineering Geology at Delft University for the Rijkswaterstaat will be summarised below.

ARMOURSTONE: THE NORMALISED VELOCITY ANALYSIS METHOD

During the construction of the Eastern Scheldt Storm Surge Barrier it was found that some of the rock fill showed breakage during transport and emplacement. In some of the instances this was so bad that the required size distribution of the blocks could not be maintained and aggregate had to be rejected. In most cases breakage was due to cracks hidden in the blocks.

Many attempts have been made in the past to use ultrasonic velocity measurement to obtain information on hidden open cracks in rock blocks or rock masses. Duncan (1969) proposed a method to compare velocity measured on intact rock cores with velocities measured through larger rock volumes. The ratio V_{mat} / V_{mass} would indicate the presence and density of cracks. Although straightforward this method has not proven very valuable, due to the fact that

lithological variation, anisotropy and moisture content variation has a major influence on material velocity and no direct correspondence of Duncan's ratio with crack density exists. The author's interest in the problem was aroused during the 1st International Symposium on Aggregates, held in Nice in 1984. An Australian engineering geologist asked me whether I knew a method to detect hidden cracks in armourstone. He was interested because of problems in finding suitable armourstone for structures along the coast of Queensland, if I recall correctly. Discussing the problem with many experienced engineering geologists, I found that all of them had tried to use ultrasonic measurement with invariably disappointing results.

In "Les Enrochements" a method is described which has been used in France for more than a decade. A continuity index, I_c, is used, which is expressed as:

$$I_c = 100 * V_{measured} \; / \; V_{calculated} \qquad (1)$$

The measured velocity is based on three perpendicular velocity measurements through a representative sample with at least one measurement perpendicular to the schistosity or lamination. The calculated velocity is determined from the results of a petrographic analysis. The theoretical intrinsic material velocity is calculated from:

$$V_{cal} = \sum_i \; (A_i * c_i) \; / \; 100 \qquad (2)$$

where c_i is the percentage of mineral i in the thin section and A_i is its material velocity. The continuity index I_c will be 100 for homogeneous isotropic rock (equation 1). But the measured velocity is not only effected by cracks, but also by porosity n, and I_c will become smaller according to the experimentally found relationship (100 - 1.4n). The practice in France is to establish a calculated velocity for a certain rock type in a quarry, measure velocities on rock blocks, calculate I_c, then correct for porosity if necessary. The corrected I_c is compared with results of drop tests, where rock blocks with known I_c are dropped from a certain height and breakage recorded. For each quarry and rock type a threshold I_c is established below which blocks are considered breakable and unsuitable. The method appears to work successfully; in practice only three perpendicular velocity measurements have to be made on a rock block for quality control, once the basic relationships have been established.

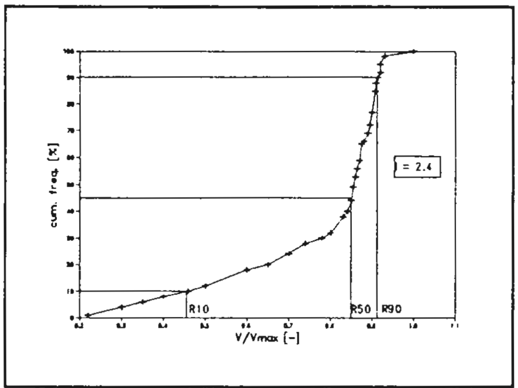

Figure 1. Distribution of normalised velocities of a limestone block. R50 is the normalised velocity at a frequency of 50%. I = R90/R10/R50 = 2.4

Another method which also uses a very simple ultrasonic velocity measurement apparatus (like the Pundit or Concrete tester) was developed in Delft. First, experiments were performed in the laboratory by simply stacking slabs of different types of rock on top of each other and measuring velocities in various directions through the rock. Also, the effect of increasing normal pressure on the rock slabs was studied. These data were processed as follows. The velocities were arranged in order of decreasing value. The maximal velocity measured was regarded as the material velocity of the block. This can vary from block to block according to variations in lithology and moisture content. By dividing all apparent velocities measured by the maximal velocity a distribution of normalised velocities (V/V_{max}) is obtained, an example of which is shown in Figure 1. The distribution of normalised velocities resembles a grain size distribution diagram. It was found that these distribution curves simply represented the number of discontinuities present in a stack of rock blocks in the laboratory. Normalisation of the apparent velocities cancelled the effect of differences in lithology or moisture content (Niese et al., 1990). The shape of the distribution curve can be described using the value of the median normalised velocity, R_{50} and a value for the spread, $S = R_{90}/R_{10}$ (see Figure 1). The ratio of the spread and the median, I, forms an index which indicates the presence of cracks:

$$I = S/R_{50} \quad (3)$$

The higher the value of I, the more discontinuities are present in the block and therefore the higher the chance of breakage. A value for I = 1 indicates the absence of cracks in the block. The method has been tried on rock blocks from

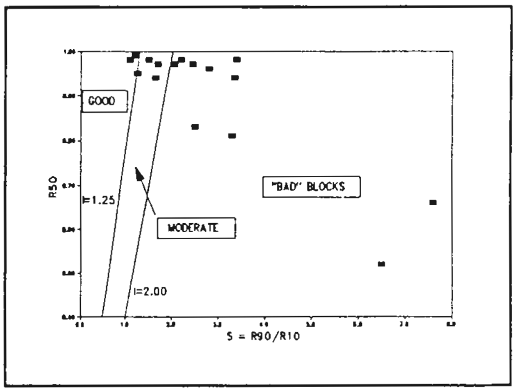

Figure 2. I-values of limestone blocks. The values I = 1.25 and 2.00 tentatively divide the diagram in areas of potentially good, moderate and bad blocks (see Niese et al. 1990).

several quarries. On these blocks drop tests have been performed. Figure 2 gives a tentative diagram showing regions of bad, moderate and good blocks. Unlike the French method, this method has not been tried in practice. It has several advantages: it is independent of rock type, moisture content etc., and is only sensitive for cracks. Once the method has been fully established (research into its applicability is still going on), no drop tests are necessary to calibrate it (Houwink and Verhoef, 1990). A drawback is that at least 15 to 20 measurements in perpendicular directions through the block are necessary. Measurement time varies from 25 to 60 minutes. Lotus and Symphony spreadsheet programs are available to process the data. An extensive description of the method may be found in Niese et al. (1990).

AGGREGATE DURABILITY ASSESSMENT

Most of the consulting work on rock aggregate carried out in Delft follows the flow diagram of Figure 3. Rock samples from all over the world are studied, mainly brought in by Dutch dredging contractors. Emphasis is on microscopic observation with special attention to mineralogy, microscopic structure, presence of microcracks and voids. In most rocks clay minerals may be present and as a routine method methylene blue dye is used. The methylene blue spot method is used on finely ground aggregate and the thin sections for microscopic study are stained with a methylene blue solution to observe the location of adsorbing substances (Cole and Sandy, 1980; Stapel and Verhoef, 1989). The method is convenient, fast and suitable to identify the presence of swelling clay minerals. The method has proved to be reliable. The LCPC in France makes extensive use of the method. At present we rely on the "soundness" table in use by Wimpey Laboratories (UK):

Indication of durability	MBA (g/100g)
Acceptable	< 0.7
Marginal	0.7 - 1.0
Unsound	> 1.0

In Australia Cole and Sandy cite a value of > 1.5 g/100g as unsound for unbound basaltic road aggregate (if we correctly recalculated their MBA value, which was given in ml MBA). The best way to represent methylene blue adsorption values is in grams methylene blue adsorbed by 100 grams of soil or ground rock. Also expression of the Cation Exchange Capacity in meq/l is allowed.

Many authors only give ml of methylene blue adsorbed, sometimes even without giving the concentration of the solution used. A laboratory description of the execution of the spot method may be obtained from the author. Part of the research efforts at the moment concentrate on the methylene blue dye method. Adsorption characteristics of a large range of minerals are being investigated.

The MBA method is an aid in the identification of deleterious substances. Once these are identified, a suitable testing programme may be designed to make a statement on the durability and soundness of the rock concerned (Figure 3).

For the development of new European Standard tests, we thought it was interesting to compare results of aggregate strength tests on 11 suites of aggregates. A poster was presented at the 2nd International Aggregates Symposium, October 1990, in Erlangen (Germany) (Kissakwa and Verhoef, 1990). The results are summarised in Tables 1 and 2.

The aim of the aggregate research project is to develop a set of procedures which can be used in the Netherlands for quality assessment of rock construction materials.

ACKNOWLEDGEMENTS

I thank Greg McNally for the invitation to present this paper at the symposium. It was written on short notice, without access to the reports and references back home. Sue Howard is thanked for polishing my Australian.

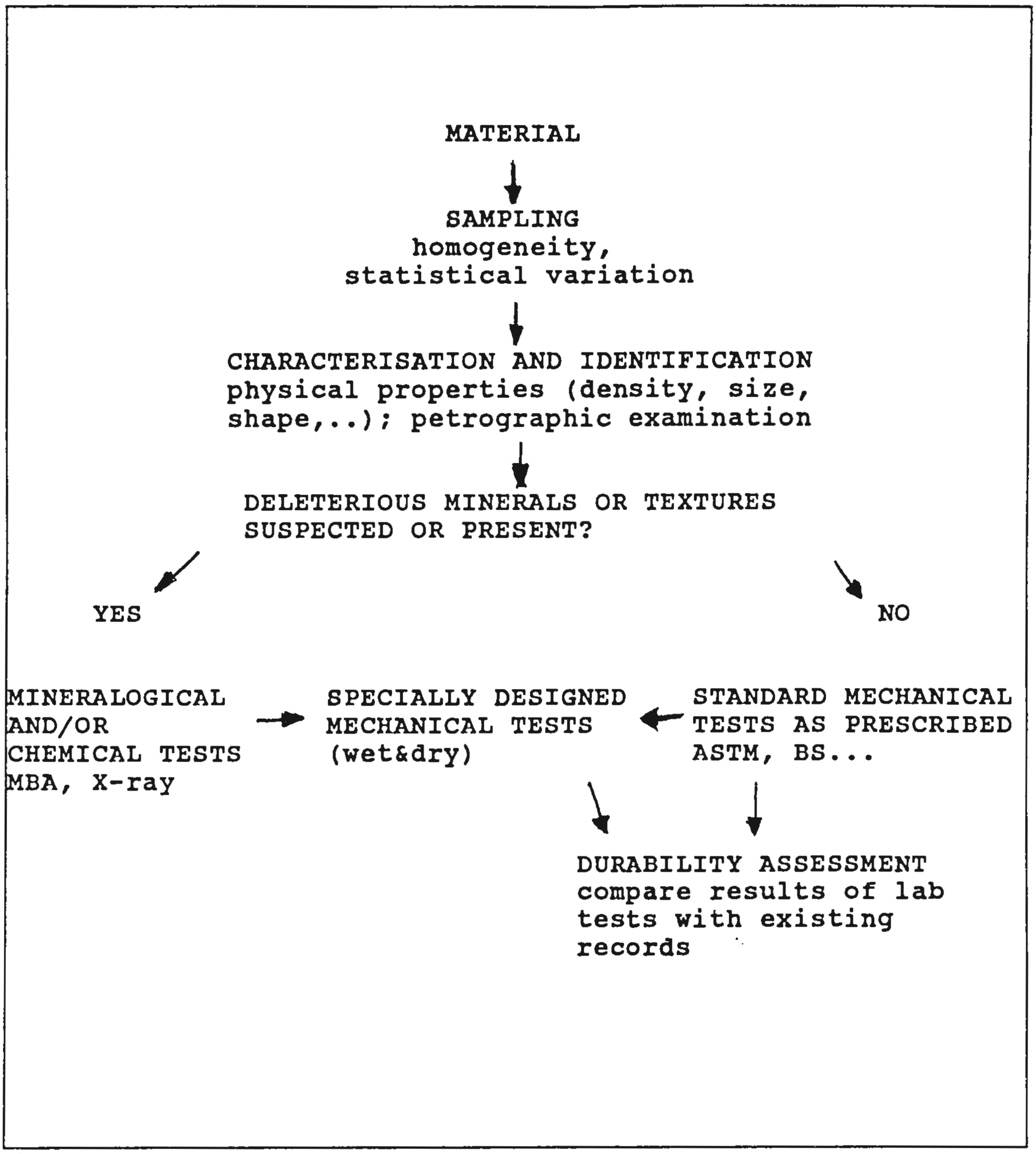

Figure 3.

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Test Sample	ACV (%)	Ten % fines (kN)	AIV (%)	MAIV (%)	Dutch AIV (%)	German AIV (%)	LAA (%)	Dry Density (Mg/m3)	WA (%)	MBA (%)	Flakin. Index (%)	German Shape Factor (%)
MG crushed building masonry	36	60	40	60	41	39.0	53.8	1.92	10.1	0.15	16	12.0
KL crushed road masonry	24	160	24	24	25	27.7	25.9	2.10	6.4	0.15	24	10.0
BG crushed concrete	24	110	26	30	29	28.1	30.9	2.32	6.3	0.15	10	1.6
LI Limestone	21	160	21	17	19	23.3	24.5	2.61	0.6	0.15	5	4.4
Ga Gabbro	15	260	14	16	12	16.8	17.1	3.15	0.6	0.30	20	5.9
Vo Tuffaceous Lava	32	100	26	32	20	23.5	29.4	2.33	8.2	0.15	18	12.2
St crushed gravel	14	300	16	17	16	22.8	17.5	2.58	0.9	0.22	23	5.3
LII Limestone	20	200	16	16	16	21.6	17.3	2.69	0.7	0.38	18	19.8
Gr Granite	20	230	20	22	18	23.4	22.1	2.62	0.5	0.30	22	9.6
Bit Basanite	20	200	16	15	16	17.9	17.1	2.82	7.0	0.15	27	14.0
Blt Basalt	12	340	11	9	10	14.5	17.1	2.82	1.9	0.15	20	9.8

Table 1. Results of the aggregate tests.

X Y	ACV	Ten % fines	AIV	MAIV	Dutch AIV	German AIV	LAA
ACV		Y = exp(3.74-0.0037X) r = 0.97; se = 2.1	Y = 0.84X + 4 r = 0.93; se = 2.8	Y = 13.33ln(X)-18.78 r = 0.92; se = 3.1	Y = 2.46X^0.72 r = 0.86; se = 4.1	Y = 0.89X + 0.68 r = 0.81; se = 4.4	Y = 18.05ln(X)-35.11 r = 0.90; se = 3.4
Ten % fines	Y = exp(6.64-0.069X) r = 0.97; se = 20.9		Y = exp(6.43-0.06X) r = 0.95; se = 34.6	Y = 3095X^-0.95 r = 0.92; se = 47.2	Y = 5433X^-1.18 r = 0.90; se = 44.4	Y = exp(6.70-0.07X) r = 0.85; se = 59.1	Y = 11575X^-1.34 r = 0.93; se = 45.4
AIV	Y = 1.03X-1.30 r = 0.92; se = 3.1	Y = -14.68ln(X) + 96.55 r = 0.95; se = 2.7		Y = 0.56X + 7.76 r = 0.97; se = 2.[illegible]	Y = 0.89X + 3 r = 0.96; se = 2.2	Y = 1.15X-6.21 r = 0.95; se = 2.6	Y = 21.64ln(X)-47.74 r = 0.98; se = 1.5
Mod. AIV	Y = exp(1.7 + 0.06X) r = 0.92; se = 5.2	Y = 1959X^-0.88 r = 0.92; se = 4.2	Y = 1.68X-11.61 r = 0.97; se = 3.6		Y = 1.68X-6.46 r = 0.93; se = 7.1	Y = 1.92X-21.72 r = 0.92; se = 5.8	Y = 1.24X-7.29 r = 0.98; se = 3.2
Dutch AIV	Y = X-1.58 r = 0.83; se = 5.0	Y = -15.10ln(X) + 97.96 r = 0.90; se = 4.1	Y = X-1.80 r = 0.96; se = 2.4	Y = 0.6X + 6.4 r = 0.93; se = 3.3		Y = 1.28X-9.96 r = 0.97; se = 2.1	Y = 0.76X + 1.44 r = 0.95; se = 3.0
German AIV	Y = 0.74X + 7.44 r = 0.81; se = 4.1	Y = -10.83ln(X) + 79.34 r = 0.85; se = 3.7	Y = 0.79X + 7.03 r = 0.95; se = 2.1	Y = 0.44X + 13 r = 0.92; se = 2.8	Y = 0.74X + 8.86 r = 0.97; se = 1.6		Y = 0.56X + 9.70 r = 0.92; se = 2.8
LAA	Y = 1.30X-3.53 r = 0.87; se = 5.7	Y = 663X^-0.65 r = 0.93; se = 3.6	Y = exp(2.22 + 0.044X) r = 0.98; se = 1.4	Y = 0.77X + 6.76 r = 0.98; se = 2.5	Y = 1.20X + 0.90 r = 0.94; se = 3.7	Y = 1.50X-10.80 r = 0.92; se = 4.6	

Table 2. Matrix showing the regression equations with Y = dependent variable and X = independent variable; r = regression coefficient; se = standard deviation of estimate. ACV = aggregate crushing value; 10 % fines = ten per cent fines value; AIV = aggregate impact value (all according to BS-812, 1975). MAIV = modified aggregate impact value (Hosking and Tubey, 1969); Dutch AIV (Dynamische verbrijzelingswaarde: NEN 5185, draft 1988); German AIV (Schlagzertrümmerungswert $SZ_{8/12}$: TPMin-StB Teil 5.2.1.4, 1982). LAA = Los Angeles Abrasion test (ASTM C131-81).

