Η εκκλησία του Αγίου Νικολάου

ΕΛΛΗΝΙΚΗ
ΕΠΙΣΤΗΜΟΝΙΚΗ
ΕΤΑΙΡΕΙΑ
ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ
& ΓΕΩΤΕΧΝΙΚΗΣ
ΜΗΧΑΝΙΚΗΣ

Τα Νέα της Ε Ε Ε Ε Γ Μ

143

Αρ. 143 – ΟΚΤΩΒΡΙΟΣ 2020

SIMSG ISSMGE

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Πολύ ισχυρός σεισμός, Μ6.7, βόρεια της Σάμου
Μεγάλες ζημιές στην Σμύρνη

Π Ε Ρ Ι Ε Χ Ο Μ Ε Ν Α

The Earthquake of Oct. 30, 2020, M6.7 (11:51GMT) North of Samos Island (Greece): Observed strong ground motion on Samos island

The earthquake of October 30, 2020 11:51GMT, M6.7, (or Mw7.0 according to EMSC-CSEM), took place in the sea between Samos island and western shores of Turkey, close to Izmir region). (37.91N, 26.84E). The focal mechanism of the mainshock was normal faulting with an almost E-W strike (see Fig. 1). At Samos island two teenagers were killed and several residents were injured, while according to preliminary information there were victims and injured people in the city of Izmir as well. As of late afternoon on the same day of the event, the full picture of the damage extension was not yet fully recorded.

The accelerograph station of ITSAK-EPPO installed at the capital of Samos island with a station-to-epicenter distance R~15km (see Fig.2), recorded ground motion with a horizontal PGA=0.23g and strong ground motion duration ~7sec (bracketed duration including ground acceleration ≥0.05g).

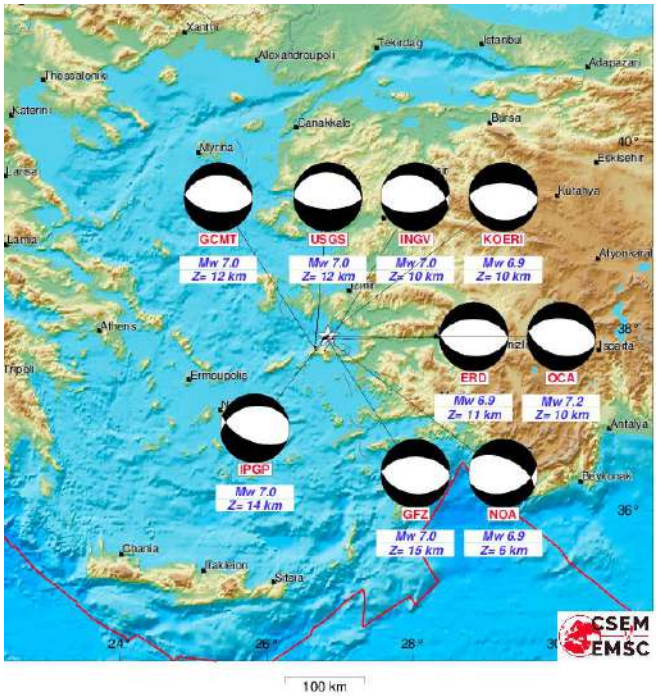

Fig. 1. Epicenter and focal mechanism of the 30/10/2020 11:51 earthquake.

In Figs. 3, 4, 5 the recordings of the mainshock (3 components) are presented. In Figs. 7, 8, 9 the corresponding acceleration response spectra are shown. Higher spectral values of >0.4g are observed within the eigen-period window of 0.4sec<T<0.7sec. Such a period range according to seismic code provisions in Greece, corresponds to medium rise buildings (say roughly between 4 to 7 storeys).

The shakemaps generated by ITSAK-EPPO (Fig. 6) demonstrated high intensity values (>VI) to be expected both on the northern part of the Samos island as well as on the western Turkey shore opposite the island.

Hereafter an effort to compare the observed response spectra at the Samos (SMG1 station, at the Vathi town) with the elastic design spectra of the EC8 and those of the national Hellenic seismic codes is presented. Figure 7 shows the comparison of the 5%-damped elastic acceleration response spectra between the earthquake record in Vathi, Samos and the Greek Aseismic Code (EAK2003) for the horizontal components of motion. For the code-specified spectra, those referring to soil type B and "Γ" are shown.

Fig. 2. Accelerograph station SMG1 installed on Samos island (white triangle) and the epicenter of the mainshock (yellow star). The city of Izmir is also shown.

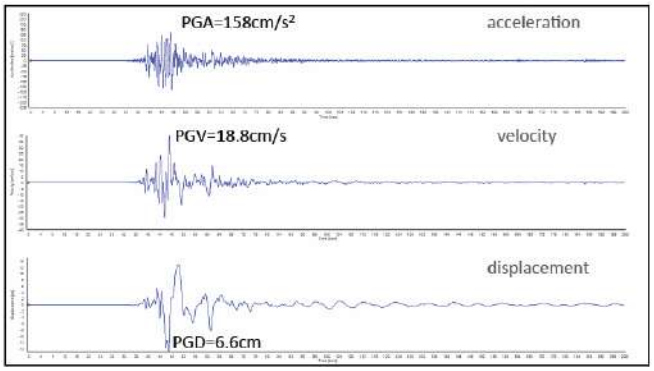

Fig. 3. Time histories of the horizontal component (direction N48W).

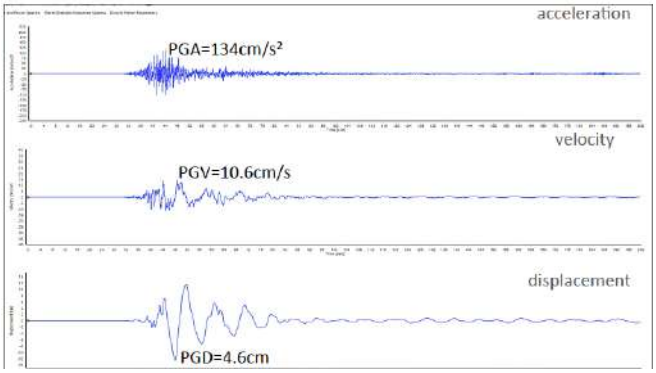

Fig. 4. Time histories of the vertical component.

The corresponding comparison for the EC8-based elastic response spectra is shown in Figure 8 for soil type B and C. The above selection was based solely on the Vs30 value (equal to 380 m/sec) at the location of the accelerometric station. The comparison between record and code design spectra for the vertical component of the seismic motion is shown in Figure 9.

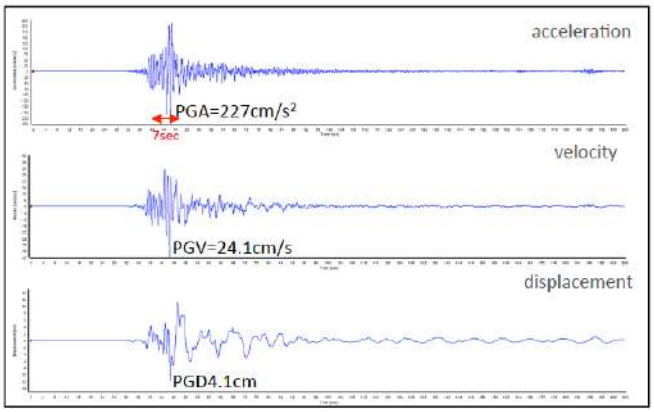

Fig 5. Time histories of the horizontal component (direction N42E).

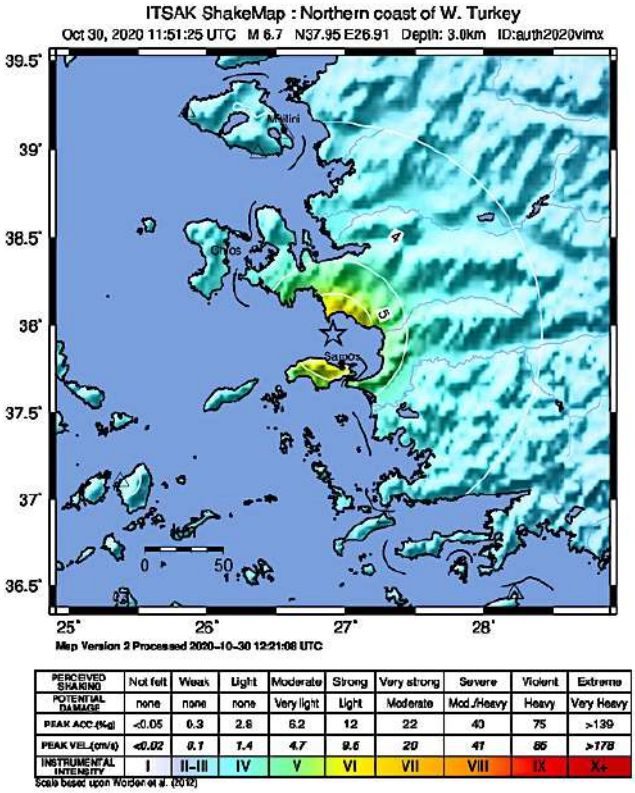

Fig. 6. Shakemaps generated a few minutes after the mainshock (http://shakemaps.itsak.gr).

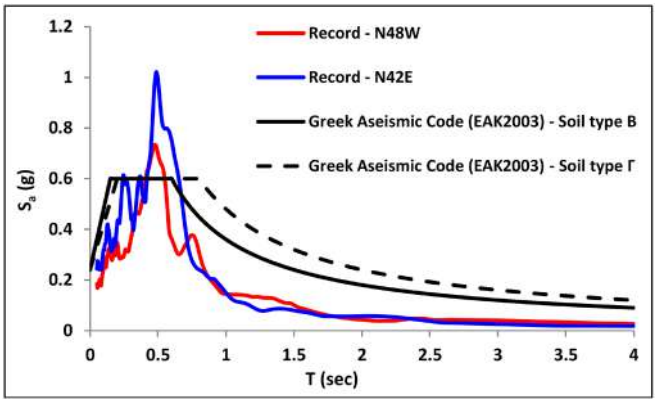

Fig. 7. Comparison of the 5%-damped elastic acceleration response spectra between the earthquake record in Vathi, Samos and the Greek Aseismic Code (EAK2003): Horizontal components of seismic motion.

