Εθνική Βιβλιοθήκη - Κέντρο Πολιτισμού
Ίδρυμα Σταύρος Νιάρχος

Αρ. 92 – ΙΟΥΛΙΟΣ 2016

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The Gharameel Desert, Al-Ula, Saudi Arabia

Arches National park, Moab, Utah, United States

The bay in the resort of Novyi Svet, Crimea

The bay in the resort of Novyi Svet, Crimea

ΑΡΘΡΑ

Παρουσίαση άρθρων, στην συγγραφή των οποίων μετείχαν Έλληνες, στο XVI European Conference on Soil Mechanics and Geotechnical Engineering, Edinburgh, 13-17 September 2015 (κατ' αλφαβητική σειρά, στα ελληνικά, του ονόματος του πρώτου συγγραφέα).

Shallow tunneling in an urban environment: geotechnical modelling and assessment of risk

Tunnellisation en cas de faible profondeur dans un environnement urbain: modélisation géotechnique et évaluation du risqué

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ABSTRACT This paper presents an assessment of geotechnical risk identified by investigations for a proposed sewer tunnel in south Glasgow. The alignment has a total length of 5.4km including three permanent shafts and tunnel sections with diameters ranging from 2.10m to 4.65m. The majority of the route is beneath open parkland and public roads to minimise the impact on buildings. The tunnel will pass at shallow depth under three railway lines, a heavily trafficked motorway and some residential areas; the minimum overburden height of 4.0m being below a railway cutting. The investigation process was challenging due to the urban environment and complexity of the project. Early development of the geological model benefitted from a considerable quantity of archive information freely available from various public bodies, which revealed the complexity of ground conditions. Borehole investigation targeted specific geotechnical risk items arising from made ground being contaminated; alluvium being soft and highly compressible with layers of running sand; and glacial till presenting a highly variable interface with rockhead. The bedrock presented widely varying characteristics (lithology, weathering, bed thickness, fracturing, strength etc.), structural folding, fault zones, intact coal seams and notably extensive mining (mine shafts, packed waste, collapsed material and voids). Ground water was at or close to the ground surface; the underlying bedrock having numerous water bearing strata with varying connectivity disrupted by mine workings and fault zones.

1 INTRODUCTION

The biggest upgrade of Glasgow's wastewater network since Victorian times includes construction of a new £100m sewer tunnel through the south of the city. A total length of 5.4km is proposed with internal diameter of tunnel ranging from 4.65m to 2.10m and three permanent shafts of 15m diameter. The initial section of the sewer (550m) is to be constructed in open cut excavation and the remainder in bored tunnel.

The majority of the route is in open space (i.e. public parks, golf course, football pitches) to mitigate ground risk and to minimise impact on privately owned buildings. The tunnel will however pass at shallow depth under three railway lines, a heavily trafficked motorway and residential areas; the minimum overburden height of 4.0m being below a railway cutting.

2 DESK STUDY

Geotechnical risk management commenced with a desk study and walkover survey to gain knowledge on topography, land use and industrial heritage. This revealed historic mining, heavy industry and manufacturing activity. Mining records were obtained from public archive and a local mining consultant (JWH Ross Ltd.), which revealed grouting records of historic mine workings.

Early development of the geological model benefitted from a considerable quantity of archive information being freely available from various public bodies, in particular the British Geological Survey (BGS 1984 and 1985). This area was part of the 'Clyde Urban Super Project' being developed by the BGS and it was commissioned to provide a 3D Lithoframe model of the study corridor. This assisted in appreciating the complexity of ground conditions likely to be encountered by tunnelling operations and informed the scoping of ground investigation.

Prior to the commencement of the ground investigation survey an UXO study was carried out to examine the risk along the alignment. Some areas attracted the highest probability of UXO encounter (zone 3) due to historic land use. The type of risk mitigation measure to be applied depends not only upon the probability rating for UXO encounter but also the type of works being undertaken (Stone et al. 2009). As tunneling operations are located below the maximum bomb penetration depth, the potential risk for this kind of operation was considered negligible and no further action was required. Construction of the shaft however, will require mitigation measures; primarily survey, safety and awareness briefings and specialist banksman support.

3 GROUND INVESTIGATION SURVEY

The information gained at desk study stage allowed early identification of geotechnical risk and provided opportunity to target specific ground hazards when scoping the ground investigation. The principal risk items arose from the made ground being contaminated; alluvium being soft and highly compressible; a high water table with layers of running sand; and glacial till containing boulders and presenting a highly variable interface with rockhead. The underlying bedrock presented widely varying characteristics (lithology, weathering, bed thickness, fracturing, strength etc.), structural folding, fault zones, intact coal seams and extensive mining features (mine shafts, packed waste, collapsed material and voids). Implementing the ground investigation itself was challenging considering the difficult ground conditions and urban environment. A contract was let for £1.5m in 2013.

3.1 Boreholes

To prove ground conditions, cable percussion boring with rotary core follow on was carried out in combination with rotary open hole drilling. In total some 5.0km of drilling was undertaken at 179No. locations, delivering an overall spacing of one borehole per 30m length of sewer. These were located outwith the tunnel footprint to mitigate risk of creating pathways for groundwater ingress to the tunnel face or obstructions from loss of steel casing. In the event, two boreholes had to be abandoned leaving steel casing at the elevation of the tunnel, offset 3.6m and 7.9m from the centreline. Their locations were logged and added to the project risk register.

133No. single and dual gas and water monitoring standpipes were installed in selected boreholes and monitored on a monthly basis to determine base-line levels for gas and ground water.

3.2 In-situ testing

In-situ testing targeted the particular hazards with potential to constrain choice of tunneling methods.

3.2.1 Standard penetration test

Standard penetration tests (502No. SPTs) were undertaken at 1.5m centres in cable percussive boreholes. These were used to assess strength and support characteristics of the deposits.

Coarse soil formations recorded a very loose condition below the water table, and in proximity to the tunnel face, presenting a likelihood of running sand being encountered. This particular area corresponded to the area of minimum overburden height, just below the railway cutting.

3.2.2 High pressure dilatometer testing

High pressure dilatometer tests (25No. HPD) were carried out in boreholes at shaft locations to define the in-situ mass properties of the bedrock.

Each test included at least two unload/ reload cycles to define coefficient of earth pressure at rest (k_o), strength parameters such as drained cohesion (c') and peak friction angle (φ_p) and stiffness parameters such as the shear modulus (G). The latter results being considered more reliable than earth pressure at rest and strength values due to limitations/ hypotheses of the processing methods.

3.2.3 Surface geophysics

Surface geophysical surveying was carried out primarily to profile the variability of rockhead where in proximity to the tunnel crown, but also to investigate the presence of shallow mine workings.

Rockhead profiling was carried out at selected sections using resistivity and seismic refraction (compressional and shear) techniques. The results of the surface geophysics carried out in the parkland areas were calibrated against the borehole findings to define the bedrock profile in some detail.

The existence of mine workings was investigated with resistivity, electromagnetic, magnetic and micro-gravity methods (Figure 1).

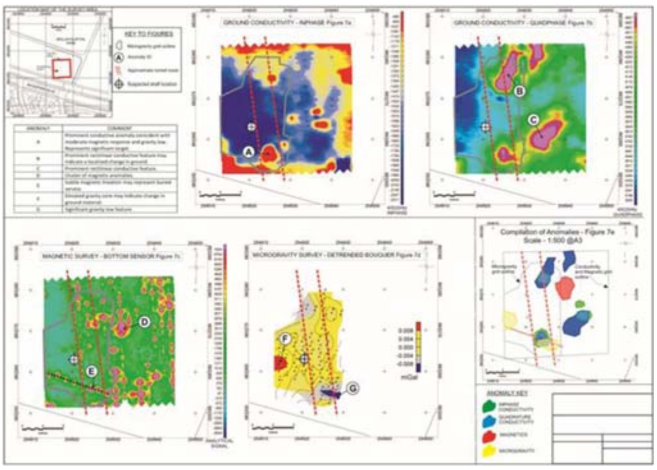

Figure 1. Investigation of mine shaft – combined resistivity, magnetic and microgravity survey.

3.2.4 Downhole geophysics

Downhole geophysics techniques were used to investigate the presence of mine workings and to determine structural features of strata such as bedding dip/dip direction, minor fractures and major fractures/faulted zones. The corresponding surveys included optical/acoustic televiewer loggings, natural gamma, density and caliper measurements and fluid temperature, conductivity and flowmeter recordings.

The results from the optical/ acoustic televiewer loggings proved useful in identifying structural features and discontinuities (minor and major fractures) and particularly successful in identifying mining features (Figure 2).

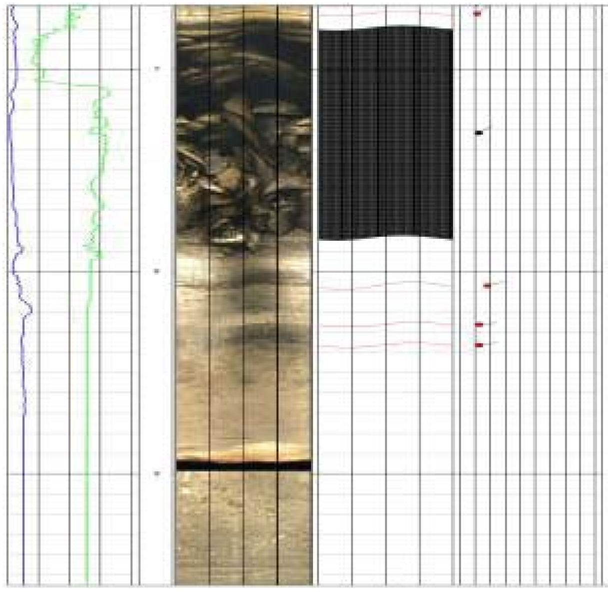

Figure 2. Optical televiewer logging – dark zone (right) corresponds to collapsed mine working (left).

Natural gamma measurements were used for interpretation of the formations based predominantly on the potassium content of the formation associated with its clay content.

The fluid temperature, conductivity and flowmeter recordings were used in minor occasions to detect fluid movement within the boreholes. This was undertaken where boreholes were drilled through suspected mine workings.

3.2.5 Permeability testing

To assess the potential for ingress of groundwater to the tunnel, in-situ permeability testing was carried out. Single and double packer testing (52No.) was carried out during bedrock drilling at selected boreholes in shaft locations and along the tunnel crown. Both falling head and rising head techniques (34No.) were used in boreholes equipped with water monitoring standpipes.

3.2.6 Groundwater monitoring

Monitoring of standpipes proved the ground water table to be at or close to ground surface through much of the route. Differences in the hydraulic head between shallow and deep installations indicate that the underlying bedrock has a number of separate water bearing strata potentially with connectivity to mine workings.

3.2.7 Gas monitoring

Monitoring of gas standpipes indicated that hazardous gases such as methane, carbon dioxide, hydrogen sulphide, carbon monoxide were present in sufficient quantities to present a significant risk to tunneling works. The clarification of this risk was important in developing the specification for the TBM (e.g. slurry TBM equipped with gas monitoring devices) to reduce construction risk.

3.3 Laboratory Testing

3.3.1 Geotechnical/ geo-environmental testing

The suite of routine testing scheduled for recovered samples of soil, rock and water is summarized in Table 1.

Statistical analysis of the laboratory results was carried out using typical functions and regression analysis to define material properties and derive values suitable for the design/ construction of the sewer

Table 1. Geotechnical and geo-environmental testing.

Soil samples	Rock samples	Environmental samples
Moisture content, Bulk density, Atterberg limits (LL, PL, PI), Particle size distribution Oedometer test, Direct shear strength test and Triaxial shear test.	Moisture content, Porosity / density Point Load Test, Uniaxial compressive strength with determination of Young's modulus (E) and Poisson's ratio (v), Cerchar abrasivity test, Slake durability test and Petrographic/ Quartz Content Analysis.	Soil samples: Metals/Metalloids, TPH-CWG (speciated aliphatic/aromatic) (to include BTEX and MTBE), PAHs (speciated) (USEPA-16), Cyanide (Total), Cyanide (Free), pH, Total Organic Carbon, and Asbestos – Screen Water samples: Metals, Total Cyanide, Free Cyanide, Phenols, Sulphide, Sulphate, pH, PAH, Chloride, Ammoniacal Nitrogen, Nitrate, Total Petroleum Hydrocarbons

3.3.2 Specialised rock testing – Drillability Indices

Specialised rock testing was scheduled to estimate the Tunnel Boring Machine's penetrability and the wear potential on the discs through the determination of the following drillability indices (Bruland 1998).

The Drilling Rate Index (DRI™) gives a measure of specific properties of the rock sample (i.e. rock ability to resist mechanical impact) and an estimation of the surface hardness of the rock. The Bit Wear Index (BWI™) is used to estimate the lifetime of drill bits while the Cutter Life Index (CLI™) expresses

lifetime of TBM disc cutter steel. These indices represent critical factors during tunneling operations.

4 GROUND MODEL

The findings of the ground investigation were assessed and evaluated in conjunction with the results of the mining interpretation in order to establish an accurate and comprehensive ground model.

4.1 Geotechnical formations

The geotechnical formations adopted for the purposes of the geotechnical interpretation/ evaluation are summarized in Table 3. The descriptions indicate a wide range of material properties; variations from these descriptions are expected along the route but this represents the baseline ground model.

With regards to the Glacial Till formation, several boulders were encountered during the drilling works giving a general indication of the frequency and size of the boulders that may be expected during the tunnel construction through this formation.

4.2 Mining hazard

The mining regime of the project area was established based the geotechnical investigation findings and the past mine plan records. In collaboration with a local mining specialist (JWH Ross Ltd.), the identified coal seams were classified according their increasing likelihood of having been worked. Where appropriate, identified coal seams were classified as 'working not suspected'; thereafter, a probability scale with 5No categories was adopted, from 'very low' to 'very high' (see Figure 3).

Table 2. Drillability indices testing results.

Formation	DRI™	BWI™	CLI™
MUDSTONE with layers of ironstone	74 V. high	8 Ex. low	106 Ex. high
MUDSTONE with iron bands	82 V. high	7 Ex. low	73.4 V. high
Massive MUDSTONE	81 V. high	11 V. low	59.2 V. high
Laminated MUDSTONE	71 V. high	11 V. low	37.9 V. high
Alterations of SILTSTONE/ SANDSTONE	75 V. high	13 V. low	34.9 V. high
Laminated MUDSTONE with fine sandstone	74 V. high	12 V. low	33.0 High
SANDSTONE with layers of mudstone	79 V. high	16 V. low	30.6 High
Massive SANDSTONE	76 V. high	15 V. low	29.0 High
Laminated SANDSTONE	68 High	16 V. low	28.7 High
Well bedded SILTSTONE	81 V. high	13 V. low	27.1 High
Laminated SANDSTONE	80 V. high	16 V. low	27.0 High
SANDSTONE with mudstone layers	74 V. high	17 V. low	24.7 High
SANDSTONE with iron laminations	97 Ex. high	12 V. low	23.6 High
Sideretic SANDSTONE	91 Ex. high	13 V. low	22.1 High
SANDSTONE	99 Ex. high	11 V. low	20.4 High

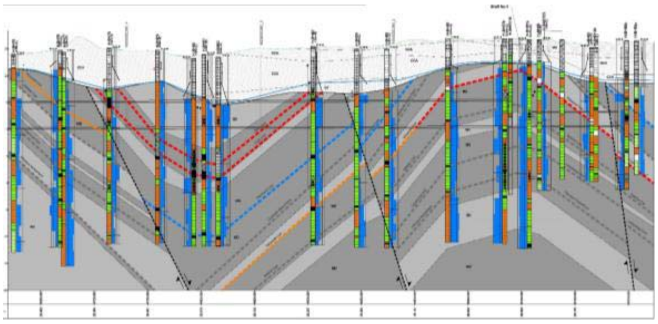

Figure 3. Sample of the geotechnical and mining model (coloured lines represent coal seams and their likelihood of being worked).

In order to minimise the risk of potential instability and to protect the tunnel during the construction along the mine worked sections, grouting works are considered necessary to artificially consolidate the coal workings.

The medium to very high risk areas, which correspond to 1.4km of the total tunnel's length will be consolidated by drilling and grouting before the commencement of tunnel construction. The treatment zone will be 12m below the invert and 12m above the crown of the tunnel while the lateral extent of the treatment zone will be 6.0m from each side of the tunnel.

Where the risk from workable seams has been assessed as very low to low, being 0.5km of the tunnel's length, this will be subject to further exploratory drilling. The probability that these areas will be subsequently grouted is assessed to be less than 50%.

Table 3. Geotechnical formations.

Formation	Description
Top soil and Made Ground	Very soft to firm, brown to grey, SILT (CLAY) of (mainly) intermediate plasticity (occasionally of low and high plasticity), with ashes, gravels, cobbles, bricks, fragments of sandstone, mudstone, concrete etc.
Cohesive Alluvium	Very soft to firm, grey to brown, sandy laminated CLAY (SILT) of intermediate to high (and occasionally low) plasticity.
Granular Alluvium	Very loose to medium dense, brown to orange, silty (clayey) SAND, fine to medium grained with occasional appearances of gravels.
Glacial Till	Firm to hard, light to dark brown, gravelly (sandy) CLAY, of mainly low and occasionally intermediate plasticity, with occasional appearances of cobbles and boulders (d_{max}=2.0m); the gravels are medium to coarse, angular to subrounded.
Sandstone	Moderate strong, unweathered to slightly weathered, light brown to pale grey, fine to coarse grained, thinly to massive bedded, SANDSTONE. Discontinuities are moderately spaced, sub-horizontal, planar smooth to rough with (where applicable) clayey filling material.
Mudstone	Of low strength, slightly to medium weathered, dark grey, fine to medium grained, well bedded, MUDSTONE. Discontinuities are closely spaced, sub-horizontal, planar, rough and smooth, with clayey filling material.
Coal seams	Identified coal seams according to the findings of the boreholes and the mining interpretation. Both intact (unworked) and worked seams (packed waste and voids) are classified to this group.

The ground water table measurements indicate that the abandoned workings along the route are likely to be substantially flooded. Assuming that any such workings have been grouted, the risk from water ingress during the construction of the tunnel is considered to be much reduced, albeit this cannot be eliminated.

5 SUMMARY AND CONCLUSIONS

A detailed and wide ranging ground investigation programme was carried out for a proposed sewer in south Glasgow to establish the geotechnical model and highlight the potential geotechnical risks associated with constructing the tunnel and shafts; the following significant risks were identified:

- Unexploded Ordnance in shaft locations causing delays to the construction programme
- Alluvium being soft and highly compressible below shallow cover causing face instability and increased surface settlement
- Layers of running sand at tunnel crown level leading to increased volume loss at the tunnel face and surface settlement above the tunnel
- Existence of hazardous gases and water bearing strata with varying connectivity inducing delays to TBM's operation and influencing the selection and design of the TBM
- Shallow rock cover with collapse potential leading to influx of the overlying superficial deposits into the face of the tunnel and increased surface settlement under low pressure operation
- Superficial natural deposits in a highly variable interface with underlying rockhead leading to difficulties in controlling the TBM drive at transition zones and increased risk of interventions
- Boulders (of different size, frequency and composition) in Glacial Till causing delays due to required interventions
- Complex solid geology and bedrock with widely varying characteristics, structural folding and fault zones resulting in problems at the tunnel face and decreased TBM's penetrability rates
- Extensive mining (mine shafts, packed waste, collapsed material and voids) causing further subsidence risk due to potential collapse of the abandoned working.

The geotechnical risks were quantified through contractual statements, referred to as Baseline Statements, in the Geotechnical Baseline Report for Bidding (GBR-B) which followed the Geoenvironmental Interpretative Report (GIR). In essence, the Baseline Statements described the geotechnical risk share between the Employer and the Contractor during the construction, hence offering common ground for the project's tendering process. During this process, the potential risks have been considered and mitigated against by the tenderers by selection of appropriate tunnel construction methods (e.g. grouting of mine workings, use of mixshield slurry TBM etc.). This was considered the first step in the development, via negotiation between the Employer and the preferred Contractor of a Geotechnical Baseline Report for Construction (GBR-C). The GBR-C is the basis of the Contractor's price and will be the most significant criterion to determine future compensation event.

ACKNOWLEDGEMENT

The authors would like to thank Scottish Water for their permission to proceed to the publication of this paper. The authors also appreciate the kind support and valuable comments of Mark Welsh (CH2M HILL, Project Manager), Colin Warren (CH2M HILL, Geotechnical and Tunnelling Consultant) and Vik Adam (JWH Ross, Project Mining Engineer).

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Investigation of pile-soil interaction in a sliding mass using 3D FEM

Enquête sur l'interaction sol-pieu dans une masse en movement par l'utilisation de 3D FEM

A. Papavasileiou and C. Anagnostopoulos

ABSTRACT Rows of piles are an effective and extensively used landslide remedial measure, almost independent of the cause of the problem. The economical design has a great interest and thus the sound knowledge of the piles-slide system behavior is of great importance. In the present study three-dimensional finite element analyses have been carried out to investigate the interaction between a row of piles and sliding mass. Analyses were initially carried out to determine and calibrate the most suitable model, which not only simulated better the soil-pile interaction but also enabled computational efficiency. The distance between the boundaries and the piles turned out to be very important for the reliability of the results and for this reason parametric analyses were carried out to investigate their influence. Further analyses investigated the parameters that influence the efficiency of the piles as a remediation measure, such as the depth of the sliding mass, the soil strength properties and the strength properties of the sliding surface, the length of pile embedment, pile diameter and of course the arrangement of the pile group. From the analyses the additional shear forces, which increase the resistance of the sliding mass against sliding and consequently the factor of safety of the slope, were calculated and presented in diagrams in order to clarify the influence of the above mentioned parameters.

1 INTRODUCTION

Landslides often result in extensive damages and sometimes in human losses. The stabilization of the landslides and the increase of the safety factor of the slope are of great importance in order to avoid the catastrophic consequences of a landslide. One of the most important countermeasures for their stabilization is the use of piles. Through the decades many researchers have studied the use of stabilizing piles and proposed techniques (De Beer and Wallays 1970, Ito and Matsui 1975, Fukuoka 1977, Nakamura and Tsuchiya 1987, Poulos 1995).

Stabilizing piles are subjected to lateral forces induced by the soil movement of the unstable layer. This kind of piles is called "passive". Their use is lying more stable layer but also on providing to the slope an additional force which resists the sliding and increases the safety factor of the slope.

The current paper presents a simplified model for simulating the pile-soil system and parameters are examined that influence the additional resistance force (ΔF) of a row of stabilizing piles under passive lateral loading.

2 DESCRIPTION OF MODEL

The problem examined in this paper consists of a row of piles installed to stabilize a laterally moving soil mass. The simplified model used to simulate the pile-slope system and to conduct the analyses with the FE program Abaqus contains four parts; the unstable soil layer, the stable soil layer where the pile is embedded, the slip plane along which the sliding of the unstable soil mass takes place and the stabilizing pile (Fig.1).

Due to symmetry the problem can be simulated by examining only a slice of an infinite length slope. So, the width of the model depends on the pile configuration and specifically on their spacing (s). As shown in Fig.2, the width of the model extends s/2 on the left and right side of the pile. Consequently, the total width of the model is s (center-to-center pile distance).

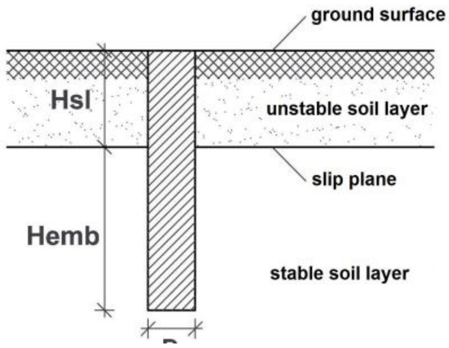

Figure 1. Parts describing the simplified model

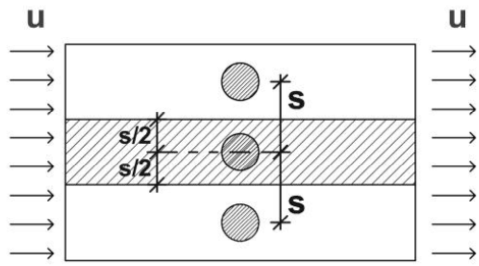

Figure 2. Geometry of simplified model

The model length is a mesh dependent phenomenon because the placement of the boundaries close to the pile may affect the pile behavior. Numerical analyses have been carried out to investigate the appropriate model length so that the results may not be affected by the boundaries and at the same time avoid creating a large model with an increased computational time.

The effect of the placement of the left and right boundaries has been investigated at distances of 5D, 10D and 15D from the pile center. The analyses have shown that the pile deflection and the exerted shear force and bending moment are almost the same for the distances 10D & 15D. By choosing a distance of 10D uphill and downhill of the pile center we ensure the reliability of the results and enable computational efficiency. This distance is in accordance with the proposed ones 8D (Kanagasabai 2010) and 9D (Miao et al. 2006).

The sliding mass extends from the ground surface to the slip plane. So, the depth of the part representing the unstable soil layer depends on the position of the slip plane. The part which simulates the stable layer extends from the slip plane to a depth equal to $2H_{emb}$. Parametric analyses have been carried out to investigate the effect of the placement of the bottom boundary of the stable layer and have shown that a depth equal to or greater than H_{emb} under the pile toe does not affect the results.

The nodes of the bottom surface of the soil mesh (Fig. 3) were restrained in all directions while the nodes on the ground surface were free to move. Due to symmetry, the nodes of the front and rear sides were not allowed to move on y-direction but free to move on x- and z- directions. The nodes of the left and right faces of the stable layer were restrained from moving on the x-direction. The same restraints were applied on the left and right faces of the unstable layer but only during the step of gravity loading. During the next steps the displacement of the soil mass were imposed on the nodes of those faces.

The pile was modelled as a linear elastic material having a Young's modulus of 29 GPa, a Poisson's ratio of 0.1 and a diameter of 1m. The soils in both layers were modelled as elastoplastic materials with a Mohr-Coulomb failure criterion with uniform shear strength c_u (shear strength of unstable layer was 100 kPa and of the stable 500 kPa), a Poisson's ratio of 0.495 and unit weight 1.83t/m^3. In most analyses, the Young's modulus Es was taken as 250cu (within the range proposed for clays from Poulos & Davis 1980). The gravitational acceleration was taken 9.81 m/s^2 in the positive z-direction and the earth pressure coefficient K_0=1.

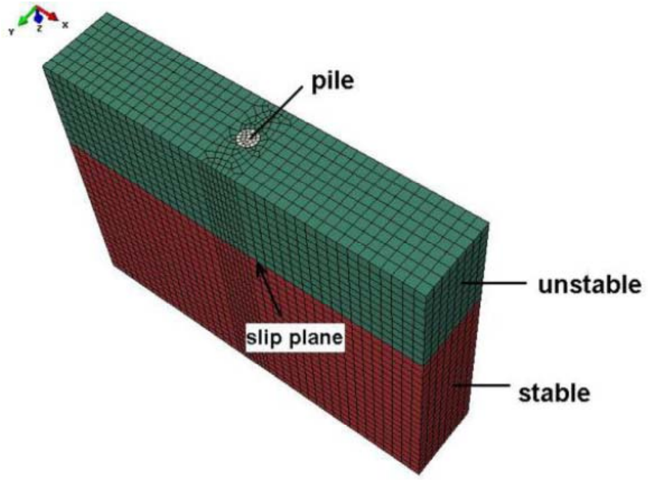

Figure 3. Mesh geometry of the model

The soil-pile interface and the sliding interface that simulated the slip plane were described by an adhesion factor (a) and a maximum allowable shear stress (τmax = a * c_u). This factor is equal to 0 for zero strength interfaces and equal to 1 for full strength interfaces. The soil-pile interface was considered as a full strength interface and the slip plane had a strength equal to 30% of the strength of the unstable layer (τ_{max} = 0.3* $c_{u,sl}$).