СССР ИНЖЕНЕРНАЯ ГЕОЛОГИЯ КАРСТА ПЕРМЬ

1992

МЕЖДУНАРОДНЫЙ СИМПОЗИУМ

INTERNATIONAL SYMPOSIUM

ENGINEERING GEOLOGICAL PROBLEMS OF KARST

INTERNATIONAL SYMPOSIUM «ENGINEERING GEOLOGY OF KARST»

6—8 July, 1992

Perm, USSR

First Circular

INTERNATIONAL SYMPOSIUM «ENGINEERING GEOLOGY OF KARST»

First circular and call for papers

In the name of host country the Organizing Committee cordially invites all engineering geologists, scientists and specialists to participate in International Symposium «Engineering Geology of Karst» on 6—8 July, 1992 in Perm (USSR) to exchange scientific experience and research results, to hold talks and explore possibilities of scientific cooperation.

1. Subject and Main Theme of the Symposium

The emphasis will be placed at a broad discussion on the key aspects of engineering karstology — influence of karst processes on engineering geological properties of rocks, karst territory stability, surface and subsurface water interaction with soluble rocks, forecast methods of karst processes development under industrial, civil and hydrotechnical construction and problems of rational use and environmental protection in karst areas.

The following subjects have been chosen for scientific papers presentation:

— Present-day knowledge on formation of engineering geological properties of karstified (soluble) rocks and massifs
— Methods of karst rock investigation
— Karst process geodynamics
— Forecast, control and protection measures of karst process development
— Rational territory use and environmental protection in karst areas

2. Place and Time of the Symposium

The Symposium will be held on 6—8 July, 1992 in Perm, USSR.

Perm is situated in the Ural, approximately 1500 km away from Moscow, not far from the Earope — Asia border. This area has been designated a place of outstanding natural beauty and provides the setting for numerous walks and geological excursions. Karst rocks are widely spread in the area. Many karst caves, Kungur Ice Cave being the most famous, and other karst features are very common. It contains places of historic interest; many unique geological objects are found in its environs.

The Organizing Committee will book rooms in different price categories for the Symposium participants and accompanying persons in Hotel Complex «Tourist» in the centre of Perm.

Price categories	1 person/night	US$/night
Deluxe		117
Single room		50
Double room		33

3. Scientific Excursions

After technical sessions (9—16 July, 1992) scientific excursion will be organized to the various regions of Western Ural, to the areas of sulphate, carbonate and salt karst development. The tour will start in Perm with 4 days excursion (9—12 July, 1992) upstream the Kama River (Kamskoje Reservoir) on a board of comfortable passenger liner up to Berezniki and Solikamsk cities, covering the distance 230 km long. The participants will be given a chance to observe shore retreat phenomenon (abrasion) and salt karst forms manifestation. Solikamsk is a historic place and is considered to be the monument of ancient Ural architecture. Berezniki is one of the world largest centre of potash production. Then the excursion will be continued by coach (13—16 July, 1992) and the participants will be brought to Kungur to observe its environs, well-known throughout the world Kungur Ice Cave and unique gypsum karst objects included. Total length of the tour is 350 km. Approximate price for the excursion up the Kama River (on a board of passenger liner) is US$ 400 and covers transport, meals and social programme. Price depends on a category of cabin

Cabin category	No of person(s)	Price for 1 person US$
I	1—2	191
IA	2	183
IB	2	175
II	2	167
IIA	2	158
IIB	4	133

Approximate price of coach excursion (per 1 person) is US$ 200. The price covers transportation by coach, meals and accommodation in Tourist Hotel «Stalagmite» (Kungur).

Total price for excursion is about US$ 600.

Final price will be announced after return of Form A where participants wish to take part in the excursion and cabin category will be indicated.

4. Official Languages

The official languages of the Symposium are English and Rassian.

5. Participation and Registration

The Symposium is opened to anyone interested in its problems. If you wish to participate, please, complete the attached application Form A and send it before Junaury 31, 1991 to the address of the Chairman:

International Symposium «Engineering Geology of Karst»
I. A. Pechorkin, Chairman
Perm State University
Bukirev St., 15, Perm, 614600, GSP,
USSR

Those who do so automatically receive the Second Circular.

8. Registration Fee

According to the official rate of US$ in March, 1990, approximate registration fee for full member is US 400, for accompanying persons — US$ 200 and for corresponding members — US$ — 100. The latter entitles to publish papers and to receive the Sumposium documents. Registration fee does not cover hotel accommodation, meals and excursions.

D.I.G. Subsidence-excursion: A visit to the NAM Assen.

A.R.G. van de Wall

Being a producent of oil and gas the NAM is concerned with the possible consequences the production. In the Netherlands the attention is focussed on the North; there the largest (gas) reservoir is present. Most will know there have been a lot of discussions about the causes of the subsidence and the future subsidence. This article discusses the influnence of gasproduction on subsidence and the way measurements are done by the NAM. Because there has just been a symposium on the subject of subsidence in the north of Holland this article will not go very deep into the subject.

I. Introduction

The gas production in Groningen causes a decrease in porepressure in the gas containing layers. This results in a slow compression of this layer. The compression depends on mechanical properties, the amount of pressure decrease and the thickness of the reservoir. Depending on the thickness and the extension of the layer the reservoircompaction can result in subsidence at the surface. Because of the extension of the gas field in Groningen the total subsidence at the surface will come close to the amount of compaction of the reservoir. This applies - of course - only to the centre of the subsidence basin. The subsidence is visible as a large shallow basin with a very small gradient. Altough its influence on civil structures like buildings can be neglected its influence on the water regiem can be of great importance, as was discussed in the the previous edition.

Fig. 1 Groningen gas field and border fields.

Figure I. shows the Groningen gas field.

II. Observations

Observations show that the subsidence as predicted in the past is too high. The most recent prognoses estimate a subsidence of 33 - 43 cm in the year 2050. Also it can be seen from figure 2 that the centre of maximum subsidence is moving to the north. This is due to the depletion history. The pressure in the northern part decreased slower than in the south. To prevent big deiirences more wells were drilled in the north, resulting in the mentioned shift.

To get insight in the reservoir various measrement techniques are being used:
- Waterlevel measurements
- Compaction measurements in shallow wells
- Compaction measurements in deep welles
- 3D seismics

III. Waterlevel measurements

This methods consists of taking measurements of the ground level. The measurements are done on a grid which covers the subsidence basin and the stable area around it. The frequency of the measurements depends on the expected subsidence. Since 1980, each year a remeasuring is executed on a coarse grid consisting of 1000 observation points (800 km). Every six years measurements are taken on a finer grid consisting of 2600 observation points (1400 km). The latter has two aims:
- Determination of subsidence with a higher accuracy.
- Verification of the stability of the connection points.

Fig. 2 The shift of the lowest point of subsidence.

The accuracy is in the order of 1mm/^{1}km.

IV. Compaction measurements in shallow wells

The method can best be explained by figure 3.

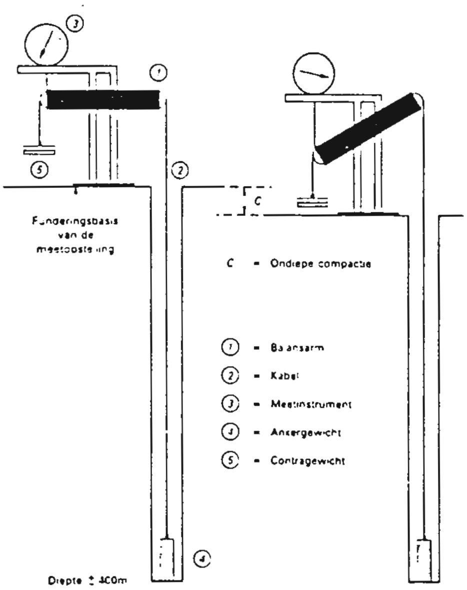


Fig. 3 Principle of cable method.

The apparatus consists of an arm with a cable over it. This cable is fixed on the bottom of the well (400 m) by an anchoring weigth. The other side is connected to a counter weight. The arm can rotate with very little friction around it axis. The rotation of the arm causes the tip to shift over a distance equal to the total compaction os the sediment between surface and anchoring depth. The measurements have an accuracy of 0.05 mm.

V. Compaction measurements in deep wells

1There are 11 deep observation wells for in-situ compaction measurements. These are spread regularily over the area. In the wells low radioactive bullets have been fixed at regular distances (fig 4). The relative displacement of these bullets is recorded to calculate the compaction coefficient in-situ.

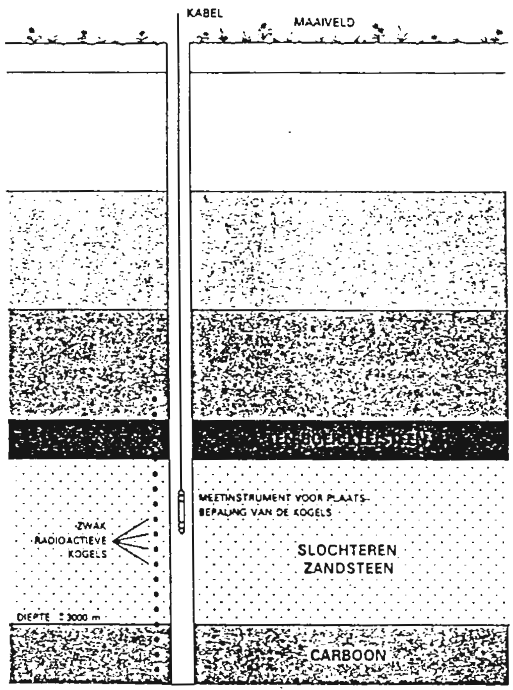


Fig. 4 Principle of in-situ compaction measurements

Book Review

A. Pinto da Cunha (ed.): "Scale effects in rock masses", Proceedings of the first International Workshop on Scale Effects in Rock Masses, Loen, Norway, 7-8 June 1990. Balkema, Rotterdam. pp. 339, Price: Hfl. 125.00

Peter N.W. Verhoef, Section of Engineering Geology, TU Delft

Following the symposium on rock joints in Loen, a workshop on scale effects in rock masses was held. The book holds the contributions to this workshop. It contains some very interesting papers of scale effects on the deformability and strength of intact rock and rock joints, rock masses and interestingly also on the determination of internal stresses in rock masses. Pinto da Cunha gives an extensive introduction on scale effects in rock masses, using much of the data internationally known, but complementing these with data assembled at LNEC, the laboratory from Lisbon, Portugal, that has a splendid name in rock mechanics.

Barton provides the reader with an attractive account called "Scale effects or sampling bias". Apart from highlighting the most salient new developments reported at the workshop he also pinpoints at weaknesses or blank spots in our present knowledge. Barton has a remarkable talent for data handling. I was struck again by the apparent ease with which he derives relationships between various parameters. His paper is delightful reading for anyone interested in how to incorporate shear strength data of rock joints into models of rock masses. The question is what scale is really of influence for the problem at hand? The numerous data given in the diagrams on dependency of parameters like roughness, stiffness, slip magnitude on size are really helpful in this respect. He gives an example which shows the effect of incorporating such joint data in a UDEC computer simulation of the Ecofisk oilfield, to obtain very realistic surface subsidence predictions.

Concerning joint roughness, the fashion of using fractal description of roughness surfaces is coming under serious criticism. I always was puzzled by the use of the fractal dimension D to describe joint surfaces. If these would be self-similar, the D determined on a hand specimen would be similar on all scales, which would mean that there was no size effect! Maerz and Franklin clearly show that fractal plots from joint surfaces are non-linear and that D decreases for longer "yard sticks" used to determine D. In fact a plot of fractal dimension D versus resolution (sampling length) looks identical to the well-known Rengers plot of roughness angle i versus sampling length. The nice correlation found by many researchers between D and JRC (joint roughness coefficient) values is only valuable at the scale of observation (10 cm). Like JRC, D is also dependent on size. The conclusion is that fractal analysis may not be appropriate for characterising rock joint surfaces, because these are not self-similar. (Maerz and Franklin also give another argument: the fractal dimension of a continuous differential function, such as a sine wave is 1, the same as that of a straight line. We know that a sinusoidal surface has a very different roughness than a flat surface).

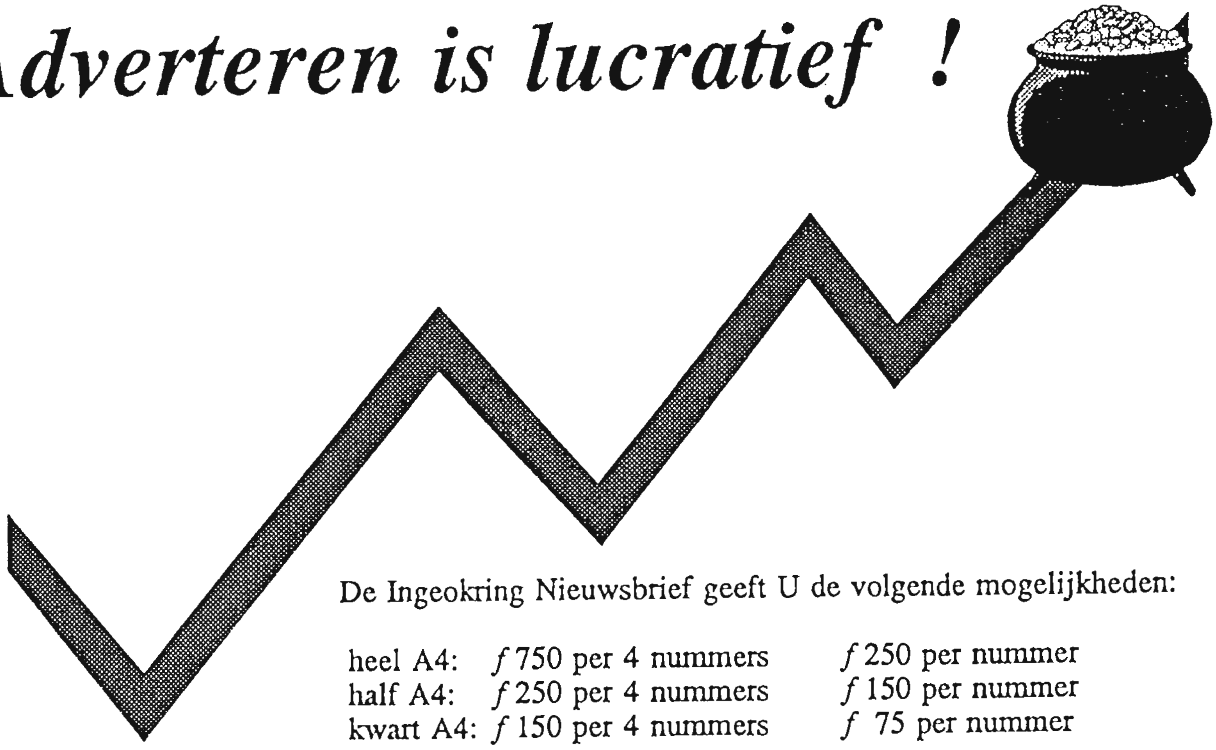
The book contains much more interesting material (lots of data!) and is therefore highly recommended.

Adverteren in de speciale uitgave september 1991

In september zal een speciale uitgave gepubliceerd worden die gericht zal zijn op het EEG '91 (zie ook pagina 44 ev). Deze uitgave zal tevens aangeboden worden aan de bezoekers van dit congres. In verband met deze speciale uitgave mogen bedrijven en instellingen die adverteren tevens een artikel over hun bedrijf/instelling plaatsen. Dit artikel wordt er gratis bij geplaatst.

Met het oog op de doelgroep wordt men verzocht om de artikels in het Engels te schrijven.

Adverteren is lucratief !



De Ingeokring Nieuwsbrief geeft U de volgende mogelijkheden:

heel A4:	*f* 750 per 4 nummers	*f* 250 per nummer
half A4:	*f* 250 per 4 nummers	*f* 150 per nummer
kwart A4:	*f* 150 per 4 nummers	*f* 75 per nummer

BOOK REVIEW

Richard Brummer (ed).: "Static and dynamic considerations in rock engineering".

A.P. Balkema, Rotterdam, 1990, 401 pp. Price: Hfl. 145,--.

Peter N.W.Verhoef, section of Engineering Geology, TU Delft.

The book contains the proceedings of an I.S.R.M. international symposium held in Swaziland in September 1990. The focus was specifically on rock mechanics experience in Southern Africa, which ranges from very deep mining to civil engineering works in mountainous areas. The contributions treat a wide variety of subjects, related to both mining and civil engineering projects. Subjects range from mudrock swelling behaviour, blasting design in hard rock, numerical analysis around underground openings, rock slope stability to tunnelling and drilling techniques. Most of the papers relate to cases in Southern Africa. The editor clearly has not been able to group the papers in subjects or themes and could not do better than arranging them in authors alphabetical order. Hopefully the book will be of use in the area in which the symposium was held. The title of the book promises much more than is offered: the word "considerations" has been taken very broadly. Some papers that offer interesting material, for engineering geologists, are mentioned below:

B.H. Brady: "Dynamic performance and design of underground excavations in jointed rock".