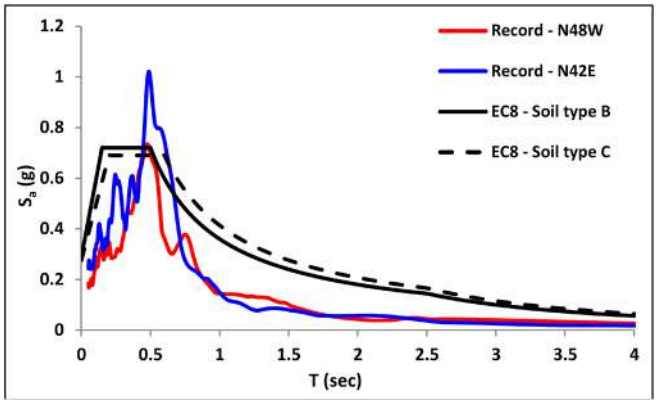

Fig. 8. Comparison of the 5%-damped elastic acceleration response spectra between the earthquake record in Vathi, Samos and the EC8 Code: Horizontal components of seismic motion.

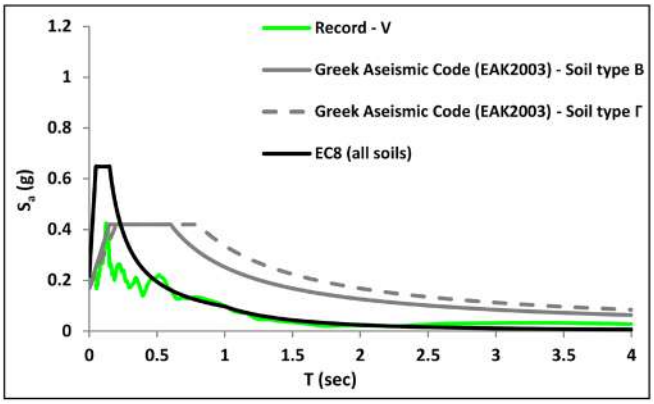

Fig. 9. Comparison of the 5%-damped elastic acceleration response spectra between the earthquake record in Vathi, Samos and the Seismic codes (EAK2003 and EC8): Vertical component of seismic motion.

From the comparison between the observed and elastic design spectra of the seismic codes (EC8 , EAK2003) it is apparent that the latter satisfactorily cover the observed ones for almost the entire period range except for a rather narrow window between 0.5sec to 0.7sec, for the horizontal motion. This period range roughly corresponds to medium-rise R/C buildings (that is 5-7 storeys).

A preliminary idea of the fundamental period of the recording site SMG1 as well as a lower level of amplification amplitude can be obtained using the well-known Horizontal-to-Vertical spectral ratio (eHVSR). In Fig. 10 the eHVSR for both horizontal components is shown. A double peak is apparent on the eHVSR showing a fundamental period at around 2sec (0.5Hz) while a second dominant period appears at lower period around 0.5sec (2Hz). The corresponding amplitudes range from 3 to 5, meaning that the real site amplification would be possibly much higher. Such an observation implies that the role of soil layers in shaping the strong ground motion could be important. However, additional data and further investigation is needed to clarify this issue.

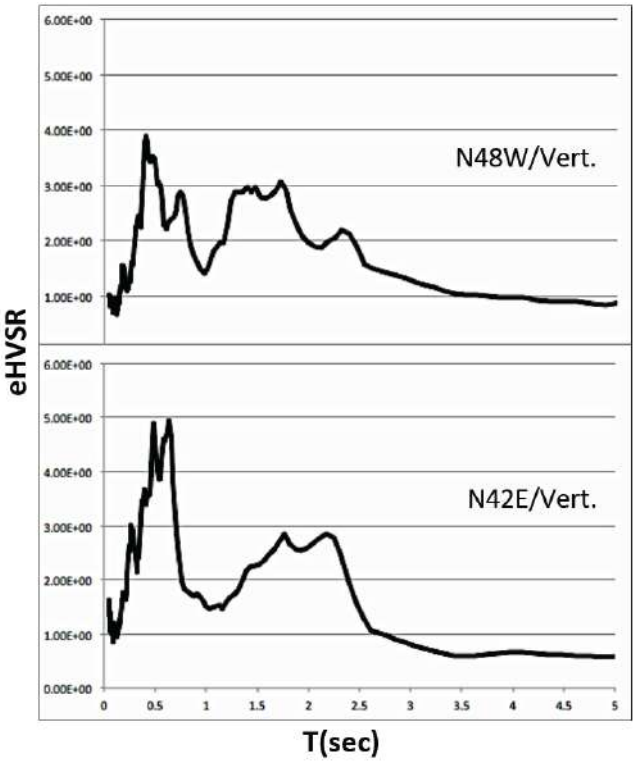

Fig. 10. Earthquake Horizontal-to-Vertical spectral ratio for both horizontal components based on the 5% damped response spectra at the site of the SMG1 station.

The Earthquake of Oct. 30, 2020, M6.7 (11:51gmt) North of Samos Island (Greece): Observed Strong Ground Motion on Samos Island

Preliminary Report v2.0

Thessaloniki, October 2020

In this Report the following researchers of ITSAK have contributed:

Στην έκθεση αυτή συνεισέφεραν οι παρακάτω ερευνητές του ΙΤΣΑΚ:

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Σαλονικιός Θωμάς (Salonikios T.), Δρ. Πολιτικός Μηχανικός, Κύριος Ερευνητής

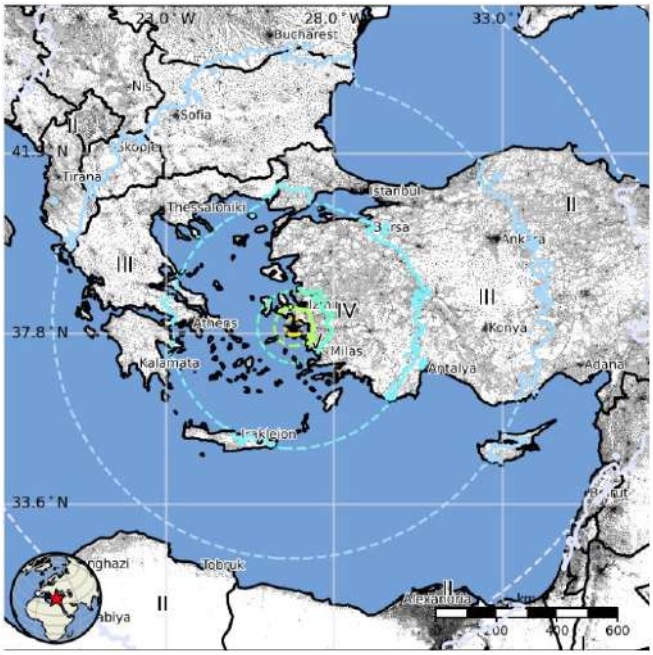
The Laboratory and the Computer Center of iTSAK actively participate in the operation of accelerometer network and its data transmission and storage.

Be cited as:

ITSAK (2020): Earthquake North of Samos Island(Greece) of 30/10/2020-Preliminary Report ITSAK, Thessaloniki pp. 9.

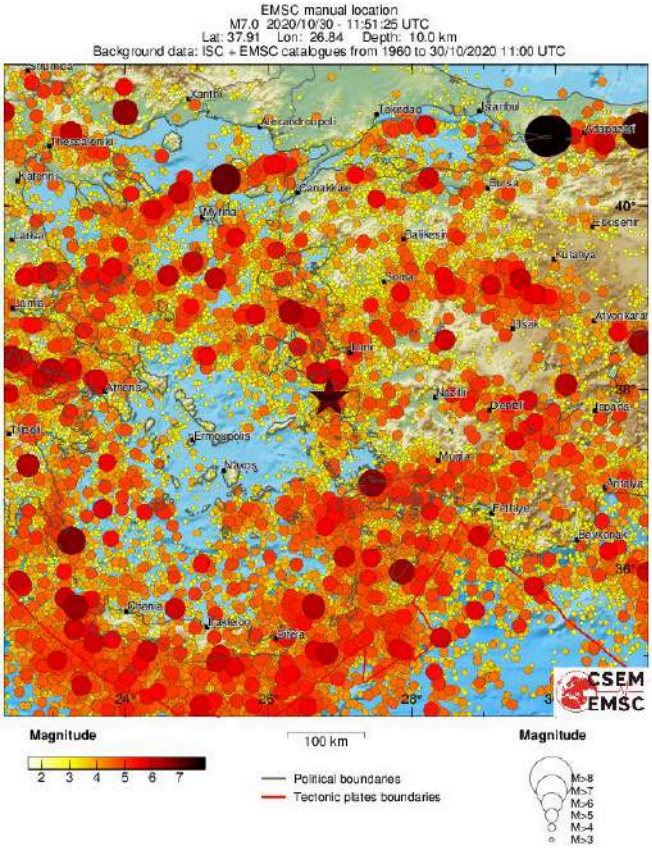
www.itsak.gr/news/EQ_Samos_20201030_report_v2

Estimated population exposure to earthquake shaking



MMI	Shaking	Population
I	Not Felt	35,810 k*
II-III	Weak	169,296 k*
IV	Light	15,831 k
V	Moderate	4,425 k
VI	Strong	498 k
VII	Very Strong	30 k
VIII	Severe	0 k
IX	Violent	0 k
X	Extreme	0 k

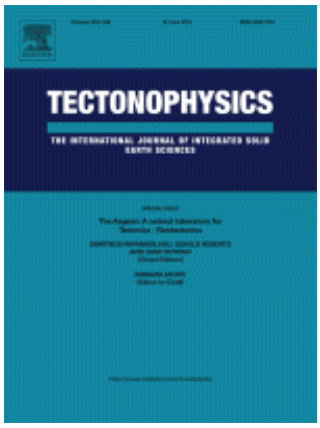
Regional seismicity



Selected cities exposed

MMI	City	Population
VII	Neon Karlovasion	7 k
VII	Kokkari	1 k
VII	Mytilinioi	2 k
VII	Chora	1 k
VII	Vathy	2 k
VII	Samos	2 k
V	Izmir	2,501 k
III	Istanbul	11,174 k
III	Ankara	3,517 k
II	Alexandria	3,812 k
II	Cairo	7,735 k

The Aegean: a natural laboratory for tectonics - Neotectonics



Edited by Dimitrios Papanikolaou, Gerald Roberts, Leigh Royden

Volumes 597–598, Pages 1-160 (19 June 2013)

https://www.sciencedirect.com/journal/tectonophysics/vol/597

Special Issue

The Aegean: A natural laboratory for Tectonics – Neotectonics

Guest Editors

Dimitrios Papanikolaou[a], Gerald Roberts[b], Leigh Royden[c]