The analyses were conducted in steps. The first step was a geostatic one during which the model was brought to equilibrium under gravity loading. In the next step the soil elements in the position of the pile were replaced by the elements simulating the pile and during the subsequent steps the model was loaded incrementally by imposing the lateral load, due to the soil sliding, on the nodes of the left and right faces of the unstable layer to a soil movement of 0.80m (u_{ff}).

3 RESULTS OF PARAMETRIC ANALYSES

The additional resistance force per unit width of the slope (ΔF: kN/m) was calculated by summing the shear force of the pile developed on the level of the sliding surface and the frictional resistance force developed all over the slip plane and subtracting from this summation the frictional resistance force of the slip plane developed in the case were no piles exist. Therefore, identical analyses of the same model though without piles were conducted. The result was divided by center-to-center pile distance (s) in order to express the force per unit width of the slope.

3.1 Influence of pile embedment depth

The pile embedment depth (H_{emb}) is the part of the pile that extends into the stable layer and influences the resistance provided by the pile as it affects the stiffness of the pile-soil system and its deflection. There is an embedment depth, called critical, beyond which the resistance force offered by the pile remains unchanged for the same load. The examined cases consist of a shallow, a deep and a very deep slide. As it can be seen in Figures 4-5, the embedment depth has greater impact on the shallow slide (Fig.4). In the shallow and deep cases it is obvious that an embedment depth of $1H_{sl}$ is the critical one whereas for the very deep slide the critical depth decreases to a value of $0.5H^{sl}$.By increasing the embedment length there is also an increase in the resistance force offered by the pile. The increase of the resistance force reaches its limit when the embedment depth reaches a critical value.

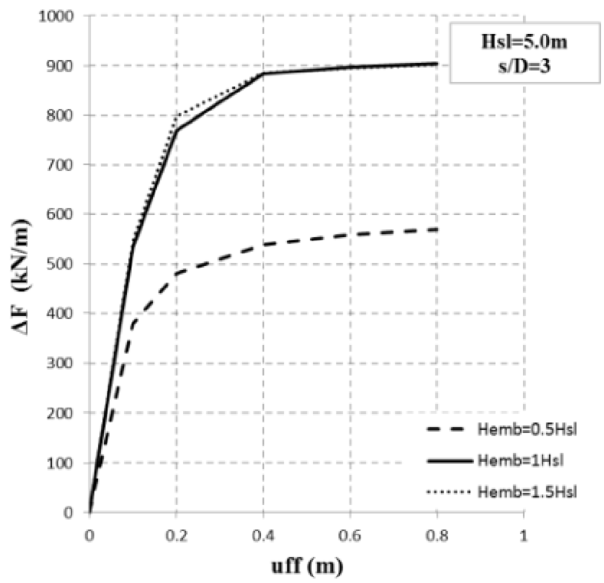

Figure 4. Influence of H_{emb} for shallow slide

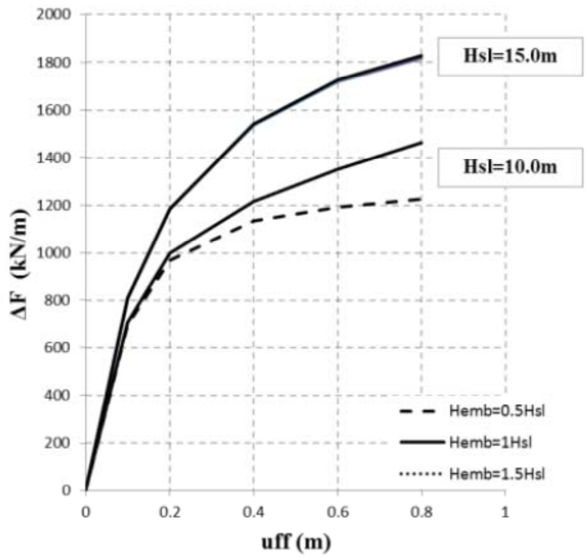

Figure 5. Influence of H_{emb} for deep and very deep slide

3.2 Influence of sliding depth

The lateral movement is imposed on the upper unstable layer of the model which simulates the sliding mass. The depth of this soil layer affects the resistance force provided by the pile. The deeper the sliding mass the greater the resistance force of the pile (Fig.6), because as the depth of the unstable layer increases, the soil mass pushing the pile increases too.

3.3 Influence of pile diameter

By increasing the pile diameter and keeping the same ratio s/D, the resistance force provided by the piles is almost the same until an imposed displacement of 0.10m (Fig.7) but the moment developed on the pile is smaller for smaller pile diameter (Fig.8). For further increase of the imposed displacement the resistance force is higher for bigger pile diameter. Choosing a smaller diameter leads to lower section

forces and moments on the pile but for the same slope depth there will be needed to install more piles. Therefore, in every case, different pile configurations and different pile diameters must be examined in order to choose the most appropriate and economically efficient solution.

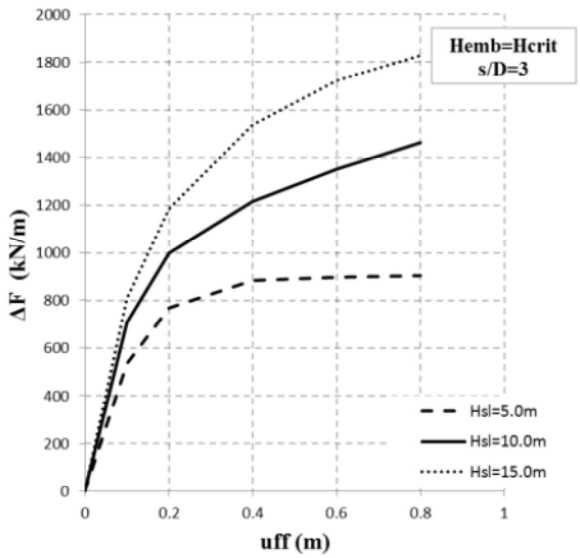

Figure 6. Influence of H_{sl}

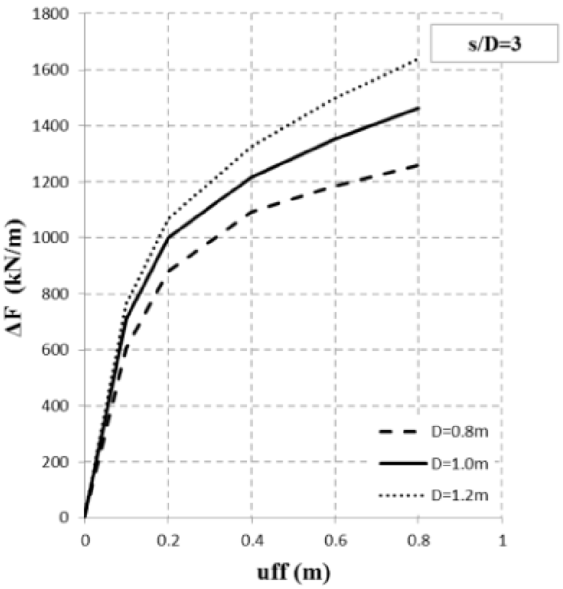

Figure 7. Influence of pile diameter on the resistance force

3.4 Influence of elasticity modulus (E_s)

Keeping constant the Young's Modulus of the stable soil layer and changing that of the unstable layer the additional resistance force of the pile increases. Beyond a value of E_s the results are almost unaffected by the elasticity modulus of the sliding mass (Fig.9). The ultimate value of ΔF seems to be unaffected by E_s of the sliding mass.

An increase of the elasticity modulus of the stable layer, while E_s of the unstable layer remains constant, leads to an increase of ΔF but in this case the ultimate ΔF is affected at some extend by the elasticity modulus of the stable layer (Fig.10).

3.5 Influence of undrained shear strength

In the current analyses the elasticity modulus and the maximum frictional force of the slip plane have not been chosen as aforementioned but have fixed values (E_{s1}=25000kPa, E_{s2}=125000kPa and τ_{max}=15kPa) in order to avoid including in the results the influence of other parameters.

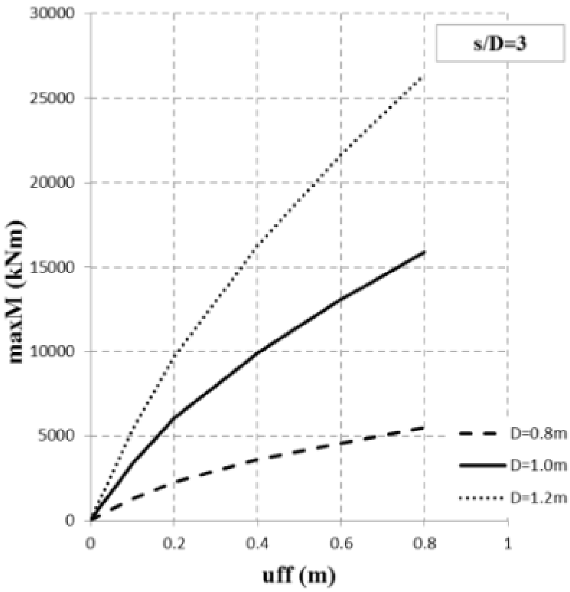

Figure 8. Influence of pile diameter on the moments

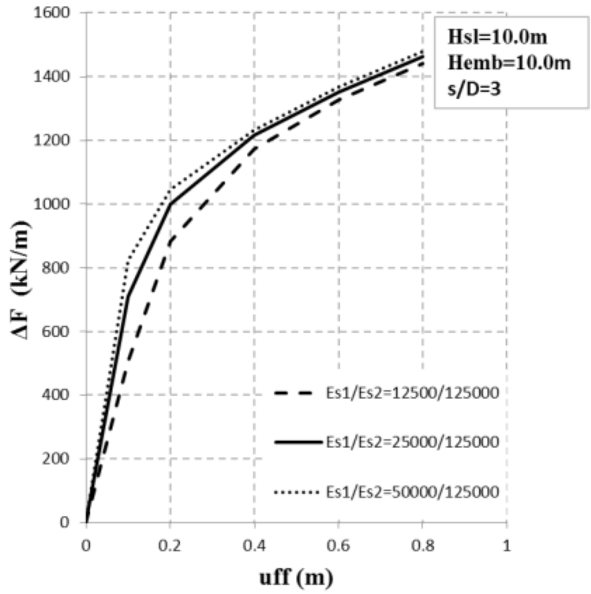

Figure 9. Influence of unstable layer's E_s

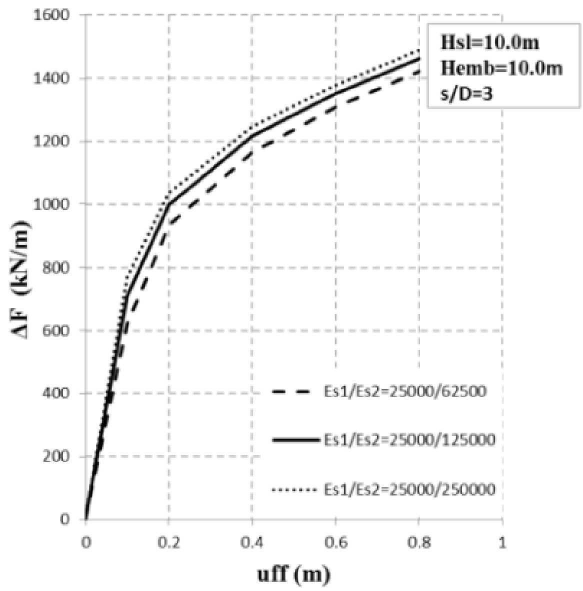

Figure 10. Influence of stable layer's E_s

From Fig. 11 & 12 it is obvious, that an increase of the undrained shear strength of either of the soil layers leads to an increase of the additional force offered to the slope from the piles. An increase of c_u of the unstable layer makes the flow of the soil between the piles more difficult which results to an increase of the load transferred to the pile. The strength of the stable layer determines the fixity conditions of the pile. A stronger underlying layer makes the system stiffer and leads to higher values of ΔF. The shear strength of the sliding mass seems to have a bigger influence on the results.

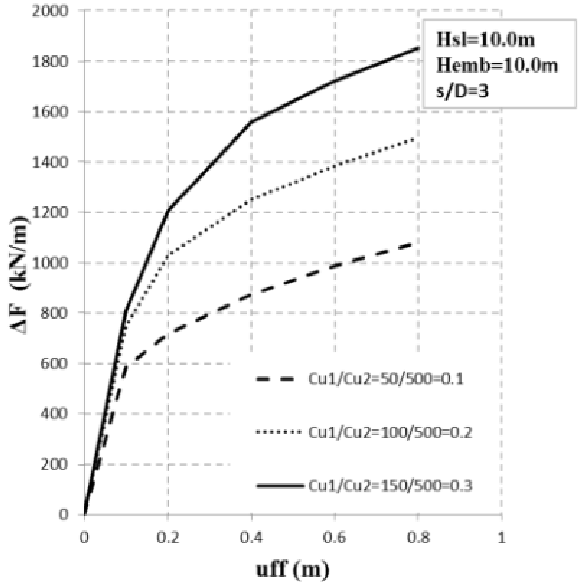

Figure 11. Influence of stable layer's c_u

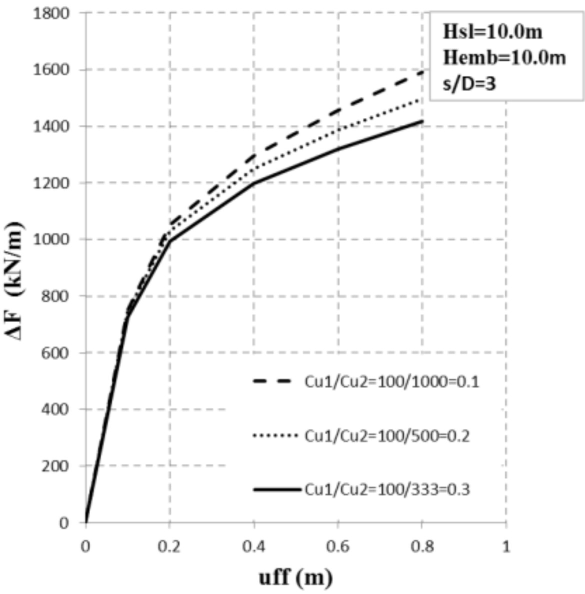

Figure 12. Influence of unstable layer's c_u

3.6 Influence of slip plane's strength

The sliding takes place along the surface between the unstable and stable layer. This surface is simulated using an interface with an adhesion factor (a) and a maximum allowable shear stress (τ_{max} = a * $c_{u,sl}$). The increase of the adhesion factor makes the interface rougher which leads to an increase of the frictional resistance of the slip plane. Hence, more load is being transferred from the moving slope to the slip plane and less to the pile. In the theoretical case of a perfect sliding (a=0) the whole load of the sliding mass is being directed to the pile. The values of ΔF for a=0.1~0.5 do not vary a lot but the values between a=0.5~1 exhibit a great difference (Fig.13). By increasing the roughness of the slip plane, the relative motion of the unstable and stable soil layer decreases which has as result the decrease of the imposed on the pile loading.

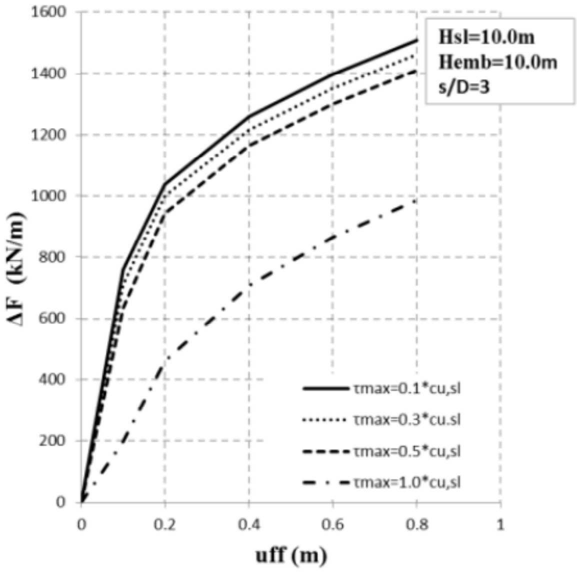

Figure 13. Influence of slip plane's strength

4 SUMMARY

This paper has presented a simplified model simulating the pile-soil system of a row of piles stabilizing an unstable slope. Parametric analyses have been conducted in order to clarify and to gain a sound knowledge of the pile-slope system behavior. Some of the most important factors affecting the additional resistance force per unit width (ΔF) of the piles have been investigated. The parameters examined were the embedment depth of the pile, the depth of the sliding mass, the pile diameter, the elasticity modulus and the shear strength of both the unstable and stable soil layers and the strength of the slip plane along which the sliding of the slope takes place.

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ΠΑΡΟΥΣΙΑΣΗ ΔΙΔΑΚΤΟΡΙΚΩΝ ΔΙΑΤΡΙΒΩΝ ΣΤΗΝ ΓΕΩΤΕΧΝΙΚΗ ΜΗΧΑΝΙΚΗ

Διερεύνηση των Γεωτεχνικών Παραμέτρων που Ελέγχουν τις Καταπτώσεις Βράχων

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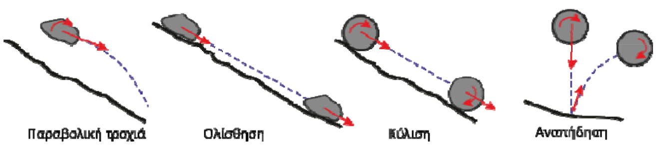
Περίληψη

Η κατάπτωση βραχωδών τεμαχών σε περιοχές με ανθρώπινη δραστηριότητα μπορεί να προκαλέσει σημαντικά προβλήματα με δυσμενείς κοινωνικές και οικονομικές επιπτώσεις. Τα πρόσφατα παραδείγματα από τον Ελλαδικό χώρο είναι αρκετά, όπου σε περιπτώσεις καταπτώσεων υπήρξαν ακόμη και απώλειες ανθρώπινων ζωών.

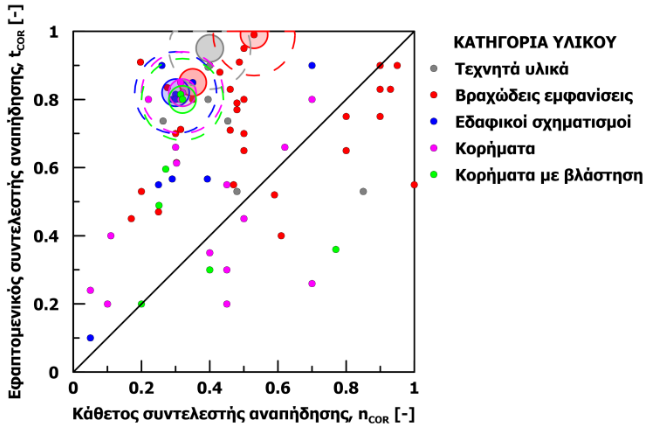
Οι καταπτώσεις βράχων αποτελούν φυσικό φαινόμενο και εκδηλώνονται με την αιφνίδια και βίαια κίνηση μεμονωμένων βραχωδών τεμαχών, με κινητήριο δύναμη την βαρύτητα, μετά την αποκόλληση - απόσπασή τους από την αρχική τους θέση στα πρανή. Τα τεμάχη υφίστανται απώλεια ταχύτητας κατά την πρόσκρουση, την κύλιση ή την ολίσθησή τους στην επιφάνεια του πρανούς (**Σχήμα 1**). Η προσομοίωση της αναπήδησης είναι ιδιαιτέρως πολύπλοκη και δεν επιδέχεται αναλυτικής λύσης. Έτσι, έχει επικρατήσει να γίνεται απλουστευμένα με την χρήση των συντελεστών αναπήδησης, που περιγράφουν την απώλεια ταχύτητας ή ενέργειας εξαιτίας της κρούσης.



Σχήμα 1. Τύποι κίνησης στις καταπτώσεις βράχων (Descoeudres and Zimmermann, 1987)

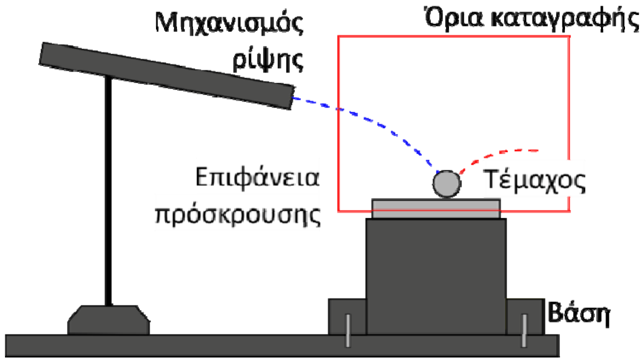
Γενικώς, στη σχετική βιβλιογραφία διατίθεται πλήθος μαθηματικών ορισμών για τους συντελεστές αναπήδησης, χωρίς να είναι σαφές ποιος περιγράφει καλύτερα την αναπήδηση. Οι τιμές που χρησιμοποιούνται στις πρακτικές εφαρμογές επιλέγονται βάσει της φύσης του υλικού που δομεί το πρανές. Για τον σκοπό αυτό υπάρχουν προτεινόμενες τιμές που θεωρούνται ως χαρακτηριστικές των υλικών. Ωστόσο, παρουσιάζουν σημαντικό εύρος μεταξύ διαφορετικών διερευνήσεων, απόρροια των πολλών και ευμετάβλητων παραμέτρων που επηρεάζουν την απόκριση του τεμάχους (**Σχήμα 2**).

Η προσέγγιση της παρούσας έρευνας βασίζεται στην πειραματική διερεύνηση και στον επαγωγικό λογισμό. Πιο συγκεκριμένα, αναπτύχθηκαν πειραματικές διατάξεις πρόσφορες για την παραμετρική διερεύνηση της αναπήδησης και πραγματοποιήθηκε σημαντικός αριθμός δοκιμών στο εργαστήριο και στο πεδίο. Τα αποτελέσματα αξιοποιήθηκαν για τον προσδιορισμό των κρισιμότερων παραμέτρων που επηρεάζουν την απόκριση του τεμάχους και για την κατάρτιση εμπειρικών συσχετίσεων και μεθοδολογιών εκτίμησης των χαρακτηριστικών της διαγραφόμενης τροχιάς.



Σχήμα 2. Σύγκριση των βιβλιογραφικών τιμών του καθέτου και του εφαπτομενικού συντελεστή αναπήδησης (σημεία) με τις προτεινόμενες στο λογισμικό RocFall (κυκλικά χωρία) ανάλογα με την σύσταση του πρανούς

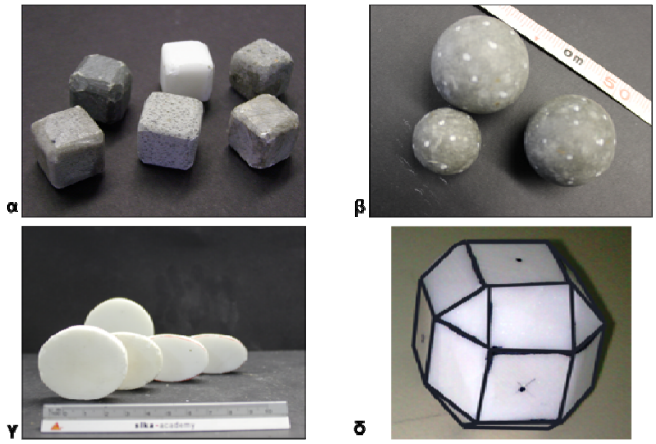
Γενικώς, η εκτέλεση μιας δοκιμής για τον προσδιορισμό των συντελεστών αναπήδησης είναι εύκολα πραγματοποιήσιμη, καθώς αρκεί η απελευθέρωση και πτώση ενός τεμάχους σε μια βάση πρόσκρουσης με ταυτόχρονη καταγραφή της κίνησης (**Σχήμα 3**). Ωστόσο, δεν υφίσταται κανονιστικό πλαίσιο για την διεξαγωγή τέτοιων δοκιμών, με επακόλουθο να μην είναι ευχερής η αξιολόγηση των αποτελεσμάτων από άλλες σχετικές διερευνήσεις.



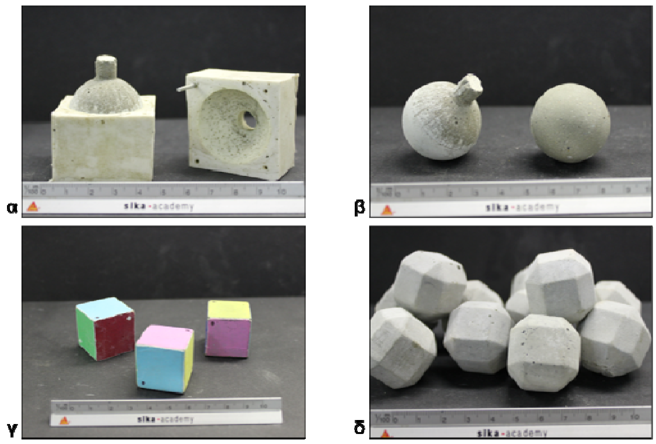
Σχήμα 3. Τυπική διάταξη για την εκτέλεση δοκιμών στο εργαστήριο

Οι δοκιμές πραγματοποιήθηκαν, στο πλαίσιο της παρούσας έρευνας, με φυσικά πετρώματα και με τεχνητά υλικά, για τα οποία προσδιορίστηκαν οι φυσικές και μηχανικές ιδιότητας σύμφωνα με τις εκάστοτε προδιαγραφές. Τα τεχνητά υλικά εμφανίζουν σημαντικά πλεονεκτήματα στην διαμόρφωση των τεμαχών και την συστηματοποίηση της επεξεργασίας. Χρησιμοποιήθηκαν τεμάχη διαφόρων σχημάτων (**Σχήμα 4 και 5**) που απελευθερώθηκαν, από κατάλληλους μηχανισμούς ρίψης, σε ελεύθερη πτώση ή παραβολική τροχιά και προσέκρουαν σε επιφάνειες με διαφορετικά χαρακτηριστικά.

Γενικώς, η κίνηση του τεμάχους ολοκληρώνεται σε ιδιαιτέρως σύντομο χρονικό διάστημα, οπότε η καταγραφή γίνεται συνήθως με φωτομηχανές ταχείας λήψης. Δόθηκε ιδιαίτερη έμφαση στην αναγνώριση και στον εντοπισμό της θέσης του τεμάχους στις καταγραφές, ενσωματώνοντας στην επεξεργασία τεχνικές μηχανικής όρασης. Έτσι, αυξήθηκε δραστικά η ακρίβεια προσδιορισμού της τροχιάς και συγχρόνως περιορίσθηκε ο απαιτούμενος χρόνος επεξεργασίας, συγκριτικά με τον χειροκίνητο εντοπισμό του. Τούτο, επέτρεψε την εκτέλεση σημαντικού πλήθους δοκιμών στις ελεγχόμενες συνθήκες του εργαστηρίου, απομονώνοντας συγκεκριμένες κάθε φορά παραμέτρους για τον προσδιορισμό της επίδρασής τους.