B.P. Boisen: "Applied underground instrumentation".

A.G. Butler & J.A. Franklin: "Classex: An expert system for rock mass classification".

C. Douat & C.Fairhurst: "Micro-Computer modelling and practical design/monitoring of large underground excavations".

G.S. Esterhuizen: "Combined point estimate and Monte Carlo techniques for the analysis of wedge failure in rock slopes.

H.J. Olivier: "Assessment of the geomechanical properties of swelling and slaking mudrocks in tunnel excavations".

J.P. Pellissier & U.W.Vogler: "A contribution to the explanation of the behaviour of swelling rock".

S.Sakurai & Y. Kitamura: "Dynamic behaviour of structures caused by blasting for excavations in rock".

Also a Dutch contribution was made: J.P.A. Roest and J.Gramberg: "Cyclic processes of fracture and failure around deep level longwall stopes", where a nice example is given of the non-conventional phenomenological approach of rock mechanics developed by Gramberg.

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 alle 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.

Correspondentie adres:

Redaktie Nieuwsbrief Ingeokring
Faculteit der Mijnbouwkunde en Petroleumwinning
Sectie Ingenieursgeologie
Mijnbouwstraat 120
2628 RX Delft
Nederland
Telefoon: 015-782543

Book Review: "Rock Joints"

Nick Barton and Ove Stephansson (eds.), Proceedings International Symposium on Rock Joints, Loen, Norway, 4-6 June 1990. Balkema, Rotterdam. pp. 814, Price: Hfl. 159.00

Peter N.W. Verhoef, Section of Engineering Geology, TU Delft

This book has done very well as from its appearance; no one that I know off who is interested in rock joint behaviour is unaware of it. The proceedings of the symposium have been organised in the fashion familiar to others published by Balkema, but the overall quality of lay-out and presentation of the papers is higher than usual. More important, the scientific and practical value of many of the papers is very high.

The Symposium has been organised by the ISRM Commission on Rock Joints. It was the first of two speciality conferences dealing with individual rock joints. The second conference will be held in 1992 in California and will deal with rock mass behaviour. The organisers have been involved in research on rock joints since the late sixties, when the major features governing mechanical rock joint behaviour started to become clear. Especially Nick Barton has remained an inspiring person continuously searching for simple and practical methods to measure rock joint properties in order to derive valuable engineering parameters from these to predict rock joint or rock mass behaviour.

The proceedings of the symposium have become very attractive, because researchers studying rock joints from different backgrounds have contributed material which clearly could be of use for most of the applications in rock engineering. The organisation of subjects has been as follows:

1. Characterization
2. Mechanical properties
3. Hydraulic properties
4. Dynamic properties
5. Coupled behaviour
6. Constitutive models

With regard to **joint characterization** some interesting developments can be noted. First that in the field of structural geology further progress has been made with regard to joint origin and development. In a paper on natural hydraulic fracturing by Engelder and Lacazette the knowledge of surface morphology of joints has been used to constrain hypotheses concerning joint initiation under high fluid pressures. Using linear elastic fracture mechanics they could derive that cross-joints in the siltstone under study were initiated from fossils, concretions and flute casts when the pore pressure was about 85% of the overburden stress. The crack growth and propagation can also be explained by fluid pressure and fluid flow considerations.

Rawnsley, Hencher and Lumsden consider whether knowledge of joint origin can help in understanding or predicting the geotechnical properties of joints. Their conclusion is that it is doubtful that an understanding joint genesis will ever allow accurate assessment of joint geometry in unexposed ground. The range of variation of joint geometry properties is simply too high. The latter has been the subject of two interesting studies, which may be the onset of work that can help towards better methods to predict joint geometry in unexposed areas of a rock mass. The papers of Kulatilake and collaborators describe the development of a stochastical model with which they could reasonably predict the geometry of the joint system of the rock mass of the Stripa Mine gabbro. A geostatistical study by Villaescusa and Brown revealed that joint locations can be spatially correlated. Structured variograms of joint spacing with respect to distance and with respect to joint sequence number and joint trace density with respect to distance were studied. This showed that the locations of the joints within their rock masses is not purely random.

The section on **mechanical properties of rock joints** starts with a review paper by Bandis which emphasises the empirical approach first taken by Barton, where joint behaviour is expressed in terms of JCS (joint compressive strength) and JRC (joint roughness coefficient). Bandis shows that considerable advance has been made in the description of the mechanical properties of joints, but concludes that quantitative procedures of general acceptance are limited or lacking. His paper provides a well written state-of-the-art contribution, with suggestions of new research necessary. One of the problems with the establishment of parameters describing mechanical joint behaviour (shear strength, normal- and shear stiffness) is that all of these are scale dependent. This has lead to many experiments on joint surfaces at different scales, the most well known work being the PhD thesis of Bandis. In the proceedings Kutter and Otto examine the problem again. The dilational behaviour of a rock joint was studied under successively more complicated boundary conditions and also the behaviour of cross-jointed multiple shear surfaces. They used a large servo-controlled direct shear machine, a tilt table and a base friction machine. The tilt table was used to allow quick and destruction-free measurements of the failure angle ($\phi_b + i$) at very low normal stress for preliminary trend studies, examining the effect of size and cross joints. In the direct shear machine tests with high normal stress were carried out in two loading modes: constant normal load or constant normal stiffness. Relative shear and dilatancy measurements were done very near the shear surface. The base friction machine was used to make detailed observations and measurements of dilation angles of all component blocks in a multiply-jointed rock model and was specifically suited to study the size effect. This machine was specially built for the project and is of interesting design. The base plate of the machine is a 750 x 400 mm magnetising table which exerts a maximal normal contact stress of 110 kPa on soft iron cores which are cast in and uniformly distributed over the bottom area of the plaster models. Sufficient friction forces can be generated this way and there is a constant erosion-free friction between the base and the model. Both the latter and the way of exerting the normal force are an elegant improvement over the conventional sand-paper base friction machines. The major conclusion of this study is that shear data from limited sections of rock joints are fully suitable for assessing the strength behaviour of the rock mass whose discontinuity elements are represented by the samples. If size effect, quality of surface interlocking, and effective normal stress are taken into consideration laboratory tests are fully sufficient and there is no justification for additional large scale tests.

Other papers drawing my attention were those related to shear strength of joints of partial continuity or with rock bridges (Hung & Lee; Li, Stephanson & Savilahti; Savilahti et al), a paper by Barton and Zoback showing the self-similar (fractal) distribution of macroscopic fractures along a 1700 m section of a borehole in crystalline rock (the paper should have been in section 1), papers on behaviour of reinforced jointed models (Egger & Pellet; Bakhtar, Zahra & Chity), papers on strength of infilled joints (Papaliangas, Lumsden et al; Paulino Pereira, Phien-wej, Shrestra & Rantuci, Suoreni & Tsidzi, Shulin Xu & De Freitas).

The section on **hydraulic properties** is introduced by a readable paper by Gale on hydraulic behaviour of joints, where the application of different models (porous media, discrete fracture, stochastic discrete network) is discussed. He emphasises that basic geological factors should be considered when assembling and analyzing field data and used for the models as well. He exemplifies this by the observations of joint systems in the Stripa Mine and notes that fracture origin (extensional-tensional, shear fracture etc.) relates to hydraulic properties directly. Distinction of different types of fractures and joints while characterizing and measuring them therefore is useful. Then basic flow laws and concepts are discussed, followed by flow through rough fractures subjected to normal stresses. The other papers in this section describe experiments on flow through single joints studying the effect of roughness asperities and aperture variation. Also flow through complex simulated fracture networks is described.

Dynamic behaviour of rock joints is discussed by Hobbs, Ord & Marone. They developed a new interpretation of observed frictional response to a perturbation in slide velocity in terms of cohesion and friction angle evolution laws. These laws have a softening character and relate to the evolution of cohesion (c), friction angle (ϕ) and dilation angle (ψ) in a gouge layer of constant thickness. The problem therefore can be described in terms of the behaviour of a granular aggregate. The authors note that elastic constants are known to be strain-rate dependent in brittle materials and that a strain-rate dependence of frictional shear stress would be expected. Experimental data are scarce, however. They used the computer code FLAC to simulate a velocity stepping experiment using the constitutive parameters c, ϕ and ψ based on measurements by Marone of friction in a shear test in quartz sand where slip rates were changed in steps. The model showed a realistic development of shear bands oriented at 10 to 16 degrees to the direction of shearing.

Experiments by Barla et al show a typical increase in shear strength with shear stress rate.

Myer, Pyrak-Nolte & Cook give an analysis of the effects of single fractures on seismic wave propagation. They show that fractures both cause a frequency dependent loss of amplitude and a time delay in the transmitted wave even for the completely elastic system in which only one discontinuity is present. The effect of fluid viscosity is to add a dissipative factor and to alter the frequency dependent characteristics of the theory. This new approach of modelling of fractures will, according to the authors, lead to significant improvements in the use of seismic data for the determination of geotechnical properties of fractures and joints.

The last two sections of the proceedings: **coupled behaviour** and **constitutive models** comprise some of the most interesting papers of the book. A better understanding of the coupling of dilation, closure, shear, joint propagation, fluid pressures and permeability in joints eventually will lead to better modelling of rock mass behaviour. This will lead to better constitutive modelling of such diverse processes as rock excavation, high level radioactive waste repository impact, underground fluid storage, earthquake prediction and control etc.

An overview of the present knowledge of **coupled behaviour** is given by Tsang. Brown and Robinson describe a series of pressurisation tests of a 3.5 km deep body of jointed crystalline rock. Makurat et al have conducted coupled shear conductivity tests on natural rock joints. Joint conductivity is dependent on uniaxial compressive strength (σ_c), JCS, JRC and the normal stress acting across the joint and the shear displacement. In hard rocks small amounts of displacement are enough to dilate joints and cause conductivities to increase by two orders of magnitude, when joints are rough. Soft rock joints suffer normally from asperity crushing and the resulting gouge causes conductivity decrease during shear. Also in hard rock, like the Stripa rock, gouge formation may lead to blocking and conductivity reduction.

In the section on **constitutive modelling** my attention was focused specifically on Barton's JRC-JCS model. Barton and Bandis wrote a paper on the predictive capabilities of this model in engineering practice. Although the paper doesn't really cover the title, it gives additional data how to derive relevant parameters and how to include scale. They have incorporated their formula's in their version of UDEC (a computer code used by the authors of many papers). Xu and De Freitas, however, conducted a series of carefully designed experiments on saw tooth joints, studying the breakdown of the asperities. The flattening of the asperity profiles explains the curving of the peak shear strength envelope as normally observed on clean joints. They conclude that Barton's shear strength models are correct.

The above is only an account of a biased survey through the book, which I consider a must for anyone studying rock mass engineering behaviour.

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.

REMOTE SENSING EN ENKELE TOEPASSINGEN

Steven de Jong, Vakgroep fysische Geografie, Rijks Universiteit Utrecht.

Samenvatting KIVI-voordracht, gehouden op dinsdag 26 februari 1991 in de Leeuwenborg, Wageningen

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Remote sensing of teledetectie is een verzamelnaam voor een aantal technieken die ons in staat stellen informatie over onze omgeving te verzamelen. Het zijn technieken en methoden voor het op afstand waarnemen van objecten zonder fysiek contact te hebben met dat object. Het werkveld van de remote sensing is in het algemeen beperkt tot het aardoppervlak en de atmosfeer, "ons leefmilieu". Sinds 1972 voorzien satellieten en vliegtuigen ons met grote regelmaat van opnamen van het aardoppervlak. Met de sensoren in deze satellieten worden niet alleen opnamen gemaakt in het zichtbare licht, maar ook andere delen van het electromagnetische spectrum zoals het nabije en midden infrarood, het thermisch infrarood en in het radargebied. Het bekendste voorbeeld van een dergelijk satellietopname is het Meteosat beeld, deze worden bijna dagelijks op de televisie getoond bij het weerbericht. De Meteosat is een een zogenaamde "lage resolutie" satelliet die op een quasi vaste positie boven het aardoppervlak zijn waarnemingen doet op een hoogte van ongeveer 36.000 km.

Er zijn echter ook een groot aantal satellieten die in een veel lagere baan om de aarde draaien en veel nauwkeuriger informatie geven over het aardoppervlak. De bekendste van deze satellieten zijn de Amerikaanse Landsat met het sensor systeem "Thematic Mapper" en de Franse SPOT satelliet. De baan van deze satellieten ligt op ongeveer 800 km hoogte en het oplossend vermogen van deze satellieten ligt tussen de 10 en 30 meter. Vooral deze laatste twee satellieten voorzien ons van waardevolle informatie voor milieustudies.

De hoge positie van deze satellieten maakt het mogelijk grote oppervlakken tegelijkertijd waar te nemen. Dit in combinatie met de overkomst frequentie van ongeveer eens in de 16 dagen biedt ons een ideaal waarnemings systeem om bijtijds veranderingen in het milieu of ongewenste verstoringen van het milieu op te merken. Hierdoor kunnen dan tijdig de nodige beheersmaatregelen genomen worden. Een voorwaarde voor een kwalitatief goede opname van deze satellieten is natuurlijk wel dat het aardoppervlak niet bedekt wordt door wolken.

De sensoren in de satellieten in andere delen van het spectrum dan de zichtbare banden biedt voordelen voor het waarnemen van bijvoorbeeld gewassen, vegetatie en bodems. De reflectie eigenschappen van deze objecten wijken namelijk sterk af van die in het zichtbare licht. In het algemeen heeft bijvoorbeeld vegetatie de eigenschap electromagnetisch straling in het zichtbare deel van het spectrum (0.4 tot 0.7 μm) sterk te absorberen maar juist sterk te reflecteren in het nabije en midden infrarood. Dit deel van het spectrum biedt dan ook veel beter de mogelijkheid verschillende typen gewassen of vegetatie te herkennen dan het zichtbare deel. Het is zelfs mogelijk om met een combinatie van verschillende golflengten een schatting te maken van de biomassa van dat gewas of waar te nemen of het gewas lijdt aan een watertekort.

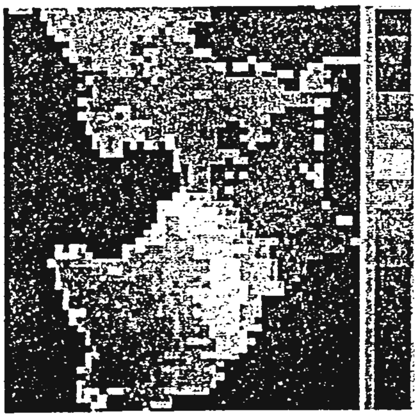
Nederland heeft behoorlijk bijgedragen aan het tot ontwikkeling komen van diverse remote sensing toepassingen mede dankzij stimuleringsfondsen van de overheid zoals het Nationaal Remote Sensing Programma (NRSP). Dit programma bevordert door finaciele ondersteuning het fundamentele onderzoek naar remote sensing, het toepassingsonderzoek en de operationalisering van remote sensing technieken. De Europese Gemeenschap stimuleert eveneens het gebruik van remote sensing technieken. In mei 1991 is de lancering van de eerste "European Remote Sensing Satellite" (ERS-1) gepland. De ERS-1 heeft tal van instrumenten gecombineerd aan boord die voorheen slechts gescheiden op satellieten voorkwamen. Zo heeft de ERS-1 een geavanceerd radarsysteem aan boord, dat ook in staat is zijn waarnemingen te doen als wolken het aardoppervlak aan het oog onttrekken. Radargolven worden nauwelijks gestoord door bewolking. De verwachtingen van deze nieuwe satellieten zijn zeer hoog.

Een toepassing van remote sensing is bijvoorbeeld waterkwaliteitscontrole van het IJsselmeer. Het IJsselmeergebied heeft een aantal belangrijke functies, het voorziet een groot aantal mensen van drinkwater, het is een intensief gebruikt recreatiegebied en het vormt een belangrijke hydrologische schakel in de Nederlandse waterhuishouding. Een belangrijke parameter van waterkwaliteit is het zwevende stofgehalte van het water omdat hieraan vele verontreinigingen gehecht zijn. Patronen van zwevende stof verschaffen de waterbeheerder informatie over de verspreiding van verontreiniging. Bovendien leveren deze patronen in combinatie met analyses van watermonsters informatie over de mate van verontreiniging. De door de satelliet gemeten reflectiewaarden in het rode en het groene licht blijken hoog gecorreleerd te zijn met het zwevende stofgehalte. Geklassificeerde satellietbeelden verschaffen op deze wijze snel en voor het hele IJsselmeergebied tegelijk een beeld van de waterkwaliteit.