[a]Fac. of Geology & GeoEnvironment, National & Kapodistrian University of Athens, Panepistimioupolis, Zografou, Athens, Greece
[b]School of Geography, Birkbeck College, University of London, Malet Street, London, UK
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CONTENTS

Active faulting in the north-eastern Aegean Sea Islands

A. Chatzipetros, A. Kiratzi, S. Sboras, N. Zouros, S. Pavlides

Abstract

The distribution of seismicity, faulting pattern and its effect on local geomorphology is examined for the islands of Lemnos, Aghios Efstratios, Lesvos, Chios, Samos and Ikaria of north-eastern Aegean Sea, Greece. The main active faults on each island are described in terms of their geometrical characteristics and geomorphology. Faults that comply with specific criteria (geological age, effect on relief, their geometrical relationship to the active stress field) have been characterized as active. We evaluated and reviewed published information, augmented with new field data for onshore faults, while the effects of faulting on the sea-floor and their probable association with recorded earthquakes were used to determine offshore faulting. The relation of active faulting to the stress pattern has been examined as well. It is shown that as the deformation changes gradually from transtensional in the north to extensional in the south, so does the active faulting pattern. The effect of the westernmost splays of the North Anatolian Fault Zone, the largest of which is the ~ 300 km long, North Aegean Trough, is profound due to their close vicinity, causing shearing in good agreement with the modeled principal displacement zone deformation pattern. Faulting in the area is controlled by the distance from the main dextral principal displacement zones: the northern part of the area is directly affected by the North Anatolian Fault Zone and its splays, while this effect gradually weakens in the central and southern areas. The geomorphology responds to this faulting, causing the formation of fault-parallel gulfs near Lesvos and Lemnos and fault-defined shorelines in the rest of the islands. Ikaria exhibits a notable fault-controlled tilted topography as the result of footwall uplift.

Highlights

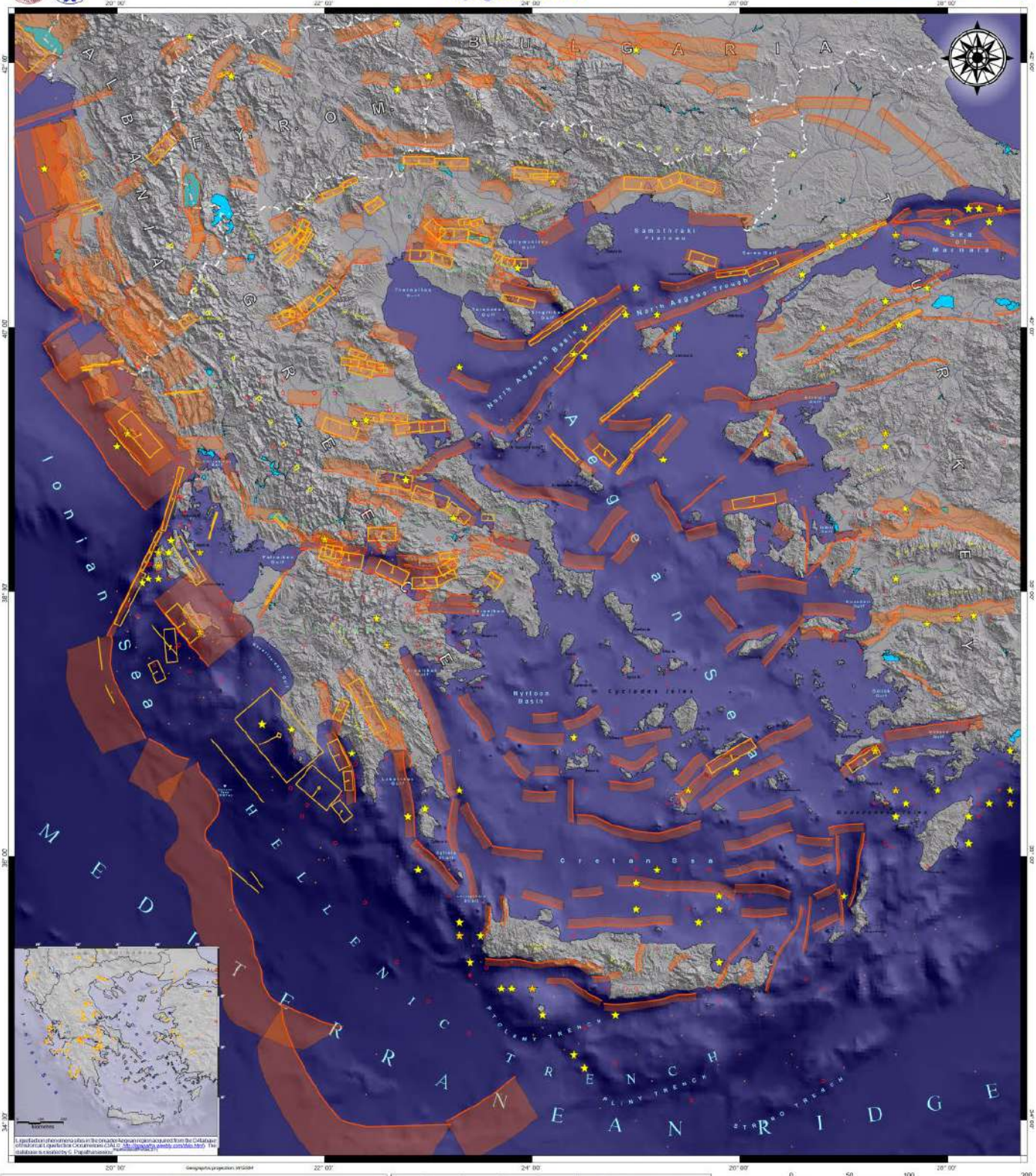
► We identify the main active fault zones of the northeastern Aegean islands (Greece) ► Faulting pattern changes gradually from North to South ► Faults may be explained as shears of the splayed North Anatolian Fault Zone ► Focal mechanisms are in good agreement with this deformation model ► The geomorphology of the islands is largely controlled by neotectonics

Tectonophysics, Volumes 597–598, 19 June 2013, Pages 106-122, https://doi.org/10.1016/j.tecto.2012.11.026, https://www.sciencedirect.com/science/article/abs/pii/S0040195112007536

Active faults of the broader Aegean region in the GREEK DATABASE of SEISMOGENIC SOURCES

http://eqgeogr.weebly.com/database-of-active-faults.html
http://gredass.unife.it/

Earthquake Geology Research Team
eqgeogr.weebly.com



Geographic projection: WGS84

0 50 100 200
kilometres

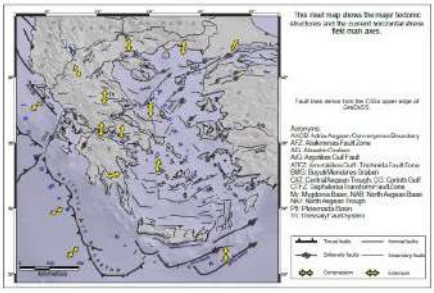
LEGEND

Earthquakes (M = Magnitude): 550 BC - 2010 AD (Parameters: M≥6.5)

M ≥ 7.0 | 6.0 ≤ M < 7.5 | 6.5 ≤ M < 6.0

Individual Seismogenic Sources: they are obtained from geological and geophysical data and are characterized by a full set of geometric (strike, dip, length, width and depth), kinematic (rake, average displacement per event) and seismological (magnitude, slip rate, return period) parameters. ISSs are assumed to exhibit "characteristic" behaviour with respect to rupture length/width and expected mean and maximum magnitude. Moreover, ISSs can also be considered as fault segments of larger fault zones when there are evidences of individual rupture. The ISSs favour accuracy of the information supplied over the completeness of the sources themselves. As such, they can be used for deterministic assessment of seismic hazard, for calculating earthquake and tsunami scenarios, and for tectonic and geodynamic investigations.

Composite Seismogenic Sources: they are obtained from geological and geophysical data and characterized by geometric (strike, dip, width, min/max depth) and kinematic (rake) parameters, but their sliding surface geometry is more loosely defined and can contain an unspecified number of ISSs. They are not assumed to be capable of a characteristic earthquake but their potential can derive from existing earthquake catalogues or other geological considerations. A CSS is essentially inferred on the basis of regional surface and subsurface geological data that are extended well beyond the sample identification of active faults or youthful tectonic features. Opposite to the ISSs, this category of sources favours completeness of the record of potential earthquake sources over accuracy of source description. In conjunction with seismicity and modern strain data, CSSs can thus be used for regional probabilistic Seismic Hazard Assessment and for investigating large-scale geodynamic processes. A CSS can represent a large fault zone which can consist of one or more well defined ISSs. However, it can also be 'empty' of ISSs if none can be recognized. The seismic behaviour of the CSSs can be completely independent for the ISSs, given that a potential event may rupture the total length of the source, whether it contains none, one or more ISSs.



The **Greek Database of Seismogenic Sources** is a repository of geological, tectonic and active-fault data for the Greek territory and its surroundings. It represents a complete and modern tool for improving the Seismic Hazard Assessment (SHA) of the region and a valuable source of information for scientists who want to deal with earthquake scenarios and modelling, geodynamics, active deformation and many more.

GreDaSS is an open-file, continuously updatable, that can accommodate all proposals from multi-field researchers. It is a GIS-based database consisting of several layers both graphical and metadata ones. For more information and complete bibliography, visit our website.

The Gre.Da.S.S. Working Group consists of:

Project Coordinators:
Spyros Pavlides, Riccardo Caputo,
Aikaterini Chatzipetros

Principal scientific contributors:
Sotiris Sboras, Alexandros Chatzipetros, Ioanna Kouskouseta, Anastasia Michailidou, George Papathanassiou, Sofoklis Valkaniotis, Anna Zannopoulou

Database structure & technical support:
Roberto Basili, Giancarlo Tarabusi

Software provided by the G.I.S.S. WG from the Istituto Nazionale di Geofisica e Vulcanologia (INGV - Italy)

Poster design: Sotiris Sboras

ΑΡΘΡΑ

Το παρακάτω πολύ ενδιαφέρον άρθρο δημοσιεύθηκε ως Case Study στο περιοδικό INTERNATIONAL WATER POWER AND DAM CONSTRUCTION. Λόγω του μεγάλου μεγέθους του παρατίθενται οι πρώτες σελίδες. Το πλήρες άρθρο είναι προσπελάσιμο στην ιστοσελίδα που παρατίθεται στο τέλος του άρθρου.