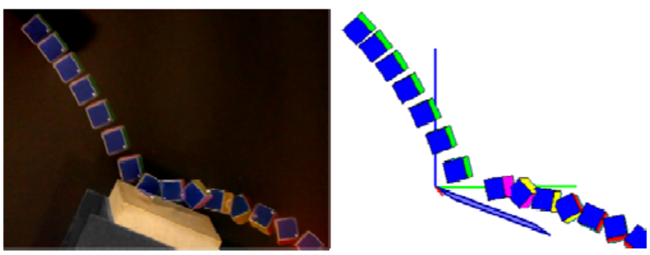


Σχήμα 4. Τεμάχη από φυσικά υλικά: α. κυβικά με λειασμένες ακμές, β. σφαιρικά, γ. ελλειπτικοί δίσκοι και δ. πολυεδρικά.



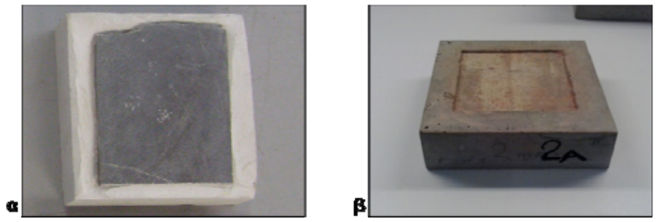
Σχήμα 5. Τεμάχη από τεχνητό υλικό: α. εκμαγείο σιλικόνης για την διαμόρφωση σφαιρικών τεμαχών, β. σφαιρικό δοκίμιο μετά την σκλήρυνση του ενέματος και στην τελική του μορφή, γ. κυβικά τεμάχη χρωματικά κωδικοποιημένα και δ. πολυεδρικά.

Αν και το φαινόμενο εξελίσσεται στον τριδιάστατο χώρο, μέχρι πρόσφατα σπανίως λαμβανόταν υπόψη η τρίτη διάσταση στις σχετικές έρευνες, αλλά και στα λογισμικά προσομοίωσης. Στην παρούσα έρευνα, εφαρμόσθηκαν στερεοφωτογραμμετρικές μέθοδοι στην επεξεργασία των καταγραφών (**Σχήμα 6**), επιτρέποντας την ανακατασκευή της τροχιάς στον χώρο και την εξέταση της εκτροπής του τεμάχους εξαιτίας της κρούσης.



Σχήμα 6. Ανακατασκευή τροχιάς με την υπέρθεση των καταγεγραμμένων εικόνων και σύνθεση της πληροφορίας από την επεξεργασία τους σε ψηφιακό περιβάλλον.

Στο εργαστήριο πραγματοποιήθηκαν περίπου 3000 δοκιμές και εξετάστηκε η επίδραση που ασκούν στην διαγραφόμενη τροχιά οι φυσικές και οι μηχανικές ιδιότητες των υλικών καθώς και τα χαρακτηριστικά της κίνησης πριν την κρούση. Όσον αφορά στο τέμαχος, εξετάστηκε η επίδραση της μάζας, του σχήματος της ταχύτητας και της γωνίας πρόσκρουσης. Για τις επιφάνειες πρόσκρουσης εξετάσθηκε η επίδραση της τραχύτητας, της αποσάθρωσης, της επικάλυψης με εδαφικό υλικό και της διαφοροποίησης του τύπου του υλικού σε σχέση με αυτό του τεμάχους (**Σχήμα 7**). Επίσης διερευνήθηκε η επίδραση του προσανατολισμού της επιφάνειας πρόσκρουσης σε σχέση με την διεύθυνση της τροχιάς του πίπτοντος τεμάχους.



Σχήμα 7. Επιφάνειες πρόσκρουσης: α. από φυσικό υλικό (χαλαζιακός ψαμμίτης) εγκιβωτισμένη σε συνδετική κονία και β. με εγκοπή που πληρώνεται με εδαφικό υλικό.

Στο πεδίο οι δοκιμές έγιναν σε 3 φάσεις, όπου εκτελεστήκαν συνολικά περίπου 300 δοκιμές. Σκοπός ήταν να εξετασθεί η δυνατότητα αναγωγής των συμπερασμάτων της εκτενούς εργαστηριακής διερεύνησης στην πραγματική κλίμακα του φαινομένου. Έτσι, οι δοκιμές αυτές πραγματοποιήθηκαν αναπαράγοντας, όσο ήταν εφικτό, τις συνθήκες του εργαστηρίου στην ύπαιθρο (**Σχήμα 8**).

Σχήμα 8. Διάταξη επιτόπου δοκιμών στη Σπηλιά Νταβέλη στην Πεντέλη

Τα αποτελέσματα της παρούσας έρευνας είναι εν γένει σε συμφωνία με τα αναφερόμενα στην σχετική βιβλιογραφία. Ωστόσο, δεδομένου του πλήθους των δοκιμών και των παραμέτρων που διερευνήθηκαν, προκύπτει η μεταξύ τους αλληλεπίδραση. Έτσι, συμπληρώνεται, ή σε ορισμένες περιπτώσεις αναθεωρείται, η υφιστάμενη γνώση αναφορικά με τις κρίσιμες παραμέτρους και τον τρόπο που επηρεάζουν την απόκριση του τεμάχους. Ποιοτικά συνοψίζονται ακολούθως:

Εκκινώντας από την κρούση σε μια διάσταση, δηλαδή από την περίπτωση της ελεύθερης πτώσης τεμαχών βράχου, τα σημαντικότερα συμπεράσματα της παρούσας έρευνας έχουν ως εξής:

- Το μέγεθος της αναπήδησης σχετίζεται καλύτερα με τη σκληρότητα που προσδιορίζεται από τη σφύρα Schmidt. Γενικώς, η αναπήδηση είναι μεγαλύτερη σε σκληρότερα υλικά, ενώ όταν η κρούση γίνεται μεταξύ ανόμοιων υλικών τότε η σκληρότητα της επιφάνειας πρόσκρουσης έχει σημαντικότερη επίδραση από αυτήν του τεμάχους. Επίσης, μέσω της σκληρότητας της επιφάνειας πρόσκρουσης δύναται να ληφθεί υπόψη και η επίδραση της αποσάθρωσης

- Η αναπήδηση εξαρτάται από την ένταση της κρούσης, καθώς αυτή καθορίζει την έκταση των παραμορφώσεων και κατ' επέκταση την απώλεια ενέργειας. Έτσι, η αύξηση είτε της μάζας του τεμάχους είτε της ταχύτητας πρόσκρουσης οδηγούν στον περιορισμό της αναπήδησης

- Η ορμή, δηλαδή το γινόμενο της μάζας με την ταχύτητα πρόσκρουσης, περιγράφει ικανοποιητικά την επίδραση που έχει η σφοδρότητα της κρούσης στην αναπήδηση

- Η ύπαρξη εδαφικής επικάλυψης της βραχώδους επιφάνειας πρόσκρουσης προκαλεί περιορισμό της αναπήδησης, με το πάχος της στρώσης, τη σύσταση και την κατάσταση του υλικού επικάλυψης να καθορίζουν το μέγεθος της. Η αύξηση του πάχους της στρώσης περιορίζει την αναπήδηση. Σε ξηρή κατάσταση, η αναπήδηση είναι μικρότερη στα χονδρόκοκκα υλικά από ό,τι στα λεπτόκοκκα. Ωστόσο, αν πρόκειται για αργιλική στρώση, η αύξηση της περιεκτικότητας σε νερό έχει ως αποτέλεσμα το υλικό να γίνεται υδαρές, συνεπώς παραμορφώνεται περισσότερο, οπότε περιορίζεται η αναπήδηση

- Όταν το σχήμα του τεμάχους είναι σφαιρικό, η διαγραφόμενη τροχιά μετά την κρούση αποκλίνει ελάχιστα από την κατακόρυφο και το ύψος αναπήδησης είναι, εν γένει, επαναλήψιμο. Όμως, όταν το σχήμα του τεμάχους είναι γωνιώδες, η τροχιά του μετά την κρούση καθορίζεται από την γεωμετρία επαφής και μπορεί να έχει οποιαδήποτε γωνία σε σχέση με την κατακόρυφο. Ωστόσο, όταν η τροχιά της αναπήδησης είναι σχεδόν κατακόρυφη, τότε το μέγεθός της προσεγγίζει αυτό των σφαιρικών τεμαχών, ενώ στις υπόλοιπες περιπτώσεις είναι μικρότερο

Στην συνήθη περίπτωση, η τροχιά του τεμάχους πριν την κρούση σχηματίζει γωνία με την επιφάνεια πρόσκρουσης, καθιστώντας το πρόβλημα διδιάστατο.

- Η αναπήδηση εξακολουθεί να είναι μεγαλύτερη στα σκληρότερα υλικά, αλλά η διακύμανσή της καθορίζεται κυρίως από την γωνία πρόσκρουσης και το σχήμα του τεμάχους

- Στα σφαιρικά τεμάχη, το μέγεθος της αναπήδησης συνδέεται με την κάθετη συνιστώσα της ορμής ως προς την επιφάνεια πρόσκρουσης. Όπως και στην ελεύθερη πτώση, η αύξηση της ορμής πρόσκρουσης έχει ως αποτέλεσμα τον περιορισμό της αναπήδησης.

- Στα γωνιώδη τεμάχη, όσο μειώνεται η γωνία πρόσκρουσης αυξάνεται η διακύμανση των χαρακτηριστικών της τροχιάς μετά την κρούση, δηλαδή του μεγέθους της ταχύτητας και της γωνίας αναπήδησης

- Η τραχύτητα της επιφάνειας πρόσκρουσης έχει παρόμοια επίδραση στην διαγραφόμενη τροχιά με το σχήμα του τεμάχους

- Τόσο το σχήμα του τεμάχους όσο και η τραχύτητα της επιφάνειας πρόσκρουσης καθορίζουν την γεωμετρία επαφής. Συνεπώς, η μη κανονικότητα του σχήματος και της επιφάνειας πρόσκρουσης έχουν ως αποτέλεσμα την αύξηση της διακύμανσης που έχει η διεύθυνση της τροχιάς μετά την κρούση. Έτσι, η γεωμετρία επαφής θεωρείται ως η σημαντικότερη αιτία που προκαλεί την τυχαιότητα της τροχιάς μετά την πρόσκρουση

- Η γωνιακή ταχύτητα του τεμάχους δεν φάνηκε να επηρεάζει την αναπήδηση, τουλάχιστον στην μακροσκοπική προσέγγιση που ακολουθήθηκε στην παρούσα έρευνα. Ωστόσο, εφόσον μελετηθεί διεξοδικά η επίδραση της γεωμετρίας επαφής, αναμένεται η επίδρασή της να είναι ευκρινής

Τέλος, εξετάζοντας την τροχιά στις τρεις διαστάσεις, προκύπτει ότι η εκτροπή του τεμάχους, από το κατακόρυφο επίπεδο κίνησης πριν την κρούση, μπορεί να έχει σημαντικό μέγεθος και πρέπει να λαμβάνεται υπόψη στο σχεδιασμό. Το μέγεθος της εκτροπής καθορίζεται από το σχήμα του τεμάχους, την κλίση της επιφάνειας πρόσκρουσης και τον σχετικό προσανατολισμό μεταξύ της τροχιάς και της επιφάνειας πρόσκρουσης. Πιο συγκεκριμένα, η εκτροπή αυξάνεται:

- με την αύξηση της γωνιότητας του τεμάχους. Γενικώς, τα σφαιρικά τεμάχη εμφανίζουν αμελητέα εκτροπή και στα κυβικά τεμάχη το μέγεθός της είναι σημαντικό

- με την μείωση της κλίσης της επιφάνειας πρόσκρουσης

- με την αύξηση της διαφοράς διεύθυνσης μεταξύ της τροχιάς πριν την κρούση και την φορά μεγίστης κλίσης της επιφάνειας πρόσκρουσης

Επίσης, προτείνονται νέες μέθοδοι για την εκτίμηση της διαγραφόμενης τροχιάς. Πιο συγκεκριμένα, διατυπώνεται μια συσχέτιση για την εκτίμηση του καθέτου συντελεστή αναπήδησης που εξαρτάται από την σκληρότητα του υλικού και την ορμή του τεμάχους κατά την πρόσκρουση για την απλή περίπτωση της ελεύθερης πτώσης τεμαχών σφαιρικού σχήματος. Οι επιδράσεις του σχήματος και της γωνίας πρόσκρουσης εισάγονται στην εν λόγω σχέση, μέσω διορθωτικών συντελεστών, επιτρέποντας την γενίκευσή της ώστε να εφαρμόζεται στην συνήθη περίπτωση της κεκλιμένης κρούσης ακανόνιστου τεμάχους. Επίσης, καταρτίζεται μια μεθοδολογία, βάσει των χαρακτηριστικών της πρόσκρουσης, για τον προσδιορισμό της διακύμανσης του καθέτου συντελεστή και της γωνίας αναπήδησης, από τα οποία και μπορεί να εκτιμηθεί με ακρίβεια η διαγραφόμενη τροχιά. Τέλος, προτείνεται μια σχέση για την εκτίμηση του εύρους της εκτροπής, εξαιτίας της κρούσης, που λαμβάνει υπόψη την διεύθυνση της τροχιάς πριν την κρούση, την φορά μεγίστης κλίσης και την κλίση της επιφάνειας πρόσκρουσης.

Η κατάρτιση των παραπάνω συσχετίσεων και μεθοδολογιών έγινε με βάση τις εργαστηριακές δοκιμές και οι επιτόπου δοκιμές χρησιμοποιήθηκαν για την αξιολόγηση της αξιοπιστίας τους. Δεδομένου ότι η απόκριση των τεμαχών στο πεδίο προσεγγίζεται αρκούντως ικανοποιητικά από τις προτεινόμενες σχέσεις, συμπεραίνεται πως η γενίκευσή τους στην πραγματική κλίμακα του φαινομένου είναι εφικτή, με αποτέλεσμα να αποτελούν χρήσιμα εργαλεία για τον ορθολογικότερο σχεδιασμό των μέτρων αντιμετώπισης των καταπτώσεων βραχωδών τεμαχών.

Η διατριβή υποβλήθηκε στην Σχολή Πολιτικών Μηχανικών του Εθνικού Μετσοβίου Πολυτεχνείου προς εκπλήρωση των προϋποθέσεων του τίτλου του Διδάκτορος Μηχανικού.

Η Συμβουλευτική Επιτροπή απετελείτο από τον Καθηγητή Ε.Μ.Π. Γεώργιο Τσιαμπάο, τον Ομότιμο Καθηγητή Ε.Μ.Π. Παύλο Μαρίνο και τον Αναπληρωτή Καθηγητή (ε.σ.) Βασίλειο Παπαδόπουλο.

Η Εξεταστική Επιτροπή αποτελείτο από τον Καθηγητή Ε.Μ.Π. Γεώργιο Τσιαμπάο, τον Ομότιμο Καθηγητή Ε.Μ.Π. Παύλο Μαρίνο και τον Αναπληρωτή Καθηγητή (ε.σ.) Βασίλειο Παπαδόπουλο, τον Καθηγητή Ε.Μ.Π. Αλέξανδρο Σοφιανό, τον Καθηγητή Πανεπιστημίου Πατρών Νικόλαο Σαμπατακάκη, τον Αναπληρωτή Καθηγητή Ε.Μ.Π. Μιχαήλ Καββαδά και τον Associate Prefessor of the University of Michigan Δημήτριο Ζέκκο.

Η υποστήριξη της διατριβής έγινε στις 30 Μαΐου 2016.

Το πλήρες κείμενο της διατριβής είναι διαθέσιμο στον σύνδεσμο: http://dspace.lib.ntua.gr/handle/123456789/42685.

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

Για τις παλαιότερες καταχωρήσεις περισσότερες πληροφορίες μπορούν να αναζητηθούν στα προηγούμενα τεύχη του «περιοδικού» και στις παρατιθέμενες ιστοσελίδες.

S3: Slopes, Slides and Stabilization, August 1-3, 2016, Denver, USA, events@dfi.org

6th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics August 1-6, 2016, Greater Noida (NCR), India, www.6icragee.com

EUROC 2016 - ISRM European Regional Symposium Rock Mechanics & Rock Engineering: From Past to the Future, 29-31 August 2016, Ürgüp-Nevşehir, Cappadocia, Turkey http://eurock2016.org

ICEGE 2016 1st International Conference on Energy Geotechnics, 29-31 August 2016, Kiel, Germany, www.iceg-2016.de

International Symposium Qualification of Dynamic Analyses of Dams and their Equipments and of Probabilistic Assessment of Seismic Hazard in Europe, 31 August - 2 September 2016, Saint-Malo, France, www.barrages-cfbr.eu/2016-Barrages-et-seismes.html

3rd ICTG – 3rd International Conference on Transportation Geotechnics 4 - 7 September 2016, Guimaraes, Portugal, www.civil.uminho.pt/3rd-ICTG2016

IAS'5 5th International Conference on Geotechnical and Geophysical Site Characterisation, 5-9 September 2016, Gold Coast, Queensland, Australia, http://www.isc5.com.au

Urban Underground Space & Tunneling Asia Summit 2016, September 6-9, 2016, Singapore, www.equip-global.com/urban-underground-space-and-tunnelling-asia-summit-2016

The World Multidisciplinary Earth Sciences Symposium–WMESS 2016, 5-9 September 2016, Prague, Czech Republic www.mess-earth.org

3rd European Conference on Unsaturated Soils E-UNSAT 2016, 12-14 September 2016, Paris, France, http://eunsat2016.sciencesconf.org

ACCUUS 2016 15th World Conference Underground Urbanisation as a Prerequisite for Sustainable Development, September 12-15, 2016, http://acuus2016.com

SAHC 2016 - 10th international Conference on Structural Analysis of Historical Constructions 13-15 September 2016, Leuven, Belgium, www.sahc2016.be

Hydropower Development Europe 2016 - Flexible hydropower and pump storage generation for a safe renewable electricity system, 14 – 15 September 2016, Lyon, France, http://www.wplgroup.com/aci/event/hydropower-development-europe-2016

13 Baltic States Geotechnical Conference Historical Experiences and Challenges of Geotechnical Problems in Baltic Sea Region, 15 - 17 September 2016, Vilnius, Lithuania, http://www.13bsgc.lt

Dam Surveillance Practice - 3rd Experts Seminar, 18 - 23 Sep 2016, Landeck, Tyrol, Austria, www.atcold.at/de/home-1/41-2016-veranstaltungen/155-dam-surveillance-practice-2016

ACE 2016 12th International Congress on Advances in Civil Engineering, 21-23 September 2016, Istanbul, Turkey, http://www.ace2016.org

International Geotechnical Engineering Conference on Sustainability in Geotechnical Engineering - Practices and Related Urban Issues, 23-24 September 2016, Powai, Mumbai, India, www.igsmumbaichapter.in

EuroGeo 6 – European Regional Conference on Geosynthetics, 25 – 29 Sep 2016, Istanbul, Turkey, www.eurogeo6.org

8th Nordic Grouting Symposium State of the art – Future Development, 26-27 September 2016, Oslo, Norway, http://nordicgrouting.com

International Conference on
Problematic Soils and Ground Improvement
September 26-28th, 2016, Bandung, Indonesia
www.softsoils2016.org

The Committee of International Conference on Problematic Soils and Ground Improvement (Soft Soils 2016) cordially invite you to participate and contribute papers in the conference. The committee of Soft Soils 2016 also warmly welcomes members of the Indonesian Geotechnical Society, the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE), geotechnical engineers, engineering geologists, environmental engineers, consultants, contractors, government employees and all interested parties to attend and share knowledge in this important conference.

This conference is a synergy of cooperation between Civil Engineering Department, Faculty of Engineering Universitas Katolik Parahyangan and Universiti Tun Hussein Onn Malaysia (UTHM) under the auspices of Indonesian Geotechnical Society (HATTI) and International Society of Soil Mechanics and Foundation Engineering (ISSMGE). A number of outstanding keynote speakers have been invited to deliver excellent lectures and technical papers are presented for exchange of ideas and for discussions among practical engineers.

Two short courses are arranged to share the knowledge of outstanding engineers on the practical solutions. The first one is on Problematic Soils and Their Countermeasures and the second one is on the use of CPTu on Problematic Soils which is very effective in identification of soft soil behavior.

We would like to encourage you to explore the Soft Soils 2016 website, www.softsoils2016.org, to keep updated about the program. We are looking forward to see you participate in this conference in Bandung, Indonesia.

Problematic soils in most parts of the Asian countries have been one of the major challenge for infrastructure planning and implementation. On the other hand, they pose opportunities in research and technology development for testing, modelings and ground improvement. Contractors and Practical Engineers always struggle to face design and construction problem and owners need to consider additional cost for solutions as well as maintenance.

Despite the difficulties, ground improvement is one of the solution which is effective including the use of wick drains, vibro-compaction, dynamic compaction and grouting technique, Insitu Reinforcement (soil nailing, stone column, micropiles, jet grouting, deep mixing method, and permanent ground anchor), Reinforcement of constructed Earth and the Use of Geotextile for wall and embankment and for foundations and subgrade improvement, Chemical admixtures including the use of soil cement, lime columns and other miscellaneous methods.

Many universities, research institutions, contractors and geotechnical consultants mainly in Asia have gained experience and knowledge which are suitable for particular sites. Case histories are also of significant values for the state of the art practice. Hence the conference is very important event for exchange of ideas and experience and for contribution among Asian countries and all over the world.

Contact

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5th International Scientific Conference on Industrial and Hazardous Waste Management, 27 - 30 September 2016, Chania, Crete, Greece, http://hwm-conferences.tuc.gr

Basements and Underground Structures 2016, 5-6 October 2016, London, United Kingdom, https://basements.geplus.co.uk

2nd International Specialized Conference on Soft Rocks – ISRM 2016 Understanding and interpreting the engineering behavior of Soft Rocks, 6-7 October 2016, Cartagena, Colombia, www.scg.org.co/?p=1634

HYDRO 2016 - Achievements, opportunities and challenges 10-12 October 2016, Montreux, Switzerland, www.hydropower-dams.com/hydro-2016.php?c_id=88

The British Tunnelling Society Conference and Exhibition 2016, October 11 – 12, 2016, London, United Kingdom, www.btsconference.com

65th Geomechanics Colloquium 2016, Georg Feder Colloquium, October 13 - 14th, 2016, Salzburg, Austria, www.oegg.at/en/geomechanics-colloquium-3/65th-geomechanics-colloquium-2016-georg-feder-colloquium-79

ARMS 9, 9th Asian Rock Mechanics Symposium, ISRM Regional Symposium, 18-20 October 2016, Bali, Indonesia, http://arms9.com

SFGE 2016 Shaping the Future of Geotechnical Education International Conference on Geo-Engineering Education 20 - 22 October 2016, Minascentro, Belo Horizonte, MG, Brazil, http://cobramseg2016.com.br/index.php/sfge-sobre/?lang=en

10th ICOLD European Club Symposium & Exhibition, 25-30 October 2016, Antalya, Turkey, http://trcold.com

1st International Symposium on Seismic Rehabilitation of Heritage Structures 30-31 October 2016, Tehran, Iran, www.srhs.ir

NEMO International Conference Probing the Santorini volcano for 150 years / Διεθνές συνέδριο NEMO 150 χρόνια μελέτης ηφαιστείου της Σαντορίνης, 3-5 November 2016, Santorini, Greece, http://nemo.conferences.gr

GeoAsia 6 - 6th Asian Regional Conference on Geosynthetics 8-11 November 2016, New Delhi, India, http://seags.ait.asia/news-announcements/11704

3rd Annual Underground Infrastructure & Deep Foundations UAE, 13 - 15 November 2016, Dubai, United Arab Emirates, www.undergrounduae.com

Risk Management in Underground Construction, November 14-16, 2016, Florida University, USA, http://undergroundriskmanagement.com/agenda

5th International Conference on Geotechnical Engineering and Soil Mechanics, 15-17 November 2016, Tehran, Iran, www.icgesm2016.ir

RARE 2016 Recent Advances in Rock Engineering 16-18 November 2016, Bangalore, India, www.rare2016.in

TBM DiGs Istanbul 2016 2nd International conference on "TBM DiGs in difficult grounds", 16-18 November 2016, Istanbul, Turkey, www.tbmdigsturkey.org

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International Seminar on Roads, Bridges and Tunnels
18-24 November 2016, Thessaloniki, Greece
http://isrbt2016.civil.auth.gr

The School of Civil Engineering along with the Highway Engineering Laboratory of the Aristotle University of Thessaloniki (AUTh), Greece, organize theInternational Seminar on Roads, Bridges and Tunnels.

The seminar is addressed to:

Construction Engineers, Engineers of International Projects, Scholars, Road Engineering Designers, Construction Managers, Contractors, Motorway Operators, Road Engineers, Bridge Engineers, Tunnel Engineers, Motorway Concessionaire, State Engineers, QA and QC Engineers.

Scope – objectives

During the last two decades, a great number of major construction projects have been carried out in Greek territory, namely, the Egnatia Motorway, the suspended Rio-Antirrio bridge, the Attica Motorway, the Athens Airport, the Olympic Games edifices, Metrorail projects and other. In this gigantic operation of infrastructure development, local and foreign engineers, contractors and managers, academics and designers, strived to produce high quality assets through innovative methods of construction. The residual value, that is, the applied engineering knowledge combined with valuable external expertise may prove a powerful means for succeeding in difficult construction projects of international character.

Seminar lectures are intended to address practical aspects of construction, aiming, especially, to enlighten the applied part of the engineering know-how, useful to professionals of international prospects. Young, but also experienced, engineers will get acquainted with a wide range of innovative methods of construction in the fields of roads, bridges and tunnels. Specific Sessions for the topics of "Construction Management" and "Motorway Safety and Operations" are also included to give the insight into these important issues in terms of rationalism and efficiency.

Topics

ISRBT2016 seminar Topics/Lectures will cover the following subjects:

- Construction management of motorway projects
- Motorway concession projects
- Motorway construction projects in international context
- Road alignment, earthworks and environment
- Landsides and stabilization measures
- Construction techniques for motorway embankments
- Construction methods for bridges
- Suspended bridges
- Bridges on prestressed box beams
- NATM tunnelling method for motorways
- "Cut and cover" and "Cover and cut" methods
- Motorway pavements and asphalt courses
- Traffic safety on motorways

For any further information please contact:

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(for the ISRBT2016 Seminar)
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Aristotle University of Thessaloniki
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Greece

GEOTEC HANOI 2016, The 3rd International Conference on Geotechnics for Sustainable Infrastructure Development, 24-25 November, Hanoi, Vietnam, www.geotechn.vn

Pinpointing project opportunities and exploring innovation in tunnelling
7-8 December 2016, London, U.K.
https://tunnelling.newcivilengineer.com

New Civil Engineer is delighted to announce dates for the 10th annual Tunnelling Summit – the annual gathering for the decision-makers and influencers from across the tunnelling industry. Taking place on 7 – 8 December in London, this year's event will once again bring together the leaders of the industry to explore pipeline projects, share best practice from UK and international schemes and explore the latest technology and innovation making an impact on tunnelling projects.