Een tweede voorbeeld van remote sensing toepassingen is het waarnemen van heidevergrassing met behulp van SPOT-beelden. De ecologische waarde van de Nederlandse heidevelden is zeer hoog. Onze heidevelden dreigen echter in een hoog tempo te vergrassen mede onder invloed van zure regen. Indien echter op tijd de juiste beheersmaatregelen (plaggen, branden) worden genomen, kunnen de heidevelden worden behouden. Dit vereist echter een waarnemingssysteem dat informatie verschaft over de mate van vergrassing en de plaatsen waar vergrassing optreedt. Een combinatie van de rode en de nabij infrarode band van de Landsat satelliet blijkt een optimaal hulpmiddel voor het bepalen van de mate van vergrassing. Voor eén heideveld wordt in het veld de correlatie tussen reflectie en vergrassing vastgesteld. Vervolgens kunnen alle heidvelden binnen het satellietbeeld geklassificeerd worden naar de mate van vergrassing.

Het derde voorbeeld van remote sensing is het gebruik van satellietbeelden voor het karteren en waarnemen van bodemerosie. De RUU voert samen met de Europese Gemeenschap een onderzoek uit naar landschapsdegradatie in het middellandsezeegebied. Hierbij worden satellietbeelden ingezet voor het karteren van bodems en veranderingen in de natuurlijke vegetatie. De resultaten hiervan worden gebruikt als invoer voor simulatie modellen die een voorspelling geven waar en in welke mate er bodemerosie op zal treden. Dit project is echter nog in het onderzoeksstadium en operationalisering zal pas in de komende jaren plaats vinden.

Afsluitend kan gesteld worden dat remote sensing een belangrijke bijdrage heeft geleverd en nog levert aan onze kennis over ons leefmilieu. De verwachting is dat remote sensing een steeds belangrijkere plaats zal gaan innemen in tal van milieu bewakingssystemen, remote sensing vormt dan een belangrijke spil in onze activiteiten om de wereld leefbaar te houden.



Reflectiebeelden van de NOAA-satellieten kunnen m.b.v. puntmetingen vanaf schepen omgezet worden in zwevend-stof-concentratiebeelden. De laagste concentratie zwevend stof komt voor in het zuidelijke deel van het IJsselmeer (donkergroen = ± 10 mg/l). De hoogste concentratie bevindt zich bij Marken (rood = ± 50 mg/l). De nauwkeurigheid van dit beeld van 5 juli 1987 volgt uit de statistieken van de vergelijking tussen de scheepswaarnemingen en de pixelwaarden in het beeld: correlatiecoefficient = 0.8, RMSD = 3.6 mg/l, factor = 1.4

MSS-beelden van de LANDSAT-satellieten laten veel meer details zien dan de NOAA-AVHRR-beelden. Echter de opnamefrequentie van LANDSAT (1x per week) en de hoge kosten maken de LANDSAT-MSS en TM minder geschikt als monitoringsinstrument aan de NOAA-AVHRR.

Report on presentation by Ir. F.C. Dufour on:

Water resources assessment in the Republic of Yemen

A short report is given on an interesting talk with slide show on a water resources study in the Republic of Yemen given by ir. Charles Dufour: 30th May, 1991 for the Mijnbouwkundige Vereeniging. Hopefully Mr. Dufour will give a similar presentation for the IngeoKring. Mr. Dufour studied at the (then) Mining Department of TH Delft. His doctoraal thesis was done under guidance of Prof.Dr. J.J. Dozy. He works at present with TNO-IAG as project manager. (Ir. Dufour was Publicity Secretary on the Organising Committee of the 6th International Conference of the I.A.E.G. in Amsterdam 1990.)
The water resources study was a technical cooperatiion programme between DGIS (Directoraat Generaal Internationale Samenwerking) and the Ministry of Oil and Mineral Resources of the Yemen Arab Republic.

The country was the Yemen Arab Republic; rain falls during seasonal Monsoons and the amount rainfall increases with elevation. At low elevations rainfall is from near 0 mm to 50 mm then rises to 700mm per year locally usually at the highest point of elevation. Average rainfall (measured in the study area) is about 140mm per year. Because the rainfall is seasonal, rainstorms are of high intensity. The topography consists of a very dry coastal strip then rises along a steep escarpment towards the highlands. Much of farming between the elevations of 2400m and 1800m consists of growing mild stimulant "quat" plants whose leaves are chewed. The uplands gradually fall towards an elevation of about 900m of the Arabian Desert in the east.

Local Moslem tradition/culture means that the first recipient of water from run-off owns the water and can store it if there is an appropriate wadi on ones property to build a dam. This means that in the Yemeni setting the higher the land the more one can dominate the water. Many landowners dam water upstream by bull-dozing embankments across streams. Over-flow and leakage water remains for the recipient further downstream, who in turn may also dam this water without regard for demands even further downstream. In the past this was less likely as heavy earth-moving equipment made its appearance in Yemen only recently. Conversely one is never refused water by its owner on the owner's land and they often make provision for free drinking water along the roadside for thirsty travellers.

Slides showed a steep landscape of terraces and villages one above the other on the western escarpment. The Capital, Sa'na, is situated at elevation of 2300 m. The city has modern structures but it is still dominated by "high rise" traditional building. Market gardens in city in small yards, courtyards are usually associated with local Mosques and helps provide income. The city's population is approximately 400,000. Water is obtained from aquifers. Depletion rates cause ground water levels to drop by an alarming annual rate of 4 to 7 m.

Extending towards the east up to between 100 to 150 km gradually dropping towards the sand sea basin of the hinterland of the Arabian Peninsula is the location of one of the areas being studied by this project in close cooperation with the General Department of Water Resources Studies of the Yemen Ministry of Oil and Mineral Resources. Much of the work was performed by TNO-IAG (Institute of Applied Geosciences; *TNO-IGG Instituut voor Grondwater en Geo Energie*, formerly *DGV, Dienst Grondwater Verkenning*). This particulary area is known as the Wadi Adhanah Catchment.

At the uplands volcanism has, in Tertiary and early Quaternary times, added some relief in form of basalts in a geological setting containing Jurassic limestones, the Amran formation, some shales and the Tawilah sandstones formations of the Cretaceous (*Tawilah* in Arabic means *long stretched feature*). Older rock consists of pre-Cambrian metamorphics.

In 1986 construction of the Marib Dam, a rockfill dam, was completed across Wadi Adhanah; upstream of the ancient Marib Dam of Queen of Sheba fame (more accurately the older Marib Dam supplied water through two prominent sluice gates at either side of the dam to irrigate farms which in turn supplied a staging town along the frankincense route). The route had its origins in South Yemen and headed along approximately the outwash planes at the base of the eastern escarpment towards the Mediterranean. This route was used probably as it was less dangerous then by sea and less rugged then along the top of the escarpment or along the Red Sea coastal plane.) A compact ghost town exists at Marib today; it is situated on a small elevated hillock and it seemed to float in the haze when observed from a distance. The town was the home of the more conservative elements in the late sixties civil war and was damaged during this civil war. Since then it has been abandoned and is now occupied by one or two families.

Farming in this area has expanded considerably. The government is intensifying investment in the Marib region not only to increase food production but also to win back favour with the predominantly conservatively orientated inhabitants of the Marib region. Water supply for farming is from drilled wells rather then from the irrigation system of the dam. Aquifer studies show considerable reserves though present rate of pumping means more water is withdrawn then replenished.

The dam reservoir filled in its first year causing a large lake to form behind; the lake however is not deep. The large surface area of water means evaporation loss is huge; 8 mm/day adding up to a total of 35m m^3 per year based on measurements made from 1986 to 1990.

Some concern has been expressed by local medical authorities that the Bilharzia parasite may find its way into the waters. (This parasite is endemic in African rivers especially the Nile. Snails and people assure its life cycle.)

Early studies of the dam design and development was carried out under the supervision of Electrowatt Engineering, Zurich. They had predicted much higher inflows. Their estimates were based on sparse data (almost non-existent for the Adhanah Wadi catchment area, so that most of their estimates are extrapolations from slightly more numerous data from the escarpment extending north into Saudi Arabia.) The dam function as a flood control structure could be considered, on the basis of more recent data, to be built on the safe side.

Ideally the Marib Dam should have followed, rather than preceded, a water resources study. Owing to social-political pressures the more logical approach usually is not possible. Furthermore, socially the concept of a total collective water management system (catchment runoff control, flood storage reservoir(s), aquifer infiltration and exploitation, distribution networks and conservation practices) which should ideally serve a community most equitably still has to find acceptance amongst very independent Yemenis. The Marib farmers have maintained their independence by drilling their own wells to supply irrigation water. The number of wells increased considerably since 1980.

The Adhanah catchment has a total surface area of 11500 km^2 and the outwash/infiltration Marib area along the wadi extends up to 1000 km^2. The area under cultivation is 10000 hectares spread over an area of about 20 by 25 km (500 km^2).

Siltation found to be less then predicted as this is probably because inflows are much lower in the last five years (yearly average of 104 million m^3 instead of the design forecast of 200 million m^3). Silt thickness were determined by penetrating echo sounder profiling carried out from an inflatable raft motor boat. (Boating is normally not allowed by the militia, hence it was a special treat to go boating in an area traditionally remote from any surface water).

TNO-IAG made aquifer studies by electro-magnetic, resistivity and from reflection seismic surveys (the latter obtained from hydrocarbon exploration). The study also included wireline logging of existing wells and exploratory/trial boreholes. Future studies will investigate possibilities of infiltrating water into the aquifers to ensure replenishment and reduce present evaporation imbalance.

To date the water resources study has achieved its original aim to assess the amount of fresh water there is in terms of run-off and aquifer storage. More incidental: the study has increased the awareness of engineers involved in such studies with regard to the implications of local and national social traditions and socio-political aspects may have on a water management project as they can be quite different to what engineers take for granted in western Europe .

The slides were photographically of high quality with good pictures taken of local market in Sa'na to indicate male dominance in purchasing (women stay at home). Dufour had to select two trays (total 125 slides) from a larger collection. Hence, in view of the time allotted, comprise dictated that further slides of archaeological interest could not be shown.

P.M.M. 11/6/91

Photo 1: Wadi Ardhanah levelling at run-off measuring station

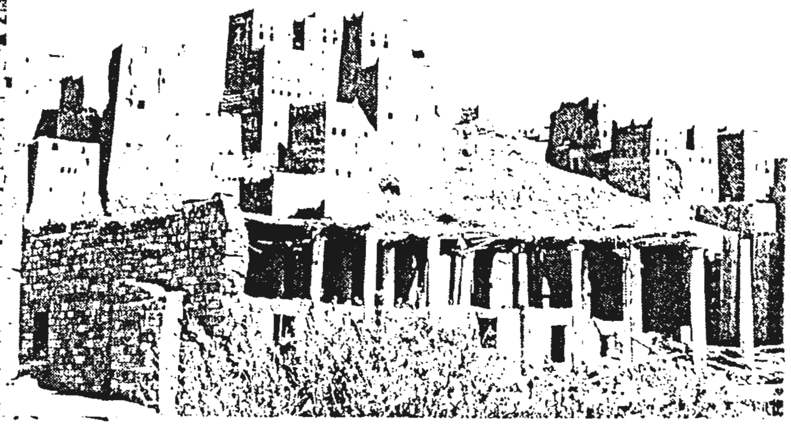


Photo 4: Marib ghost town

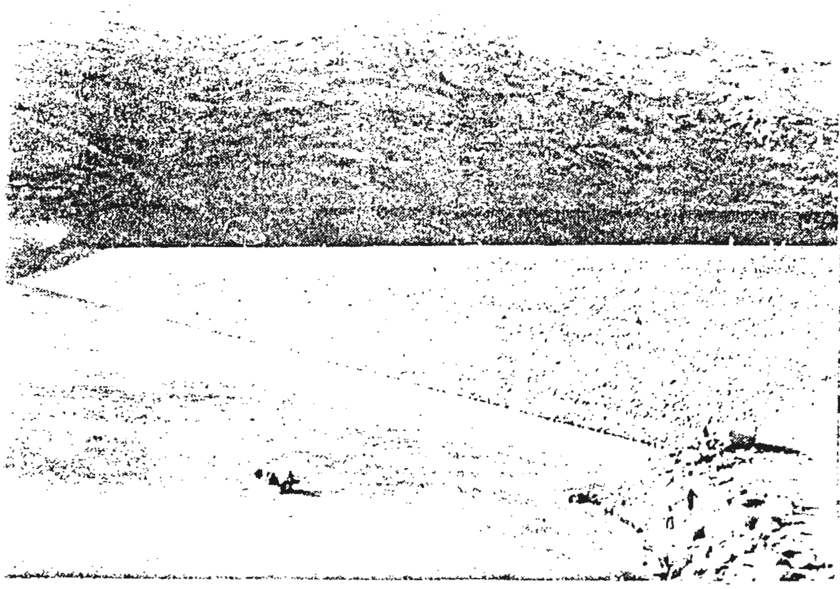


Photo 2: Marib Reservoir and Dam

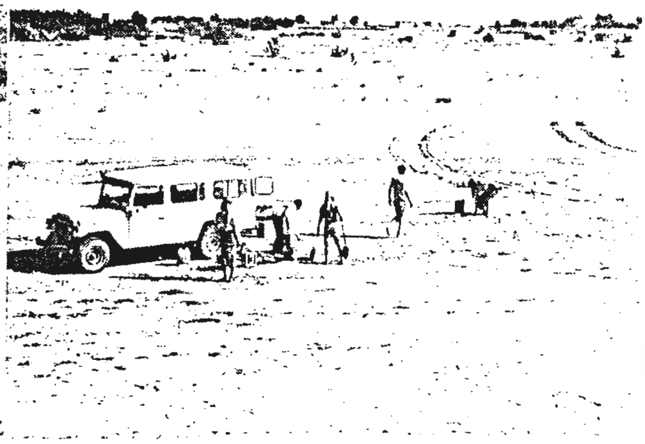


Photo 5: Geo-electric survey in Marib region

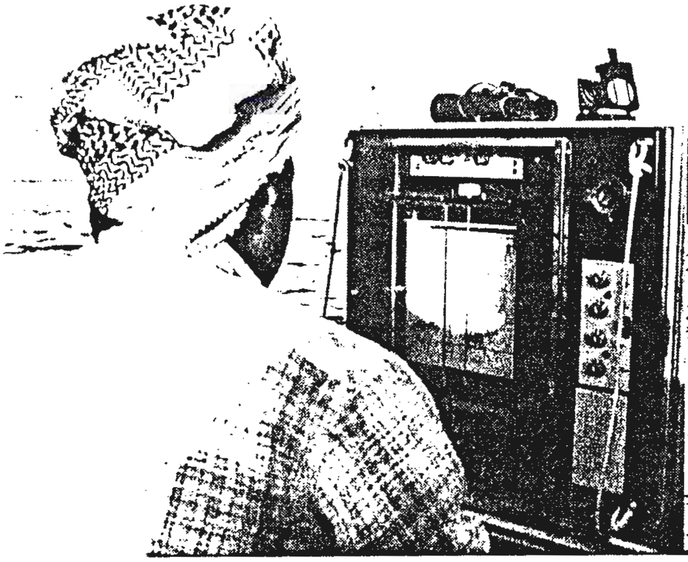


Photo 3: Sub-bottom profiling Marib Reservoir

Photo 6: Exploratory drilling in Marib region

From the final bulletin on The Engineering Group of the Geological Society of London *Study Tour to Europe:*

EUROPEAN ENGINEERING GEOLOGY '91

The Engineering Group of
The Geological Society of London

EEG 91
EUROPEAN ENGINEERING GEOLOGY

8 - 14 SEPTEMBER 1991

FINAL BULLETIN AND BOOKING FORM

Symposium

The role of the Engineering Geologist in Europe

Engineering Geology Fair

Study Tour

Engineering Geology practice in North West Europe

EEG '91 does not stand for "Europese Economische Gemeenschap 1991" as most Dutch speaking nationals would interpret but "European Engineering Geology 1991". Each year the Engineering Group of the Geological Society holds a "Regional Field Meeting" in September. The Regional Field Meetings consisted of a conference on a particular theme, the last in 1990, was "Engineering Geology of Weak Rocks" held at Leeds University. This year the Engineering Group are breaking with tradition after 20 years and coming to Europe. They would like to meet as many people as possible involved with engineering geology in Europe. Such meetings are possible by joining the group on the pre-symposium excursion and visits through the Netherlands, Belgium, Germany and France starting in Delft early Monday morning, 9th September, 1991 and ending Thursday evening 12th September, 1991. One can also meet ones European counterparts by attending the symposium on Friday 13th September, 1991 and participating or attending the trade exhibition on the same day in Brussels. Friday the 13th is also the day the Herbert Lapworth Club (students and graduates from Imperial College Engineering Geology) and more recently DIG (students and graduates from Delft Engineering Geology) have their social get-together. Hence old students and students from these two institutions are almost obliged to meet; a unique occasion and on neutral ground instead of at "The Admiral Codrington" or at "Het Noorden". We will ensure our Belgian counterparts choose a suitable venue. The text below has been taken from the Bulletin for those who have misplaced, what in the course of time, will become a document of antiquarian value.