Planning and detailed engineering design of Dudhkoshi CFRD in Nepal

Cesar Alvarado Ancieta describes the challenge in the design and execution planning of the 265m high Dudhkoshi concrete faced rockfill dam (CFRD) in the eastern development region of Nepal, focused on the geomechanics for dam material characterization and rockfill sizing taking the angle of shearing resistance, breakage index and the anisotropic behaviour of the quartzite rockfill into account and their implications for dam stability and impact of stresses on concrete face slab. Additionally, the main design features a conventional plinth on a roller compacted concrete (RCC) toe wall, a drain and grouting gallery for consolidation grouting and injection grouting, and diaphragm up to sound bed rock, all on alluvial and a shear zone

DUDHKOSHI STORAGE HYDROELETRIC PROJECT is located on the Dudhkoshi river between the boundaries of Okhaldhunga and Khotang Districts in Eastern Development Region of Nepal. The hydropower project includes a 265m high concrete faced rockfill dam (CFRD) on Dudhkoshi River, with a spillway on the left abutment taking advantage of a stream tributary of Dudhkoshi. The project has two underground powerhouses defined by means of two waterways: i) The 13.3km long Dudhkoshi-Sunkoshi headrace tunnel which crosses the rock mountains on the left bank of Dudhkoshi river up to an underground powerhouse of 600MW with water releases into Sunkoshi river; ii) 1km long Dudhkoshi headrace tunnel which crosses the near mountains on the dam right abutment with an underground powerhouse of 200MW installed power, with water releases dam downstream on Dudhkoshi River; and iii) Dudhkoshi dam toe surface powerhouse of 35MW, taking advantage of the ecological flow. The total installed power capacity is 835MW. For details see Figure 1.

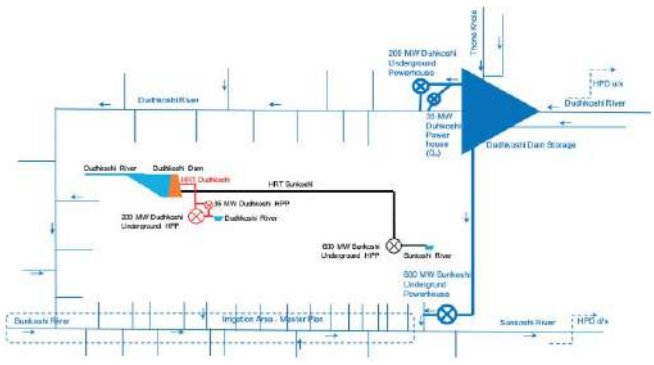


Figure 1 – Hydraulic scheme of Dudhkoshi storage hydropower project complex

Other ancillary works are the main gated spillway with four bays for a design discharge of 9027m^3/sec for a T_r = 10000 years; a labyrinth free overflow auxiliary spillway for a design discharge of 2250m^3/sec; a river diversion structure composed of three river diversion tunnels of 12m diameter each for a design flow of 5838m^3/sec for a 100 years return period and considering special conditions due to moonson flood seasons; bottom, low and middle level outlet for design flow of 5400m^3/sec (Figure 3). The project also includes a 50m high upstream cofferdam, incorporated into the main dam body by means of a stabilizer block and including a plastic diaphragm cut-off in the alluvial layer through the river bed, which will allow for the erection of the main dam during monsoons. There is also a 25m high downstream cofferdam incorporated into the main dam body, by means of a stabilizer block. Cofferdams and stabilizer blocks support main dam for stability.

Important design features are regarding the special dam foundation treatment which comprises a conventional plinth on a 25m high roller compacted concrete (RCC) toe wall which is placed on an excavated 40m depth alluvial layer on main river bed up to the right and left river banks. This is the main upstream dam footing foundation measure, which reaches a deep shear zone, non-active fault. Below the RCC toe wall a drain and grouting gallery for consolidation and injection grouting is arranged as the best solution for foundation on a shear zone. Arrangement of the gallery required a solid dental concrete structure on the partially excavated shear zone. This dental concrete is provided on a concrete plug layer which is placed on the non-excavated shear zone area. The base of the dental concrete serves as the base for location of a concrete guide wall in the gallery's invert, from which a 60m deep concrete sheet pile wall up to bed rock is implemented. A curtain grouting is going to be performed through the concrete sheetpile walls - secant pile wall along the main river bed width and abutments, at the upstream footing, where the plinth must be arranged (Figure 6). The drain-injection gallery will be connected to the right and left abutments by two galleries in order to allow dam impermeabilization during construction and operation. Consolidation grouting is planned bellow the gallery, in the shear zone, upstream and downstream gallery's sides, see Figure 2.

Dam detail and storage design features

Dudhkoshi concrete face rockfill dam (CFRD) is 265m high, will have a main dam body volume of 30 millions m3 approximately, and presents a set of particularities, such as the material zoning, a narrow valley, of V type section, with a shape factor A/H^2, around 2.70, and steep right and left abutments, with average inclination of 60° and 50° respectively, that conditioned important design features. The dam design demanded rigorous solutions based on the state of the art adapted to the site conditions in order to guarantee the dam proper performance. Details are shown in Figure 2.

Topographical conditions

The dam site is located in a gorge nearly one kilometer downstream of the confluence between Dudhkoshi River and Thotne Khola, where the river width is about 120m, at an average elevation of 430.00m asl (Figure 4). The protection of the upstream dam footing starts at the second half of the concave curve with radius R1 next to the left bank. The dam axis is located at the half of the convex curve with radius R2 next to the right bank. The protection of the downstream dam footing is at the end of the curve with radius R2. At the dam axis, the average slope steepness ranges around 50o in left bank, and 60o on the right bank.

The rock outcrops are widely exposed on right bank, while on left bank the lower area is covered with colluvium. The main lithotypes at the dam site are alluvial deposits, superficial deposits, glacial deposits, phyllite and quartzite. Considering the valley shape factor either A/H^2 = 2.70 or L/H = 2.27, and

the expected theorical rockfill embankment modules when plotted in Figure 12, Dudkoshi CFRD is beneath the safe line, which led to design provisions further described, that should guarantee the dam adequate performance. Aiming to attain the expected rockfill deformation modulus, thinner layers were adopted compacted with heavy rollers, in addition to systematic use of water.

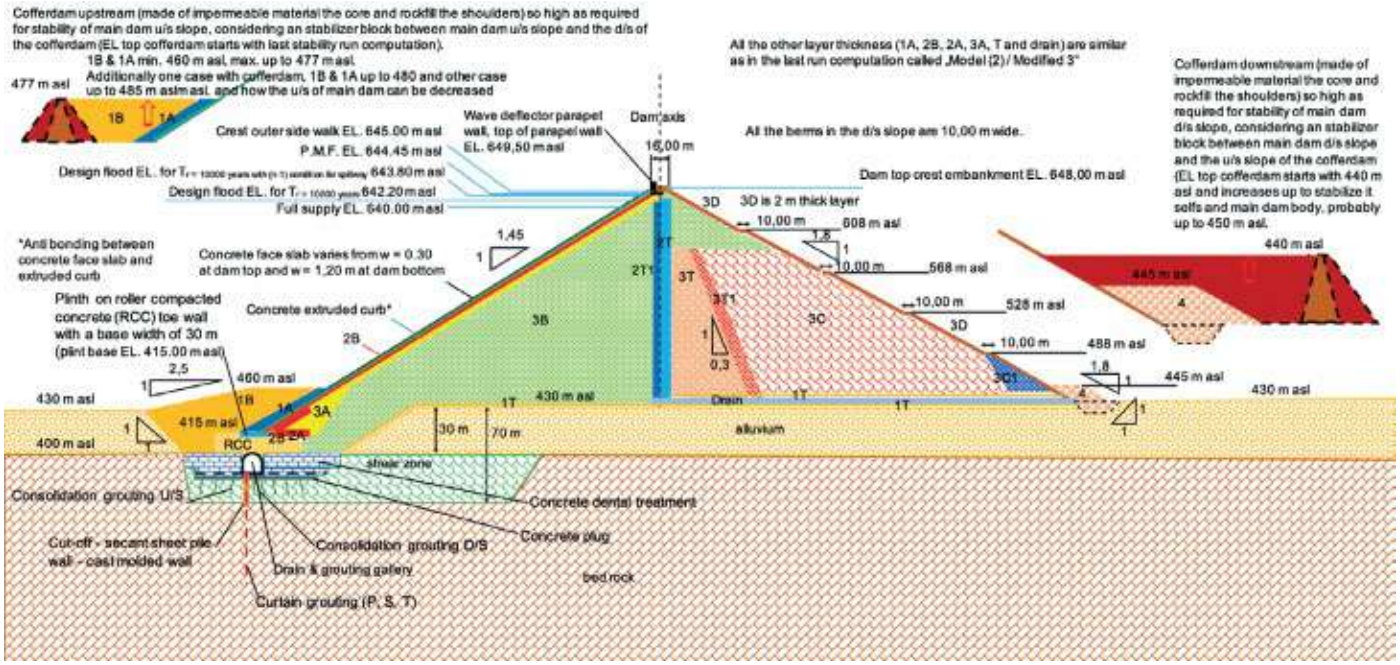


Figure 2a – Dudhkoshi dam body cross section

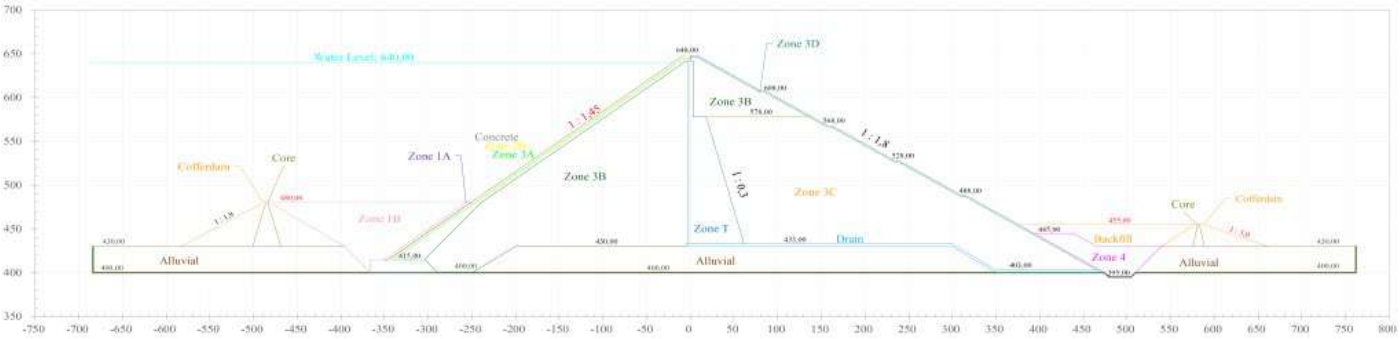


Figure 2b – Dudhkoshi dam body cross section

In order to define the size and foundation surface of the plinth, the main consideration taken was based on the quality of the massive foundation according to the rock mass rating, RMR (Bieniawski Classification) classification, the respective maximum hydraulic gradient supported by the type of rock mass, and the shape of the valley with jambs, steep slopes with an average inclination of approximately 42° on the left bank and 65° on the right bank nearby the river bed.