This year's event is firmly focused on providing you with an update on current and future projects and the opportunities available for the industry to shape and deliver those schemes. Major projects of focus this year include:

- HS2
- Tideway
- Crossrail 2
- Silvertown Link
- National Grid's power tunnels
- London Underground Future Stations Programme
- Bank Station capacity upgrade
- Trans-Pennine Tunnel

NCE Tunnelling Summit - Customer Services:
+44 (0) 203 033 2609 | NCEEvents@emap.com

5th International Conference on Forensic Geotechnical Engineering, 8-10 December 2016, Bangalore, Karnataka, India, http://5icfge.com

International Symposium on Submerged Floating Tunnels and Underwater Tunnel Structures (SUFTUS-2016), 16—18 December 2016, Chongqing, China, www.cmct.cn/suftus

International Workshop on "Advances in Multiphysical Testing of Soils and Shales", 18-20 January 2017, Villars, Switzerland, http://atmss.epfl.ch

ICNCGE-2017 International Conference on New Challenges in Geotechncial Engineering, 23 January 2017, Lahore, Pakistan, www.pges-pak.org/home/icncge-2017

4th Arabian Tunnelling Conference &
20th Gulf Engineering Forum
21-22 February 2017, Dubai, UAE
www.atcita.com

We are cordially inviting you to join us for the 4th Arabian Tunnelling Conference (ATC 2017), held in conjunction with the 20th Gulf Engineering Forum (GEF 2017),on the 21-22 February 2017 at the Ritz Carlton in Dubai International Financial Center, United Arab Emirates. The ATC is the number one networking hub of Tunnelling and Underground Space experts and professionals in the region. The event will focus on 'Advancing Underground Space' through key activities such as conference, exhibition, Young Engineers Forum, awards and the Gulf Engineering Forum.

Once again, the ATC 2017 will serve as a gathering of key and influential participants who will network with hundreds of the engineering professionals, tunnelling experts and a both regional and international audience. The conference will address challenges and opportunities in advancing under-ground space and connect international experts and partners in the industry to create sustainable solutions and business opportunities. The 20th Gulf Engineering Forum will highlight the industry advances in the Gulf States, and bring together leading delegations from the Gulf Engineering Union.

Endorsed by the International Tunnelling and Underground Space Association (ITA), Society of Engineers-UAE will organize the ATC2017. Our technical program will present leading-edge technology, updates, significant developments and best practices that support advances in tunnelling and underground space use for infrastructure, transportation, telecommunication, energy, water, storage facilities, waste management and urban planning.

We are developing a stimulating programme with inspiring, fresh subject matter. This milestone event will explore advances in the underground space sector and will present case studies and strategies that demonstrate innovation, skills and best practices that will assist delegates in advancing both their knowledge and the industry.

Through keynote presentations, parallel sessions and networking, delegates will find ample opportunities to learn new and exciting developments, and mingle with colleagues and leading experts from all over the world.

Conference secretariat

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AFRICA 2017 - Water Storage and Hydropower Development for Africa, 14-16 March 2017, Marrakech, Morocco, www.hydropower-dams.com/AFRICA-2017.php?c_id=89

2nd International Conference on Geotechnical Research and Engineering (ICGRE'17)
April 3 - 4, 2017, Barcelona, Spain
http://icgre.org

The 2nd International Conference on Geotechnical Research and Engineering (ICGRE'17) aims to become the leading annual conference in fields related to geotechnical engineering. The goal of ICGRE'17 is to gather scholars from all over the world to present advances in the relevant fields and to foster an environment conducive to exchanging ideas and information. This conference will also provide an ideal environment to develop new collaborations and meet experts on the fundamentals, applications, and products of the mentioned fields.

Topics:

- Dams
- Engineering Geology
- Geoenvironmental related topics
- Geohazards
- Geotechnical Infrastructure
- Geotechnical Structure
- Geosynthetics and Geoproducts
- Marine Geotechnics
- Mining and Geotechnics
- Modelling and Design
- Soil and Rock Mechanics and Characterization
- Sustainable development, education and safety
- Terrain Characterization
- Transportation geotechnics

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EURO:TUN 2017
IV International Conference on Computational Methods in Tunneling and Subsurface Engineering
18 – 20 April 2017, Innsbruck, Austria
www.eurotun2017.com

Conference Objectives

Computational models and methods in tunneling and subsurface engineering have been evolving from the research state to well accepted tools in underground engineering. Together with advanced exploration and monitoring techniques nowadays they play an important role in the design, construction and maintenance of complex underground structures. However, important new issues are to be addressed because of the continuously increasing complexity of the analyzed underground structures and the substantial research efforts for further advancing computational models and methods.

EURO:TUN 2017 is the fourth conference of a series of successful ECCOMAS Thematic Conferences on Computational Methods in Tunneling, started in 2007 in Vienna and continued in 2009 and 2013 in Bochum. Like the previous conferences, EURO:TUN 2017 will provide an excellent overview of the current state of research and future perspectives of numerical modeling and computational technologies in underground construction. By discussing recent developments, applications and by identifying future research needs and challenges, the further development of computational prognosis models and methods in tunneling and subsurface engineering will be promoted.

Conference Topics

Topics related to recent advances in numerical models and computational methods for the design, construction and maintenance of tunnels and underground facilities include:

- spatial and temporal discretization strategies for static and dynamic numerical analyses at various scales
- advanced constitutive models for geological materials and materials used for supporting measures, including multi-phase and multi-scale models
- model identification and sensitivity analysis
- validation of numerical models by in-situ measurement data
- case studies for underground structures
- computer aided process control
- computational methods in ground exploration
- computational life cycle management, life time assessment, smart tunnels and embedded monitoring
- logistics modeling and data management
- soft computing, visualization, data mining and expert systems
- uncertainty modeling and risk analysis
- other related topics

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TechnoHeritage 2017 3rd International Congress Science and Technology for the Conservation of Cultural Heritage, May 20-23, 2017, Cádiz, Spain, http://technoheritage2017.uca.es

EPS'17 5th International Conference on the Use of EPS Geofoam Blocks in Construction Applications, 22-24 May 2017, Istanbul, Turkey, www.geofoam2017.org

Rapid Excavation and Tunneling Conference, June 4-7, 2017, San Diego, USA, www.retc.org

World Tunnel Congress 2017 Surface challenges – Underground solutions, 9 to 16 June 2017, Bergen, Norway, www.wtc2017.no

EUROCK 2017 Human Activity in Rock Masses, 20-22 June 2017, Ostrava, Czech Republic, www.eurock2017.com

BCRRA 2017 Tenth International Conference on the Bearing Capacity of Roads, Railways and Airfields, 28th to 30th June 2017, Athens, Greece, www.bcrra2017.com

GeoMEast2017, 15 - 19 July 2017, Sharm El-Sheik, Egypt, www.geomeast2017.org

3rd International Conference on Performance-based Design in Earthquake Geotechnical Engineering (PBD-III), July 16 - 19, 2017, Vancouver, Canada, http://pbdiiivancouver.com

19th International Conference on Soil Mechanics and Geotechnical Engineering, 17 - 22 September 2017, Seoul, Korea, www.icsmge2017.org

AfriRock 2017, 1st African Regional Rock Mechanics Symposium, 2 – 7 October 2017, Cape Town, South Africa, www.saimm.co.za/saimm-events/upcoming-events/afrirock-2017

Geotechnique Symposium in Print 2017
Tunnelling in the Urban Environment
http://www.icevirtuallibrary.com/pb-assets/Call%20for%20Papers/Geo-Symposium-CFA-AW.pdf

Tunnelling in the urban environment is booming worldwide. In the UK alone the underground works for Crossrail are almost complete, major underground station upgrades are under way, while several other major infrastructure tunnelling projects are in preparation (e.g. Tideway, HS2). Understanding and accurately predicting the ground and structural response to tunnelling and the associated risks are vital in such projects. This is fundamental to safeguarding the urban fabric, such as existing infrastructure for transport and services and historic and sensitive structures. The entire scenario is a complex ground-structure boundary value problem with many engineering challenges both practically and academically.

This symposium aims to bring together researchers and practitioners interested in the design and construction of tunnelling works. It will provide a platform for sharing knowledge and experience. Abstracts (limited to 200 words) are invited for papers concerning, but not limited to, the following subject areas. Abstracts focusing on practical applications and high quality case studies are particularly welcome.

- Engineering geology and advanced laboratory testing: characterisation of the ground and its potential effects on tunnelling operations and ground movements.

- Numerical and physical modelling: ground response and performance of geotechnical systems during tunnelling.
- Development of innovative monitoring schemes and instrumentation.
- Design methods and innovative solutions to improve the performance of geotechnical systems.
- Case studies: inter-relating field monitoring data with construction activities

If you have any queries, please contact craig.schaper@icepublishing.com.
https://tunnelling.newcivilengineer.com/resources/nce-tunnelling-summit-brochure-2016.

GeoAfrica 2017
3rd African Regional Conference on Geosynthetics
9 – 13 October 2017, Morocco

AFTES International Congress
"The value is Underground"
13-16 November 2017, Paris, France
www.aftes2017.com

AFTES, the French Tunnelling and Underground Space Association, is organising its 15th International Congress, to be held from 13 to 16 November 2017.

The congress with the general theme of «The value is underground » (L'espace souterrain, notre richesse), will highlight the latent value of underground space as a means of developing our living spaces, especially if urban planning harnesses it to establish a symbiosis between ground-level and underground. It will also focus on the abundance of, and the necessity of interweaving know-how and disciplines that are crucial to providing those spaces with a sustainable life.

This topic will be explored over the first three days, in conferences focusing on the optimisation of projects and innovation as from their design phase and through to their construction and equipment with the aim of optimising the operation of actual underground structures and the services and companies they accommodate. The fourth day will be dedicated to underground urban development and the architecture of subsurface structures.

A competition will also be organised for architecture and engineering students on the topic of «Underground, breathing space for the cities of tomorrow» (Le sous-sol, la respiration des villes de demain).

For the first three days, emphasis will also be placed on an exhibition reserved for professionals, bringing together all the players in the field, including project owners, developers, contractors, engineers, architects, urban planners, academics, builders, suppliers and operators. Local government representatives will play an active part in this event, against the backdrop of the launch of Grand Paris worksites which will be visited. Strong delegations from outside France are also expected, especially with the holding of the 2017 Tunneling Awards ceremony during the Congress.

The 4 topics around which the program will be based are:

Topic A: Developing underground space, value to be conquered and harnessed

Demonstrating the relevance and usefulness of a project is of paramount importance, especially when it involves developing underground spaces which call for major investments. This topic is aimed at decision-makers and designers, who are invited to explain their vision and solutions in the face of the constraints and reticence they have to overcome: integrating these structures into a complex environment, the quality of constructions, pleasantness of underground spaces created and project costeffectiveness. The following sub-topics may be covered with reference to feasibility studies, projects carried out and feedback:

- Intregrating transport infrastructure into urban settings
- Creating and offering high-quality, safe and sustainable underground spaces providing innovative solutions to site constraints
- Demonstrating the socioeconomic benefits of underground construction

Topic B: Optimising projects, bringing out tomorrow's value

This topic targets players in the design field who have the job of proposing suitable solutions to the challenges of underground construction. Project optimisation entails the study of sites (geological surveys of sites and their vicinity), design (optimisation of spaces and structures: excavation methods, supports and linings) as well as contractual and project management aspects. The specific question of overall cost is highlighted, as the vision of project owners should go further than the initial construction phase. Optimisation in keeping with a long-term vision also meets some sustainable development requirements. The following subtopics may be covered:

- Planning projects while integrating surveys and environment-related constraints
- Optimising the design of spaces and structures
- Maximising opportunities and managing risks (risk management, insurances)
- Controlling costs with a long-term view: overall cost

Topic C: Capitalising the wealth of feedback and innovating

Contractors, urban planners, architects, project managers and project owners are invited to share their experiences, as regards their successes and also difficulties they have encountered in constructing underground structures. Special emphasis will be placed on innovative solutions. The following topics may be covered:

- Specific challenges related to underground engineering works on urban sites
- Innovative solutions for underground engineering works
- Feedback on underground cities worldwide

- Architects, urban planners and engineers tackling innovation in the field of underground spaces

Topic D: Harnessing and preserving the value of underground heritage

Underground structures constitute an invaluable heritage. They must be equipped with complex systems to ensure their safe and efficient operation. Players contributing to their maintenance and operation are invited to discuss strategies for their operation, servicing, renovation, monitoring and maintenance, as well as innovative solutions that can be implemented to monitor, improve and preserve this heritage.

- Equipping and operating underground cities
- Monitoring and maintaining underground structures
- Renovating structures and diversifying and developing their uses

The congress will also host the ITA Tunneling Awards 2017 ceremony in the following categories:

- Major project of the year - over €500 M
- Remarkable tunnelling project of the year - between €50 M and €500 M
- Outstanding project of the year - up to €50 M
- Renovation / Upgrading project of the year
- Technical innovation of the year
- Environmental initiative of the year
- Safety initiative of the year
- Innovative use of underground space
- Start-up company of the year

World Tunnel Congress 2018
20-26 April 2018, Dubai, United Arab Emirates

EUROCK 2018
22-26 May 2018, Saint Petersburg, Russia

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16th European Conference on Earthquake Engineering (16thECEE), 18-21 June 2018, Thessaloniki, Greece, www.16ecee.org

CPT'18 4th International Symposium on Cone Penetration Testing, 21-22 June 2018, Delft, Netherlands, www.cpt18.org

UNSAT2018 The 7th International Conference on Unsaturated Soils, 3 - 5 August 2018, Hong Kong, China, www.unsat2018.org

11th International Conference on Geosynthetics (11ICG)
16 - 21 Sep 2018, Seoul, South Korea
www.11icg-seoul.org

On behalf of the Organizing Committee, it is my great honor and pleasure to invite you to the 11th International Conference on Geosynthetics (11ICG), which will be held in Seoul, Korea from September 16 to 21, 2018.

The Korean Geosynthetics Society (KGSS) will have the privilege of hosting 11ICG in Korea, and plans to go to great lengths to ensure the conference surpasses all expectations. The 11ICG will provide all participants a firm platform for a meaningful academic, professional, social and cultural experience. The theme of the 11ICG is "Geosynthetics: Innovative Solutions for Sustainable Development," and will cover diverse disciplines of geosynthetics from fundamentals to applications.

With the vision of making a multidisciplinary conference for the geosynthetics industry and engineers, we plan to offer special events as well as a very dynamic and stimulating array of scientific and practical engineering programs. At 11ICG, academia and industry will gather in force to not only show their best, but to share valuable ideas and develop new friendships.

11ICG will provide a comprehensive overview of the most recent developments in the field of geosynthetics, the latest technologies and applications, and a unique and extensive technical exhibition. With fascinating ancient traditions and ultramodern lifestyle, the city of Seoul will surely be the center of many unforgettable moments.

Theme & Topics

Geosynthetics: Innovative Solutions for Sustainable Development

- Sustainability and Green Technology with Geosynthetics
- Geosynthetic Barriers
- Geosynthetics in Filtration, Drainage and Erosion Control

- Reinforced Walls and Slopes
- Ground Improvement Using Geosynthetics
- Roads, Railways and Other Transportation Applications
- Soil-Geosynthetic Interaction
- Hydraulic Applications
- Innovative Uses and New Developments
- Cases Histories
- Durability and Long Term Performance
- Physical and Numerical Analysis
- Geosynthetics Properties and Testing
- Quality Control and Quality Assurance
- Design Approaches and Other Applications

11ICG Secretariat: People-X, Inc.
1F, Haeoreum B/D 16, Yeoksam-ro 17 gil, Yeoksam-dong, Gangnam-gu, Seoul, Korea
Tel. +82-2-566-5950, 6031 Fax. +82-2-566-6087
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Ο3 ΒΟ

ARMS10
10th Asian Rock Mechanics Symposium
ISRM Regional Symposium
October 2018, Singapore
www.arms10.org

Contact Person: Prof. Yingxin Zhou
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Telephone: (+65) 637 65363
Fax: (+65) 627 35754
E-mail: zyingxin@dsta.gov.sg

Ο3 ΒΟ

14th ISRM International Congress
2019, Foz de Iguaçu, Brazil

Contact Person: Prof. Sergio A. B. da Fontoura
E-mail: fontoura@puc-rio.b

Ο3 ΒΟ

ISDCG 2019
7th International Symposium on
Deformation Characteristics of Geomaterials
26-28 June 2019, Strathclyde, Scotland, UK,

Organizer: TC101

Ο3 ΒΟ

The 17th European Conference on
Soil Mechanics and Geotechnical Engineering
1st - 6th September 2019, Reykjavik Iceland
www.ecsmge-2019.com

The theme of the conference embraces all aspects of geotechnical engineering. Geotechnical engineering is the foundation of current as well as future societies, which both rely on complex civil engineering infrastructures, and call for mitigation of potential geodangers posing threat to these. Geotechnical means and solutions are required to ensure infrastructure safety and sustainable development. Those means are rooted in past experiences enhanced by research and technology of today.

At great events such as the European Geotechnical Conference we should: Spread our knowledge and experience to our colleagues; Introduce innovations, research and development of techniques and equipment; Report on successful geotechnical constructions and application of geotechnical design methods, as well as, on mitigation and assessment of geohazards and more.

Such events also provide an opportunity to draw the attention of others outside the field of geotechnical engineering to the importance of what we are doing, particularly to those who, directly or indirectly, rely on our services, knowledge and experience. Investment in quality geotechnical work is required for successful and safe design, construction and operation of any infrastructure. Geotechnical engineering is the key to a safe and sustainable infrastructure and of importance for the society, economy and the environment. This must be emphasized and reported upon.

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

Υπό την έλξη της Σελήνης
Οι παλίρροιες προκαλούν σεισμούς στο ρήγμα του Αγίου Ανδρέα

Το ρήγμα του Αγίου Ανδρέα, ορατό από την επιφάνεια, έχει μήκος 1.300 χιλιόμετρα και θεωρείται ένα από τα πιο επικίνδυνα του κόσμου

Οι σεισμολόγοι θα δήλωναν δύσπιστοι πριν από μια δεκαετία, σήμερα όμως γνωρίζουμε ότι οι παλίρροιες που προκαλεί η βαρυτική έλξη του Ήλιου και της Σελήνης μπορούν να επηρεάσουν ρήγματα και να προκαλέσουν ασθενείς σεισμούς.

Η τελευταία μελέτη στην επιθεώρηση PNAS(*) εξετάζει το διαβόητο ρήγμα του Αγίου Ανδρέα, μια γιγάντια ρωγμή που διατρέχει την Καλιφόρνια σε μήκος 1.300 χιλιομέτρων και απειλεί τις πόλεις του Λος Άντζελες και του Σαν Φρανσίσκο.

Εξετάζοντας δεδομένα για 81.000 σεισμικές δονήσεις το διάστημα 2008-2015, ερευνητές της αμερικανικής γεωλογικής υπηρεσίας USGS διαπίστωσαν ότι υπάρχει σχέση ανάμεσα στην παλίρροια και ασθενείς σεισμούς που εκδηλώνονται σε μεγάλο βάθος.

Η ανάλυση έδειξε ότι η εκδήλωση σεισμών ακολουθεί όχι μόνο των κύκλο των δύο παλιρροιών ανά μέρα που συμβαίνουν καθώς η Σελήνη περιφέρεται γύρω από τη Γη, αλλά και τις παλίρροιες που εκδηλώνονται δύο φορές το μήνα όταν η Γη ευθυγραμμίζεται με τη Σελήνη και τον Ήλιο.

Η ευθυγράμμιση αυτή μεγιστοποιεί τη βαρυτική έλξη που δέχεται η Γη. Η έλξη αυτή προκαλεί παλίρροιες όχι μόνο στο νερό αλλά και στον γήινο φλοιό, αν και στην περίπτωση αυτή η παραμόρφωση είναι πολύ μικρότερη.

Το εντυπωσιακό είναι ότι οι παλίρροιες επηρεάζουν το ρήγμα του Αγίου Ανδρέα παρόλο που δεν είναι προσανατολισμένο με τέτοιο τρόπο ώστε να δέχεται τη μέγιστη δύναμη.

Σύμφωνα με τους συντάκτες της νέας μελέτης, οι παλιρροϊκές δυνάμεις δεν μπορούν να προκαλέσουν επικίνδυνους σεισμούς. Συνδέονται μόνο με δονήσεις χαμηλής συχνότητας οι οποίες εκδηλώνονται σε βάθη άνω των 20 χιλιομέτρων, εκεί όπου τα πετρώματα του ρήγματος είναι πιο ασθενή.

Η μελέτη των δονήσεων αυτών, λένε οι ερευνητές, προσθέτει νέες γνώσεις για τη συμπεριφορά του ρήγματος και θα μπορούσε ενδεχομένως να βοηθήσει στην πρόβλεψη του επόμενου μεγάλου σεισμού.

Σύμφωνα με μελέτη στο Nature το 2006 (), το επόμενο χτύπημα του Εγκέλαδου στην Καλιφόρνια θα μπορούσε να έρθει ανά πάσα στιγμή (http://news.in.gr/science-technology/article/?aid=717869).

(Newsroom ΔΟΛ, 19 Ιουλ. 2016, http://news.in.gr/science-technology/article/?aid=1500091155&ref=newsletter)

Fortnightly modulation of San Andreas tremor and low-frequency earthquakes

Nicholas J. van der Elst, Andrew A. Delorey, David R. Shelly, and Paul A. Johnson

Significance

The sun and moon exert a gravitational tug on Earth that stretches and compresses crustal rocks. This cyclic stressing can promote or inhibit fault slip, particularly at the deep roots of faults. The amplitude of the solid Earth tide varies over a fortnightly (2-wk) cycle, as the sun and moon change their relative positions in the sky. In this study, we show that deep, small earthquakes on the San Andreas Fault are most likely to occur during the waxing fortnightly tide—not when the tidal amplitude is highest, as might be expected, but when the tidal amplitude most exceeds its previous value. The response of faults to the tidal cycle opens a window into the workings of plate tectonics.

Abstract

Earth tides modulate tremor and low-frequency earthquakes (LFEs) on faults in the vicinity of the brittle−ductile (seismic−aseismic) transition. The response to the tidal stress carries otherwise inaccessible information about fault strength and rheology. Here, we analyze the LFE response to the fortnightly tide, which modulates the amplitude of the daily tidal stress over a 14-d cycle. LFE rate is highest during the waxing fortnightly tide, with LFEs most strongly promoted when the daily stress exceeds the previous peak stress by the widest margin. This pattern implies a threshold failure process, with slip initiated when stress exceeds the local fault strength. Variations in sensitivity to the fortnightly modulation may reflect the degree of stress concentration on LFE-producing brittle asperities embedded within an otherwise aseismic fault.

This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1524316113/-/DCSupplemental

(http://www.pnas.org/content/early/2016/07/13/1524316113)

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New, Massive Earthquake Threat Could Lurk Under South Asia

A megathrust fault could be lurking underneath Myanmar, Bangladesh, and India, exposing millions to the risk of a magnitude 9.0 earthquake.

A new GPS study of Bangladesh, India, and Myanmar (Burma) has found startling evidence that the northeastern corner of the Indian subcontinent is actively colliding with Asia, potentially posing a major earthquake risk to one of the world's most densely populated regions.

The years-long analysis is the first to incorporate GPS data from Bangladeshi tracking stations. It is now the latest volley in a long-running academic debate over if and how the geologically complex region is seismically active.

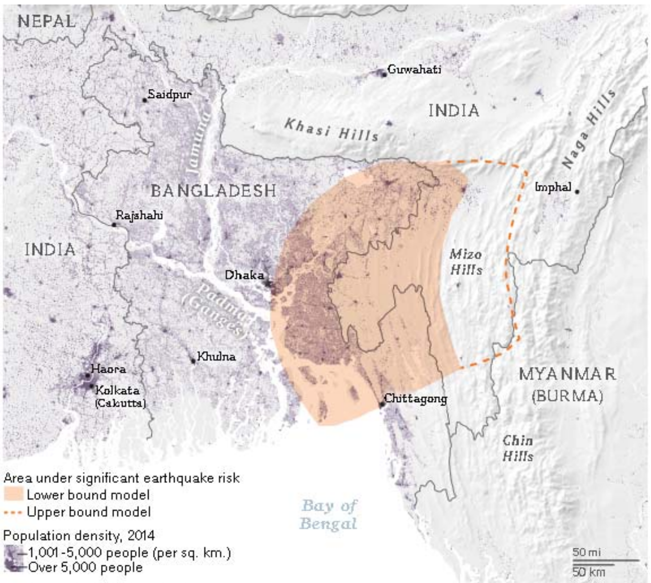
If the new study's models are correct, the region—home to more than 140 million people—could be sitting atop an active megathrust fault, the same kind of geologic feature that caused the catastrophic magnitude 9.0 earthquake in Japan in 2011.

What's more, the models suggest that the fault is stuck and has been accumulating stress for more than 400 years, since before the Mughals made the Bangladeshi city of Dhaka the regional capital in the early 1600s.

That means an area more than 124 miles (200 kilometers) wide may be spring-loaded with significant levels of tectonic strain, the researchers warn today in *Nature Geoscience*. If the entire fault were to give way at once, the team estimates that it could spawn earthquakes up to magnitude 9.0, causing vast devastation in a region underprepared for seismic catastrophes.

However, researchers do not know if and when the fault will give way.

"Whether this region actually will slip in one single earthquake, nobody can say yes or no," says Vineet Gahalaut, a geologist at India's National Geophysical Research Institute and an expert on the region's seismicity who wasn't involved with the study. "We don't have enough data to prove or disprove this."



LAUREN C. TIERNEY, NG STAFF
SOURCES: MICHAEL S. STECKLER AND OTHERS, NATURE GEOSCIENCE, 2016; LANDSCAN 2014

Locked and Loaded

For more than 40 million years, the Indian subcontinent has been crashing slowly into Asia in a geological pileup that created and continues to feed the Himalaya.

As the mountains erode, sediment washes into the Ganges and Brahmaputra, among the world's largest rivers, and flows into the Bay of Bengal at a current rate of a billion tons a year.

Over millions of years, piled-up sediment has extended the continental margin near Bangladesh by about 250 miles (400 kilometers). Some parts of the region's crust are caked with more than 12 miles (19 kilometers) of the stuff.

The region's rich sedimentary deposits, key to its fertility, make it even more challenging for researchers to determine the threat facing Dhaka—a megacity with more than 14 million people in its metropolitan area—and its surroundings.

"There are thick sediments everywhere … and that kind of area is covering a lot of geology," says Ashraf Uddin, an Auburn University sedimentary geologist who wasn't involved with the study. "We don't get to see it, [and] we don't get to study it very well."

From 2003 to 2014, researchers led by geologist Michael Steckler of Columbia University's Lamont-Doherty Earth Observatory installed and carefully monitored 26 GPS tracking stations across Bangladesh, to see how the country's western half was moving relative to the Indian Peninsula.

When they combined their data with previous GPS studies done in northeast India and Myanmar, they determined that overall, Myanmar's Shan Plateau is moving southwest at a rate of nearly 2 inches (51 millimeters) a year relative to the Indian Peninsula.