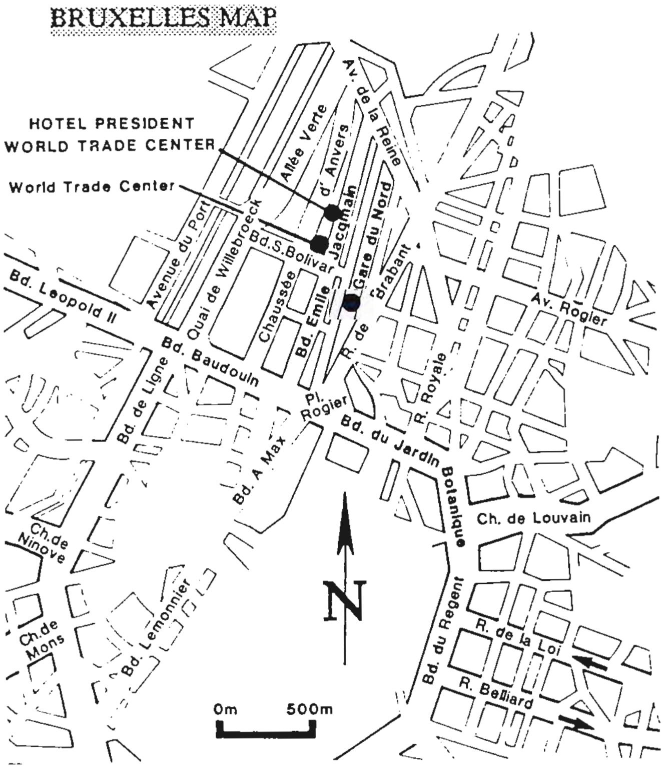
INTRODUCTION

1992 brings the single European market; is the geotechnical community ready for the changes and potential opportunities that this will bring? In order to survive against increased competition at home and to compete on equal terms in other countries the engineering geologist and geotechnical engineer must possess not only a knowledge of European geology but must also understand the differences in technical, professional and commercial practice across Europe.

The engineering Group of the Geological Society of London is organising a Symposium Engineering Geology Fair and Study Tour under the title **European Engineering Geology '91.** EEG'91 will provide an opportunity for engineering geologists and geotechnical engineers to meet and consider the similarities and differences of the geotechnical problems, solutions and practices in Belgium, France, Germany, The Netherlands and the United Kingdom. EEG'91 will be held from Sunday 8th to Saturday 14th September 1991. Delegates may attend for either the whole week, or for the one day Symposium and Engineering Geology Fair to be held in Bruxelles on Friday 13th September.

This is the Final Bulletin and includes a booking form which must be returned by 30th June 1991. The number of places available is strictly limited. There has been a very high response to previous bulletins and early booking is recommended to ensure a reservation.

BRUXELLES MAP



ENGINEERING GEOLOGY FAIR

The Engineering Geology Fair will enable contractors, consultants, equipment manufacturers, publishers, academic and professional institutions and national bodies in the fields of engineering geology and geotechnics to exhibit their products and services to a European audience. Delegates will have the opportunity to make contact with key European companies and institutions and to meet potential competitors and possible future business partners. Held in conjunction with the Symposium, the Fair will be widely advertised to the profession, to client organisations, European funding and administrative agencies, and to academic institutions as well as the technical and professional media. Transport of UK exhibits will be provided from a central collection point and exhibitors may travel with the Study Tour or make their own arrangements.

The Fair will be held on Friday 13th September from 0900 to 1700 hrs at the Hôtel Président World Trade Center, Bruxelles. Entrance to the Fair is free, but will be restricted to delegates who have completed and returned the attached booking form by **30th June 1991.**
Organisations wishing to exhibit at the Fair should return their booking form by **30th June** for further information. Space is limited and will be allocated on a 'first come' basis.

BRUXELLES VENUE

The Symposium and Engineering Geology Fair will be held at the Hôtel Président World Trade Center, Boulevard Emile Jacqmain, 180, 1210 Bruxelles. The hotel is a large white building adjacent to the World Trade Center with ample car parking.

By rail/metro: Train/metro to Gare du Nord, Bruxelles. 5 minutes walk following signs to World Trade Center.

By road from the west: From the Bruxelles ring road take junction 21 onto Avenue Charles Quint. Go around the Basilique du Sacre-Coeur and straight on to Boulevard Leopold II. Take the underpass onto Boulevard Baudouin and left into Boulevard Emile Jacqmain. The hotel is on the left after 1 km.

By road from other directions: Take the inner ring road in central Bruxelles until you reach the northern part. From the west this is called Boulevard Baudouin, and Boulevard Emile Jacqmain is a turning to the left. From the east the northern ring road is called Boulevard du Jardin Botanique, and Boulevard Emile Jacqmain is a turning to the right. The hotel is on the left after 1 km.

By air: Take a taxi to the World Trade Center from Bruxelles International Airport.

SYMPOSIUM

The role of the Engineering Geologist in Europe

The one day Symposium will be held on Friday 13th September from 0900 to 1700 hrs at the Hôtel Président World Trade Center, Bruxelles. Entrance to the symposium is free, but will be restricted to delegates who have completed and returned the attached booking form by **30th june 1991**.

The theme of "The role of the Engineering Geologist in Europe" will be addressed by four invited speakers:

Dr.L.Halleux (Université de Liège, Belgium)
Prof.E.Krauter (Geologisches Landesamt, Germany)
P.M.Maurenbrecher (Delft Technical University, The Netherlands)
Dr.L.Primel (Laboratoire Central des Ponts et Chaussées, France).

Each speaker will provide a review that includes a description of the main geological features of their country, particular geotechnical problems that arise from these features and how they are investigated. Basic sources of geotechnical, geological, hydrogeological and environmental information will be reviewed. Professional and commercial aspects will then be addressed so as to illustrate the role of the practising engineering geologist inside and outside the civil engineering industry; the necessary qualifications required in order to practise, and the relevant professional and technical organisations representing the engineering geologist and geotechnical engineer. The speakers will also touch on the subject of contracts and how they are structured and awarded and the role of the national bodies and academic institutions. All presentations will be in English.

The delegates will be able to attend the Engineering Geology Fair running concurrently in the same venue. Lunch is provided only for those delegates attending the symposium dinner in the evening, at which the guest speaker will be Dr. G.Adams, Member of the European Parliament for Northumbria and Vice Chairman of the European Parliament's Energy, Research and Technology Committee. He will address delegates on the value of having Parliamentary contacts, the issue of having an office in Bruxelles, whether a European partner is necessary and the nature of contracts within Community law. The dinner will be preceded by an informal symposium reception.

STUDY TOUR

Engineering Geology practice in North West Europe

The Study Tour will visit active construction sites, geotechnical laboratories and national geological surveys in Belgium, France, Germany and The Netherlands. At each location there will be a description and inspection of the specific technical aspects of the contract or organisation, followed by a discussion of the commercial aspects and more general issues of geotechnical practice within that country.Numbers are limited; delegates will be split into groups visiting different sites such that each group visits at least one surface site, an underground site and a laboratory or survey, as well as attending the Symposium and Fair in Bruxelles. Accommodation will be in hotels in Liège and Bruxelles. Delegates will travel by coach departing from London on Sunday 8th September, crossing the Channel by overnight ferry to Hoek van Holland and picking up further delegates at Delft in The Netherlands on Monday 9th September. Delegates will return from Bruxelles on Saturday 14th September via Calais.

The Study Tour visits will include:

In the Netherlands:
an inspection of the Delft Geotechnical Laboratories, a visit to the Geological Survey at Haarlem, an introduction by hydrogeological investigations at Nieuwegein and East Brabant, a study of shallow mining and mine stability in the Maastricht area, and active construction sites where environmental studies, earthworks and foundation installation are being undertaken.

In Germany:
an excursion to the remarkable brown coal open-cast sites in the Rhine graben west of Köln and featuring a study of their design (the graben is still seismic), excavation, control of groundwater and environmental programmes including those for ash disposal from nearby power stations and reinstatement of sites; a visit to the Geological Survey at Krefeld and engineering geology at Aachen University.

In Belgium:
a study of the engineering geology of the Strepy-Thieu ship lift and Lanaye locks, a visit to the Geological Survey at Bruxelles, the Coo pump storage scheme and slope failures in the Ardennes, the Eau-Rouge viaduct and deep foundation construction in Bruxelles.

In France: travelling to France via the large aggregate quarries at Tournai; thence to the Geological Survey at Lille (the regional office with major Channel Tunnel involvement) and a study of engineering and geological work associated with sections of the TGV under construction, also an opportunity to see the infrastructure works of the Regional Authorities in the area of Lille.

STUDY TOUR MAP

EEG'91 PUBLICATIONS

Each fee paying delegate will receive the following publications:
Directory: a directory of some 1300 major non-commercial geotechnical contacts in Belgium, France, Germany, The Netherlands and the United Kingdom.

Country reviews: a written account of the reviews presented by the four symposium speakers on the role of the engineering geologist in each of the countries considered, together with a similar review for the United Kingdom by Mr.D.Holt (a former Chairman of the Engineering Group of the Geological Society).

Technical and Commercial Documentation: examples of the technical and professional aspects of working in each of the countries as illustrated by guides to the Study Tour localities. A list of delegate names and addresses and a directory of organisations exhibiting at the Fair.

ACCOMPANYING PERSONS PROGRAMME

A programme of guided tours and free time shopping or independent sightseeing has been organised for accompanying persons.

Monday 9th: a tour of Delft's famous Royal Porcelain factory, renown for its hand painted ware, followed by a train journey to Liège and tour of the city and its Roman roots.

Tuesday 10th: travel by train to the ancient spa town of Aachen, with its Imperial Chapel of Charlemagne in the Cathedral; visit the Couven furnishings Museum, and explore the city; return to Liège by train.

Wednesday 11th: a trip by coach to three countries in the Euroregio region, centred on Aachen, with the scenery varying from the lowland meadows of The netherlands to the rugged hills of the Ardennes and then across the Eifel to Raeren and Cologne, famous for its pottery and wicker works.

Thurdsday 12th: travel by train to Brugge, founded in the 9th century and built in typical Flemish style; there will be time to visit the old buildings including the Waterhuis and the Gruuthusemuseum.

Friday 13th: the day will be spent sightseeing in Bruxelles (this being the day of the symposium) and it is hoped to include a visit to the European Parliament.

FURTHER INFORMATION

For further information and bookings contact:

Mr. D.R. Norbury
EEG '91 Organising Committee Secretary,
Soil Mechanics Associates,
Glossop house, Hogwood Lane,
Finchampstead, Wokingham,
Berkshire RG11 4QW, United Kingdom.
Tel. 09-44.734.328888; Fax. 09-44.734.328383
Telex: 847253 SMERCN G

BOOKINGS

Each delegate should complete the attached booking form, or a photocopy, and return it to the organising Committee Secretary, Mr. D.R. Norbury, at the address given, (preferably by 30th June, 1991. Numbers are limited and will be allocated on a "first come" basis. *(There are still a few places left; when the Nieuwsbrief went to press).*
In Bruxelles delegates will have to share bedrooms and many will also have to share rooms in Liège.
Please tick the appropriate boxes on the booking form.

1) FULL ATTENDANCE

Study tour, symposium and fair, (including all coach travel, bed, breakfast and lunch each day), symposium reception, symposium dinner and publications.

a) Joining at London. Sunday 8th to Saturday 14th September. Including sleeper seats in overnight ferry> **£400-00**

b) Joining at Delft. Monday 9th to Saturday 14th September. **£365-00**

2) ACCOMPANYING PERSONS

Sightseeing and shopping tours (including all travel, bed and breakfast each day), symposium reception and symposium dinner.

a) Joining at London. Sunday 8th to Saturday 14th September. Including sleeper seats on overnight ferry. **£335-00**

b) Joining at Delft, Monday 9th to Saturday 14th september. **£300-00**

3) EXTRAS

a) Extra for shared cabin on overnight ferry. Per person. **£25-00**
b) Extra for single room for two nights in Liège hotel. (Not available in Bruxelles). Per person. **£40-00**

4) FRIDAY 13TH SEPTEMBER ONLY

a) Symposium, fair, lunch, symposium reception, symposium dinner and publications. **£105-00**

b) Symposium and fair only (no meals and no publications) **free**

5) LATE BOOKINGS

Bookings made after 30th June but before 31st July. (no bookings can be accepted after 31st July) **Plus 10%**

6) EXHIBIT AT FAIR Tick box for further information. (Exhibitors requiring meals or accommodation must register as delegate)

7) ADVERTISEMENT IN EEG '91 DIRECTORY

Tick box for further information.

8) PAYMENT

Payment in full in £ sterling should be enclosed with the booking.

a) Tick box if paying by cheque. Cheques should be drawn on a British bank, without deduction of banking charges and made payable to "**EEG '91**".

Payments from outside the United Kingdom can be made by credit card in £. All details must be on as the card.

b) Tick box if paying by Access / Eurocard / Mastercard.

c) Tick box if paying by Visa.

d) Tick box if you require a receipt.

9) CANCELLATIONS

A charge is made for cancellations as a percentage of the booking fee.

a) Cancellations received before 30th June 10%
b) Cancellations received from 30th June to 31st July 50%
c) Cancellations received after 31st July 100%

Please give on the booking form the name of any accompanying person, the name of any other delegate you prefer to share accommodation with and any special dietary requirements you have.

NOTICE

All arrangements made by The Engineering Geological Group of the Geological Society for any person to visit any works or any other place, including arrangements for transportation in connection with such visits, are made by the Society as agent for such person. Such arrangements are made on condition that the Society shall not be liable for any injury, loss, damage, theft or inconvenience to, or suffered by, such person or his property in consequence of, or in connection with, such a visit. The Society reserves the right to cancel the itinerary or any part thereof, for any reason, but should this occur, the fee, or appropriate portion thereof, will be refunded. The Society cannot be held responsible in the event of a change of speaker or programme in any part of the itinerary.

BOOKING FORM

	✓		✓		✓
1a) £400		3a) £25		6) Exhibit/Ausstellen/Présentation	
1b) £365		3b) £40		7) Advertisement/Werbung/Publicité	
2a) £335		4a) £105		8a) Cheque/Check/Chèque	
2b) £300		4b) £0		8b) Access/Eurocard/Mastercard	
		5)+10%		8c) Visa	
TOTAL/ GESAMTSUMME	£			8d) Receipt/Quittung/Reçu	

Please print / Bitte in Blockschrift ausfüllen / Veuillez compléter

Title / Titel / Titre ______ Name / Nom ______________________

Organisation ________________________________

Address / Anschrift / Adresse ____________________________

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Country / Land / Pays ________________________________

Tel / Tél ________________ Fax / Télécopie ________________

Accompanying person / Begleitperson / Personne accompagnatrice ______________________

Share with / Zimmer teilen mit / Chambre partagée avec ______________________

Special diet / Sonderdiät / Régime spécial ____________________________

CREDIT CARD / KREDITKARTE / CARTE DE CREDIT

Number / Nummer / Numéro Expiry date / gültig bis / Date d'expiration ______________

|__|__|__|__| |__|__|__|__| |__|__|__|__| |__|__|__|__|

Cardholders name / Name / Nom du titulaire ______________________

Cardholders address / Anschrift / Adresse ____________________________

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Signature / Unterschrift ____________________ Date / Datum ________

AMIGOE WOENSDAG 5 JUNI 1991

Proefboringen in opdracht Kodela

Geoloog Degen: 'Bodem is behoorlijk vervuild'

WILLEMSTAD - Naast het havenkantoor staat sinds een paar dagen een vier meter hoog boortorentje, verdekt, opgesteld. Daarmee worden in opdracht van Kodela proefboringen uitgevoerd. Onderzocht wordt wat de bodemconstitutie is, daar de Kodela van plan is een pijp dan wel een tunneltje onder de Sint Annabaai aan te leggen. De transportleiding zou directe verbinding mogelijk maken tussen Seru Pratu naar Kingjan.

Behalve water zou door de nieuwe pijp ook plaats gemaakt kunnen worden voor hoogspannings- en telefoondraden. Er zou zelfs olie doorheen geleid kunnen worden. Het zal van dit voorbereidende onderzoek mede afhangen of zo'n multifunctioneel gebruik van de leiding mogelijk is. De huidige transportleidingen lopen nu via een omweg langs Stenen Koraal. Een nieuwe leiding onder de Sint Annabaai zou efficiënter transport betekenen.

Met het boortorentje worden proefboringen tot ongeveer 50 meter diepte onder NMP uitgevoerd. De maximale diepte waarop geboord kan worden is overigens 700 meter. "We gaan bekijken hoe de grond hier is opgebouwd", verklaart geoloog Degen. Hij is druk bezig met het verpakken van zakjes geelachtig slib. Dat is van belang om vast te kunnen stellen wat de ideale diepte is om een eventuele transportleiding aan te leggen. "De grond bestaat hier voornamelijk uit kalksteen, wat hier klip genoemd wordt, en diabaas. Diabaas is keihard. Het is duidelijk dat het veel duurder uitkomt om door dit materiaal een leiding aan te leggen dan door het zachtere kalksteen". Volgens hem is het ongeveer zeven keer zo duur om door diabaas te moeten boren. Het water in de Annabaai is gemiddeld 23 meter diep. Op de bodem ligt een laag slib van ongeveer 8 meter.