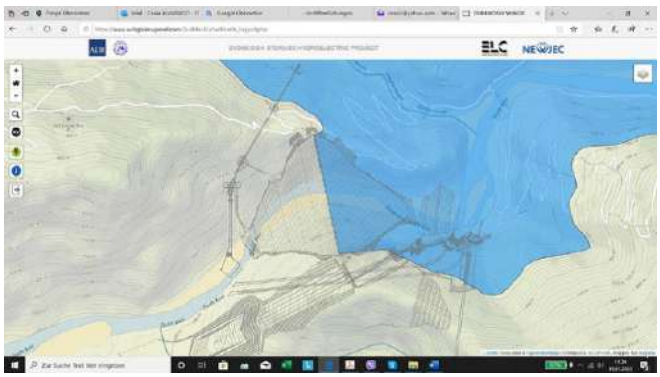


Figure 3 – Plan layout Dudhkoshi dam

Geotechnical dam foundation conditions

Main lithotypes are phyllites and quartzites. Phyllites are ductile and tend to fold and disconnect while quartzites are more rigid rocks and tend to break.

At dam site, quartzites are present along the left abutment of the valley, while phyllites are present along the right abutment. The limit between the two lithotypes is clearly visible on outcrop only on the right side of the valley.

The analysis of foliation bedding carried out on surface structural surveys and terrestrial laser scanner point cloud processing confirms the presence of an antiformal structure with axis oriented along the river course (about E-W) and axial surface dipping to the north with high inclination (78°). Moreover, core data from boreholes drilled on the valley bottom confirm the presence of a shear zone - non active fault - related to a subvertical fault damage zone and oriented along the axial plane of the antiform, along which the river course was incised.

Figure 4 – Aerial view of Dudhkoshi dam site. The dam axis is located at the half of the convexe curve with radius R2 next to the right bank

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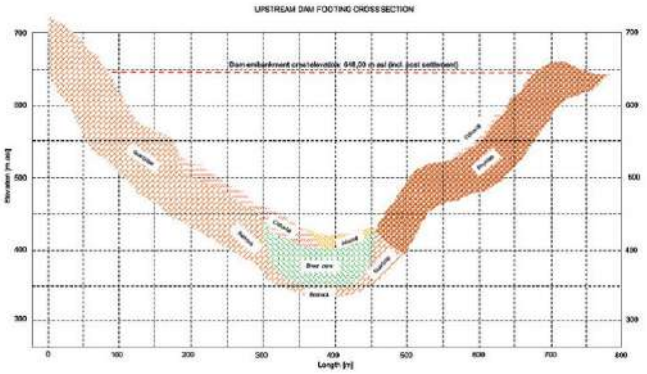

Figure 5 – Dam valley cross section at upstream dam foot. Quartzites are present along the left abutment of the valley, while phyllites are present along the right abutment. The river bed is formed on the top of coalluvium and alluvium material, composed of gravelly deposits, cobbles and boulders, up to 30m depth. Below these, a 40m thick shear zone formed by uncohesive fault rocks, fault gouge, was encountered, between 30 and 70m depth. Bedrock is found at 70m depth

The river bed is formed on the top of colluvium and alluvium material, composed of gravelly deposits, cobbles and boulders, up to 30m depth, i.e. between 430 to 400m asl. Below these, a 40m thick shear zone formed by uncohesive fault rocks, fault gouge, was encountered, between 30 and 70m depth, i.e. between 400m and 360m asl. Bedrock is found at 70m depth, i.e. at 360m asl. Details are shown in Figure 5.

Describing from upstream to downstream, the shear zone at dam site, starts at the left dam abutment before the dam upstream footing - where the plinth is located - up to a few meters before the dam axis. Then the shear zone penetrates into the right dam abutment.

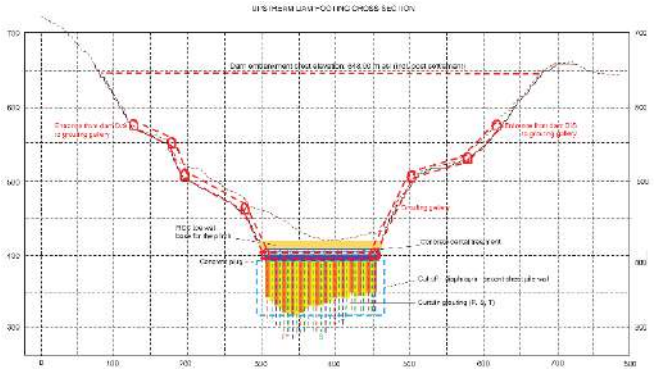

Figure 6 –Dudhkoshi dam foundation treatment

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(Case Study, INTERNATIONAL WATER POWER AND DAM CONSTRUCTION, April 2020, pp. 36-45, https://www.researchgate.net/publication/340979282_Planning_and_Detailed_Engineering_Design_of_the_265-m-high_Dudhkoshi_Concrete_Faced_Rockfill_Dam_CFRD_in_Nepal/link/5ea85247a6fdcc705094b972/download)

Developments of Tsunami Observing Systems in Japan

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Being situated on the major subduction zones in conjunction with a considerable number of submarine active faults and coastal volcanoes, Japan has a long history of catastrophic tsunami events. Consequently, enormous efforts in disaster mitigation, particularly in relation with tsunami hazards, have been made across the country. It is of our interest to review the developments of tsunami observing systems in Japan, which may lead to a global implication beyond national boundaries. In this paper, we first discuss, in general, the evolution of past to present tsunami observing systems available around the territory of Japan. More specifically, we identify the existing offshore observational networks that are mainly consisted of cabled ocean bottom pressure gages and global navigation satellite system buoys, and briefly analyze their performance and viability in the long-term future. In that context, we also appraise the potential of emerging technologies in the offshore tsunami detection leveraging unconventional platforms such as commercial ships and airplanes, which have recently been introduced by several studies in Japan.

Keywords: natural hazard, tsunami, offshore observing systems, Japan, unconventional platforms

Introduction

Tsunamis have been part of Japan's history since thousands of years ago. A paleotsunami research conducted in the eastern Hokkaido of Japan identified at least 15 prehistoric tsunamis dating back to approximately 6000 BP that had occurred in the region (Sawai et al., 2009). The abrupt and violent nature of tsunamis has startled the Japanese coastal communities and will continue to threaten for years to come. Hence, the frequent struggles to cope with such a destructive force of nature have brought Japan to the forefront of tsunami disaster prevention technologies. Long before the modern instrumental era, the earliest form of a tsunami disaster prevention was warnings carved in stones, admonishing the inhabitants about the past tsunami event in the vicinity. Hundreds of such stone markers were found along the coasts of Japan, and some were approximately 600 years old (Tkalich, 2011), which indicate the Japanese people's awareness to the potentially repeated tsunami at the same location. Other than commemorating the ancestral memory of past events, this is among the first notable milestones of the functioning tsunami warning system invented by the Japanese society as part of their efforts to tame the devastating natural disaster.

The stones have now evolved into cutting-edge technologies manifested in various sophisticated geophysical monitoring devices. However, before we proceed with the most recent advanced apparatus, the role of preceding conventional tide gages in the course of tsunami research in Japan is worth acknowledging. A study by Satake et al. (1988) was one of the earliest attempts to thoroughly quantify the response of such a relatively straightforward instrument to tsunamis. To date, there are more than 200 tide gages operating along the coast of Japan[1], and some of them have been utilized either for inferring tsunami sources or validating forward models (e.g., Satake et al., 2013; Gusman et al., 2017). Another variant of a sea level measurement tool is seabed wave gages normally deployed at water depths of less than 50 m, which have also been reported to record tsunamis in Japan (Nagai et al., 2004, 2007). However, the typical placements of both tide and wave gages, being adjacent to the coastlines, are not ideal for an early tsunami detection. Hereinafter, we focus our discourse on the state-of-the-art existing and potential offshore tsunami observing systems in Japan.

Existing Offshore Observing Systems

A global navigation satellite system (GNSS) buoy, first known as a global positioning system (GPS) buoy, is an advancement to the tide and wave gages in the tsunami observation, particularly in terms of station locations. The initial deep-sea GNSS buoy dedicated for the tsunami disaster mitigation in Japan was deployed in April 2004 at a water depth of 100 m, about 12 km offshore (Kato et al., 2005). There are presently 18 GNSS buoys around the coasts of Japan moored at water depths of 100–400 m with an approximately 10- to 20-km distance from shorelines (see Figure 1). The entire system is an integral part of the Nationwide Ocean Wave Information Network for Ports and Harbors (NOWPHAS) program administered by The Ports and Harbors Bureau of Japan's Ministry of Land, Infrastructure, Transport and Tourism together with its associated organizations including the Port and Airport Research Institute. Additionally, a network of GNSS buoys that can also be used to monitor crustal activities is being proposed (Kato et al., 2018). In brief, each unit works using a mounted GNSS receiver on a floating buoy anchored to the seafloor, by which the sea surface fluctuations are measured based on a series of altitude records relative to the Earth's ellipsoid. Then, the data is transmitted in real time to the terrestrial server via radio link. The GNSS buoy of the NOWPHAS uses a real-time kinematic (RTK) algorithm with an accuracy of 4 cm at a distance of 20 km from the base or reference station (Kawai et al., 2013). Such an accuracy is sufficient for tsunami detections as demonstrated during several events, such as the 2010 Chile (Kato et al., 2011) and 2011 Tohoku-oki (Kawai et al., 2013) tsunamis.