After subtracting out the known movements of the region's faults—a tricky task—the researchers were left with an extra 0.51 to 0.67 inches (13 to 17 millimeters) of annual motion, consistent with the Indian tectonic plate actively slipping underneath the Eurasian plate. What's more, the nature of movement across the region suggested that the Indian plate was stuck, locked to the underside of northwest Myanmar's mountains.

"It's very dangerous to us," says study co-author Syed Humayun Akhter, a seismologist at Bangladesh's University of Dhaka. "More elastic energy is being accumulated."

Shake Up

While the region's sediments take up some of the strain along the newly proposed fault, they're not especially stable, particularly around the rapidly developed eastern outskirts of Dhaka. If a major earthquake strikes, the sediments could even amplify the seismic waves.

"Dhaka's basically like building a city on a bowl of Jell-O," says Steckler.

Meanwhile, building codes in the rapidly growing city have long gone ignored, and the public remains unsure of what to do during an earthquake.

The lack of preparedness has already posed threats: When a magnitude 7.8 earthquake struck Nepal, to the northwest of Bangladesh, in April 2015, tremors caused buildings to tilt and reportedly led to the deaths of at least three Bangladeshis as a result of panic attacks, cardiac arrest, and stampedes.

"We are preparing … but not to the level mark," says Akhter. "The government and NGOs are trying to educate the people, but it's slow."

(Michael Greshko / National Geographic, July 11, 2016, http://news.nationalgeographic.com/2016/07/earthquakes-mega-thrust-dhaka-bangladesh-geology-science)

Locked and loading megathrust linked to active subduction beneath the Indo-Burman Ranges

Michael S. Steckler, Dhiman Ranjan Mondal, Syed Humayun Akhter, Leonardo Seeber, Lujia Feng, Jonathan Gale, Emma M. Hill & Michael Howe

The Indo-Burman mountain ranges mark the boundary between the Indian and Eurasian plates, north of the Sumatra–Andaman subduction zone. Whether subduction still

occurs along this subaerial section of the plate boundary, with 46 mm yr^{-1} of highly oblique motion, is contentious. About 21 mm yr^{-1} of shear motion is taken up along the Sagaing Fault, on the eastern margin of the deformation zone. It has been suggested that the remainder of the relative motion is taken up largely or entirely by horizontal strike-slip faulting and that subduction has stopped. Here we present GPS measurements of plate motions in Bangladesh, combined with measurements from Myanmar and northeast India, taking advantage of a more than 300 km subaerial accretionary prism spanning the Indo-Burman Ranges to the Ganges–Brahmaputra Delta. They reveal 13–17 mm yr^{-1} of plate convergence on an active, shallowly dipping and locked megathrust fault. Most of the strike-slip motion occurs on a few steep faults, consistent with patterns of strain partitioning in subduction zones. Our results strongly suggest that subduction in this region is active, despite the highly oblique plate motion and thick sediments. We suggest that the presence of a locked megathrust plate boundary represents an underappreciated hazard in one of the most densely populated regions of the world.

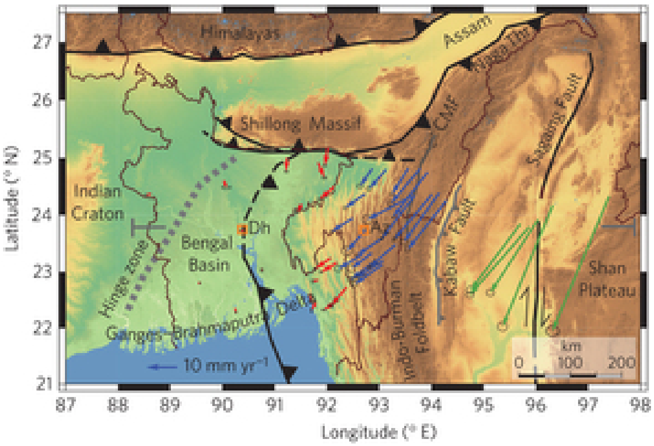


Figure 1: Topographic map of the Ganges–Brahmaputra Delta and Indo-Burman Foldbelt showing GPS velocities.

(Nature Geoscience, **9**, 615–618, August 2016, http://www.nature.com/ngeo/journal/v9/n8/full/ngeo2760.html)

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Coal Seam Gas

Sidoarjo mud flow - Lumpur Sidoarjo

(also known as the Lapindo mud flow, or Lusi)

May 2006 the biggest mud volcano in the world; responsibility for it was credited to the blowout of a natural gas well drilled by PT Lapindo Brantas, although some scientists and company officials contend it was caused by an earthquake which happened a couple of days earlier, 250 kilometres (125 miles) away.

Thirteen people have died and nearly 50,000 people were displaced.

Lusi, located in the Sidoarjo district of the island of Java, erupted on May 29, 2006 in the middle of a rice field.

It has destroyed 13 villages, dozens of factories and shops and a highway, prompting the government to build dykes 10 metres (33 feet) high to try to contain its spread.

Lusi villages have disappeared under the mud, which is 60 feet (18 meters) deep in places, according to a 2008 article in National Geographic magazine (http://news.nationalgeographic.com.au/news/2011/03/pictures/110304-mud-volcano-indonesia-java-erupt-26-years/).

At its peak Lusi spewed up to 180,000 m³ (6.4 million cubic feet) of mud per day.

By mid August 2011, mud was being discharged at a rate of 10,000 m³ per day, with 15 bubbles around its gushing point. This was a significant decline from the previous year, when mud was being discharged at a rate of 100,000 cubic metres per day with 320 bubbles around its gushing point.

By 2013, the rate has fallen to between 15,000 and 20,000 cu. m. (500,000 and 700,000 cu. ft.) per day, according to the government's Sidoarjo Mudflow Mitigation Agency, or BPLS - FoxNews (http://www.foxnews.com/world/2013/07/21/new-study-ignites-debate-over-indonesia-mud-volcano.html).

It is expected that the flow will continue for the next 25 to 30 years. Although the Sidoarjo mud flow has been contained by levees since November 2008, resultant flooding regularly disrupt local highways and villages, and further breakouts of mud are still possible.

Amein Widodo, a geologist from the Sepuluh Nopember Institute of Technology in nearby Surabaya city, said it was impossible to predict how long the volcano would keep erupting.

"The amount of mud has reduced a lot, but having seen other cases in Java, it's possible it could erupt for more than 100 years," said Widodo.

Cause of the Mud Volcano - gas drilling or natural?

The most likely cause according to a majority of experts was the gas exploration well, Banjar-Panji-1, drilling about 500 feet (150 m) from the mud volcano.

In 2008, during a conference in South Africa, supporters of both hypotheses presented their arguments before a panel of independent experts.

The debate was chaired by Edinburgh University's Professor John Underhill, who was also a top level football referee.

The majority of experts, 42 out of 74, favoured the drilling explanation.

Professor Davies supported the drilling hypothesis: "There is a lot of evidence now that shows it was caused by drilling - there was a blowout that was not controlled."

In 2008, the company that was drilling in the area and blamed for triggering the volcano agreed to pay compensation to the 50,000 displaced people. However, it did not say the drilling activities were the sole cause of the volcano. - BBC (http://www.bbc.com/news/science-environment-12567163)

A study published in the journal Nature Geoscience in 2013 supported the theory that an earthquake 250 kms away two days earlier caused the mud volcano.

Asked to comment on the study, British geologist Richard Davies pointed to the daily drilling reports from the Lapindo Brantas team at Sidoarjo.

It showed their gas exploration was going awry, Davies said.

On the day of the eruption, the drillers acknowledged that they were having problems in stabilising pressure in the hole, a routine procedure that uses injected fluids, as they sought to withdrew their drill bit, he said.

That, and the lack of protective casing around the hole, "was like pulling the cork out of a champagne bottle," causing a "kick" of high-pressure mud to blow from the hole, Davies, a professor at Durham University, told AFP in a phone interview.

"When the Yogyakarta earthquake occurred, nothing happened in the well. The pressure in the well was already many orders of magnitude bigger than the pressure changes due to the Yogyakarta earthquake," Davies said.

"They've come up with an elaborate geophysical model but I think they've ignored the more obvious data," Davies said.

Seismologists have widely, but not unanimously, sided with his explanation. Some note that much larger earthquakes had previously occurred closer to Sidoarjo yet not caused any mud volcano. - FoxNews (http://www.foxnews.com/world/2013/07/21/new-study-ignites-debate-over-indonesia-mud-volcano.html)

Responsibility & Compensation

Oil and gas company Lapindo Brantas, which operated the well, claimed the eruption was due to natural causes. However, the Indonesian government, citing research from an international team of scientists, have instead held the company financially responsible, demanding it pay $420 million to cover retribution for the victims and aid efforts to stop the mud flow. - Huffington Post (http://www.huffingtonpost.com/2013/07/22/mud-eruption-indonesia-disaster-drilling-quake_n_3634361.html)

All victims have received some compensation, some of them from the government and others from Lapindo Brantas, despite its claim of no wrongdoing. The company is part of a business empire controlled by Indonesia's powerful Bakrie family.

Around 5,000 people are still waiting for full payment, according to an AFP report published in July 2013.

Santos Exits

The Australian oil and gas company Santos Ltd. was a minority partner in the venture until 2008. In December 2008, the company sold its 18% stake in the project to Minarak Labuan, the owner of Lapindo Brantas Inc.

Labuan also received a payment from Santos of $US22.5 million ($A33.9 million) "to support long-term mud management efforts". The amount was covered by existing provision for costs relating to the incident.

Santos had provisioned for $US79 million ($A119.3 million) in costs associated with the disaster. Santos had stated in June 2006 that it maintained "appropriate insurance coverage for these types of occurrences".

IndustrySearch (http://www.industrysearch.com.au/mud-disaster-santos-no-more-liable-sells-project-stake/n/36045) - Santos Ltd has distanced itself from exposure to liability claims related to a mud-flow disaster in Indonesia after selling its minority stake in the gas project.

The disaster in May 2006 affected entire villages and thousands of people and there has been debate since about whether it was related to drilling for gas or an unrelated geological event.

Any liability claims are expected to be high and the clean up costs alone could run into the billions of dollars, according to earlier Indonesian reports.

Santos said on Thursday in a statement it would receive a "release" from the project participants covering "any past, present or future claims ... in connection with the incident".

The oil and gas producer said it would sell its 18 per cent stake in the asset in Sidoarjo, East Java, to Minarak Labuan, the owner of project operator Lapindo Brantas Inc.

Lapindo Brantas already owns 50 per cent of the project while private Indonesian oil and gas company Medco holds the remaining 32 per cent.

"The transfer has been approved by BPMIGAS, the relevant regulatory body of the Indonesian government," Santos said in a statement.

Santo also said it would pay Minarak $US22.5 million ($A33.9 million) "to support long-term mud management efforts".

"This amount will be covered by existing provision for costs relating to the incident."

Santos said in June 2006 it had maintained "appropriate insurance coverage for these types of occurrences".

It has provisioned for $US79 million ($A119.3 million) in costs associated with the disaster.

Mud has flowed at the project since early 2006, displacing tens of thousands of villagers.

The main vent of the Lusi mud volcano taken within a few months of eruption.

Javan mud volcano triggered by drilling, not quake

By Claire Whitelaw, Durham University, and Robert Sanders, UC Berkeley Media Relations

BERKELEY – 09 June 2008 A two-year-old mud volcano that is still spewing huge volumes of boiling mud, has displaced more than 30,000 people and caused millions of dollars in damage on the island of Java was triggered by the drilling of a gas exploration well, an international team of scientists has concluded.

The most detailed scientific analysis to date of the mud volcano disproves the theory that an earthquake that happened two days before it erupted in East Java, Indonesia, was to blame.

In the new analysis, the scientists outline and analyze a detailed record of operational incidents during the drilling of a gas exploration well, Banjar-Panji-1, that had been kept by oil and gas company Lapindo Brantas, which operated the well.

"We are more certain than ever that the Lusi mud volcano is an unnatural disaster and was triggered by drilling the Banjar-Panji-1 well," said lead author Richard Davies, a professor of earth sciences at Durham University in the United Kingdom.

Satellite image of the Lusi mud volcano. The white plume in the centre of the picture is steam from the central vent of the volcano. (Ikonos satellite image, copyright CRISP NUS 2007/200)

The report by British, American, Indonesian and Australian scientists, including UC Berkeley's Michael Manga, professor of earth and planetary sciences, was published this week in the academic journal Earth and Planetary Science Letters.

Lusi, already more than seven square kilometers (2.5 square miles) in extent, is still flowing at 100,000 cubic meters per day, enough to fill 53 Olympic swimming pools or submerge a football field under 610 feet of mud, the depth of a 61-story building.

Davies published research in January 2007 that argued that the drilling was most likely to blame for the eruption of Lusi on May 29, 2006. Manga subsequently published findings pointing a finger at drilling rather than an earthquake.

Davies' and Manga's initial theory was challenged not only by the company that drilled the well, but also by some experts who argued that the cause was the 6.3 magnitude Yogyakarta earthquake and its aftershocks that shook the island two days before the eruption.

The epicenter of that earthquake, which caused almost 6,000 deaths in the capital, was 250 kilometers (160 miles) from the mud volcano, which is in the Porong subdistrict of Sidoarjo in East Java.

As part of the new study, Manga and UC Berkeley graduate student Maria Brumm undertook a systematic study to test the claims that the eruption was caused by this earthquake. They found that none of the ways earthquakes trigger eruptions could have played a role in Lusi.

"We have known for hundreds of years that earthquakes can trigger eruptions. In this case, the earthquake was simply too small and too far away," Manga said.

The new report concludes that the effect of the earthquake was minimal because the change in pressure underground due to the earthquake would have been tiny - much less, in fact, than the pressure changes generated by the tides or variations in atmospheric pressure. Instead, the scientists said they are "99 percent" certain that drilling operations were to blame.

"We show that the day before the mud volcano started, there was a huge 'kick' in the well, which is an influx of fluid and gas into the wellbore," said Davies, of Durham University's Centre for Research into Earth Energy Systems (CeREES).

"We show that after the kick, the pressure in the well went beyond a critical level. This resulted in the leakage of the fluid from the well and the rock formations to the surface - a so-called 'underground blowout.' This fluid picked up mud during its ascent, and Lusi was born."

The leaking pressurized fluid fractured the surrounding rock, allowing the mud to spurt out of cracks rather than out of the wellhead, which normally could have been capped to stanch the flow. Davies said that chances of controlling this pressure would have been increased if there was more protective casing in the borehole.

"There is not a hope on Earth they are going to stop it now," Manga added. "You can plug up a hole, but if you try to plug a crack, stuff just flows around the plug, or the crack gets bigger. The well now has no effect on the erupting mud, it was just the trigger that initiated it."

Manga noted that mud volcanoes are hard to study because they frequently erupt underwater, such as in the Gulf of Mexico, where sediments are laid down rapidly. Lusi, which is short for lumpur Sidoarjo, Indonesian for Sidoarjo mud, is so far the world's largest known mud volcano and, because of its accessibility, the most studied active one.

"It's sad, because lots and lots of people are displaced, and five villages were buried in mud, but it will leave us with a better understanding of the birth, life and death of a volcano," Manga said.

Recent research in which Davies was involved showed that the dome of the mud volcano and the surrounding area are collapsing by up to three meters - nearly 10 feet - daily and could subside to depths of more than 140 meters (530 feet), having a significant environmental impact on the surrounding area for years to come.

Other authors of the report were petroleum engineer Rudi Rubiandini of the Institut Teknologi Bandung in Indonesia, Richard Swarbrick of Geopressure Technology Ltd. Science Labs in Durham, and Mark Tingay of the School of Earth & Environmental Sciences at the University of Adelaide, Australia.

Erupting mud volcano

University of Aberdeen research supports the suggestion that the eruption of the Indonesian mud volcano Lusi, which has been erupting for more than 200 days, was caused by drilling for hydrocarbons.

The first scientific report reveals that the 2006eruption will most likely continue to erupt and emit several thousand cubic metres of mud a day for months, if not years to come. This will leave at least 10 km2 around the volcano vent uninhabitable for years and over 11,000 people permanently evacuated.

An Aberdeen researcher contributed to the study, which was led by Durham University, and is published in the February issue of US journal, GSA Today (http://www.coal-seam-gas.com/seasia/indonesia01.htm#.V5II2eh97IU). It reveals that the eruption was almost certainly caused by the drilling of a nearby exploratory borehole looking for gas. The finding reinforces a United Nations report from July last year.

Sidoarjo mud flow, Java erupted on May 29, 2006
Photo left dated August 28, 2004 before the eruption
Photo right dated November 11, 2008 after the eruption

The mud volcano, known locally as 'Lusi', has destroyed infrastructure and erased four villages and 25 factories. Thirteen people have also died as a result of a rupture in a natural gas pipeline that lay underneath one of the holding dams built to retain the mud. It first erupted on 29 May, 2006 in the Porong subdistrict of Sidoarjo in Eastern Java, close to Indonesia's second city of Surabaya.

The team of mud volcano and pressure experts, who analysed subsurface and satellite images of the area for their study, propose that a local region around the central volcano vent will collapse to form a crater. In addition, an area of at least the dimensions of the flow (10km2) will probably sag over the next few months and years.

Dr Mads Huuse, a Lecturer in Geophysics, College of Physical Sciences, said: "Mud volcanoes are a common feature of the geological record around the world, and this is an excellent opportunity for scientists to observe the onset and continued eruption of a mud volcano - to understand how they are created and what happens when they erupt."

"Whilst the volcano is an interesting science project in itself, it is far more important that our research could impact positively on the livelihood of the 11,000 people who lost their homes to this mud volcano."

Mud volcano expert, Professor Richard Davies of Durham University's Centre for Research into Earth Energy Systems (CeREES) said: "It is standard industry procedure that this kind of drilling requires the use of steel casing to support the borehole, to protect against the pressure of fluids such as water, oil or gas. In the case of Lusi a pressured limestone rock containing water (a water aquifer) was drilled while the lower part of the borehole was exposed and not protected by casing. As a result rocks fractured and a mix of mud and water worked its way to the surface. Our research brings us to the conclusion that the incident was most probably the result of drilling."

"Lusi is similar to a 'blow-out' (eruption of water at the surface) that happened offshore of Brunei in 1979. Just as is most probably the case with Lusi, the Brunei event was caused by drilling and it took an international oil company almost 30 years and 20 relief wells and monitoring before the eruption stopped."

Professor Davies continued: "Up to now scientists have known relatively little about mud volcanoes and Lusi has provided the first opportunity for experts to study one from birth onwards. Our work offers a clearer understanding of how they are created and what happens when they erupt. We hope that the new insights will prove useful to the oil and gas industry, which frequently encounters pressurised fluid in rock strata that could, if not controlled, force their way to the surface during exploration drilling. Ultimately we hope that what we learn about this incident can help insure it is less likely to happen again."

The team from Durham, Cardiff and Aberdeen Universities and GeoPressure Technology Ltd, an Ikon Science company, has essentially discounted the effect of an earthquake which occurred in the region two days prior to the mud volcano as the cause of the eruption. This is based on the time-lapse between the earthquake and the eruption, the low magnitude relative to distance of the epicentre, the fact that there were no other mud volcanoes in the region following the earthquake and through comparison with other geological examples.

Notes to Editors:

This news release is based on the findings published in the paper: Birth of a mud volcano: East Java (29 May 2006). Davies, R.J et al; GSA Today v. 17, no 2 (2007) 4-9 published by the Geological Society of America. Link to paper - http://www.gsajournals.org/perlserv/?request=get-toc&issn=1052-5173&volume=17&issue=2

The team involved in the study comprised: Richard J. Davies, CeREES (Centre for Research into Earth Energy Systems), Durham University, Richard E. Swarbrick, Geopressure Techonology Ltd, an Ikon Science company, Robert J. Evans, School of Earth, Ocean and Planetary Sciences, Cardiff University and Mads Huuse, Department of Geology and Petroleum Geology, University of Aberdeen.

Dr Mads Huuse, a Lecturer in Geophysics, College of Physical Sciences, is available for media interviews. Please contact him direct on: (01224) 273440 or email: m.husse@abdn.ac.uk

About mud volcanoes

Mud volcanoes are extrusions of a water and mud mix on the earth's surface that form cone-shaped volcanoes. These can be metres to kilometers wide and metres to hundreds of metres thick. They commonly occur in convergent tectonic settings, such as Azerbaijan, in front of deltas, such as the Mississippi and due to the gravitational collapse of continental margin sediments such as the Niger Delta.

About CeREES

CeREES aims to be a world leading research centre in petroleum and sustainable energy sources. Opened in 2006, it works closely with other research groups to create and transfer knowledge through innovative, cross-disciplinary research programmes & education.

(http://www.coal-seam-gas.com/seasia/indonesia.htm#.V5IJK-h97IV)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

Ancient Engineering Wonders: This 1,200-Year-Old Temple Was Carved out of Solid Rock!

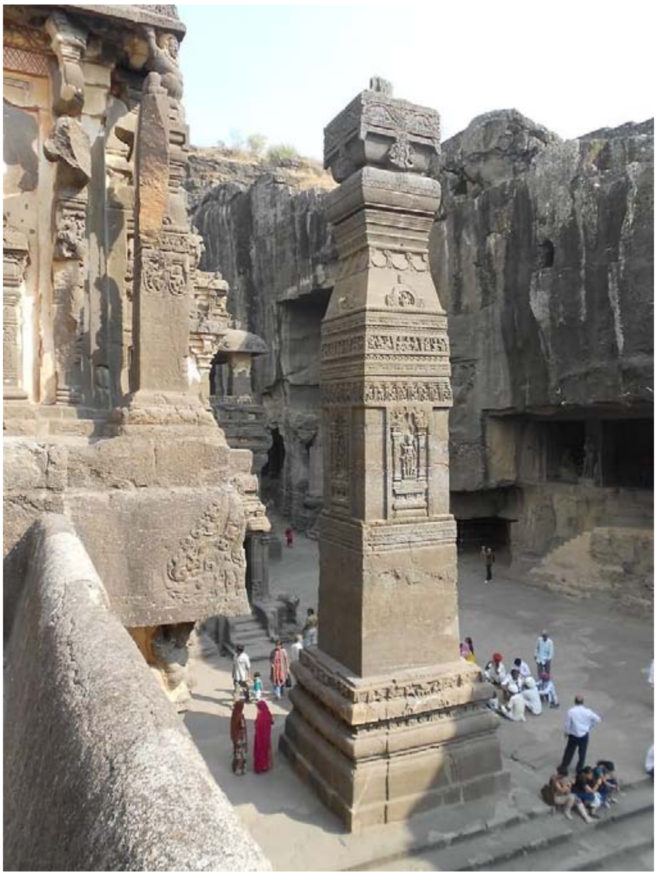
Many archaeological discoveries and ancient monuments that survived to the present day suggest that our ancestors were **far more advanced** than we think. **Massive and sometimes "impossible" structures** make us wonder how the ancient people built something like this thousands of years ago, without the sophisticated construction equipment we have today. One of such structures is the majestic ***Kailasa temple***, which was carved out of a single rock 1,200 years ago.

Located in the Maharashtra state in western India, it's definitely one of the most impressive ancient Hindu temples. It's a part of the famous **Ellora Caves**, an area that extends over more than two kilometers (1,2 miles) and includes the total of 34 monasteries and temples.

The Kailasa temple is 164 feet deep, 109 feet wide, and 98 feet high, which makes it **one of the largest monolithic structures in the world**. It is oriented towards the **Mount Kailash**, which is the home of the god **Shiva**, according to the Hindu beliefs.

The temple is full of **remarkable details** and is decorated with the **traditional Hindu architectural elements**, such as elephants, lions and makaras (sea-creatures in Hindu culture), erotic male and female figures, scenes from the Ramayana, the Mahabharata and the adventures of Krishna.

The huge monolithic pillars in the courtyard, which are flanking the entrance on both sides, are particularly striking.



It is estimated that about **400,000 tons of rocks** were cooped out to build this amazing monolithic structure. The walls were carved with extreme precision from top down, with a vertical excavation method. No surprise that this challenging task took centuries of human labor to complete.

Most archaeologists believe that the Kailasa temple was **completed in the 8th century**, during the reign of King Krishna I of the Rashtrakuta dynasty. It is also thought that the earliest carvings were made back in 300 BC.

K. Dhavalikar, a retired Professor of Archaeology and the Director of the Deccan College Post-Graduate Research Institute in Pune, India, wrote a book based on the results of his research in the Ellora Caves. According to him, "*all these shrines and the Kailasa were not excavated at the same time, but belong to different periods.*" ("*Ellora*", M. K. Dhavalikar, 2003, p. 44).

Despite all the research efforts, the archaeologists are clueless as to who built the temple and for what purpose. The only certain thing is that the builders of the Kailasa temple had truly remarkable skills since they managed to create such a huge monolithic structure using just a few hand tools like hammers, chisels, and picks.

There are still many questions that remain unanswered about the origin and builders of the temple. Some people even argue that it was built with the use of **alien technologies**. You can learn more about this theory in the video below:

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(THE MIND UNLEASHED , Jun 23, 2016, http://themindunleashed.org/2016/06/ancient-wonders-temple-carved-rock.html)

Illustrating Geology: Great images that transformed the field

William Smith's famous geologic map of England, Wales and southern Scotland, published in 1815, featuring a labeled cross section of strata at middle right. The original map measured 2.6 meters by 1.8 meters and was assembled from 15 sections. Credit: courtesy of the Geological Society of London.

Last year marked the 200th anniversary of the publication of what many consider the greatest geologic image ever produced: William Smith's epic map, entitled "A Delineation of the Strata of England and Wales with Part of Scotland." In striking color, scale and detail, the 1815 map laid bare the region's bedrock — from tilted layers of slate and fossil-rich marls and sandstones to Carboniferous coal seams and granite plugs — as none had before. The bicentennial of the map's publication was commemorated in several sessions and displays at the annual meeting of the Geological Society of America (GSA) in Baltimore last October.

Although it is perhaps the single-most recognized depiction within geology, and its extraordinary influence is hard to dispute, it is but one of many historically transformative images in a field that relies heavily on illustration and visualization to help convey information and shape our understanding of the natural world. Some of these other illustrations were celebrated in another session at GSA last fall, aptly titled "The Great Images in Geology."

What makes for a great image is fairly subjective, of course. Often, they're illustrations that synthesize large amounts of data into forms that are far more digestible and comprehensible than the thousands of words it might otherwise take to explain the observations. Or they are images that introduce the utility of novel techniques, or that distill and reframe complex and provocative theories in new ways.