MONSTERS

Wordt er ook gekeken naar de vervuilingsgraad van het slib dat naar boven gehaald wordt? Geoloog Degen: "Dat is niet onze opdracht maar dat zouden we natuurlijk wel kunnen. Ik heb wel genoeg monsters gezien om te kunnen zeggen dat hier behoorlijk vervuild is. Het is niet voor niets dat de Shell het toendertijd voor een symbolisch bedrag aan de overheid van Curaçao heeft verkocht". Een geluk bij een ongeluk noemt hij het feit dat er een dikke laag slib op de bodem ligt die de gevaarlijke stoffen vasthoudt. "Daarom blijft het op zijn plaats liggen en kan het niet doorlekken. Omdat er geen noemenswaardige stroming is zal het slib ook niet in de zee verdwijnen. Gelukkig maar want dat zou veel schade kunnen toebrengen aan de onderwaternatuur voor de kust." Volgens hem zou het redelijk 'eenvoudig' zijn om de vervuilde sliblaag te verwijderen. Onlangs heeft hij nog bodemmetingen gedaan in de haven van Rotterdam op de twee meest vervuilde plekken van Nederland. Dat slib zal worden opgeruimd. "En dat is een geldverslindende operatie".

PLATFORM

De geoloog werkt in opdracht van Geo-Consult.

Dit bedrijf is ook actief op Aruba en Bonaire. Op Aruba wordt bodemonderzoek verricht in opdracht van de Coastal raffinaderij. Het laaste bodemonderzoek dat het bedrijf verrichtte was in opdracht van de Isla raffinaderij om te bekijken in hoeverre de dijken van het asfaltmeer doorlekken. Op Bonaire gaat Geo-Consult het voorbereidend grondonderzoek doen voor een industrieel verkavelingsplan.

Op 13 juni aanstaande zal ook een boring in de Annabaai zelf gedaan worden. Daarvoor wordt een platform op het water aangebracht dat met vier kabels aan de oevers bevestigd wordt. Daarom zal die dag geen scheepvaartverkeer op de Annabaai mogelijk zijn. Het hele boorprojekt zal in totaal zo'n vijf weken in beslag nemen.

Channel Tunnels, Adits, Shafts and Pipelines: a Weekend Guide

by P.M. Maurenbrecher

The Engineering Group of the Geological Society, London organizes two field visits each year; The Spring Field Visit and the Autumn Field Visit. The Autumn Field Visit in 1988 was an extended weekend visit to the Folkstone area in Kent, to visit geological features of the Channel Tunnel works. The report below was for a presentation given at this year's NGMSO - Nederlandse Geologische en Mijnbouwkunde Studenten Organisatie symposium under the theme "The Channel Tunnel Project Tunnel: Interactions between geology and mining" hosted and organised by the Mijnbouwkundige Vereeniging at the Aula, Delft.

Tunnelling through a paper mountain?

If papers and articles were collected on the Channel Tunnel it would now fill several volumes. An extreme example is a paper by Professor Hernando Pinzon-Isaza of the National University of Colombia in Bogota with the title "Eurotunnel-a Tunnel beneath the English Channel" and published in the proceedings of the 3rd International Conference of Underground Space and Earth Sheltered Buildings in Shanghai (the fifth conference is at Delft: ICUSESS '92). Hence, to write yet another technical paper on the Channel Tunnel would be misplaced. Less often seen in the literature are reports of visits to the tunnel. A visit furthermore is unique to the person experiencing the visit. A paper on a visit may, hopefully, still give some semblance of originality in the context of the bulk of publications now streaming from far-away places such as Bogota.

Shakespearean tunnels... more literature?

The visit took place in November 1988 as part of the autumn field visit of the Engineering Group of the Geological Society. This visit was spread over three days. The first day the party met at the exhibition centre and then went by bus to Shakespeare Cliff. Going through the works entrance gate was like going through customs as TML/ Euro-Tunnel is very much concerned with security. TML (Trans-Manche Link)/ Euro Tunnel are the consortium comprising the client and construction company for the tunnel.

A short introduction was given by Bill Rankin, one of the senior tunnel engineers at TML. In addition hand-outs on the geology of Shakespeare Cliff were given at the site office introduction. This was followed by our first tunnel experience, the tunnel through the Middle Cretaceous Chalk connecting the site office complex with the construction and materials stacking area infill platform at the foot of the cliff. The morning was spent looking at the geology of the cliff face and at the construction of the infill lagoons for the tunnel spoil. In this way the platform is being extended in size and possibly giving extra protection to the cliffs vulnerable to landslip along the coast. Special trip wires suspended at the base of the slope would be activated if a landslip occurred to act as an early warning for train traffic which runs between the cliff and the platform. A lunch of sandwiches followed on the Shakespeare Cliff slope. It was only after lunch that the party was informed that they could visit the tunnel works underneath the channel.

Lady guides underground and under the Channel

The party was led by a female engineering geologist, Sarah Chapman (no mining taboos about not letting the fairer sex underground; she worked under Helen Natrass senior geotechnical engineer!). A further ramp tunnel (excavated by road-header and lined by the New Austrian Tunnelling Method), led down to the main junction concourse chamber underneath Shakespeare Cliff. Large tunnels and pilot tunnels radiated from this junction towards France and towards Folkstone. The large tunnels were still being prepared by road header excavators for the tunnelling machines. The party walked for about 1 to 2 km down the pilot tunnel underneath the channel up to the junction where the previous channel tunnel effort had stopped and the new, present, effort had started. At two points the pilot tunnel is cross-linked to larger chambers with exposed lower chalk marl lying in the path of the west tunnel.

Photographing was not allowed. Hence as only evidence of having been "underneath" is a piece of grey Lower Chalk Marl which is my contribution towards excavating the tunnel. These pieces, which are in fact calcareous siltstone, could be pulled off the tunnel wall along clean joint planes.

Lady novelists on Chief Executioner's list
(from "The Mikado" opera by Gilbert & Sullivan)

Of interest is how a channel visit of this sort attracts fringe members; a technical journalist, Bronwen Jones who wrote part of and edited the book, "The Tunnel; The Channel and Beyond", which is not always favourably disposed towards TML. TML were not exactly well disposed towards her either, despite her attractive looks.

Three Dutch petroleum geologists from Shell also tagged along for the visit. The fringe came for the tunnel only and made their excuses for the remainder more interesting two days... candidates for The Mikado's Chief Executioner's list?

Dredgers, landfall, landfill & landslips

The next day we were shown the large construction site for the Cheriton terminal, Folkstone. Discreet photographing was possible. The hike that day started at the exhibition center crossing over the main motorway to the site using the bridge that carries the main hydraulic fill pipeline. The pipeline transports the marine sands being dredged at the Goodwin sand banks by Boskalis Westminster's dredger "Cornelia" and pumped ashore by the "Aquarius" off Sandgate, Folkstone.

The engineering geological problems were more interesting than at Shakespeare Cliff, especially because the tunnel portals through the first hill "Castle Hill" and the following portal into "Sugarloaf Hill" are subject to slope instability which exists along the whole chalk escarpment at Cheriton, Folkstone. The instability dates from glacial times and is still active today. An old colleague, Peter Avgherinos, little aged since I saw him last 12 years ago was one of our guides.

The guides all work for Mott Haye and Anderson (now Mott Mac-Donald) who provide the staff for the engineering design consortium of Euro-Tunnel-Trans Manche Link. The tunnel could not skirt Castle Hill because the present motorway is to be extended towards Dover (Dover's compensation for the economic loss it will probably experience once the tunnel comes into operation). The motorway, too, will enter a tunnel in between the tunnel portals of Castle and Sugarloaf hill. The visit amounted to a long walk through the Cheriton site and along the escarpment.

BBC's *Fawlty Towers & Tech Talk* become reality

The nights were spent at the Carlton Hotel, a typical English seaside hotel along the Leas, Folkstone. One gravitated from a dining room, occupied by elderly couples, mostly resident in the hotel and whispering waitresses, not much younger then the couples, to the lounge bar for typical best bitters brewed with famous Kent hops. John Cleese was not on hand to liven things up though our next guide certainly cannot be regarded as passive. Rory Mortimer, who I had first heard on the programme "Tech Talk" from the BBC World Service and lecturer in Engineering Geology at Portsmouth Polytechnic joined us the last evening to act as guide for the last stage of the field visit on the Sunday.

This visit was along the famous Folkstone Warren cliff with its large concrete aprons and horizontal drainage adits into the cliff to try and stabilize the massive landslips. The whole chalk sequence rises from tide level to form the cliff. Underneath is Gault clay. The combination of an erosive sea and the more pervious chalk overlying the impervious Gault presents ideal conditions for slope instability.

Despite the stabilization measures, nearer the Shakespeare Cliff end of the Warren complex, large slip blocks revealed whole sections of brick-lined ventilation shafts infilled with foam plastic; "disused and infilled" said Rory, "didn't need the ventilation once they (British Rail) switched from steam to electricity. Infilled, because bits and pieces kept falling down." Now great chunks are lying on the shore. "Only a few meters cover now between existing railway tunnel and scarp".

More BBC... Whitaker's World

At the Folkstone end of the "Warren" a large mechanical contraption lay (then) half buried in the cliff face. This is the Whitaker Machine, a tunnel bore machine, used by the then consortium "Channel Tunnel Company" for a trial tunnel in the 1920s. Trying to extract the machine once the tunnelling project was cancelled for the "so-many-times" a slip occurred at the portal and the machine remained semi-buried ever since... until recently it was finally extracted by weekend enthusiasts and now can be viewed, restored, at the exhibition centre.

What the locals think about the tunnel

The weather was wet and windy that day; I stayed another night in Folkstone and heard the locals' scepticism on the tunnel. The "locals" none other then an aunt and uncle who live in Folkstone. The huge changes, that have been brought about on the landscape of Folkstone, and the increased traffic such a tunnel will inevitably generate, generates the scepticism. The Monday they drove me to Dover after a typical pub lunch to catch the hydrofoil to Oostende. It started snowing. I later learnt that I arrived at Oostende before they had returned back to Folkstone. The snow had brought the traffic to a standstill. Possibly a tunnel is not such a bad idea after all.

EPILOGUE:

The Channel Tunnel symposium was not the first to be held in Delft. The student's chapter for Tunnelling held a symposium back in 1985 prior to construction. Hence a recurrence of the theme especially now that the pilot/ service tunnel has allowed the French and English tunnel workers to shake hands are dreams fulfilled since the French and British ambassadors in the Netherlands symbolically enacted the occasion in 1985 in the Aula of Delft University of Technology. Although it is a Franco-British effort, some credit can go towards the Dutch besides showing interest in the project; two old mining students from Mijnbouwkunde work on the tunnel, ir. R.A. Hulscher (ventilation engineer) and ir. A. van Kersen (excavations supervisor on a section of one of the tunnels).

The symposium addressed a variety of interesting aspects of the tunnel. The French (Ir. M.C. Huijbregts of the Bureau de Réchèrches Geologiques et Minières) produced maps of the tunnel profile based on geo-statistics showing the range of depth one can expect a litholigical boundary to be found. Another consideration (from A.M.B. McCullough of Transmanche Link; Translink Joint Venture) is the problem of ventilating up to 30 km of tunnels with no shafts along the route to shorten the ventilation distance. A further aspect looked at the "robotics" used in in the tunnel bore machines. The machines have a complete train of support systems following the actual drilling machine, such as the shield to offer protection of the newly excavated tunnel walls. Behind the shield hydraulic arms place concrete liner blocks into place. The concrete blocks are held by vacuum grips pads developed and manufactured by the NAGRON Aerolifts of Woudenberg The Netherlands. Mr. H.A.C.C. Crone of NAGRON gave numerous examples of such grips in action using a video recording.

7th International Congress on Rock Mechanics, Aachen 16-20.9.91

Bulletin No. 2 has just been received by most members of the International Society of Rock Mechanics. This year members in the Netherlands have to only travel a short distance to attend, what appears to be, a very promising congress. The congress is hosted by the German Society for Soil Mechanics and Foundation Engineering. It is a good opportunity to meet our immediate neighbours at Aachen University of Technology the RWTH. At DM 450 for the week the cost for the conference is extremely reasonable and well worth the investment. A listing is given below of some of the subjects that will be discussed at the conference.

The Conference will start on Monday 16.9.91 and the themes covered up to Wednesday 18.9.91 are:

1. Rock Mechanics and environmental protection:

*Foundation of depositories
*Contaminant migration in fissured rock
*Underground storage of waste and raw materials
*Final disposal of nuclear waste

2. Rock mechanics based on reliable description of geological conditions

*Modelling stress-strain behaviour of rock masses
*Modelling the permeability of rock masses
*Exploration methods and testing techniques
*Computational methods in rock mechanics

3. Stability of rock slopes

*Case history of slides and remedial works
*Toppling failures
*Slope stability reliability analysis in weathered rock

4. Underground construction in rock

*Excavation by TBM Tunnel Bore Machine
*Blasting technology
*Caverns including civil defence shelters
*Tunnels shafts and adits!
(*Read article in this newsletter on Channel Tunnel*)

Besides the main sessions there are on the Thursday (19.9.91) Workshops for those who want to learn more about the subject of Rock Mechanics;

Workshop 1: Drilling of deep boreholes and their stability, the significance of modern drilling technique in civil engineering

Workshop 2: Stresses in the Earth's crust
*Stress measurements in deep boreholes
*Stress measurements from underground openings
*New methods and techniques

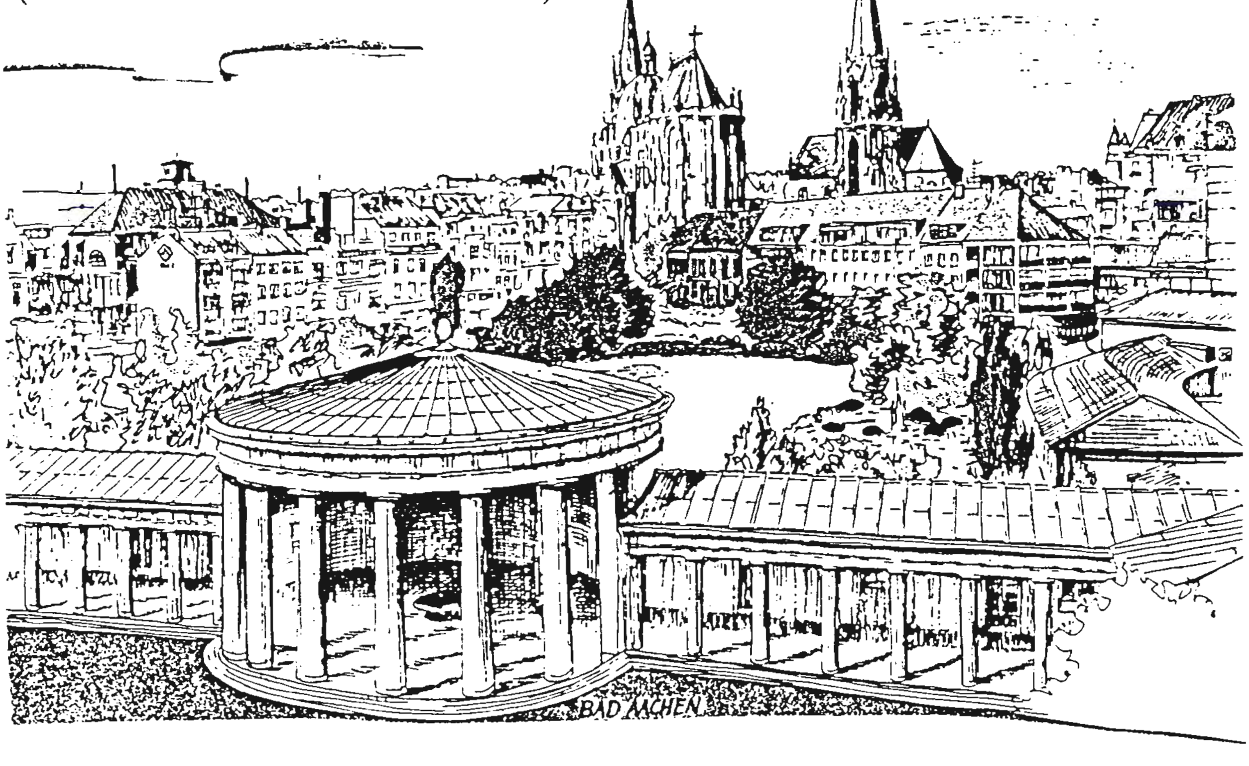
Workshop 3: Dam foundations in rock

Workshop 4: Construction in regions with recent tectonic movements (*Chaired by the Professor of Engineering Geology at RWTH, Kurt Schetelig*)
*Prediction of earthquakes
*Geological and dynamic modelling

Workshop 5: Rock Salt Mechanics
*Constitutive modelling
*Mining and Civil Engineering in rock salt

Workshop 6: Computer orientated methods

Excursions (one and two days) start on Friday 20.9.91 *Cologne, *Liège, *North Germany, *South Germany.