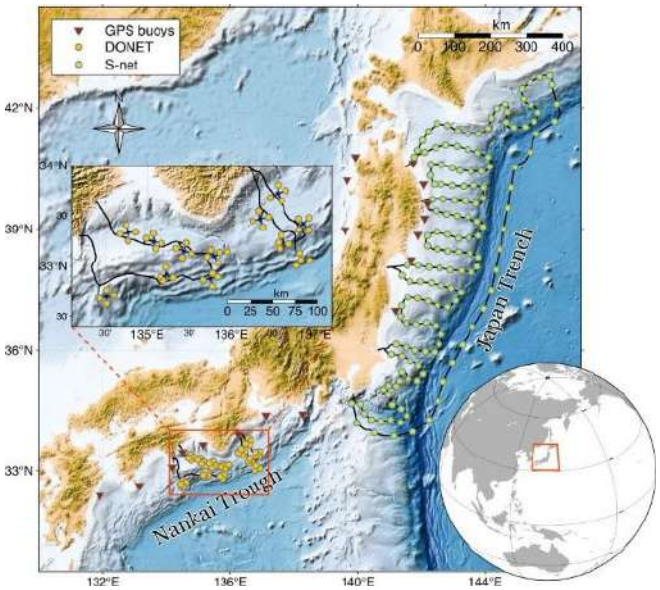

Figure 1. Three major networks of offshore tsunami observing system in Japan.

Unlike the RTK–GNSS buoys, where the measurement accuracy is constrained by the distance to the reference station, another system based on ocean bottom pressure (OBP) gages can be placed farther offshore at seafloor depths of more than 3,000 m. The earliest version of cabled OBP gages in Japan was laid in 1978 off Omaezaki by the Japan Meteorological Agency (Taira et al., 1985), followed by installations of a similar system at other locations operated by several Japanese institutions: the Earthquake Research Institute of the University of Tokyo, the National Research Institute for Earth Science and Disaster Resilience (NIED), and the Japan

Agency for Marine–Earth Science and Technology (JAMSTEC). A complete list of prior cabled OBP systems in Japan can be found in Rabinovich and Eblé (2015).

In 2006, JAMSTEC started to install a large-scale 20 innovative cabled OBP gages paired with ocean bottom seismometers (OBSs) called the Deep Ocean-floor Network system for Earthquakes and Tsunamis (DONET) around the Nankai Trough (Figure 1). Later on, the network was expanded with additional 29 stations covering a wider area. In the DONET system, a group of four to five OBP gages are connected to a science node that acted as a hub linking the looped backbone cable to the instruments for data transmission and power (Kaneda et al., 2015). Such a configuration aims for an uninterrupted operation and functioning during the maintenance, replacement, or extension. The cable is one of the main appealing features of the system ensuring a fast and reliable high-rate data communication. Furthermore, the pressure sensor has an excellent accuracy capable of detecting less than a 1-cm tsunami generated by the 2015 Torishima volcanic earthquake (Wang et al., 2019) and a slightly larger tsunami of the 2016 Off-Mie earthquake (Kubota et al., 2018) including the 2011 Tohoku-oki event (Nosov et al., 2018). However, since the system was initially meant to monitor the hypocentral region of the Tonankai earthquake (Nakano et al., 2013), the spatial distribution of stations does not cover the entire seismogenic zone of the Nankai Trough, thus may not be optimal for quantifying earthquakes using tsunami data from other potential source regions (Mulia et al., 2017a).

While the attention was drawn to the Nankai Trough that was expected to host a large submarine earthquake in the near future, a megathrust earthquake ruptured the Japan Trench subduction zone in March 2011. The earthquake of magnitude *M*w 9.0 accompanied with a giant tsunami shattered the country with direct tsunami impacts stretching 600 km along the coasts facing the Pacific Ocean (Suppasri et al., 2013). A few years later, as the answer to such a tragic event, the NIED of Japan installed the seafloor observation network for earthquakes and tsunami along the Japan Trench (S-net) consisted of 150 observatories equipped with both OBP gages and OBSs (Figure 1). Similar to DONET, the communication link is via submarine optical cable, but S-net has a considerably vaster coverage encompassing the entire focal region of the 2011 Tohoku-oki earthquake and its surrounding areas. Consequently, the network requires a length of 5,800 km of cable connecting each station within an interval of 30–50 km within an area of 1,000 km × 300 km (Kanazawa et al., 2016). Besides the overall astounding dimension and enhanced station distribution, a particular segment located in the outer rise region would be beneficial for real-time tsunami observations as the wave propagates faster in deep water (Mulia et al., 2019). Since the system is relatively new, S-net has hitherto registered only one small tsunami event from the August 20, 2016 off Sanriku earthquake characterized by a magnitude of *M*w 6.0 (Kubota et al., 2020).

Potential Future Observing Systems

An unconventional way of utilizing a GNSS receiver on a ship turns out to be a promising alternative to measure tsunami elevations and currents. This type of measurement has been relatively well established in geodetic science (e.g., Roggenbuck et al., 2014). However, the first use of such an observation to detect the tsunami was reported by Foster et al. (2012), where they accidentally intercepted an offshore tsunami signal of ~10-cm height near Hawaii originating from the *M*w 8.8 2010 Maule, Chile earthquake. More recently, Inazu et al. (2016) conducted thorough analyses on GNSS height positioning records of a navigating research vessel off Tohoku region of Japan. The study suggested that using a precise point positioning (PPP) method, which does not require a reference station, the noise level of measured sea surface height (SSH) is approximately 10 cm, thus is suitable to detect offshore large tsunamis typically generated by earthquakes of magnitudes larger than *M*w 8.5. With the noise level characterized from the actual observation, synthetic experiments to forecast coastal tsunami heights originating from a hypothetical megathrust earthquake (*M*w 8.7) of the Nankai Trough were introduced (Inazu et al., 2016; Mulia et al., 2017b). Assuming that 92 commercial ships were available as observation platforms during the earthquake, the studies showed promising results complementing the existing DONET system. Inazu et al. (2018) further extended their study to ingeniously make use of GNSS horizontal positioning and ship heading records as a proxy for tsunami current measurement applied to the 2011 Tohoku-oki event. In principle, utilizing ships as observation platforms resembles the GNSS buoy system, but it offers a unique spatial coverage most likely wider than the conventional one, depending on the shipping lanes.

Motivated by the perennial distribution and spatial coverage of commercial airplane routes around Japan, another innovative approach to observe a tsunami from such a high-speed moving platform has been proposed (Hirobe et al., 2019). The notion was then supported by their results of airborne measurements of SSH using an airplane equipped with a GNSS receiver and a radar altimeter. The SSH can be obtained by subtracting the distance between the airborne radar and ocean surface from the airplane absolute altitude relative to a reference of Earth's ellipsoid retrieved by a GNSS positioning method. In their study, they have conducted several field experiments around the Nankai Trough and validated the observed SSH against satellite altimetry data. Remarkably, the results suggest that the SSH variations along the airplane tracks can be measured with an accuracy of less than 10 cm, which is comparable to the ship-based observation. Similar airborne observations of SSH as part of the Japanese altimetry mission COMPIRA (Coastal and Ocean Measurement mission with Precise and Innovative Radar Altimetry), but for a different purpose with a lower level of accuracy was performed by Uematsu et al. (2013) using a wide-swath altimeter. To demonstrate how such a type of observation can be utilized for a real-time tsunami forecasting, Mulia et al. (2020) proposed an efficient tsunami data assimilation method numerically propagating the virtually observed SSH from actual 65 commercial airplanes to the areas of interest. Through numerical experiments, it is evident that assimilating spatiotemporal variations of SSH along the track of moving platforms can significantly improve the tsunami forecasting skill when underpinned by a decent source estimate.

Discussion

With 18 GNSS buoys, 49 OBPs of DONET, and 150 OBPs of S-net, Japan is a country with the largest offshore tsunami instrumentation in the world. The viability of these contemporary systems is proven by the numerous detected past tsunami events. The systems have greatly contributed to both practical and scientific applications in the tsunami disaster prevention field. However, implementing new similar systems in other regions and maintaining the existing ones are costly. The cost for a unit of GNSS buoy is estimated to be about US$3M, and a 1,000-km cabled observatory with 164 OBP gages is US$500M (Bernard and Titov, 2015). Therefore, it is unlikely to adopt Japan's array configuration of tsunami observation networks to cover the world's tsunamigenic regions. Even a more affordable system, such as the Deep-ocean Assessment and Reporting of Tsunamis (DART) (González et al., 2005) with an estimated cost of US$0.5M/station developed by the Pacific Marine Environmental Laboratory of the National Oceanic Atmospheric Administration, is probably

still too expensive to maintain as not all tsunami-prone countries participate in this global initiative. Furthermore, regardless of the type, most ocean observing systems using dedicated platforms will inevitably encounter sustainability issues in the long run. For example, the DONET system was designed with the intended effective operational life span of a mere 20–30 years (Kawaguchi et al., 2008). A buoy-based platform has even shorter deployment duration of 1–2 years (González et al., 2005; Rabinovich and Eblé, 2015) or at least 10 years using expectedly improved buoy specifications (Kato et al., 2018).

On the contrary, the proposed new tsunami observing systems based on existing platforms, such as commercial ships and airplanes, may be potent to address future challenges in the tsunami observation, as their number will continuously grow over time. Moreover, the required measuring devices are readily available on a certain type of ships and airplanes, especially that of the more newly built. For example, the GNSS receiver is installed on all passenger ships and other types of ship over certain gross tonnage. Such ships are obligated to broadcast their voyage information (e.g., ship's identity, type, position, course, speed, navigational status, and other safety-related information) through an Automatic Identification System (AIS), a real-time framework for sending and receiving data, enforced by the International Maritime Organization (IMO) (International Maritime Organization [IMO], 2002). However, a high-precision ship altitude information is not included in the present AIS data, but it can still be useful for large tsunami current observations (Inazu et al., 2018). In addition to the GNSS receiver, the radar altimetry is also available on most recent commercial airplanes, though normally, the radar is activated only during takeoff and landing (Hirobe et al., 2019). Furthermore, since using the existing avionic computer may not be feasible at the moment, radar observations by an airborne platform require a dedicated computer for SSH data processing. Similar to the AIS, commercial airplanes should also broadcast flight information (e.g., aircraft identification, position, altitude, speed, and other parameters) in real time via an Automatic Dependent Surveillance-Broadcast (ADS-B) system to comply with the International Civil Aviation Organization (ICAO) regulation (International Civil Aviation Organization [ICAO], 2014). Overall, the aforementioned studies have shown tangible results that the unconventional platforms can be used to measure tsunamis of more than 10-cm height offshore with a sufficient level of accuracy. However, new ancillary protocols in both AIS and ADS-B systems, to incorporate preprocessed SSH, or possibly other alternative reliable connection methods, are needed for real-time data transmission.