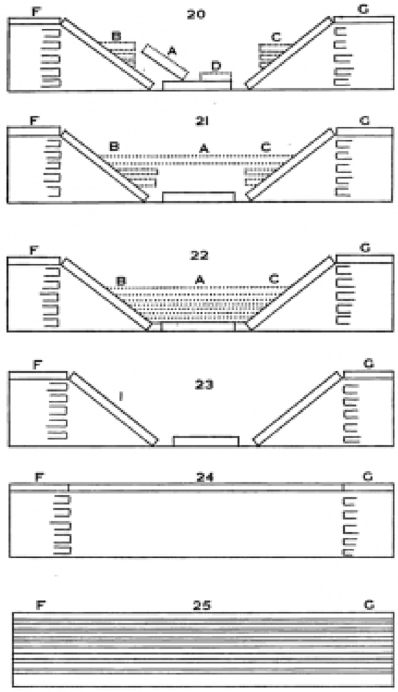
Sometimes, the images — along with the theories they represent — engender skepticism initially, and yet ultimately prove persuasive for many people, stimulating sea changes in scientific consensus. "Great illustrations commonly are ones that allow [for] … those 'aha!' moments," says Joanne Bourgeois, a sedimentologist at the University of Washington who co-chaired the "Great Images" session at GSA with Renee Clary, a geologist at Mississippi State University and director of the university's Dunn-Seiler Museum. And beyond these images' scientific significance, Bourgeois says, "a lot of them are great art."

Geologic images record the current scientific thinking of a particular time and have thus documented the development of the science, Clary notes. Although these figures' influence has long since been engrained in the field, continuing to study and appreciate them is important, particularly for students, Bourgeois and Clary say. Such figures also offer an "entrée into history" and a way for people to "learn that science changes through time … so that they are better critical readers of what we think we know today," Bourgeois says.

With that in mind, here are a few images that served as turning points in earth science.

Superposition in the Tuscan Stratigraphy

In the 17th century, geology was still in its protracted infancy. From antiquity, philosophers and scholars had observed rock layers and fossils, but understanding of how they'd come to be was still largely rooted in Biblical or cosmogonic explanations, at least in Renaissance Europe. Sedimentary strata and other rocks were presumably formed during Noah's Flood — or during great floods attributed to extraterrestrial causes — and unchanged since. A few natural historians, including Leonardo da Vinci, had posited that some fossils came from once-living animals, but the biological origins of most fossils were not widely known or accepted, nor were the processes by which they could become embedded in solid rock.



Nicolaus Steno's stratigraphic diagram from 1669, based on observations he made while in Tuscany, offers an example — in reverse order — of how a landscape can change as strata are eroded and new layers are deposited. The diagram illustrates the core stratigraphic principles of original horizontality and superposition. Credit: Steno, "De Solido Intra Solidum Naturaliter Contento Dissertationis Prodromus," 1669.

It would take another century — with the 18th-century efforts of geologists like Giovanni Arduino in Italy, James Hutton in Scotland, Johann Gottlob Lehmann in Germany, and many others — before Earth's ancient age and the actual process by which rocks form began to be more widely appreciated. But, in 1669, Danish scientist Nicolaus Steno laid the foundation upon which later scientists would build with his work, "De Solido Intra Solidum Naturaliter Contento Dissertationis Prodromus," or "Preliminary Dissertation Concerning a Solid Body Naturally Contained Within a Solid" ("Prodromus" for short). Steno's training was in anatomy, and he won early notoriety for his studies of glands, muscle structure and blood vessels. But his chance dissection of a shark's head — the teeth of which resembled so-called glossopetrae, or "tongue stones," found encased in rock — spurred an interest in fossils and rock strata.

Steno's "Prodromus" was "a slim volume — all of seventy-eight pages, with just a handful of simple diagrams — in which he laid down [geology's] blueprint: the science of the earth's geologic history, of deep time," wrote Alan Cutler in his 2003 biography of Steno, "The Seashell on the Mountaintop." One of these diagrams comprised six sequential figures, each based on locales Steno had observed during his tenure in Tuscany under the patronage of Grand Duke Ferdinando II and depicting rock strata disturbed to various extents. Steno, a devout converted Catholic and later bishop, described how successive layers of rock could have formed from water-deposited sediment, thus implying that different layers were deposited at different times in the past while not explicitly refuting their purported origins in one or more Biblical deluges. As portions of strata eroded away "by the force of fires or waters," other portions could collapse down to form valleys where new layers could be deposited.

The diagram illustrated, for the first time, the core stratigraphic principles of original horizontality and superposition: that sedimentary strata are, respectively, deposited initially as flat layers and that higher layers in a succession are necessarily younger than lower layers. The diagram also acknowledged that landscapes could transform over time due to natural forces. Even if Steno did not fully grasp how, and over how long, such change might occur, his "dynamic way of looking into Earth layers [was] absolutely original," says Troels Kardel, a retired physician in Denmark who has studied Steno for more than 40 years.

Steno's ideas about rock strata — as well as many of his ideas about fossils and anatomy — amounted to conjectures based on processes that were not observable due to the long timescales over which they worked or because of technological shortcomings, Kardel says. As most science of Steno's day was concerned with explaining nature based on directly observable phenomena, many of his hypotheses, though treated seriously by his peers, Kardel notes, were rejected at the time.

A More Ancient Dorset

Today, popular news stories about research into past life on Earth — be it early mammals, marine reptiles or dinosaurs — often include illustrations of what scientists think the ancient animals and their environments looked like. These illustrations share a tremendous amount of information and, at the same time, stoke our interest and imagination in ways that descriptions in text often can't; the same goes for museum exhibits and movies.

Henry De la Beche's 1830 watercolor, "Duria Antiquior," or "A More Ancient Dorset," was the first published scene of deep time, featuring ancient ichthyosaurs, plesiosaurs, pterosaurs, fish, ammonites and other animals set in De la Beche's imagined reconstruction of the animals' Jurassic environment. Credit: National Museum of Wales.

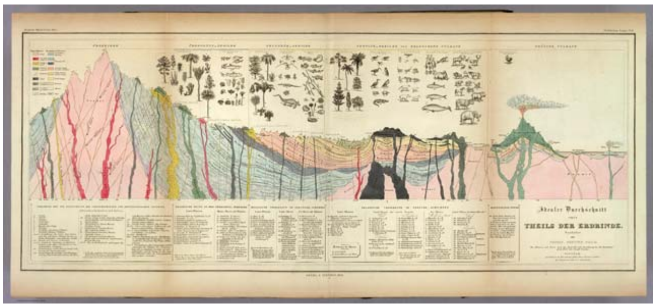
Such representations of past ecosystems, Clary says, owe their heritage to an 1830 watercolor titled "Duria Antiquior," or "A More Ancient Dorset," by English geologist Henry De la Beche. A "gentleman geologist" who was influential in the professionalization of the science, De la Beche was an active member of the Geological Society of London and the Royal Society, and, in 1835, became the first director of what would later become the British Geological Survey. His interest in geology emerged in part from his time growing up near the fossil-rich sea cliffs of Lyme Regis in Dorset, where he knew famed fossil purveyor Mary Anning, who excavated some of the first remains of ichthyosaurs, plesiosaurs and other ancient animals.

De la Beche — a gifted artist who illustrated his own books to improve sales — painted "Duria Antiquior" in 1830 to raise funds for his friend Anning. The watercolor — which was subsequently converted to a lithograph for reproduction and sale — shows an imagined scene along the palm-lined coast of Dorset, England, in the Jurassic, the water, sky and shoreline busy with ichthyosaurs, plesiosaurs, pterosaurs, ammonites, turtles, fish and other animals. There are also skeletal remains on the seafloor waiting to become fossils, and even — in a seemingly humorous nod to contemporary geologic interest in fossilized scat, Clary notes — the stuff of future coprolites falling from a frightened plesiosaur being attacked by an ichthyosaur.

French zoologist Georges Cuvier, in his notebooks, is known to have sketched lifelike renderings of ancient animals based on fossils. But "Duria Antiquior" is "the first published scene of deep time — essentially putting flesh on animals, putting them in an ecosystem, and reconstructing animal life" as De la Beche thought it might have happened, Clary says. There are a few mistakes, including wing-like features added to the living ammonites in the image, she says, but overall the watercolor and lithograph (which varies slightly from the original) offer a "remarkable" recreation of Dorset in the Jurassic. It also features the first-known use in print of the "aquarium view," where the viewer looks through the water, "a perspective that wasn't readily available until the advent of the Victorian parlor aquarium decades later," Clary says.

De la Beche's image did not spur a "sudden craze to put flesh on these [extinct] animals" or reconstruct other ancient ecosystems in illustrations, which would have to wait until the North American dash to dig up dinosaurs later in the century, Clary says. But its lasting legacy is abundantly clear today, she notes, making "Duria Antiquior" perhaps the most important image of geology's early-19th-century "golden age."

Buckland's Tour de Force



This German reproduction of the figure William Buckland included in his Bridgewater Treatise was published in 1841 in Heinrich Berghaus' "Physikalischer Atlas." In this version of the figure, Berghaus added annotations below the cross section about the geology and organisms depicted; Buckland had not included these annotations with the figure, but had instead described the figure in detail in the text of his book. Credit: courtesy of the David Rumsey Map Collection.

Several years after "Duria Antiquior," one image that did include sketches of fully reconstructed animals — in this case to help illustrate Earth's history over a long time rather than in a single snapshot — appeared in the sixth of the Bridgewater Treatises, a series commissioned by the Earl of Bridgewater to address contemporary scientific debates with discussions rooted in natural theology. The sixth treatise, published in 1836 and entitled "Geology and Mineralogy Considered With Reference to Natural Theology," was written by William Buckland, an English theologian and geologist known largely for his attempts, and then subsequent rejection of efforts, to reconcile the Biblical account of creation with emerging evidence that Earth was far older than believed.

The two-volume work was a massive compendium chronicling "the history of life on the planet based on the fossils that had been found up to that point," Bourgeois says. Buckland's ambitious effort included hundreds of illustrations of fossil plants and animals, many drawn by his wife, Mary Buckland. The most notable figure, however, was a large, hand-colored, fold-out diagram combining an idealized cross section of European geology — originally used by Scottish geologist Thomas Webster — with 120 sketches of extinct plants and animals. Accompanied by a 17-page description, the diagram shows, among many other features, a mountain of granite flanked by metamorphosed rocks, all cross-cut by a variety of veins and dikes; stacked sedimentary sequences, tilted and folded in places; and active terrestrial and oceanic volcanoes fed by underlying magma conduits, along with basalt outcrops at the surface. Above the geology sit the reconstructed species, grouped together by their occurrence in the stratigraphic record — and thus in geologic time.

"While cross sections had been published together with maps, and plates of fossils published to accompany stratigraphic sections, the synoptic view presented by Buckland and Webster was a tour-de-force illustrating all of geologic time as set out by rocks and fossils," Bourgeois wrote in the abstract to her GSA talk about the diagram. In addition to demonstrating a progression in the geology, from older, more deformed rocks to younger, less deformed ones, Bourgeois says, "the most important thing is that it shows a progression of life."

It was more than 20 years before Darwin would publish his landmark "On the Origin of Species," but ongoing debates in the 1830s questioned whether life was somehow progressive, perhaps through transmutation or other means, Bourgeois says. Although Buckland wasn't trying to settle the debate in the treatise, and he wouldn't have accepted transmutation, she says, it's clear from the diagram and his descriptions that profound changes had occurred in life on Earth.

"Whether that diagram actually changed people's minds versus just instructing them is still open to question," Bourgeois says. From historical research, however, it's known that the book was popular in its day — a best-seller, in fact, that was frequently checked out of libraries — so a lot of people, including Darwin, would likely have seen the diagram.

Geology Through the Microscope

Representative figures from Ferdinand Zirkel's 1876 work, "Microscopical Petrography," show the accuracy and detail Zirkel achieved in his hand-drawn and hand-colored illustrations of thin sections of rocks collected during the U.S. 40th Parallel Survey. Zirkel identified the sample shown in Figure 4 (bottom row, second from left), which features zoned plagioclase crystals (white) and green and brown hornblende amid a greenish groundmass, as a propylite from near Tuscarora, Nev. The nature of propylite was controversial at the time. Thought by some to be a product of primitive magmas that evolved to sequentially erupt andesites, trachytes, rhyolites and basalts, propylite was later determined to be an altered form of andesite. Credit: Zirkel, "Microscopical Petrography," Vol. 6 in the Report of the Geological Exploration of the Fortieth Parallel, U.S. Army, 1876.

In the mid-19th century, as geologists continued to rely mostly on fieldwork, fossils and hand samples, microscopic petrography — the study of thin sections of rock under the microscope — began emerging as a powerful new technique. Following the pioneering work of English microscopist Henry Clifton Sorby, German geologist Ferdinand Zirkel was largely responsible for displaying the method's merits, particularly with the thorough descriptions and beautifully detailed illustrations in his 1876 work, "Microscopical Petrography."

The volume was the sixth installment of a report detailing the findings of the U.S. "Geological Exploration of the Fortieth Parallel" (also known as the "40th Parallel Survey") conducted from 1867 to 1872. Led by Clarence King, the U.S. geologist at the time, the survey mapped about 160,000 square kilometers across Colorado, Nevada, Utah and Wyoming; the team also collected observations of extant birds and plants, as well as fossils, along with thousands of rock samples. After completing the fieldwork for the survey, King, who'd heard of Zirkel and his petrographic work in Europe, enlisted the German scientist to come to the U.S. to study the samples, many of which had been taken from Cenozoic-aged volcanic rocks spread across the American West.

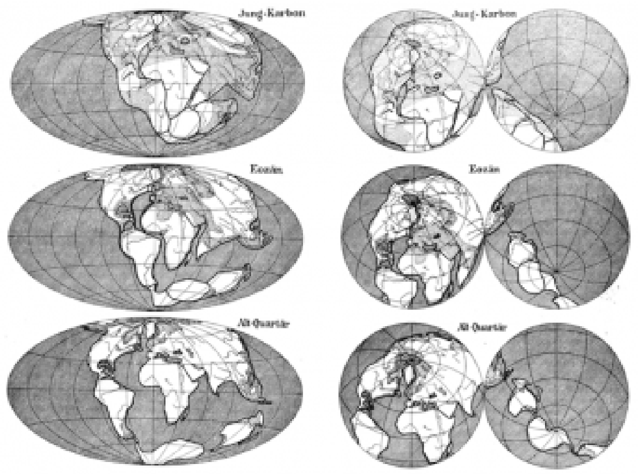
These rocks "were of major interest because the scale of volcanism in that part of the world in the Cenozoic Era was incredible … And people were interested in how to classify volcanic rocks," says Ken Aalto, a geologist at Humboldt State University in California. Zirkel's finished work included nearly 300 pages of descriptions of the samples King provided as well as 12 plates of hand-drawn and hand-colored illustrations of representative thin sections. The drawings are "incredibly accurate to what one would find if one cut a modern thin section of rocks from the survey area," Aalto says, showing mineral fabrics, grain sizes and a diversity of features in greater detail than Zirkel had achieved in prior studies. The volume "was the first publication of what we now call photomicrographs — only of course there was no photo," Aalto notes, and it introduced the technique to North America.

Working with King to explain the geologic origins of his microscopic observations, Zirkel did err in some of his interpretations: Notably, he sided with the German geographer Ferdinand von Richthofen's scheme that different Cenozoic volcanic rocks evolved sequentially from a common type of parent magma. Von Richthofen's hypothesis was later shown to be incorrect, but the impact of Zirkel's volume was great nonetheless, Aalto says. Within 10 or 15 years, he says, microscopic studies "became a major emphasis of the U.S. Geological Survey (USGS)," which was founded with King as the first director in 1879. "If you look up the published literature post-Zirkel in the U.S., you begin seeing these types of microscopic illustrations in all of the USGS reports."

As researchers adopted the technique, there were rapid advances in the understanding of the complex family of feldspar minerals, for example, Aalto notes. And ultimately, microscopic petrography offered "a new way to understand the evolution of igneous rocks, especially … the classification, the interpretation of how they developed, and what the source was for the rock material. So it was a tremendous breakthrough."

Continental Drift Goes Spherical

By the late 1800s, geoscientists had noted the occurrence of seemingly related fossil distributions and geologic terranes in distant locales — on either side of the Atlantic in South America and Africa, for example. Theories to explain these peculiarities proposed that now-submerged land bridges might have previously connected the regions across the oceans, or that portions of massive continents could have collapsed to form the ocean basins that now separate formerly conjoined areas.



Beginning with the third edition of his book, "The Origin of Continents and Oceans," published in 1922, Alfred Wegener included equal-area projections of Earth to better illustrate how continental drift works on a spherical planet. The Hammer (left) and Lambert (right) projections show Wegener's reconstructions of the continents in the Upper Carboniferous (Jung-Karbon), the Eocene (Eozän) and the Lower Quarternary (Alt-Quartär). Credit: Wegener, "Die Entstehung der Kontinente und Ozeane," 4th ed., Friedr. Vieweg & Sohn Akt.-Ges., 1929.

German geophysicist Alfred Wegener didn't buy either of those ideas, and in 1912 he published the first edition of "The Origin of Continents and Oceans," which laid out the competing theory of continental drift. While Wegener and some paleoclimatologists argued that only continental drift, which suggested that the continents moved over Earth's surface through time, could explain all of the available data — including, for example, that tropical plant fossils could be found in Greenland — the book met with heavy resistance from most geologists and geophysicists.

Undaunted, Wegener refined his arguments in subsequent editions of the book. What he realized from reading criticism of the book is that his detractors "didn't understand how Earth works on a spherical surface," says Mott Greene, a historian of earth science at the University of Washington who published a biography of Wegener in 2015. Wegener trained initially as an astronomer, so "in his mind, Earth is always a spherical object," Greene says, but this was not the case for most geologists, who were accustomed to investigating relatively small areas over which Earth's curvature has insignificant effects on physical processes. When these scientists tried to make sense of Wegener's ideas using the common Mercator map of the world — which vastly distorts the apparent size of the polar regions — it was difficult for them to see how the continents could have fit together.

For the book's third edition in 1922, Wegener created global maps using alternative projections — the Hammer and Lambert oblique orthographic projections — that offered more realistic portrayals of Earth's round surface. In each projection, he depicted the configuration of the continents during the Upper Carboniferous, when most landmasses were joined as a supercontinent, the Eocene and the Lower Quaternary, according to the predictions of continental drift theory. In this edition, "he started, right at the very beginning of the book, with those maps," Greene notes. "This made the point that Earth is a sphere, and if you look at [the continents] on a spherical surface, this is how you're going to make sense of the theory."

Although Wegener's physical explanation for how the continents moved proved incorrect — he thought they plowed through oceanic crust like icebergs through water — they did basically move "in the way that he thought they moved," Greene says. It would still take several decades before the true mechanism was revealed and geologic consensus sided with Wegener, but "for the people who were persuaded, it was those images that persuaded them," Greene says.

Seafloor Spreading Unlocks Plate Tectonics

When plate tectonic theory emerged in the 1960s, Wegener's fundamental notion that the continents had moved and continue to move around the planet was finally vindicated. Leading up to this time, there was growing evidence that one or more large-scale but as yet unknown dynamic processes were operating on Earth. Early bathymetry showed varying but fairly predictable changes in seafloor depth from shallow mid-ocean ridges to deep trenches near continental margins. Relatively thin layers of sediment and the youth of the oldest fossils on the seafloor, meanwhile, seemed at odds with the planet's ancient age. Indications of polar wander and magnetic reversals suggested that continents might have changed orientation through time. And some researchers, like Australian geologist S.W. Carey, had updated Wegener's proposed positions for the ancient continents, finding even better fits.

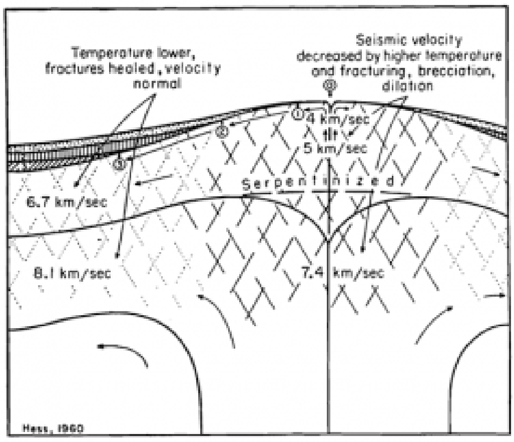


Figure 7. Diagram to represent (1) apparent progressive overlap of ocean sediments on a mid-ocean ridge which would actually be the effect of the mantle moving laterally away from ridge crest, and (2) the postulated fracturing where convective flow changes direction from vertical to horizontal. Fracturing and higher temperature could account for the lower seismic velocities on ridge crests, and cooling and healing of the fractures with time, the return to normal velocities on the flanks.

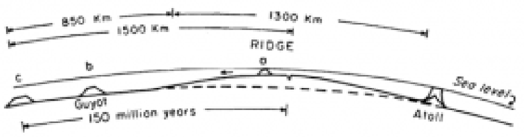


Figure 9. Diagram to show progressive migration of volcanic peaks, guyots, and atolls, from a ridge crest to the flanks, suggesting that the wave-cut surfaces of guyots or the bases of atolls may become older laterally away from the crest

Figure 7 (top), with its original caption, from Harry Hess's 1962 paper illustrates his conception of seafloor spreading: hot mantle material rising toward mid-ocean ridges to form new ocean crust, the symmetric movement of this crust away from the ridge axis, and sediment layers on the ocean bottom that grow thicker with distance from the ridge. Figure 9 (bottom) further depicts how seafloor spreading could explain the formation of flat-topped seamounts called guyots. Credit: both: Hess, "History of Ocean Basins," in Petrologic Studies: A Volume in Honor of A.F. Buddington, Geological Society of America, 1962.

Still, in the late 1950s, "the reigning paradigm … was fixed continents and old ocean basins and so forth," says Eldridge Moores, a geologist and professor emeritus at the University of California at Davis. But at a 1959 guest lecture by Carey at Princeton University, Harry Hess, a professor at Princeton, "seemed to have a flash of insight," recalls Moores, who was a graduate student at Princeton at the time. Within weeks, Moores says, Hess's thoughts had jelled into an early draft of what would become his seminal 1962 paper, "History of Ocean Basins," which hypothesized the process of seafloor spreading.

The paper, published by GSA in a volume dedicated to Hess's former advisor, Arthur Buddington, has a dozen figures, including several schematics that illustrate elements of how continents moved and ocean basins grew through mid-ocean ridge volcanism. Figure 7 offers an overall summary of the process, illustrating the rise of hot mantle material toward ridges, where it reacts with seawater to form serpentinite and then fractures as it cools and solidifies into ocean crust — processes that, in agreement with observations, attenuate the velocity of seismic waves traveling through the ridges. The figure also illustrates the symmetric movement of new crust away from the ridge axis, and how sediment layers at the ocean bottom become thicker with distance from the ridge. Figure 9 in the paper further illustrates how seafloor spreading could explain the formation of peculiar flat-topped seamounts called guyots, which Hess

had studied since the 1940s.

Although there was continued opposition to seafloor spreading in some quarters, "a number of [scientists] bought it almost immediately," Moores says. "This is a good example of a Thomas Kuhn-like scientific revolution," he says, when "somebody comes along and has a bright idea that has greater explanatory power [than the prevailing paradigm], and after a certain amount of shuffling and opposition and reluctance, people come around to the new paradigm."

There are, to be sure, many other great images that propelled plate tectonics. As examples, Moores cites the symmetric magnetic reversals around mid-ocean ridges — first noted by Fred Vine and Drummond Matthews in 1963 and then illustrated by Vine in 1966 with the now-famous zebra-stripe pattern — and the map showing earthquake foci concentrated on plate boundaries published by Bryan Isacks, Jack Oliver and Lynn Sykes in 1968. But it was Hess's 1962 diagrams illustrating seafloor spreading that triggered the revolution.

(Timothy Oleson / EARTH, Sunday, July 17, 2016, http://www.earthmagazine.org/article/illustrating-geology-great-images-transformed-field)

The Qattara Depression

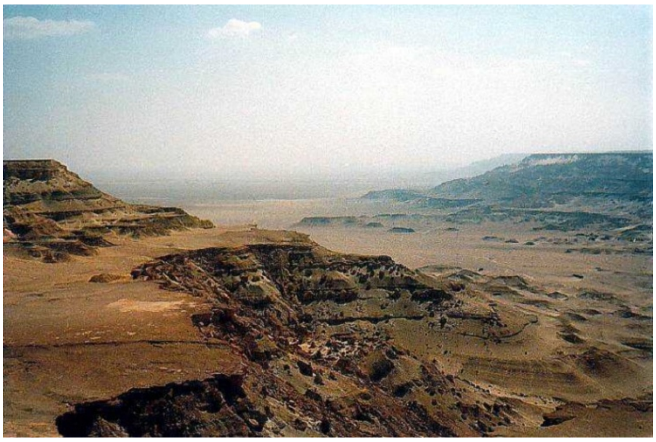
The **Qattara Depression** is a depression in the north west of Egypt in the Matruh Governorate and is part of the Libyan Desert. It lies below sea level and is covered with salt pans, sand dunes and salt marshes. The region extends between latitudes of 28°35' and 30°25' north and longitudes of 26°20' and 29°02' east. The region was created by the interplay of salt weathering and wind erosion. Some 20 kilometres west of the depression lie the oases of Siwa and Jaghbub in smaller but similar depressions.

The Qattara Depression contains the second lowest point in Africa at −133 metres (−436 ft) below sea level, the lowest being Lake Assal in Djibouti. The depression covers about 19,605 square kilometres (7,570 sq mi), a size comparable to Lake Ontario or twice as large as Lebanon. Due to its size and proximity to the Mediterranean Sea shore, it has been studied for its potential to generate hydroelectricity.

The depression has the shape of a teardrop, with its point facing east and the broad deep area facing the south west. The northern side of the depression is characterised by steep escarpments up to 280 meters high, marking the edge of the adjacent El Diffa plateau. To the south the depression slopes gently up to the Great Sand Sea.

Within the Depression are salt marshes, under the northwestern and northern escarpment edges, and extensive dry lake beds that flood occasionally. The marshes occupy approximately 300 square kilometres (120 sq mi), although wind-blown sands are encroaching in some areas. About a quarter of the region is occupied by dry lakes composed of hard crust and sticky mud, and occasionally filled with water.

The depression was initiated by either wind or fluvial erosion in the late Neogene, but during the Quaternary the dominant mechanism has been a combination of salt weathering and wind erosion working together. First, the salts break up the depression floor, then the wind blows away the resulting sands. This process is less effective in the eastern part of the depression, due to lower salinity groundwater.

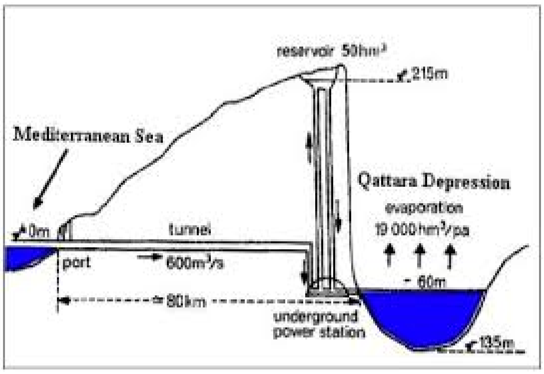


Bedouins in the vast Sahara have known about—and mostly avoided—the Qattara Depression for centuries, but scientists first discovered it less than a hundred years ago. At 436 feet below sea level, it's the second lowest point in Africa, a result so surprising that the British Army didn't believe it and had to recheck their barometers. During World War II, the sinkhole proved crucial in the Allied victories at El Alamein. Its shifting sands are impassable to vehicles, which prevented the Germans from outflanking the British general Montgomery.