INTERNATIONALER KONGRESS ÜBER FELSMECHANIK
INTERNATIONAL CONGRESS ON ROCK MECHANICS
CONGRES INTERNATIONAL DE MÉCANIQUE DES ROCHES

16.–20. SEPTEMBER 1991 · AACHEN, GERMANY

Anmeldung
Registration form
Inscription

Name / Surname / Nom ____________________

Vorname / First name / Prénom ____________________

Beruf / Profession / Profession ____________________

Firma / Company / Organisation ____________________

Postanschrift / Mailing address / Adresse postale ____________________

Land / Country / Pays ____________________

Teilnahmegebühren / Congress Fees / Frais de Participation	Datum / Date Date		Anzahl der Personen / No. of Persons / Nombre de personnes	Gesamtbetrag / Total amount / Somme totale
IGFM Mitglied* /ISRM-member* / Membre de SIMR*	16–19	450,— DM	____	____
Nicht-Mitglied / Non-member / Non-membre	16–19	675,— DM	____	____
Begleitperson / Accompanying person / Personne accompagnant les experts	16–19	95,— DM	____	____
Rahmenprogramm / Social program / Programme d'événements				
Empfang des Beirats / Reception Advisory Board / Réception du comité consultatif	16	—	____	
Orgelkonzert / Organ concert / Récital d'orgue	17	—	____	
Kongreß-Dinner / Congress dinner /Dîner du congrès	18	80,— DM**	____	
Empfang des IGFM Präsidenten / Reception ISRM President / Réception du président de l'SIMR	19	—	____	
Programm für Begleitpersonen / Accompanying persons program / Programme pour les personnes accompagnant les experts				
Tour 1 (Stadtbesichtigung / City tour /Visite de la ville)	16	20,— DM	____	____
Tour 2 (Eifel)	17	50,— DM	____	____
Tour 3 (Niederrhein / Lower Rhine / bas-rhin)	18	50,— DM	____	____
Tour 4 (Köln / Cologne / Cologne)	19	60,— DM	____	____
Exkursionen im Anschluß an den Kongreß / Post Congress excursions / Excursions après le congrès				
Exkursion 1 (STUVA)	20	60,— DM	____	____
Exkursion 2 (Lüttich / Liège)	20	60,— DM	____	____
Exkursion 3 (Norddeutschland / N-Germany / Allemagne du Nord)	20–21	300,— DM	____	____
Exkursion 4 (Süddeutschland / S-Germany / Allemagne du Sud)	20–21	300,— DM	____	____

Workshops / Ateliers

Ich möchte an folgenden Workshops teilnehmen / I intend to participate in Workshops / Je voudrais prendre part aux ateliers suivants

W 1 ☐ W 2 ☐ W 3 ☐ W 4 ☐ W 5 ☐ W 6 ☐

Zahlung / Payment / Paiement

Der Betrag von ________ DM ist am ____________ (Datum) überwiesen worden an die DGEG, „IGFM-Kongreß", Konto-Nr. 4024230, Dresdner Bank, Essen, Bankleitzahl 360 800 80.

The amount of ________ DM has been transferred on ________ (date) to Deutsche Gesellschaft für Erd- und Grundbau e.V. (DGEG), „ISRM Congress", bank account no. 4024230, Dresdner Bank, Essen, bank reference no. 360 800 80.

La somme totale de ________ DM a été transférée le ____________ (date) à la Société Allemande des Travaux de Terassements et de Fondations S.E. (DGEG), „Congrès SIMR", Dresdner Bank, Essen, N° 4024230, code bancaire: 360 800 80.

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Unterschrift / Signature / Signature Datum / Date / Date

Bitte zurücksenden an: / Please return to: / Retournez s.v.p. à :

Deutsche Gesellschaft für Erd- und Grundbau e.V.
Hohenzollernstraße 52
D-4300 Essen 1
Germany

* Wenn Sie Mitglied der ISRM werden möchten, erkundigen Sie sich bitte bei Ihrer Nationalen IGFM Gruppe oder dem IGFM Generalsekretär
* If you want to become a member of the ISRM please ask your National Group of the ISRM or the ISRM Secretary General
* Si vous voulez devenir un membre de la SIMR, veuillez-vous demander votre Groupe National SIMR ou le secrétaire général de la SIMR

** Dinner-Teilnahmegebühr beinhaltet keine Getränke
Congress dinner fee does not include drinks
Frais du dîner du congrès ne comprennent pas des boissons

In 1990 vonden de volgende activiteiten plaats:
6 juni:
Symposium "Kustbescherming en Ingenieursgeologie" georganiseerd door het Dispuut Ingenieursgeologie in samenwerking met de Ingenieursgeologische Kring en de Mijnbouwkundige Vereniging, met als sprekers en onderwerpen:
Dr.S.Jelgersma (RGD): "Zeespiegelbewegingen in het Nederlandse kustgebied".
L.L.J.Korsmit (Zinkon BV): "Werken aan het Water".
Drs.M. Pool (RGD): "Volume berekening van het jonge duinzand en reconstructie van de Hollandse kust omstreeks 1200 A.D.".
Dr.R.E.Schüttenhelm (RGD): "Kustopbouw en kustontwikkeling".
R.E.Waterman (Adv.RWS/Lid Prov.Staten Zuid Holland): "Naar een integraal kustbeleid via bouwen met de natuur. Van zand tot land".
Het symposium werd in de aula van de TU-Delft gehouden en werd door ca. 80 belangstellenden bijgewoond.

6 tot 10 augustus:

Sixth International Congress IAEG

Dit vierjaarlijkse congres waarmee dit keer tevens het 25-jarig bestaan van het IAEG gevierd werd, is in Nederland gehouden. De proceedings van het congres telt 434 wetenschappelijke bijdragen verdeeld over de thema's:
-Engineering geology mapping and site investigation
-Remote sensing and geophysical techniques
-Hydro-engineering geology
-Surface engineering geology
-Underground engineering geology
-Engineering geology of land and marine hydraulic structures
-Construction materials.
Naast een beperkt aantal keynote lectures werden de bijdragen grotendeels door panel reporters samengevat. Bovendien werd een groot deel van de publikaties in poster sessions toegelicht. Tevens werden tijdens dit congres vier symposia over actuele onderwerpen gehouden:
-Computer use in engineering geology
-Environmental protection, polution and waste disposal
-Coastal protection and erosion, including the engineering and environmental consequences of rises in sealevel
-Engineering geology in the oil industry (georganiseerd in samenwerking met de Society for Underwater Technology)

Tijdens de symposia werden 42 presentaties gegeven.
Na afloop van het congres werden excursies georganiseerd naar het kanaaltunnelproject en naar een aantal locaties in Nederland.
Het congres werd in het RAI congresgebouw gehouden en werd bijgewoond door ca. 550 deelnemers uit 58 landen.
Ter gelegenheid van de council-meeting voorafgaand aan het congres, organiseerde het bestuur van de Ingeokring een ontvangst met een rondvaart door Amsterdam voor alle councilleden.

8 november:
Symposium Bodemdaling in Nederland, georganiseerd door de Faculteit Mijnbouwkunde en Petroleumwinning in samenwerking met Ingeokring en I.S.R.M.-sprekers en onderwerpen waren:
Prof.D.G.Price (TU-Delft): Algemeen overzicht van bodemdalingsverschijnselen.
Ir.J.J.E.Pöttgens (Staatstoezicht op de Mijnen): Bodembewegingen bij delfstofwinning in Nederland, van empirie tot fenomenologie.
Drs.F.Schokking (R.G.D.): Geologie en natuurlijke bodemdaling in Nederland.
Ir.G.Hannink (Ingenieursbureau Geotechniek en Milieu, Gemeentewerken Rotterdam): Bodemdaling door polderpeilverlagingen en de gevolgen voor bebouwing.
Ir.F.H.van Veen (Prov.Groningen): Waterstaatkundige gevolgen van de bodemdaling door aardgaswinning in de provincie Groningen.
Prof.Dr.Ir.F.B.J. Barends (Grondmechanica Delft): Grondmechanische modellering van bodemdaling.
Drs.J.Ph. van Hasselt (K.S.E.P.L.): Reservoir compactie en bodemdaling tengevolge van olie en gasproductie - een overzicht van theoretisch en experimenteel onderzoek.
Drs.D.Doornhof (N.A.M.): Bodemdaling in de praktijk - het Groningen gasveld.
Dr.Ir.F.J.J. Brouwer (TNO, Meetkundige Dienst RWS): Kwaliteit en resultaten van waterpassingen.
Ir.J.P.A.Roest (TU-Delft): Mogelijkheden van kleine zettingen bij winning van gas.
Dr.H.W. Haak (Seismologie, K.N.M.I.): Seismische registraties in Nederland tegen de

achtergrond van de aardbevingen van Assen, Hooghalen en Purmerend.
Ir.H.M.E.Verhoef en Ir. H.M. de Heus (L.G.R. TU-Delft): Kwaliteitsanalyse van waterpassing t.b.v. bodemdalingsonderzoek. Het symposium werd gehouden in de Aula van de TU in Delft en werd bijgewoond door 170 belangstellenden.

28 november:
Lezing getiteld: "The selection and intitial investigation of a British soft clay test bed site" door Dr.A.B.Hawkins van Dept. of Geology, University of Bristol. De lezing werd gehouden in het ITC in Delft en bijgewoond door ca. 30 belangstellenden.

29 november Jaarvergadering
Voorafgaande aan de jaarvergadering werden enkele lezingen gegeven in het Informatie Centrum Spoortunnel Rotterdam. De heer Kok van het Informatie Centrum gaf een overzicht van de tunnelbouw. Sprekers en onderwerpen waren verder:
Drs.Th.de Groot (RGD): "Geologische ontwikkeling van Rotterdam in de laatste 10.000 tot 15.000 jaar".
Ir.A.F.van Tol (Ing.Bureau voor Geotechniek en Milieu, Rotterdam): "Geotechnische aspecten van de bouw van de spoortunnel Rotterdam".
De bijeenkomst werd bijgewoond door 25 belangstellenden.

Op de jaarvergadering vond een bestuurswisseling plaats: de heer J.G.Bakker (penningmeester) trad af, terwijl de heer A.A.M.Venmans als bestuurslid toetrad. Het bestuur kreeg hiermee de volgende samenstelling:

Dr.N.Rengers - voorzitter
Dr.J.J.A.Hartevelt - secretaris
Ir.A.A.M. Venmans - penningmeester
P.M.Maurenbrecher MSC.CEng - Drs.F.Schokking
Ir.J.P.A.Roest - vertegenwoordiger I.S.R.M.
A.R.G.v.d.Wal - vertegenwoordiger DIG.

Het bestuur van de kring kwam gedurende 1990 zeven maal bijeen en was nauw betrokken bij de organisatie van het IAEG Congres 1990 in Amsterdam, dat van 6 tot 10 augustus werd gehouden.
Het ledental van de kring bleef gedurende 1990 ongeveer gelijk en is nu 198, hiervan zijn 72 leden eveneens lid van de IAEG en 19 tevens lid van de ISRM. Het aantal studentenleden daalde van 47 naar 36 leden.
De Ingeo-kring Nieuwsbrief is gedurende 1990 drie maal verschenen en wel in juni (twee maal) en in december.

FINANCIEEL JAARVERSLAG INGEOKRING 1990

INKOMSTEN

Herinneringsactie contributies 1988		
- Ingeokring gewone leden	NLG 390,--	
- " studentleden	NLG 90,--	
- IAEG	NLG 357,50	
- ISRM	NLG 97,50	
Herinneringsactie contributies 1989		
- Ingeokring gewone leden	NLG 480,--	
- " studentleden	NLG 110,--	
- IAEG	NLG 422,50	
- ISRM	NLG 97,50	
Contributies 1990		
- Ingeokring gewone leden	NLG 3.000,--	
- " studentleden	NLG 280,--	
- IAEG	NLG 1.560,--	
- ISRM	NLG 395,--	
Contributies 1991	NLG 85,--	
Subtotaal contributies	NLG 7.365,--	
Donaties	NLG 600,--	
Rente girorekening	NLG 23,52	
Negatief saldo girorekening	NLG 354,58	
UITGAVEN		
Nieuwsbrief		NLG 2.826,28
Lezingen		NLG 50,35
Representatie		NLG 65,--
Ontvangst IAEG Council Members		NLG 2.784,50
Bijdrage symposium "Bodemdaling"		NLG 1.500,--
Contributie IAEG 1989		NLG 1.116,97
Totaal	NLG 8.343,10	NLG 8.343,10

Opgesteld 2 juni 1991
door A.A.M. Venmans

Geverifiëerd

PROGRAMME

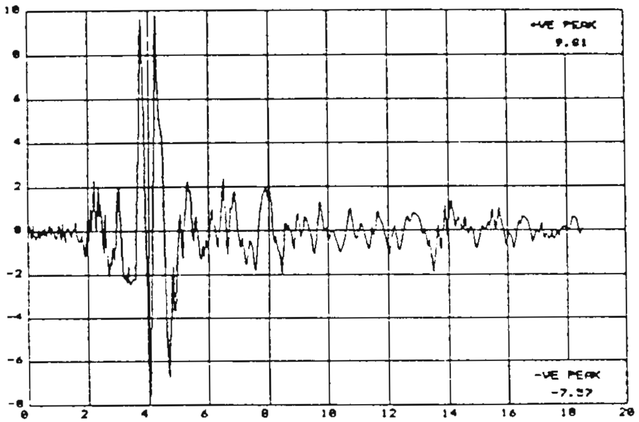
International Conference

EARTHQUAKE, BLAST & IMPACT

(Measurement and Effects of Vibration)

to be held at

UMIST, Manchester, UK on 18-20 September 1991



Organised by **S.E.C.E.D.**

(Society for Earthquake and Civil Engineering Dynamics)

SECED

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APPLICATION FORM

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Paid	
Papers	

SECED Conference

EARTHQUAKE, BLAST & IMPACT

18-20 September 1991

Please complete this form and return it by **28 August 1991** to: The Conference Office, Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA, UK.

Title (Dr/Mr/Ms)	First Name
Surname	Job Title
Organisation	
Address	
Telephone No	Fax No
Preferred name for badge	

The fees below cover attendance at the conference, conference volume, coffees, lunches and teas, Welcome Reception, Civic Reception and Conference Dinner.

		£
Registrations made before 1 July 1991		
Delegate Registration Fee	**£320** (£251 06 – £43 94 VAT – £25 documentation)	
Author Registration Fee (presenting author only)	**£270** (£208 51 – £36 49 VAT – £25 documentation)	
Student	**£100** (£63 83 – £11 17 VAT – £25 documentation)	
Registrations made after 1 July 1991		
Delegate Registration Fee	**£352** (£278 30 – £48 70 VAT – £25 documentation)	
Author Registration Fee (presenting author only)	**£297** (£231 49 – £40 51 VAT – £25 documentation)	
Student	**£100** (£63 83 – £11 17 VAT – £25 documentation)	
I require extra tickets for the Conference Dinner on Thursday 19 September 1991 @ £35 each		
ACCOMMODATION I require accommodation in the Hall of Residence for the following nights. *(please tick)* Tuesday 17 ☐ Wednesday 18 ☐ Thursday 19 ☐ Friday 20 ☐ at **£18.25** (incl VAT) per person per night (inclusive of breakfast)		
TOTAL ENCLOSED		

Hotel Accommodation

Local, four star hotel accommodation can be arranged for delegates who would prefer this option. The charge for bed and breakfast will be £56.20, inclusive of VAT. All enquiries regarding hotel accommodation should be addressed to Ms Karen Spavin, The Manchester Conference Centre, UMIST, P.O. Box 88, Manchester M60 1QD (Tel: 061-200 4100).

Methods of Payment

Remittances in sterling by cheque, bank draft or money order should be made payable to THOMAS TELFORD LTD and should accompany this form.

VAT registration number is 240 8777 47. A VAT receipt will automatically be sent to you on registration.

Cancellations

An administrative fee of £72 will be charged for cancellations received before 11 September 1991; no refunds will be given after this date, but substitute delegates will be welcomed.

Note

A single form must not be used for group applications – each individual must make a separate application. However, a single remittance may be enclosed to cover several applications. Photocopies of this form may be taken.