Nowadays, with the growing interest in avionic and maritime operations supported by the rapid advancement of navigation technology, there are many service providers that enable data access both openly and through a subscription. A real-time ship tracker is available owing to the AIS transponder equipped on the ships and a large number of terrestrial AIS-receiving stations supplemented by satellite AIS coverage. MarineTraffic is among other providers of ship tracking interface and data (e.g., FleetMon, Shipfinder, Vesselfinder, etc.) operating more than 2,000 AIS stations over 165 countries that records at least 800 million ship positions monthly[2]. Comparably, flight-tracking data derived from the ADS-B system is also available from several service providers such as Flightradar24[3], FlightAware, Plane Finder, etc. It is intriguing that majority of the providers of both ship and airplane tracking data offer free AIS or ADS-B receivers under a community-based project and data-sharing plan. This is an encouraging fact that would be favorable for the purpose of a cost-effective tsunami monitoring once the SSH can be included as one of the variables in the AIS and ADS-B systems.

Additionally, data access and display are conveniently available on smartphone applications, which can be further exploited for early warning disseminations.

Although technically possible, activations or customizations of the required features for tsunami observations in the ordinary transportation infrastructures are subject to additional regulatory provisions. Otherwise, voluntary-based observations may also facilitate the implementation of the new approaches. Such a collaborative scheme engaging stakeholders is not new. A voluntary observing ship program for marine meteorological monitoring has been carried out for decades under the World Meteorological Organization auspices (Fletcher, 2008). Another voluntary observation has also been well manifested in the Comprehensive Observation Network for TRace gases by AIrLiner (CONTRAIL) project, in which commercial airlines provide an observational platform for obtaining free tropospheric CO_2 worldwide (Machida et al., 2008). The same endeavor aiming at marine disaster preventions should be promoted due to the fact that millions of people around the world and US$ billions in assets are exposed to the global tsunami hazard (Løvholt et al., 2015). We envision that despite the developments of the new tsunami observing systems, which are still in their infancy and are locally applied to Japan, they could potentially serve as a global sustainable tsunami monitoring in the future when all various hurdles have been overcome. As illustrated in Figure 2, the global commercial shipping activities and flight routes exhibit an immense spatial coverage and density across the world's oceans including at several major subduction zones, which could substantially enhance our preparedness against impending tsunamis.

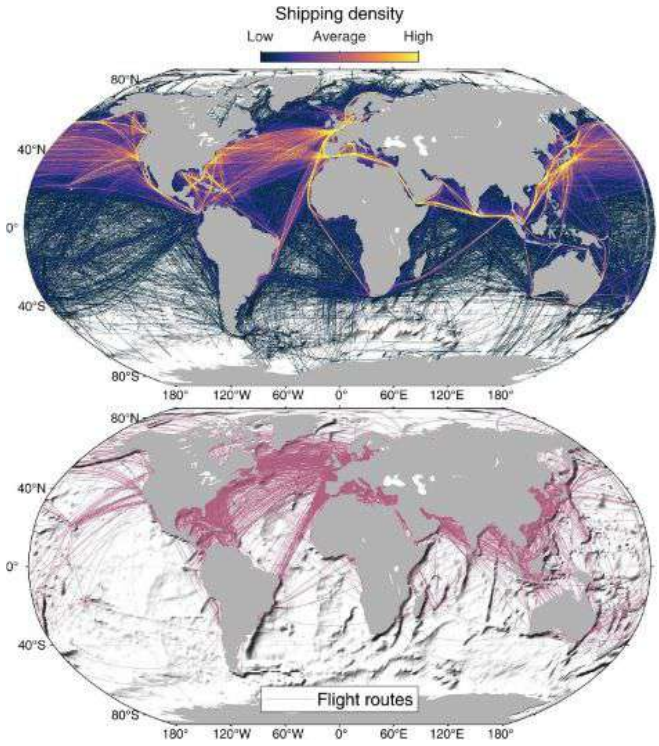

Figure 2. Global shipping density (top) and flight routes over the oceans (bottom).

Author's Note

The ship density map is from a 1-year period (2004–2005) data obtained from the United Nations Environment Program compiled by the National Center for Ecological Analysis and Synthesis (http://ede.grid.unep.ch). Flight route data is based on airline route database of June 2014 available at https://openflights.org/data.html.

Footnotes

1. https://www.jodc.go.jp/jodcweb/JDOSS/infoTide.html, accessed 28 February 2020.
2. https://www.marinetraffic.com/
3. https://www.flightradar24.com/

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Αντέχει η Αθήνα έναν μεγάλο σεισμό;

«Πες μου πότε χτίστηκε το σπίτι σου, να σου πω ποιο είναι το προσδόκιμο ζωής σου»

Ευθύμης Λέκκας, Κωνσταντίνος Σπυράκος, Γιώργος Στασινός, Βασίλης Μπαρδάκης, Γιώργος Αποστολόπουλος μιλούν για τον αντισεισμικό σχεδιασμό της Αθήνας

Στον μεγάλο σεισμό του 1981 με επίκεντρο τις Αλκυονίδες, μεγέθους 6,7 Ρίχτερ, ήμουν δέκα χρονών. Θυμάμαι που πεταχτήκαμε από τον ύπνο μας με τη μάνα μου και τις δύο αδερφές μου και αγκαλιαστήκαμε κάτω από την κάσα της πόρτας, τρέμοντας από τον φόβο μας. Από τότε μου έμεινε φοβία για τους σεισμούς. Και να σας πω την αλήθεια, μετά τη μικρή έρευνα που έκανα και ακολουθεί, δεν μπορώ να πω ότι φοβάμαι λιγότερο.

«Ένα κτίριο που κατασκευάστηκε μετά το 1996 μπορούμε να πούμε ότι είναι ασφαλές, ότι μπορούμε να κοιμόμαστε ήσυχοι σε αυτό, έχει πολύ μικρές πιθανότητες να αντιμετωπίσει προβλήματα λόγω σεισμού. Όσο πιο πίσω πάμε, όμως, τόσο αυξάνονται οι πιθανότητες να έχουμε αστοχίες», λέει ο **Βασίλης Μπαρδάκης**, μεταξύ άλλων πρόεδρος του Συλλόγου

Πολιτικών Μηχανικών Ελλάδας και διδάκτωρ του Πανεπιστημίου Πατρών. *«Για παράδειγμα», προσθέτει, «αν κάποιος ζει σε ένα κτίριο του 1970, το οποίο έχει κατασκευαστεί με τον αντισεισμικό κανονισμό του 1959 και έκτοτε δεν έχει ελεγχθεί, είναι σαν να οδηγεί αυτοκίνητο που δεν έχει αερόσακο ή antispin – και σε κάποιες περιπτώσεις το "μηχανολογικό ανάλογο" μπορεί να είναι σαν να οδηγεί αυτοκίνητο χωρίς ζώνη ασφαλείας και σε λιγότερες… σαν να οδηγεί μηχανή χωρίς κράνος»*.

Παρόμοιες θέσεις εκφράστηκαν με τον πιο επίσημο τρόπο πέρυσι στο 4ο Πανελλήνιο Συνέδριο Αντισεισμικής Μηχανικής & Τεχνικής Σεισμολογίας, από τον πρόεδρο του Τεχνικού Επιμελητηρίου Ελλάδας (ΤΕΕ), **Γιώργο Στασινό**: *«Οι σημερινοί έλληνες πολίτες διακρίνονται σε δύο κατηγορίες από άποψη προσδόκιμου ζωής: σε αυτούς που κατοικούν σε κτίρια που χτίστηκαν μετά το 1995, ή έστω το 1985, για τα οποία υπήρξαν νομοθετικές αντισεισμικές πρόνοιες και κανονισμοί, και σε αυτούς των οποίων οι κατοικίες κατασκευάστηκαν πρωτύτερα»*, είχε πει χαρακτηριστικά. Σύμφωνα με την Ελληνική Στατιστική Υπηρεσία, το 2011: Το 45% του κτιριακού αποθέματος της χώρας ήταν χτισμένο με βάση τον αντισεισμικό κανονισμό του 1959 και το 30% χωρίς κανέναν αντισεισμικό κανονισμό, δηλαδή είχαν κατασκευαστεί πριν το 1959.

Μπορεί κάποιος να προφυλαχθεί κάτω από την κάσα της πόρτας την ώρα του σεισμού; Μόνο εάν βρίσκεται σε κτίριο από φέρουσα τοιχοποιία, δηλαδή πέτρινο ή πλινθόκτιστο κτίριο. Στα κτίρια από οπλισμένο σκυρόδεμα η κάσα της πόρτας δεν προσφέρει κάποια ιδιαίτερη προστασία. Η βασική οδηγία αυτοπροστασίας σε οποιαδήποτε περίπτωση είναι: σκύψε, καλύψου κάτω από ένα γερό, ξύλινο τραπέζι ή γραφείο και κράτησε το πόδι του. - Οργανισμός Αντισεισμικού Σχεδιασμού και Προστασίας, www.oasp.gr

Ελλάδα, η πιο σεισμογενής χώρα της Ευρώπης

«Το θέμα είναι πολυπαραμετρικό», λέει ο **Κωνσταντίνος Σπυράκος**, καθηγητής Αντισεισμικών Κατασκευών στη Σχολή Πολιτικών Μηχανικών, του ΕΜΠ. *«Το πόσο μπορεί να αντέξει ένα κτίριο εξαρτάται από την ηλικία κατασκευής του, από τη συντήρησή του, από το αν γειτνιάζει με ενεργά σεισμικά ρήγματα, από το υλικό της κατασκευής του. Σε κάθε περίπτωση η αξιολόγηση της αντοχής του μπορεί να γίνει από πολιτικό μηχανικό»*. Η Ελλάδα είναι η πλέον σεισμογενής χώρα της Ευρώπης και η έκτη στον κόσμο. Στην Αττική ενεργά ρήγματα υπάρχουν στο βόρειο τμήμα και ένα στον Σαρωνικό, όμως και ρήγματα λίγο πιο μακρινά μπορούν να επηρεάσουν την Αθήνα, σημειώνει ο κ. Σπυράκος. Ένα τέτοιο βρίσκεται στις Αλκυονίδες και ήταν αυτό που προκάλεσε τον σεισμό του 1981, ο οποίος υπήρξε η αφορμή να εκσυγχρονιστεί ο αντισεισμικός κανονισμός που ίσχυε από το 1959.