The Qattara Depression is so low that it may someday be used to power much of Egypt. Theoretically, a 50-mile tunnel could be dug downhill from the Mediterranean, filling the sinkhole with seawater. New water would continue to flood into this new Dead Sea-type lake as it evaporated, providing vast amounts of hydroelectric power along the way. In fact, Jules Verne proposed a similar project in the Sahara in his last novel, Invasion of the Sea, way back in 1905.

Qattara Depression Project

The large size of the Qattara Depression and the fact that it falls to a depth of 133 m below mean sea level has led to several proposals to create a massive hydroelectric project in northern Egypt rivalling the Aswan High Dam. This project is known as the Qattara Depression Project. The proposals call for a large canal or tunnel being excavated from the Qattara due north of 55 to 80 kilometres (34 to 50 mi) depending on the route chosen to the Mediterranean Sea to bring seawater into the area. An alternative plan involved running a 320 kilometre (200 mile) pipeline north-east to the freshwater Nile River at Rosetta. Water would flow into a series of hydro-electric penstocks which would generate electricity by releasing the water at 60 m below sea level. Because the Qattara Depression is in a very hot dry region with very little cloud cover, the water released at the −70 metres (−230 ft) level would spread out from the release point across the basin and evaporate from solar influx. Because of evaporation, more water can flow into the depression, thus forming a constant source of energy. Eventually this would result in a hyper-saline lake or a salt pan as the water evaporates and leaves the salt it contains behind.



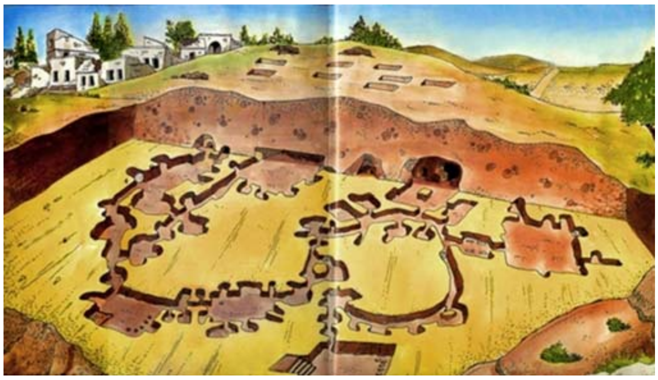
Plans to use the Qattara Depression for the generation of electricity date back to 1912 from Berlin geographer Professor Penck. The subject was discussed in more detail by Dr. John Ball in 1927. In 1957 the American Central Intelligence Agency proposed to President Dwight Eisenhower that peace in the Middle East could be achieved by flooding the Qattara Depression.

In the 1970s and early 1980s, several proposals to flood the area were made by Friedrich Bassler and the *Joint Venture Qattara*, a group of mainly German companies. They wanted to make use of peaceful nuclear explosions to construct a tunnel, drastically reducing construction costs compared to conventional methods. This project proposed to use 213 devices, with yields of 1 to 1.5 megatons detonated at depths of 100 to 500 metres (330 to 1,640 ft). This fit within the Atoms for Peace program proposed by President Dwight Eisenhower in 1953. Because of this frightening solution, the Egyptian government turned down the plan.

Planning experts and scientists intermittently put forward potentially viable options, whether of a tunnel or canal, as an economic, ecological and energy solution in Egypt, often coupled with the idea of new settlements.

(Wikipedia, https://en.wikipedia.org/wiki/Qattara_Depression and Ken Jennings / Conde Nast Traveler, June 02, 2014, http://www.cntraveler.com/stories/2014-06-02/qattara-depression-maphead)

Derinkuyu & The Underground Cities of Cappadocia



In 1963, a man in the Nevşehir Province of Turkey knocked down a wall of his home. Behind it, he discovered a mysterious room. The man continued digging and soon discovered an intricate tunnel system with additional cave-like rooms. What he had discovered was the ancient Derinkuyu underground city, part of the Cappadocia region in central Anatolia, Turkey.

The elaborate subterranean network included discrete entrances, ventilation shafts, wells, and connecting passageways. It was one of dozens of underground cities carved from the rock in Cappadocia thousands of years ago. Hidden for centuries, Derinkuyu's underground city is the deepest.

Rose Valley of Cappadocia

History

The Cappadocia region of Anatolia is rich in volcanic history and sits on a plateau around 3,300 feet (1,000m) tall. The area was buried in ash millions of years ago creating the lava domes and rough pyramids seen today. Erosion of the sedimentary rock left pocked spires and stone minarets.

Volcanic ash deposits consist of a softer rock – something the Hittites of Cappadocia discovered thousands of years ago when they began carving out rooms from the rock. It began with storage and underground food lockers; the subterranean voids maintained a constant temperature, protecting the contents from exposure to harsher surface weather extremes.

The underground tunneling would also serve a bigger purpose: Protect the Hittites from attack. The exact dates are unknown, but estimates range the tunnels first appeared between the 15th century and 12th century BCE. The Hittites were believed to have used the tunnels to hide from Phrygian raids.

Those who subscribe to this theory point to the historic account of the Phrygian destruction of Hittite city *Hattusa*, along with the identification of a small number of Hittite-related artifacts found in the tunnels.

An alternative suggestion has the Phrygians first building the tunnels later, between the 8th and 7th centuries BCE. They explain the discovered Hittite artifacts as being remnants from the spoils of war.

This theory is reinforced by reputation: Phrygian architects are considered by archaeologists to be among the finest of the Iron Age, and known to have engaged in complex construction projects.

Because the Phrygians are known to have possessed the necessary skills and inhabited the region for a long time, they are often credited with first creating the underground city at Derinkuyu.

Less popular is the theory the underground city was the work of the Persians.

Although no direct reference is made to Derinkuyu, the second chapter of the *Vendidad* (part of the Zoroastrian Avesta) includes a story of "*the great and mythical Persian king Yima*" who "*created palaces underground to house flocks, herds, and men*."

But with no other evidence, this theory has struggled to gain traction among the cognoscenti.

The oldest written reference to the underground cities of Cappadocia was by Xenophon in *Anabasis*. He mentions the Anatolian people living underground in excavated homes large enough for entire families, their food, and animals.

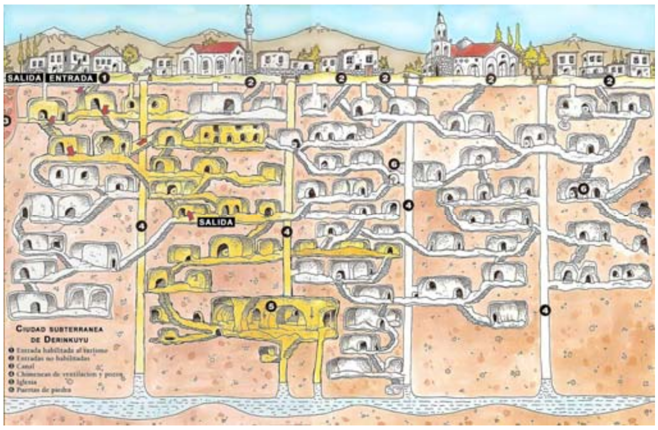
Because the city was carved from naturally-formed rock, traditional archaeological methods of dating the underground city would fail to discern the origins.

Derinkuyu

Archaeologists believe the underground cities of Cappadocia could number in the hundreds. To date, just six have been excavated.

The underground city at Derinkuyu is neither the largest nor oldest, but it fascinates as it is the deepest of the underground cities and was only recently discovered in 1963. (The largest, *Kaymakli*, has been inhabited continuously since first constructed).

While there is no consensus for who is responsible for building Derinkuyu, many groups have occupied the underground city over the centuries.



Tourist map of Derinkuyu Underground City

It is believed Derinkuyu was later expanded during the Byzantine era (330-1461 CE).

During this time the underground city was known as *Malakopea* (Greek: Μαλακοπέα). Early Christians used the tunnels to escape persecution during raids from the Muslim *Umayyad* and *Abbasid* dynasties.

Over time the need for underground shelter in Cappadocia ebbed and flowed with different ruling empires. In peacetime tunneling efforts were reduced as resources were diverted back toward the surface. During these times the subterranean city served as cold storage facilities and underground barns.

During the Roman persecutions of the 2nd and 3rd centuries (and the Arab raids between the 8th and 10th centuries) CE, use of the underground cities increased and tunnels were expanded.

Underground City Features

Derinkuyu is the deepest of the discovered underground cities with eight floors – reaching depths of 280 feet (85m) – currently open to the public.

Excavation is incomplete but archaeologists estimate Derinkuyu could contain up to 18 subterranean levels.

Miles of tunnels are blackened from centuries of burning torches. They were strategically carved narrow to force would-be invaders to crawl single-file.

Eventually the tunnels reach hundreds of caves large enough to shelter tens of thousands of people.

The build-out of Derinkuyu accommodated for churches, food stores, livestock stalls, wine cellars, and schools. Temporary graveyards were constructed to hold the dead; an ironic twist, bodies were stored underground until it was safe to return them the surface.

Over one hundred unique entrances to Derinkuyu are hidden behind bushes, walls, and courtyards of surface dwellings. Access points were blocked by large circular stone doors, up to 5 feet (1.5m) in diameter and weighing up to 1,100 lbs (500 kilos).

The stone doors *(pictured below)* protected the underground city from surface threats, and were installed so each level could be sealed individually. The tunneling architects included thousands of ventilation shafts varying in size up to 100 feet deep (30m).

Circular stones would seal access to the passageways

An underground river filled wells while a rudimentary irrigation system transported drinking water.

Derinkuyu was more than just residences, storage, and tunnels. When residents fled underground, business continued as usual. Commercial spaces included communal meeting areas, dining rooms, grocers, religious places for worship – even shopping.

Arsenals stored weapon caches while hidden escape routes offered residents a last-chance for a getaway.

Unique to Derinkuyu

On the second floor a barrel-vaulted ceiling tops a spacious room believed to have been a religious school. Rooms to the left provided individual studies.

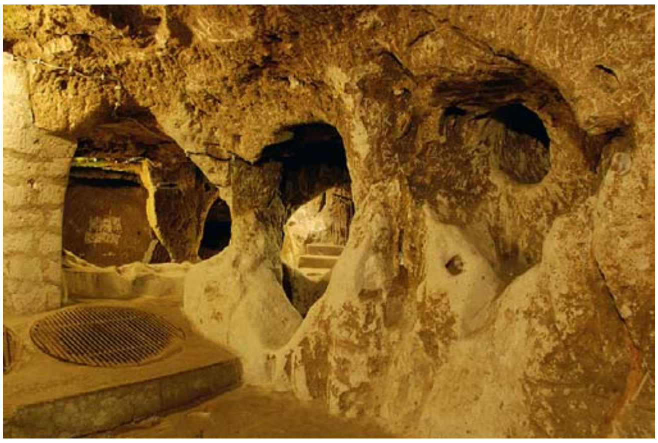
A staircase between the third and fourth levels takes visitors to a cruciform church measuring approximately 65 x 30 ft (20m x 9m) in size.

A large 180-ft (55m) shaft was likely used as the primary well – both for residents underground and on the surface. To prevent any surface aggressor attempt to poison drinking water, control of the water supply originated from the lower floors and moved upward, with lower floors able to cut-off supply to upper levels.

On the third level a 3 mile-long (5 km) tunnel connected Derinkuyu to nearby underground city *Kaymakli* – although it is no longer functioning as parts of this tunnel have collapsed.

The name *Derinkuyu* roughly translates to "deep well" – apropos given the surface city lacked running water until only recently.

A declining water table created fears of water shortages in the mid-20th century; it wasn't until 1965 the surface city finally received the infrastructure for running water.



http://sometimes-interesting.com/2014/05/09/derinkuyu-the-underground-cities-of-cappadocia/

http://www.discussionist.com/10183952

How Fast Is Earth Moving?

A new time-lapse videos combines 3,000 images from the DSCOVR satellite's EPIC camera to show a year of Earth's rotation, as seen from a million miles away. *Credit: NASA Goddard via YouTube* (https://www.youtube.com/watch?v=CFrP6QfbC2g)

As an Earthling, it's easy to believe that we're standing still. After all, we don't feel any movement in our surroundings. But when you look at the sky, you can see evidence that we are moving.

Some of the earliest astronomers proposed that we live in a geocentric universe, which means that Earth is at the center of everything. They said the sun rotated around us, which caused sunrises and sunsets — same for the movements of the moon and the planets. But there were certain things that didn't work with this vision. Sometimes, a planet would back up in the sky before resuming its forward motion.

We know now that this motion — which is called retrograde motion — happens when Earth is "catching up" with another planet in its orbit. For example, Mars orbits farther from the sun than Earth. At one point in the respective orbits of Earth and Mars, we catch up to the Red Planet and pass it by. As we pass by it, the planet moves backward in the sky. Then it moves forward again after we have passed.

Another piece of evidence for the sun-centered solar system comes from looking at parallax, or apparent change in the position of the stars with respect to each other. For a simple example of parallax, hold up your index finger in front of your face at arm's length. Look at it with your left eye only, closing your right eye. Then close your right eye, and look at the finger with your left. The finger's apparent position changes. That's because your left and right eyes are looking at the finger with slightly different angles.

The same thing happens on Earth when we look at stars. It takes about 365 days for us to orbit the sun. If we look at a close-up star in the summer, and look at it again in the winter, its apparent position in the sky changes because we are at different points in our orbit. We see the star from different vantage points. With a bit of simple calculation, using parallax we can also figure out the distance to that star.

How fast are we spinning?

Earth's spin is constant, but the speed depends on what latitude you are located at. Here's an example. The circumference (distance around the largest part of the Earth) is roughly 24,898 miles (40,070 kilometers), according to NASA. (This area is also called the equator.) If you estimate that a day is 24 hours long, you divide the circumference by the length of the day. This produces a speed at the equator of about 1,037 mph (1,670 km/h).

You won't be moving quite as fast at other latitudes, however. If we move halfway up the globe to 45 degrees in latitude (either north or south), you calculate the speed by using the cosine (a trigonometric function) of the latitude. A good scientific calculator should have a cosine function available if you don't know how to calculate it. The cosine of 45 is 0.707, so the spin speed at 45 degrees is roughly 0.707 x 1037 = 733 mph (1,180 km/h). That speed decreases more as you go farther north or south. By the time you get to the North or South Poles, your spin is very slow indeed — it takes an entire day to spin in place.

Space agencies love to take advantage of Earth's spin. If they're sending humans to the International Space Station, for example, the preferred location to do so is close to the equator. That's why space shuttle missions used to launch from Florida. By doing so and launching in the same direction as Earth's spin, rockets get a speed boost to help them fly into space.

How fast does Earth orbit the sun?

Earth's spin, of course, is not the only motion we have in space. Our orbital speed around the sun is about 67,000 mph (107,000 km/h), according to Cornell. You can calculate that with basic geometry.

First, we have to figure out how far Earth travels. Earth takes about 365 days to orbit the sun. The orbit is an ellipse, but to make the math simpler, let's say it's a circle. So, Earth's orbit is the circumference of a circle. The distance from Earth to the sun — called an astronomical unit — is 92,955,807 miles (149,597,870 kilometers), according to the International Astronomers Union. That is the radius (*r*). The circumference of a circle is equal to 2 x π x *r*. So in one year, Earth travels about 584 million miles (940 million km).

Since speed is equal to the distance traveled over the time taken, Earth's speed is calculated by dividing 584 million miles (940 million km) by 365.25 days and dividing that result by 24 hours to get miles per hour or km per hour. So, Earth travels about 1.6 million miles (2.6 million km) a day, or 66,627 mph (107,226 km/h).

Sun and galaxy move, too

To blow your mind even more: the sun has an orbit of its

own in the Milky Way. The sun is about 25,000 light-years from the center of the galaxy, and the Milky Way is thought to be about 100,000 light-years across. We are thought to be about halfway out from the center, according to Stanford University. The sun and the solar system appear to be moving at 200 kilometers per second, or at an average speed of 515,000 mph (828,000 km/h). Even at this rapid speed, the solar system would take about 230 million years to travel all the way around the Milky Way.

The Milky Way, too, moves in space relative to other galaxies. In about 4 billion years, the Milky Way will collide with its nearest neighbor, the Andromeda Galaxy. The two are rushing toward each other at about 70 miles per second (112 km per second).

Everything in the universe is, therefore, in motion.

What would happen if Earth stopped spinning?

There is no chance that you'll be flung off to space right now, because the Earth's gravity is so strong compared to its spinning motion. (This latter motion is called centripetal acceleration.) At its strongest point, which is at the equator, centripetal acceleration only counteracts Earth's gravity by about 0.3 percent. In other words, you don't even notice it, although you will weigh slightly less at the equator than at the poles.

NASA says the probability for Earth stopping its spin is "practically zero" for the next few billion years, so you can feel safe in knowing you'll stay in place. Theoretically, however, if the Earth did stop moving suddenly, there would be an awful effect. The atmosphere would still be moving at the original speed of the Earth's rotation. This means that everything would be swept off of land, including people, buildings and even trees, topsoil and rocks, NASA added.

What if the process was more gradual? This is the more likely scenario over billions of years, NASA said, because the sun and the moon are tugging on Earth's spin. That would give plenty of time for humans, animals and plants to get used to the change. By the laws of physics, the slowest the Earth could slow its spin would be 1 rotation every 365 days. That situation is called "sun synchronous" and would force one side of our planet to always face the sun, and the other side to permanently face away. By comparison: Earth's moon is already in an Earth-synchronous rotation where one side of the moon always faces us, and the other side opposite to us.

But back to the no-spin scenario for a second: There would be some other weird effects if the Earth stopped spinning completely, NASA said. For one, the magnetic field would presumably disappear because it is thought to be generated in part by a spin. We'd lose our colorful auroras, and the Van Allen radiation belts surrounding Earth would probably disappear, too. Then Earth would be naked against the fury of the sun. Every time it sent a coronal mass ejection (charged particles) toward Earth, it would hit the surface and bathe everything in radiation. "This is a significant biohazard," NASA said.

Another weird effect: most spots on Earth would have daylight for half a year, and nighttime for the other half. During the day, the surface temperature would change depending on what latitude you're at. The equator would be even hotter than it is now, because the sun's light rays shine directly on it; the poles would not have as pronounced an effect because the rays are slanted. Because there are no more sunrises and sunsets, the sun would just move up and down in the sky during the year according to the Earth's orbit and tilt.

"This long-term temperature gradient would alter the atmospheric wind circulation pattern so that the air would move from the equator to the poles rather than in wind systems parallel to the equator like they are now," NASA added.

(Elizabeth Howell / Space.com, July 23, 2016, http://www.space.com/33527-how-fast-is-earth-moving.html)

World's Deepest Blue Hole Is in South China Sea

A new exploration of a legendary blue hole in the South China Sea has found that the underwater feature is the deepest known on Earth.

According to Xinhua News, Dragon Hole, or Longdong, is 987 feet (300.89 meters) deep, far deeper than the previous record holder, Dean's Blue Hole in the Bahamas. (That blue hole measures about 663 feet, or 202 m, deep.) According to Xinhua, local legend holds that Dragon Hole is mentioned in the Ming dynasty novel "Journey to the West," in which a supernatural monkey character gets a magical cudgel from an undersea kingdom ruled by a dragon.

The findings have yet to be confirmed or reviewed by scientists in the field, but if they hold up, the measurements peg Dragon Hole as far deeper than Dean's Blue Hole, said Pete van Hengstum, a marine geologist at Texas A&M University at Galveston, who conducts research on blue holes and sinkholes throughout the Caribbean region. [See Photos of 8 Amazing Sinkholes]

Underwater wonders

Blue holes are water-filled sinkholes that form in carbonate rock such as limestone. Over long periods of time, the carbonate rock dissolves in the subsurface to form caves or cavities, van Hengstum told Live Science.

"Eventually, the process of dissolution causes the cave to reach very close to the Earth's surface, and if the cave ceiling collapses, a blue hole or sinkhole is formed," he said.

Some blue holes, like Dragon Hole, open up to the marine environment, while others are inland.

It's something of a mystery why blue holes form precisely where they do and what factors influence their development. Chemical reactions at the interface of saltwater and freshwater can create weak acids that eat away at limestone and other carbonates, said Lisa Park Boush, a geoscientist at the University of Connecticut who studies blue-hole sediments in the Bahamas. As a result, rising and falling sea levels can influence when and where blue holes form. [In Photos: Stunning Blue Holes from Around the World]

"There is also a group of researchers looking into microbial processes," Boush told Live Science. In some cases, she said, microbe activity might help to dissolve bedrock and contribute to the formation of blue holes.

In addition to microbes, other organisms also call these jaw-droppingly gorgeous holes home.

Blue-hole life

"It's interesting to see what actually lives in these blue holes," said Boush, who called the environment of blue holes "cryptic."

Scientists with the Sansha Ship Course Research Institute for Coral Protection in China used an underwater robot and a depth sensor to investigate the mysterious environment of Dragon Hole, which is a well-known feature in Yongle, a coral reef near the Xisha Islands in the South China Sea, according to Xinhua. They found more than 20 marine organisms living in the upper portions of the hole. Below about 328 feet (100 m), the seawater in the blue hole had almost no oxygen, and thus little life, the researchers told Xinhua on July 22.

Even so, diving in blue holes is extremely dangerous, she said.

"One of the reasons why it's very dangerous is because of the limited oxygen," she said. "And sometimes there are even sulfuric waters."

Well-trained divers can make the journey, van Hengstum said. In other cases, researchers park a boat right above a blue hole and send equipment down to measure depth, temperature, oxygenation and other factors. Both Boush and van Hengstum conduct research on the sediments at the bottom of blue holes. These sediments contain information about the past environment and climate change — and sometimes fossils.

The Dragon Hole in the South China Sea probably formed in an environment that's similar to blue holes in the Bahamas, van Hengstum said. Many blue holes currently flooded by seawater in the Bahamas likely originated as sinkholes during a glacial period when ocean levels were lower, but subsequently became flooded after the last ice age, when continental glaciers melted and global sea levels increased, he said.

The Bahamas sit on a big platform of carbonate that's up to 2,000 feet (610 m) thick in places, Boush said. Some of this carbonate is built up by reef organisms like coral, which excrete calcium carbonate as a sort of protective structure. But calcium carbonate comes from many places, Boush said, including calcareous algae (imagine algae with hard, calcium-carbonate skin) and even fish poop.

"Fish eat the coral reefs," Boush said. "They chomp on it — parrotfish, for example. When you go scuba diving, you hear 'click, click, click, click, click,' and that is the parrotfish eating parts of the reef. Well, what goes in goes out again."

(Stephanie Pappas / Live Science, July 27, 2016, http://www.livescience.com/55568-deepest-blue-hole-in-south-china-sea.html)

Γιατί η Αυστραλία αναγκάζεται να αλλάξει γεωγραφικές συντεταγμένες

Η απόκλιση πρέπει να διορθωθεί για να μην χάνονται οι χρήστες GPS

Λίγοι το έχουν προσέξει, όμως η Αυστραλία βρίσκεται απέχει στην πραγματικότητα 1,5 μέτρο από εκεί όπου νομίζουμε ότι βρίσκεται. Είναι ένα πρόβλημα που πρέπει να λυθεί άμεσα για να μην χάνονται οι ταξιδιώτες.

Το πρόβλημα είναι η τεκτονική πλάκα που μεταφέρει την Αυστραλία κινείται βόρεια κατά περίπου 7 εκατοστά το χρόνο. Η μετατόπιση συσσωρεύεται με τα χρόνια και σήμερα οι τοπικές συντεταγμένες αποκλίνουν κατά 1,5 μέτρο από τις συντεταγμένες που χρησιμοποιεί το GPS και άλλα συστήματα δορυφορικής πλοήγησης.

Η απόκλιση δεν είναι δραματικά μεγάλη και μέχρι σήμερα τα προβλήματα που δημιουργεί είναι ελάχιστα ως ανύπαρκτα. Αυτό όμως θα αλλάξει με την άφιξη των ρομποτικών οχημάτων, τα οποία οδηγούν τον εαυτό τους καθοδηγούμενα με GPS.

«Στις φάρμες της Αυστραλίας έχουν αρχίσει να εμφανίζονται τρακτέρ χωρίς οδηγό. Αν οι πληροφορίες για τη φάρμα δεν ευθυγραμμίζονται με τις συντεταγμένες του συστήματος πλοήγησης θα υπάρχουν προβλήματα» λέει στο **BBC** ο Νταν Γιάκσα της αυστραλιανής γεωλογικής υπηρεσίας Geoscience Australia.

Το Γεωκεντρική Σύστημα Αναφοράς Αυστραλίας, το τοπικό σύστημα συντεταγμένων που χρησιμοποιεί η χώρα, επικαιροποιήθηκε για τελευταία φορά το 1994, όταν η ήπειρος βρισκόταν περίπου 1,5 μέτρο νοτιότερα.

Θα επικαιροποιηθεί εκ νέου την 1η Ιανουαρίου 2017, όχι όμως στις πραγματικές τιμές: η χώρα αποφάσισε να εισάγει μια υπερδιόρθωση των 1,8 μέτρων προς τα βόρεια, έτσι ώστε να μείνει το σύστημα σχετικά ακριβές και για τα επόμενα χρόνια.

Στην πραγματικότητα, όμως, οι τοπικές και οι παγκόσμιες συντεταγμένες θα συμπέσουν μόνο το έτος 2020.

(Επιμέλεια: Βαγγέλης Πρατικάκης / Newsroom ΔΟΛ, 29 Ιουλ 2016, http://news.in.gr/science-technology/article/?aid=1500093137&ref=newsletter)

Australia plans new co-ordinates to fix sat-nav gap

Australia is to shift its longitude and latitude to address a gap between local co-ordinates and those from global navigation satellite systems (GNSS).

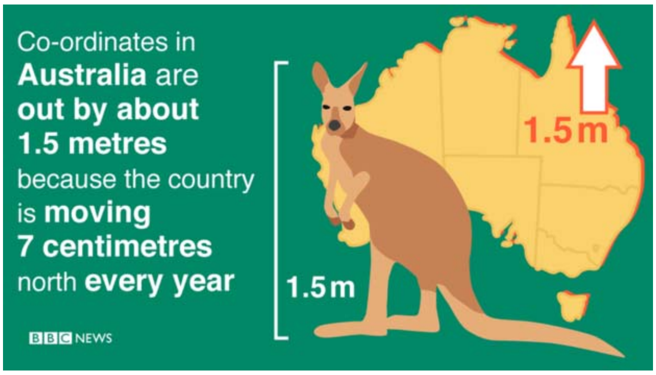
Local co-ordinates, used to produce maps and measurements, and global ones differ by more than 1m.

The body responsible for the change said it would help the development of self-driving cars, which need accurate location data to navigate.

Australia moves about 7cm north annually because of tectonic movements.

Modern satellite systems provide location data based on global lines of longitude and latitude, which do not move even if the continents on Earth shift.

However, many countries produce maps and measurements with the lines of longitude and latitude fixed to their local continent.



"If the lines are fixed, you can put a mark in the ground, measure its co-ordinate, and it will be the same co-ordinate in 20 years," explained Dan Jaksa of Geoscience Australia. "It's the classical way of doing it."

Because of the movement of the Earth's tectonic plates, these local co-ordinates drift apart from the Earth's global co-ordinates over time.

"If you want to start using driverless cars, accurate map information is fundamental," said Mr Jaksa.

"We have tractors in Australia starting to go around farms without a driver, and if the information about the farm doesn't line up with the co-ordinates coming out of the navigation system there will be problems."