SECED CONFERENCE — EARTHQUAKE, BLAST & IMPACT

Programme

(subject to amendment)

TUESDAY 17 SEPTEMBER 1991

1630-1800	Registration and coffee
1800-1930	Informal Welcome Reception

WEDNESDAY 18 SEPTEMBER 1991

0900-0945 Registration

0945-0950 **Welcome**
Dr J R Maguire, Project Manager, Lloyd's Register and Chairman, Conference Organising Committee

0950-1000 **Opening Address**
Dr N Jones, Professor, Department of Mechanical Engineering, University of Liverpool, UK

SESSION 1 *Ground Motion & Field Studies*

Chairman: Dr C W A Browitt, Head, Global Seismology Research Group, British Geological Survey, UK

1000-1015 1. **Far-field ground motions in the Bishop's Castle earthquake of 2 April 1990**
Dr W P Aspinall, Director, Aspinall & Associates, G Woo, BEQE Ltd & D J Mallard, Principal Engineer, Nuclear Electric plc, UK

1015-1030 2. **Reducing conservatisms from broad band spectra in low to moderate seismic environments**
Dr R R Kunar, Managing Director & J Donald, Senior Engineer, BEQE Ltd, UK

1030-1045 3. **A parameterless scale of seismic intensity for use in seismic risk analysis and vulnerability assessment**
Dr R J S Spence, Lecturer, A Pomonis, Research Assistant, S Sakai, Research Assistant, The Martin Centre for Architectural & Urban Studies, Cambridge University & Dr A W Coburn, Director, Cambridge Architectural Research Ltd, UK

1045-1115 Coffee

1115-1130 4. **A comparison between real, UK suited, response spectra with the present design spectra**
Dr J M H Menu, Seismic Consultant, Seismotec Ltd & J Colloff, Seismic Engineering Co-ordinator, British Nuclear Fuels plc, UK

1130-1145 5. **On the use of data from microearthquake networks for grading instrumental hypocentre parameters and quality classification of fault plane solutions for seismic hazard assessment**
Dr W P Aspinall, Director, Aspinall & Associates, Dr B O Skipp, Consultant, Soil Mechanics Associates & D J Mallard, Principal Engineer, Nuclear Electric plc, UK

1145-1200 6. **The Luzon, Philippines earthquake of 16 July 1990**
E D Booth, Senior Seismic Engineer, Ove Arup & Partners, A M Chandler, Lecturer in Structural Engineering, University College London, UK, P K C Wong, Ove Arup & Partners, Hong Kong & Dr A W Coburn, Director, Cambridge Architectural Research Ltd, UK

1200-1215 Open Forum on Session 1

1215-1345 Lunch

SESSION 2 *Analysis & Case Histories*

Chairman: Dr R R Kunar, Managing Director, BEQE Ltd, UK

1345-1400 7. **Investigation of the validity of equivalent linearisation of non-linear material properties**
Dr S K Sarma, Senior Lecturer & K Breitwieser, Ex-MSc Student, Civil Engineering Department, Imperial College of Science & Technology, UK

1400-1415 8. **Seismic response of conventional power station structures**
D B Thompson, Director, Civil Engineering Division, Dr M M Khabbazan, Principal Engineer, Dr D C Mackay, Head of Advanced Structures Group & Dr P S Fashole-Luke, Graduate Engineer, L G Mouchel & Partners Ltd, UK

1415-1430 9. **Parametric studies of the seismic response of concrete gravity dams to UK type earthquakes**
Dr C A Taylor, Manager, W E Daniell, Research Student, E J Greeves, Research Assistant, Earthquake Engineering Research Centre, University of Bristol & J L Hinks, Principal Engineer, Sir William Halcrow & Partners, UK

1430-1445 10. **Dynamic testing and analysis of Lloyd's Register House**
Dr J R Maguire, Project Manager, Civil & Structural Engineering Department, Lloyd's Register Industrial Division, UK

1445-1500 11. **Seismic qualification and construction of safety related pipebridges utilising isolation techniques**
J B Riding, Senior Structural Engineer, British Nuclear Fuels plc, P Clark, Associate Director, Design Group Partnership & C Rogers, Computer Systems Manager, Design Group Partnership, UK

1500-1515 Open Forum on Session 2

1515-1545 Tea

SESSION 3 *Isolation & Damping*

Chairman: Professor G B Warburton, Emeritus Professor, Department of Mechanical Engineering, Nottingham University, UK

1545-1600 12. **Some design aspects of dynamic isolation of buildings from seismic ground vibrations**
Dr R Shepherd, Professor of Civil Engineering & L J Billings, Graduate Student, Department of Civil Engineering, University of California, Irvine, USA

1600-1615 13. **The use of discrete dampers to reduce the torsional response of structures to earthquakes**
Professor D Key, Senior Partner, CEP Research, UK

1615-1630 14. **Seismic isolation with high damping rubber bearings — theory and practice**
H R Ahmadi, Senior Engineer, Dr K N G Fuller, Head, Physics and Engineering, Malaysian Rubber Producers' Research Association & Dr V A Coveney, Bristol Polytechnic, UK

1630-1645 15. **Application of fractional calculus in modelling viscous dampers**
N Makris, Research Assistant & Dr M C Costantinou, Associate Professor, Department of Civil Engineering, University of New York, Buffalo, USA

1645-1700 Open Forum on Session 3

1700-1830 Poster Session

1930-2030 Civic Reception

FRIDAY 20 SEPTEMBER 1991

SESSION 7 *Impact*

Chairman — **Dr P A Merriman**, Structural Assessment Section, British Nuclear Fuels plc, UK

0900-0915 **33. Laboratory and centrifuge modelling of impact loading on buried structures**
Dr M C R Davies, Lecturer in Soil Mechanics, School of Engineering, University of Wales, College of Cardiff, UK

0915-0930 **34. Ground velocity attenuation associated with the Lockerbie air crash impact**
D W Redmayne, Seismic Analyst & T Turbitt, Head, Seismic Analysis Section, Global Seismology Research Group, British Geological Survey, UK

0930-0945 **35. Dynamic response of impacted cemented backfill**
Dr G N Nnadi, Senior Geotechnical Engineer, Strata Engineering Corporation, Canada

0945-1000 **36. Methodology for assessment of high mass, low velocity impacts on concrete structures**
B R Evason, Principal Dynamicist, Taywood Engineering Ltd & K Fullard, Head of Circuit Rupture Consequences Group, Berkeley Nuclear Laboratories, Nuclear Electric plc, UK

1000-1015 **37. Experimental study and theoretical analysis of reinforced concrete structures under accidental impact loading**
Dr A V Zabegayev, Head of Department of Reinforced Concrete Structures, Moscow Civil Engineering Institute, USSR

1015-1030 Open Forum on Session 7

1030-1100 Coffee

SESSION 8 *Piling & Demolition*

Chairman — **Dr B O Skipp**, Consultant, Soil Mechanics Associates, UK

1100-1115 **38. Estimation of piling-induced ground vibration**
A Oliver, Research Assistant & Dr A R Selby, Senior Lecturer, School of Engineering & Applied Science, University of Durham, UK

1115-1130 **39. Dynamic debonding of grouted prestressing tendons cut during demolition**
A Belhadj, Research Student, P Waldron, Reader & Dr A Blakeborough, Lecturer, Civil Engineering Department, University of Bristol, UK

1130-1145 **40. Ground and structural vibrations induced by explosive demolition of adjacent structures**
Dr J M W Brownjohn, Research Fellow, Earthquake Engineering Research Centre, University of Bristol, Z A Lubkowski, Teaching Company Associate, Dr J Pappin, Project Director, Ove Arup & Partners & Dr C A Taylor, Manager, Earthquake Engineering Research Centre, University of Bristol, UK

1145-1200 **41. Dynamic monitoring of large diameter driven piles, New Galata Bridge, Istanbul, Turkey**
J S Young, Associate of Bridge Division, Mott MacDonald, UK

1200-1215 **42. Effects of constructional vibrations upon an urban environment**
I D Isaac, Principal Engineer, Mott MacDonald Scotland, UK

1215-1230 **43. Non-monotonical decay of ground surface vibrations caused by pile driving**
Dr P B Attewell, Professor, Dr A R Selby, Senior Lecturer & Dr A Uromeihy, Research Student, School of Engineering & Applied Science, University of Durham, UK

1230-1245 Open Forum on Session 8

1245-1415 Lunch

SESSION 9 *Code Issues & Feedback*

Chairman — **Professor D Key**, Senior Partner, CEP Research, UK

1415-1430 **44. Choice of design seismic hazard parameters for Eurocode 8 in areas of low seismicity**
E D Booth, Senior Seismic Engineer, Ove Arup & Partners & Dr B O Skipp, Consultant, Soil Mechanics Associates, UK

1430-1445 **45. Evaluation of effects of simplifications used in current seismic reliability analysis**
Dr S Rahman, Research Scientist, Engineering Mechanics Department, Battelle, USA

1445-1500 **46. Seismic behaviour of structures during the Manjil earthquake 1990 in Iran**
H Moghaddam, Lecturer, Civil Engineering Department, Sharif University of Technology, Iran

1500-1515 **47. Seismic design of ductile R/C members**
Dr K Pilakoutas, Lecturer, Department of Civil & Structural Engineering, Sheffield University & Dr A S Elnashai, Lecturer in Earthquake Engineering, Department of Civil Engineering, Imperial College of Science & Technology, UK

1515-1535 Open Forum on Session 9 and General Forum

1535-1545 **Summary**
Dr J R Maguire, Project Manager, Lloyd's Register and Chairman, Conference Organising Committee

1545-1550 **Closing Remarks**
E D Booth, Senior Seismic Engineer, Ove Arup & Partners & Chairman, SECED

1550-1620 Tea and disperse

THURSDAY 19 SEPTEMBER 1991

SESSION 4 *Blast*

Chairman — **Professor B L Clarkson**, Principal, University College of Swansea, University of Wales, UK

0900-0915 — **16. The effect of detonator variability on explosively induced ground vibration**
Dr B M New, Head, Ground Properties and Pipelines, Ground Engineering Division, Transport & Road Research Laboratory, UK

0915-0930 — **17. Methods for the assessment of the blast response of engineering structures**
Dr M S Williams, Lecturer, Department of Engineering Science, University of Oxford & **J P Newell**, Manager, Engineering Mechanics, W S Atkins Engineering Sciences Ltd, UK

0930-0945 — **18. Estimation of design forces on structures near quarries from field blast tests**
Dr V K Puri, Assistant Professor, Southern Illinois University & **Prof S Prakash**, Department of Civil Engineering, University of Missouri, USA

0945-1000 — **19. On the significance of internal gas explosions in buildings**
Dr B R Ellis, Principal Scientific Officer, Building Research Establishment, UK

1000-1015 — **20. Experimental studies of vibrations caused by blasting for tunnel excavation**
G Bongiovanni, Researcher, **V Gorelli**, Researcher, **G Rienzo**, Researcher & **D Rinaldis** Researcher, ENEA, Italy

1015-1030 — Open Forum on Session 4

1030-1100 — Coffee

SESSION 5 *Members & Joints*

Chairman — **Dr A S Elnashai**, Lecturer in Earthquake Engineering, Imperial College of Science & Technology, UK

1100-1115 — **21. Experimental behaviour of ductile partially-encased composite beam-columns**
A Y Elghazouli Research Student, **Dr A S Elnashai**, Lecturer in Earthquake Engineering & **P J Dowling**, Professor Department of Civil Engineering, Imperial College of Science & Technology UK

1115-1130 — **22. The behaviour of plastic hinge zones in seismic resistant concrete structures**
Dr R C Fenwick, Associate Professor, Department of Civil Engineering, University of Auckland, New Zealand

1130-1145 — **23. Design and performance of model floor-column joints for simulation of inelastic structural response under earthquake loading**
E A Nichol Research Assistant, **Dr A M Chandler** Lecturer in Structural Engineering & **Dr R H Bassett** Reader in Geotechnics Department of Civil & Municipal Engineering, University College London, UK

1145-1200 — **24. Seismic resistance of connections in existing flat-plate buildings**
Dr A J Durrani Associate Professor Civil Engineering Department, Rice University USA

1200-1215 — **25. A computational strategy for the cracking process in concrete structures under shock and earthquake loading conditions**
F B A Beshara, Research Assistant & **Professor K S Virdi**, Director, Structures Research Centre, Department of Civil Engineering, City University, UK

1215-1230 — Open Forum on Session 5

1230-1415 — Lunch

SESSION 6 *Instrumentation & Testing*

Chairman — **Dr R S Steedman** Director, Geotechnics & Special Projects Division, BEQE Ltd, UK

1415-1430 — **26. "In situ" dynamic tests of a gated gravity dam**
R J Câmara Research Officer & **A Portugal** Assistant Research Officer, Dams Department Laboratorio Nacional de Engenharia Civil, Portugal

1430-1445 — **27. Experimental study of hysteretic energy absorption and load capacity of reinforced concrete columns subjected to different cyclic loading rates**
G Verzeletti Senior Scientific Officer, **S N Bousias**, Civil Engineer, **E Gutierrez** Scientific Officer, **G Magonette**, Scientific Officer & **P Tognoli**, Technical Officer, Applied Mechanics Division, Joint Research Centre, Italy

1445-1500 — **28. Physical modelling of earthquake excitation for geotechnical engineering**
Dr R S Steedman, Director, Geotechnics & Special Projects Division, BEQE Ltd & **Dr X Zeng** Research Fellow, Cambridge University, UK

1500-1515 — **29. University of Nottingham cyclic triaxial test facility**
M J Raybould Lecturer Department of Civil Engineering, University of Nottingham UK

1515-1545 — Tea

1545-1600 — **30. Comparisons between analytical and shaking table results for the extreme response of a model steel building**
Dr A Blakeborough Lecturer, Earthquake Engineering Research Centre, University of Bristol, **P D Murphy**, Engineer, Ove Arup & Partners & **E D Booth** Senior Seismic Engineer Ove Arup & Partners, UK

1600-1615 — **31. Comparison of calculated seismic response of a 1/4 scale reactor building with measured response**
Dr J M Llambias, Section Head & **R S Johnston** Structural Analyst Safety & Structures Department, NNC Ltd, UK

1615-1630 — **32. Effects of test apparatus boundaries on shaking table test results**
Dr M Budhu Associate Professor **G Neelakantan** Graduate Student & **A Al-Karni** Graduate Student, Department of Civil Engineering & Engineering Mechanics, University of Arizona USA

1630-1650 — Open Forum on Session 6

2000 — Conference Dinner

Conferences, Seminars and Symposia

1991

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.

18-20 September SECED International Conference on Earthquake, Blast and Impact, UMIST, Manchester, UK
Topics: Ground Motion and Field Studies; Analysis and Case Histories; Isolation and Damping; Blast; Members and Joints; Instrumentation and Testing; Impact; Piling and Demolition; Code Issues and Feedback.
Info: The Conference Office Institution of Civil Engineers, 1-7 Great George Street, London SWIP 3AA, UK, Tel: 071-222 7722

18-21 September Internationale Fachmesse und Kongreß für Geowissenschaften und Geotechnik, Köln, Deutschland.
Topics: Geobiosphäre im Wandel, Erfassung und Erkundung des Systems Erde, Nutzung der Geobiosphäre, Umsetzung der Erkenntnisse zum Schutz der Umwelt.
Info: C.C.M. Cologne Congress Management GmbH Schildergasse 101a, P.O. Box 180 180, W - 5000 Köln, Deutschland. Tel. 0221-236413.

14-19 October International Symposium on Urban Geology, Sfax, Tunesia.(Postponed!)
Info: Dr L. Primel, General Secretary of the I.A.E.G, Laboratoire Central de Pontset Chaussées 58, Boulevard Lefebvre, 75732 Paris Cedex 15, France.

9-13 December Ninth Asian Regional conference on soil mechanics 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.

1992

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 organized. **Info:** see information- and subscription form in this newsletter.
2-7 August	5th International Conference on Underground Space and Earth Sheltered Struc-tures, ICUSESS '92, NOVA TERRA Foundation Delft University of Technology, The Netherlands. **Topics:** The use of underground space and earth sheltered structures within urban, national and environmental development concerning: Planning, Design and Use, Construction, Economy, Law and Politics. **Info:** Congress Office ASD, P.O. Box 40, 2600 AA Delft, The Netherlands, Tel. 015 120234, Fax 015 120250.
21-24 September	4th International Conference on the Application of Stress-Wave Theory to Piles. The Hague, The Netherlands. **Topics:** Soil Mechanical aspects of stress-wave propagation and/or pile installation, environmental influence, new developments in dynamic testing equipment and associated interpretation methods, performance of piles, hammers and vibrators during pile installation, reliability of predictions based on measurement and interpretation of stress-wave propagation. **Info:** Fourth Stress-Wave Conference c/0 KIvI, P.O. Box 30424, 2500 GK The Haque, The Netherlands.

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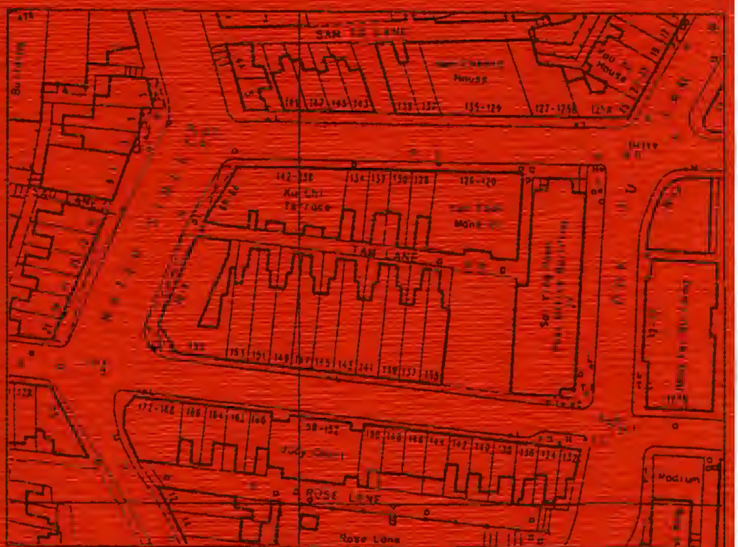

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Stationsplein 45 Postbus 29 080 3001 GB Rotterdam
Telefoon: 010 - 411 88 55 Telex: 23688

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