The Geocentric Datum of Australia, the country's local co-ordinate system, was last updated in 1994. Since then, Australia has moved about 1.5 metres north.

So on 1 January 2017, the country's local co-ordinates will also be shifted further north - by 1.8m.

The over-correction means Australia's local co-ordinates and the Earth's global co-ordinates will align in 2020.

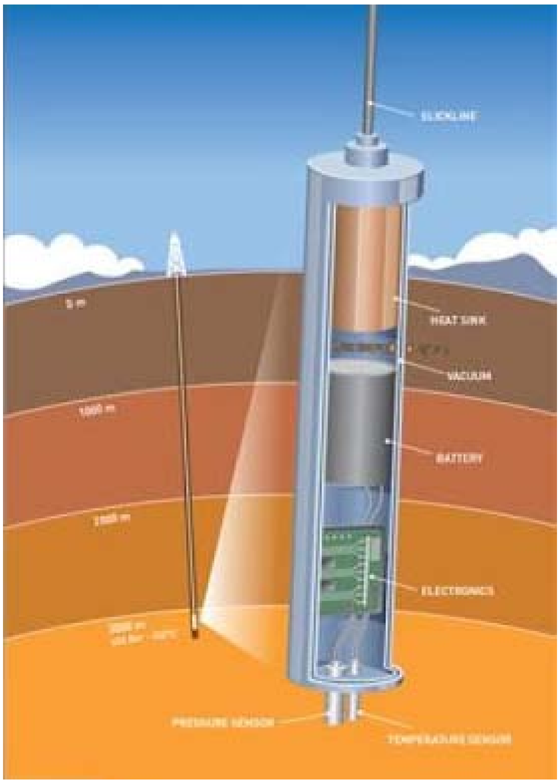
At that point a new system, which can take changes over time into account, will be implemented.

"We used the old plate fixed system to make life simple, but we don't want to do this adjustment every so often," said Mr Jaksa.

"Once we have a system that can deal with changes over time, then everybody in the world could be on that same system."

(Chris Foxx / Technology reporter / BBC News, 29 July 2016 http://www.bbc.com/news/technology-36912700)

Drilling the world's hottest geothermal well



There is an infinite amount of energy lying right beneath our feet. It is a renewable and stable energy source – free of CO2 emissions. Researchers are now planning to drill deep into the Earth to extract it. If they succeed it will be a major technological breakthrough.
Credit: Illustration: Doghouse

There is an inexhaustible amount of energy lying right beneath our feet. It is a renewable and stable energy source -- free of CO2 emissions. Researchers are now planning to drill deep into the Earth to extract it. If they succeed it will be a major technological breakthrough.

Ninety-nine per cent of planet Earth has a temperature in excess of 1,000 degrees Celsius as a result of residual heat inherited from the Earth's primordial origins and the break-down of radioactive materials. This heat can be transformed into energy -- and there is more than enough to go round.

"If we succeed in drilling for and extracting even just a small fraction of this geothermal heat, it will be enough to supply the entire planet with energy -- energy that is clean and safe." So said Are Lund, a senior research scientist at SINTEF Materials and Chemistry, in 2010.

Today, five years later, researchers and technologists from all over Europe are joining forces to pursue a common cause -- to make sure that the world's potentially most energy-rich geothermal well becomes a reality. The well will be drilled in Larderello in Tuscany, and EUR 15.6 of research funding has been earmarked for the project.

Global green energy producer Enel Green Power is heading the project called DESCRAMBLE (Drilling in dEep, Super-CRitical AMBients of continental Europe), where the aim is to extract the maximum possible energy from the well. The extreme heat in the rocks deep beneath northern Italy means that both pressures and temperatures will be right at the limit of what even innovative technologies can currently cope with. However, such conditions also mean that the energy output from such a well can be as much as ten times greater than for standard geothermal wells, and will help to ensure that the new well will be very profitable if the project succeeds.

"SINTEF's contribution to this EU project is to run simulations of the drilling operation and to develop a new instrument to monitor the well," says Øyvind Stamnes, a researcher and Project Manager at SINTEF ICT. Taming supercritical fluids Achieving the project's aim is a challenging assignment. No-one has previously managed to control a well under such extreme high temperature and pressure conditions. Specially developed equipment will be needed. -- "One of the major uncertainties is the presence of what we call supercritical fluids," explains physicist Roar Nybø at SINTEF Petroleum Research. At depths of two to three kilometres in the Earth's interior, ambient physical conditions change dramatically. Temperature increases. And so does the pressure. Something very special happens when temperatures reach 374 degrees and the pressure 218 times the air pressure at the surface. We encounter what we call supercritical water.

It isn't a liquid, and nor is it steam. It occurs in a physical form incorporating both phases, and this means that it takes on entirely new properties. Supercritical water behaves like a powerful acid, and will attack anything -- including electronics and drilling equipment. "In a TV fantasy series it would probably be called 'dragon water'," chuckles Nybø, whose background is as a theoretical particle physicist. Where he comes from, it's not uncommon to be contemplating even more extreme conditions than this project faces.

But the 'dragon water' has its advantages too. It can transport from depth up to ten times more energy that normal water and steam can achieve in a standard geothermal well. It also flows more easily through rock fractures and pores. If researchers can succeed in controlling the forces involved without the technology breaking down, we may be on the verge of a deep Earth technological breakthrough.

If all this wasn't enough, supercritical water can also transport valuable minerals to the surface in solution. This could provide potential incidental revenues. "The dragon of the deep may thus help us open a real treasure trove," says Nybø.

Technology transfer is the key

There's no doubt that the drilling operation requires highly advanced technical preparation. For this reason, the 'major breakthrough' must first be modelled in a specially designed simulator. This has already been developed by SINTEF for drilling operations for oil and gas, and is similar to an aircraft flight simulator.

It will now be installed with all available data about the planned well and its location. This will enable the researchers to take virtual "test flights" of the entire drilling operation.

"This approach to the exploitation of geothermal heat has much in common with oil recovery," says Nybø. "Oil exploration wells have been drilled to depths of more than ten kilometres," he says. "So there are good reasons for involving Norwegian drilling technologists in this project. Geothermal heat quite simply represents a unique opportunity for the oil and gas sector to advance its technological development. We strongly believe that this know-how can become a key Norwegian export," says Nybø, and lists the following similarities:

- Seismic technology is used to identify the correct well location.
- New equipment must be developed to withstand extreme conditions.
- The drilling operation itself.
- Getting the fluid to flow from depth through the rocks.
- Flushing the well to remove sediment.
- Recovery of the fluid (maintaining production and keeping the reservoir pressure stable throughout the lifetime of the well).

Unpredictable conditions

This isn't the first time that researchers and geologists have been looking deep into the Earth's interior to extract the inexhaustible amounts of energy it contains. Iceland has been exploiting geothermal heat for many years. The power station at Krafla has been using steam from below ground to generate electricity since 1977. Its annual production is 480 GWh, which is approximately equivalent to the annual electricity consumption of a town the size of Lillehammer.

In fact, twenty-five per cent of Iceland's energy needs are sourced from geothermal heat, while the remainder is hydroelectric.

In 2009 a team of Icelandic researchers set up some drilling equipment on the volcanic island. Their aim was to drill to 4,000 metres and establish the world's most effective geothermal well. In a frenzy of creativity, they named it DDP-1. Unfortunately, things didn't go to plan -- the geologists encountered lavas as shallow as 2,000 metres depth. But, after two years of tests and studies the well had to be shut down, without having generated any electricity at all. However, the Icelanders learned a great deal from their attempt, and have not given up in their efforts to win the race to drill the world's deepest geothermal well. They are currently planning a new well, with a new name -- DDP-2.

But their hoped for victory is now under threat from the Italians, who are armed with Norwegian oil and gas expertise and experience, and more favourable geological conditions. "Our well will encounter completely different types of rocks," explains Nybø.

"In Iceland the geology is "open" all the way down to the Earth's mantle, while in Italy the heat accumulates in so-called 'hot spots'. Areas such as this are also found in many other places in Europe, and success may lead to opportunities for the efficient exploitation of geothermal heat in many other locations around the world," he says.

Crystal ball

But to achieve this success, the supercritical water must be controlled. In order to predict as accurately as possible how this fluid will behave both at depth in the well and on its journey to the surface, the entire process has to be modelled in a so-called 'flow simulator'. Such tools have been employed in the oil and gas industry for many years to obtain more accurate predictions about how oil, gas and water are transported through subsea pipelines. After years of research, technologists have succeeded in controlling processes such as corrosion, hydrate (ice-like plugs) formation, and wax deposits in pipelines. The flow simulator 'LedaFlow' makes it possible to analyse more detailed and complex flow scenarios involving so-called 'multiphase transport', where oil, gas and water all flow along the same pipeline.

"The simulator is able to visualise waves, fluid plugs, phase transitions and hydrate precipitation, and can contribute towards reducing the risk of these factors causing operational difficulties," explains Bjørn Tore Løvfall at SINTEF Materials and Chemistry. "It also provides valuable information such as how much pressure support (gas injected into a reservoir) a well needs to deliver streamlined production. The simulator will now be used to provide a better insight into how supercritical water will behave," he says. Read more about the LedaFlow simulator here: Link to 'Stroman genome diet' (Flow at great depth).

Løvfall continues: "Today, the LedaFlow simulator is used by engineers who design, scale and operate subsea multiphase transport systems," he says. "It provides its users with a chance to "zoom in" on whatever aspect of flow they may want to visualise along a pipeline, enabling them to obtain detailed simulations of flow conditions at predefined locations.

The simulator is the result of one of SINTEF's most comprehensive research projects ever. However, for the DESCRAMBLE project it will be expanded with the aim of predicting the behaviour of supercritical water. This will entail developing an entirely separate module designed to answer questions such as how deep in the well the water makes its phase transformation, and how it behaves as it rises to the surface carrying its maximum energy load.

Developing a 'super tool'

While work on the modelling and simulation of the advanced drilling operation continues, yet another research team will be getting to grips with some completely different problems.

SINTEF ICT has a research group working under the inspiring name of 'Harsh Environment Instrumentation'. Øyvind Stamnes is a member of this group, working on the development of a specialised probe that will be lowered into the well to log and measure how the well behaves.

The drilling operation must be monitored in detail, so that if something unforeseen happens we can gain as much control of the well as possible. But how is it possible to build a system of electronics and sensors capable of withstanding temperatures of up to 450 degrees, and pressures that would destroy most instruments that we are familiar with today? One thing is certain. Such equipment is not currently on the market.

"We know that when the well reaches its maximum temperature, all known measuring instruments will stop functioning," says Stamnes. The electronics will encounter temperatures high enough to cause short circuits due to excessive leakage flows," says Øyvind Nistad Stamnes.

So how do you get around that? With a combination of custom-designed high-temperature electronics enclosed in a kind of thermos flask. Or in technical language -- A Dewar flask. The container must be well insulated to protect the measuring instrument which has to record conditions in the well over periods of several hours in ambient temperatures of 450°C, and 250°C in the interior of the container.

"You could say that our approach involves developing instruments enclosed in space suits," explains Stamnes. Building electronics for high-temperature applications is nothing new to researchers at SINTEF ICT. They've been looking into this since the 1990s. But the challenge now will be to assemble an array of components that can all withstand the high temperatures -- with something of a safety margin built in as well. "For example, there are no batteries on the market that can withstand temperatures greater than 200°C.. So we're working together with manufacturers to produce batteries that are safe to use at even higher temperatures," says Stamnes.

The project was launched in Pisa in Italy in mid-May, and drilling is planned to start in autumn 2016. If everything goes as planned, this well once completed will provide ten times the output of a standard shallow geothermal well.

The project will give a radical boost to the competitiveness of green, geothermal energy because the drilling costs for a well of this type are between 30 and 50 per cent of the total costs. "This makes for exciting times here at SINTEF ICT," says Stamnes as he returns to his lab to continue working on the "space suit for sensors" on which the entire project relies.

Facts: An inexhaustible source

Low-temperature geothermal energy involves the extraction of geothermal heat from between 150 and 200 metres below the surface. At these depths, the temperature is between six and eight degrees Celsius. Such energy is extracted using ground source heat pumps combined with energy wells, and is currently produced in large volumes. High-temperature geothermal heat has tremendous potential because it represents an inexhaustible, and virtually emissions-free, energy source.

Heat energy can be found in a variety of rocks in the Earth's crust. The deeper we drill, the hotter it gets. About half of the heat at depth originates from primordial heat derived from the Earth's mantle (the layer immediately below the crust) and core. The remaining fifty per cent is derived from the continuous breakdown of radioactive material in the Earth's crust. All this heat is transported towards the surface through the overlying formations.

Oil companies are currently making healthy profits from the recovery of oil from reservoirs at depths of 5,000 metres, where temperatures can reach up to 170 degrees Celsius. At deeper levels, drilling operations and materials integrity are faced with major challenges. Steel becomes brittle, and materials such as plastics and electronics either fail or start to melt. Normally, electronics only function for a short time at temperatures greater than 200 degrees Celsius. These problems must be resolved if the extraction of high-temperature geothermal heat is to become a going concern.

Facts: A democratic source

One of the unique properties of geothermal heat is that it exists all over the world. Potentially, everyone on the planet can exploit this democratic energy source that is both stable and independent of variations in climatic conditions at the Earth's surface. The depths to which we have to drill to achieve the desired temperatures will vary from country to country. This is due to variations in the thickness of the Earth's crust and the geothermal gradient. Here in Norway, temperature increases by about 20 degrees per kilometre, while in other parts of the world, this may be as high as 40 degrees per kilometre. The average is about 25. Countries currently leading the way in the generation of electricity from geothermal sources are the USA, the Philippines, Mexico, Indonesia and Italy. Iceland is lower down the list at number eight.

Facts about the DESCRAMBLE project The aim of the project is to achieve a ten-fold increase in output compared with traditional, shallow geothermal wells. For comparison, the Krafla geothermal energy plant on Iceland generates 480 GWh annually. This is equivalent to the electricity consumption of a town the size of Lillehammer. Participating countries: Italy, Germany and Norway. The Norwegian research partners are SINTEF ICT located in Oslo, and SINTEF Petroleum Research in Trondheim and Bergen. Coordinator: Italy's Enel Green Power, represented by Ruggeri Brentani Duration: 36 months following project kick-off in May Total budget: EUR 16,615,957, funded via the EU programme Horizon 2020.

(http://www.geologypage.com/2015/10/drilling-worlds-hottest-geothermal-well.html#ixzz4F8VrXE11
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The Big Bang might have been just a Big Bounce

A new study of the early universe reveals how it could have been formed from an older collapsing universe, rather than being brand new.

The universe is currently expanding and it is a common theory that this is the result of the 'Big Bang' – the universe bursting into existence from a point of infinitely dense and hot material.

However, physicists have long debated this idea as it means the universe began in a state of complete breakdown of physics as we know it. Instead, some have suggested that the universe has alternated between periods of expansion and contraction, and the current expansion is just one phase of this.

This so-called 'Big Bounce' idea has been around since 1922, but has been held back by an inability to explain how the universe transitions from a contracting to an expanding state, and vice versa, without leading to an infinite point.

Now, in a new study published today in *Physical Review Letters*, Dr Steffen Gielen from Imperial College London and Dr Neil Turok, Director of the Perimeter Institute for Theoretical Physics in Canada, have shown how the Big Bounce might be possible.

BROKEN SYMMETRY

Cosmological observations suggest that during its very early life, the universe may have looked the same at all scales – meaning that the physical laws that worked for the whole structure of the universe also worked at the scale of the very small, smaller than individual atoms. This phenomenon is known as conformal symmetry.

In today's universe, this is not the case – particles smaller than atoms behave very differently to larger matter and the symmetry is broken. Subatomic particle behaviour is governed by what is called quantum mechanics, which produces different rules of physics for the very small.

For example, without quantum mechanics, atoms would not exist. The electrons, as they whizz around the nucleus, would lose energy and collapse into the centre, destroying the atom. However, quantum mechanics prevents this from happening.

Dr Gielen (L) and Dr Turok (R)

In the early universe, as everything was incredibly small, it may have been governed solely by the principles of quantum mechanics, rather than the large-scale physics we also see today.

In the new study, the researchers suggest that the effects of quantum mechanics could prevent the universe from collapsing and destroying itself at end of a period of contraction, known as the Big Crunch. Instead, the universe would transition from a contracting state to an expanding one without collapsing completely.

Dr Gielen said: "Quantum mechanics saves us when things break down. It saves electrons from falling in and destroying atoms, so maybe it could also save the early universe from such violent beginnings and endings as the Big Bang and Big Crunch."

SIMPLE INGREDIENTS

Using the idea that the universe had conformal symmetry at its beginning, and that this was governed by the rules of quantum mechanics, Dr Gielen and Dr Turok built a mathematical model of how the universe might evolve.

The model contains a few simple ingredients that are most likely to have formed the early universe, such as the fact that it was filled with radiation, with almost no normal matter. With these, the model predicts that the effect of quantum mechanics would allow the universe to spring from a previous universe that was contracting, rather than from a single point of broken physics.

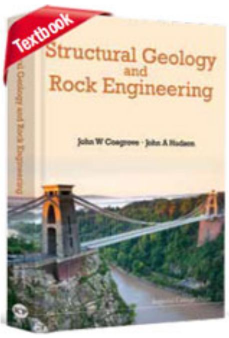
Dr Turok said: "The big surprise in our work is that we could describe the earliest moments of the hot Big Bang quantum mechanically, under very reasonable and minimal assumptions about the matter present in the universe. Under these assumptions, the Big Bang was a 'bounce', in which contraction reversed to expansion."

The researchers are now investigating how this simple model can be extended to explain the origin of perturbations to the simple structure of the universe, such as galaxies. "Our model's ability to give a possible solution to the problem of the Big Bang opens the way to new explanations for the formation of the universe," said Dr Gielen.

'Perfect Quantum Cosmologial Bounce' by S Gielen and N Turok is published in *Physical Review Letters*.

(Hayley Dunning / Imperia College Alumni e-Bulletin Augusts 2016 - 07 July 2016, http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_30-6-2016-14-4-5?utm_source=alumni-bulletin&utm_medium=email&utm_campaign=alumniebulletin)

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ



Structural Geology and Rock Engineering

John W. Cosgrove and John A. Hudson

The exploration and extraction of the earth's resources are key issues in global industrial development. In the 21st century, emphasis has increasingly being placed on geo-engineering safety, engineering accountability and sustainability. With focus on rock engineering projects, *Structural Geology and Rock Engineering* uses case studies and an integrated engineering approach to provide an understanding of projects constructed on or in rock masses. Based on Professors Cosgrove and Hudson's university teaching at Imperial College London, as well as relevant short course presentations, it explains the processes required for engineering modelling, design and construction.

The first half of the book provides step-by-step presentations of the principles of structural geology and rock mechanics with special emphasis on the integration between the two subjects. The second half of the book turns principles into practice. A wealth of practical engineering examples are presented, including evaluations of bridge foundations, quarries, dams, opencast coal mining, underground rock engineering, historical monuments and stone buildings.

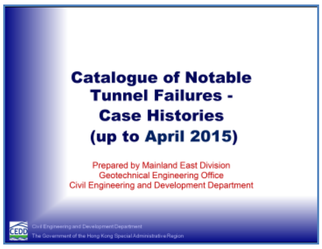
This up-to-date, well-illustrated guide is ideal for teachers, researchers and engineers interested in the study and practice of rock-based projects in engineering.

Contents:

- Introduction and Purpose of the Book
- Structural Geology Principles
- Rock Mechanics Principles
- The Clifton Suspension Bridge
- Quarries
- Dams
- Opencast Coal Mining
- Underground Rock Engineering
- Historical Monuments and Stone Buildings
- Concluding Summary
- Epilogue

Readership: Teachers, researchers and engineers interested in the study and practice of rock-based projects in engineering.

(World Scientific, Aug 2016)



Catalogue of Notable Tunnel Failures - Case Histories (up to April 2015)

Prepared by Mainland East Division Geotechnical Engineering Office Civil Engineering and Development Department

This catalogue of notable tunnel failures is primarily based on published information. Both local and international cases involving collapse or excessive deformation of the ground are included. For contractual and other reasons, there are relatively few cases reported in technical publications, and those reported are usually of such scale or seriousness that they have received public attention. Even for the cases reported, usually only limited information is available. Apart from the cases included, readers can find other information on tunnel failure in the list of Bibliography given at the end of this catalogue.

This catalogue is a live document that will be updated from time to time as further information becomes available. Readers are always welcome to provide us with additional information about cases in this catalogue for future update.

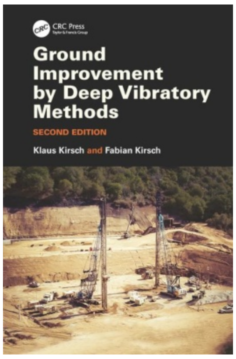
The main purpose of the catalogue is to disseminate information and promote awareness on tunnel failures which could pose a danger to life and property. The possible causes of the failures, the geotechnical problems and the lessons learnt, where these are known, are outlined in the catalogue. Readers should refer to the source reference documents quoted for details. Clients and works agents are advised to implement effective geotechnical risk management measures in the planning, investigation, design and construction of their tunnel projects.

The first edition of the catalogue was issued in February 2007 and was put together by Mr W Lee, supervised by Mr K J Roberts. The second edition issued in March 2009 was prepared by Ms L Y Pau, supervised by Mr L P Ho. The third edition issued in October 2012 was prepared by Ms L Y Pau, supervised by Mr K S Chau. This fourth edition was prepared by Ms K L Wong and Mr H H Chan, supervised by Mr K S Chau. GEO staff, members of the Hong Kong Institution of Engineers Geotechnical Division Working Group on Cavern and Tunnel Engineering and other individuals have contributed to this catalogue. All contributions are gratefully acknowledged. Special thanks are given to Mr Guy Lance for his valuable advice and guidance given to revising the systematic structure of this catalogue, sourcing figures and references from tunnel publications as well as editing reported cases.

If any information in this catalogue is found to be inaccurate or out-of-date, please contact the Chief Geotechnical Engineer/Mainland East of the Geotechnical Engineering Office, Civil Engineering and Development Department, 101 Princess Margaret Road, Ho Man Tin, Kowloon, Hong Kong.

http://www.cedd.gov.hk/eng/publications/geo/doc/HK%20NotableTunnel%20Cat.pdf

http://www.cedd.gov.hk/eng/publications/geo/notable_tunnel.html



Ground Improvement by Deep Vibratory Methods

Second Edition

Klaus Kirsch, Fabian Kirsch

Vibro compaction and vibro stone columns are the two dynamic methods of soil improvement most commonly used worldwide. These methods have been developed over almost eighty years and are now of unrivalled importance as modern foundation measures. Vibro compaction works on granular soils by densification, and vibro stone columns are used to displace and reinforce fine-grained and cohesive soils by introducing inert material.

This second edition includes also a chapter on vibro concrete columns constructed with almost identical depth vibrators. These small diameter concrete piles are increasingly used as ground improvement methods for moderately loaded large spread foundations, although the original soil characteristics are only marginally improved.

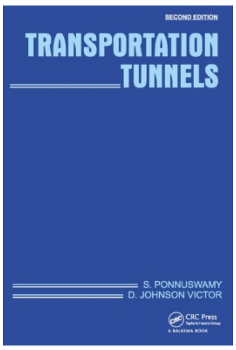
This practical guide for professional geotechnical engineers and graduate students systematically covers the theoretical basis and design principles behind the methods, the equipment used during their execution, and state of the art procedures for quality assurance and data acquisition.

All the chapters are updated in line with recent developments and improvements in the methods and equipment. Fresh case studies from around the world illustrate the wide range of possible applications. The book concludes with variations to methods, evaluates the economic and environmental benefits of the methods, and gives contractual guidance.

Features

- Offers a text that is heavily grounded in practice and updated for new developments in machinery, equipment, design, and execution
- Demonstrates the low carbon impact and superior sustainability credentials of the methods
- Provides an authoritative authorship
- Assesses the contextual issues of the methods

(CRC Press, August 12, 2016)



Transportation Tunnels

Second Edition

S. Ponnuswamy, D. Johnson Victor

Transportation Tunnels, 2nd Edition provides a comprehensive text on tunneling and tunnel engineering applicable in general to all types of tunnels, with more detailed information on highway and railway tunnels. While the First Edition of the book was confined to deal with railway and highway tunnels, the Second Edition is also extensively considering the latest trends in use of tunnels in different other fields. The book has been revised to provide coverage of water conveyance, navigation and material conveyance tunnels also and deals with these subjects in more detail.

It covers all aspects of investigation, design, construction, monitoring and maintenance of tunnels. Special emphasis has been laid on the geotechnical investigations, interpretation of findings and relating the same to the design as well as the construction of tunnels. The book reflects the advancements in the knowledge of ground behaviour and rock mechanics and also in construction technology, including use of TBM in the last two decades.

It covers in sufficient detail the basic requirements of tunnel profile, the geometric parameters, clearance requirements, aerodynamics, and cost economics in fixing alignments with different design parameters like curvature, gradient and operational requirements. It discusses in detail alternative forms of the cross section / profile and illustrates design methodology with examples.

The different methodologies that have been used in the past using timber or steel supports by stage wise expansion of cross sections and modern methodologies used for boring full profile using new tunneling methods and Tunnel Boring Machines are also comprehensively discussed.

Requirements of tunnels in respect of ventilation, lighting and drainage are adequately covered. Separate chapters have been included on 'Instrumentation' and 'Tunnel Inspection and Maintenance'.

The expanded text on the use and advantages of methodologies and equipment for dealing with various aspects of construction of tunnels is based on observations through site visits, discussions with, and experiences of people as recorded on large number of tunneling works which have been taken up recently for railways, highways and urban transport subway projects.

The book can serve as a textbook for undergraduate and graduate students and as a reference book for practicing engineers.

Features

- Covering all aspects of tunnels in general; and detailed requirements of tunnels used for movement of people and materials, including water conveyance tunnels
- Reviewing the historical development of tunnels, specially highway and railway tunnels at a global level
- Special focus on investigations, route selection and geotechnical engineering studies and design
- Covering the methodology of tunnelling through different types of rocks and soils using traditional methods and modern equipment
- Documents different problems involved in various aspects of tunnelling, monitoring and maintenance, illustrated with actual case studies

(CRC Press, May 17, 2016)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

www.geoengineer.org

Κυκλοφόρησε το Τεύχος #136 του **Newsletter του Geoengineer.org** (Ιουλίου 2016) με πολλές χρήσιμες πληροφορίες για όλα τα θέματα της γεωμηχανικής. Υπενθυμίζεται ότι το Newsletter εκδίδεται από τον συνάδελφο και μέλος της ΕΕΕΕΓΜ Δημήτρη Ζέκκο (secretariat@geoengineer.org).

Ενδεικτικά αναφέρονται:

- Landslide in China Destroys Buildings (Video)
- Trains Delayed Due to Sinkhole Under Tracks
- GEER Report on 2016 Kumamoto, Japan Earthquakes
- Drivers Stop in Road to Avoid Landslide (video)
- Christchurch City Council Warns Port Hills Residents Against Returning to Their Homes
- Massive Landslide Found in Alaska (Video)
- 23 Killed and 7 Injured by Landslide in China's Guizhou Province

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