«Μέχρι και τον σεισμό του 1981 υποτιμούσαμε τις συνέπειες ενός σεισμού στην Αθήνα. Ο σεισμός εκείνος ήταν η κύρια αιτία για τον νέο αντισεισμικό κανονισμό του 1985, ο οποίος ήταν ένα άλμα προόδου σε σχέση με τον προηγούμενο κανονισμό, που ήταν και ο πρώτος στη χώρα μας και ίσχυε ήδη από το 1959», λέει ο καθηγητής. Στη συνέχεια, το 1995 έγινε βελτίωση του αντισεισμικού κανονισμού, το 2000 υπήρξε μία ακόμη βελτίωση και από το 2017 η Ελλάδα ακολουθεί τις ευρωπαϊκές οδηγίες, οι οποίες είναι γνωστές ως Ευρωκώδικας.

Σε άλλες σεισμογενείς χώρες, όπως στις Ηνωμένες Πολιτείες, στην Ιαπωνία, στη Νέα Ζηλανδία, καθορίζεται με νόμο κάθε πότε θα πρέπει να ελέγχονται τα δημόσια κτίρια. Στην Ελλάδα δεν υπάρχει τέτοιος νόμος και μόλις το 25% των δημόσιων κτιρίων (σχολεία, νοσοκομεία, δικαστήρια, υπηρεσίες κ.λπ.) έχει ελεγχθεί, δηλαδή περίπου 18.000 κτίρια. Αυτό που υπάρχει στη χώρα μας είναι μία «σύσταση» από την επιτροπή παρακολούθησης των αντισεισμικών κανονισμών, μέλος της οποίας είναι ο κ. Σπυράκος:

«Η σύσταση είναι οι κατοικίες να ελέγχονται κάθε 10 χρόνια, τα βιομηχανικά κτίρια κάθε 5 έως 10 χρόνια, οι οδικές γέφυρες κάθε 1 έως 4 χρόνια, οι σιδηροδρομικές γέφυρες κάθε 1 έως 2 χρόνια και τα τεχνικά έργα, στα οποία εντάσσονται και τα νοσοκομεία για παράδειγμα, κάθε 5 χρόνια».

Τι πρέπει να κάνει αμέσως μετά τον σεισμό κάποιος που βρίσκεται μέσα σε κτίριο; «Μετά το τέλος της σεισμικής δόνησης θα πρέπει, διατηρώντας την ψυχραιμία του, να φορέσει παπούτσια και κατάλληλα για την εποχή ρούχα και να κλείσει τους γενικούς διακόπτες (ηλεκτρικού ρεύματος, φυσικού αερίου, νερού). Στη συνέχεια θα πρέπει να εκκενώσει προσεκτικά το κτίριο από το κλιμακοστάσιο, παίρνοντας μαζί του τα εφόδια έκτακτης ανάγκης, όπως: φακό, νερό, κλειδιά, φάρμακα κ.ά. Θα πρέπει να κινείται γρήγορα και προσεκτικά, χωρίς να τρέχει, μέχρι να φτάσει στον προεπιλεγμένο κοντινό, ανοικτό, ασφαλή χώρο καταφυγής (πλατεία, πάρκο κ.λπ.)» - Οργανισμός Αντισεισμικού Σχεδιασμού και Προστασίας, www.oasp.gr.

Μέτρα τώρα ζητεί το ΤΕΕ

Τη δέσμη μέτρων που έχει προτείνει το Τεχνικό Επιμελητήριο Ελλάδας μας υπενθυμίζει ο πρόεδρός του, Γιώργος Στασινός: «Το ΤΕΕ έχει προτείνει στην πολιτεία 7 μέτρα και πολιτικές που έπρεπε να έχουν ξεκινήσει ήδη, αν θέλουμε να προλάβουμε τις επιπτώσεις ενός μεγάλου σεισμού.

1. Έλεγχος όλων των δημοσίων κτιρίων με άμεσο πρωτοβάθμιο προσεισμικό έλεγχο δομικής τρωτότητας.
2. Ταυτότητα Κτιρίου (που ξεκινά το 2021) και προσεισμικός έλεγχος ιδιωτικών κτιρίων.
3. Μόνιμα οικονομικά κίνητρα για την ενίσχυση ιδιωτικών κτιρίων που διατρέχουν κίνδυνο βλαβών από σεισμό.
4. Σύνδεση προγραμμάτων σεισμικής ενίσχυσης και ενεργειακής εξοικονόμησης.
5. Ανακατασκευή κενών, παλαιών και διατηρητέων κτιρίων μέσω των δήμων.
6. Ψηφιακή Τράπεζα Γης (που αναμένεται εντός του έτους να ψηφιστεί) και μέσω αυτής μηχανισμός ανακατασκευής των προσόψεων διατηρητέων κτιρίων.
7. Ηλεκτρονικό Μητρώο Έργων Υποδομής, που έχει ξεκινήσει ήδη ο σχεδιασμός του και θα υλοποιήσει το ΤΕΕ.

Για κάθε ένα από αυτά τα μέτρα το ΤΕΕ έχει καταθέσει στην πολιτεία συγκεκριμένες και υλοποιήσιμες προτάσεις με χρονοδιάγραμμα και τους πόρους που απαιτούνται – και πώς μπορούν να καλυφθούν. Αλλά πρέπει να προχωρήσουν όλα τώρα, χθες αν ήταν δυνατόν, παράλληλα και ολοκληρωμένα, όχι α-

ποσπασματικά. Η συγκυρία της χρηματοδότησης από το Ταμείο Ανάκαμψης της ΕΕ, που έχει ως βασικό στόχο την ανθεκτικότητα, και της έναρξης του νέου ΕΣΠΑ σταματά κάθε αμφιβολία για την εύρεση των πόρων που απαιτούνται. Η χώρα χρειάζεται ένα εκτεταμένο και ολοκληρωμένο πρόγραμμα προσεισμικού ελέγχου, αντισεισμικής προστασίας και ανθεκτικότητας ιδιωτικών και δημοσίων κτιρίων, που να καλύπτει όμως όλα τα δομήματα: μνημεία, γέφυρες και τεχνικά έργα, φράγματα και όλες τις υποδομές».

Ο αντισεισμικός έλεγχος σε ένα κτίριο δεν αποτελεί μόνο θέμα ασφάλειας, αλλά έχει να κάνει και με την εμπορική αξία του κτιρίου, επισημαίνει ο κ. Μπαρδάκης, συνιστώντας σε κάθε έναν που θέλει να αγοράσει ένα σπίτι να πάρει τη γνώμη ενός μηχανικού που εμπιστεύεται. Σημειώνει ακόμη ότι με την εξέλιξη της επιστήμης και της τεχνολογίας οι ενισχύσεις ενός κτιρίου είναι πιο εύκολες, περισσότερο ποιοτικές αλλά και πιο οικονομικές. «Υπάρχουν πολλά παραδείγματα κτιρίων στο κέντρο της Αθήνας, τα οποία μελετήθηκαν με τις διατάξεις του 1959, δηλαδή με πολύ πτωχές αντισεισμικές προβλέψεις και ενισχύθηκαν πρόσφατα ώστε να αποκρίνονται με ασφάλεια στη σύγχρονη σεισμική δράση. Σε ένα τέτοιο χαρακτηριστικό παράδειγμα», λέει, «υλοποιήθηκαν παρεμβάσεις στο σκελετό του κτιρίου που το καθιστούν τόσο ασφαλές όσο και αν κατασκευαζόταν σήμερα, με συνολικό κόστος παρόμοιο με τη δαπάνη επένδυσης όλων των δαπέδων με φθηνό πλακάκι».

Ποιες είναι οι σωστές ενέργειες που πρέπει να κάνει ένα άτομο με κινητική αναπηρία κατά τη διάρκεια του σεισμού; Την ώρα της δόνησης θα πρέπει να παραμείνει στη θέση του, μακριά από επικινδυνότητες, όσο αυτό είναι δυνατόν. Αν χρησιμοποιεί αμαξίδιο πρέπει όταν αισθανθεί το σεισμό να βάλει φρένο και στη συνέχεια να καλύψει το κεφάλι του και τον αυχένα με τα χέρια του ή με κάποιο άλλο αντικείμενο, σκύβοντας όσο το δυνατόν περισσότερο. - Οργανισμός Αντισεισμικού Σχεδιασμού και Προστασίας, www.oasp.gr.

ΟΑΣΠ: Η Αθήνα θα αντέξει σε ένα μεγάλο σεισμό

Ψυχραιμία και μακριά από λαϊκισμούς συνιστά ο **Ευθύμης Λέκκας**, πρόεδρος του Οργανισμού Αντισεισμικού Σχεδιασμού και Προστασίας (ΟΑΣΠ) και καθηγητής Δυναμικής Τεκτονικής, Εφαρμοσμένης Γεωλογίας και Διαχείρισης Φυσικών Καταστροφών στο ΕΚΠΑ. Ο κ. Λέκκας λέει ότι η Αθήνα είναι μία πόλη με ιστορία 3.000 ετών, υπάρχουν τα αρχαία μνημεία, τα βυζαντινά, τα κτίρια που χτίστηκαν μετά την επανάσταση του 1821, αυτά που προηγήθηκαν του Β΄ Παγκοσμίου Πολέμου, τα κτίρια μετά το 1960. «*Υπάρχει μια ποικιλομορφία κτιρίων. Τα κτίριά μας από το 1970 και μετά είναι ανθεκτικά και όσο πλησιάζουμε στα σύγχρονα χρόνια γίνονται ακόμα καλύτερα, λόγω των βελτιώσεων στους αντισεισμικούς κανονισμούς. Το 70% των κτιρίων της χώρας είναι κατασκευασμένα βάσει αντισεισμικών κανονισμών, χωρίς αυτό να σημαίνει ότι τα κτίρια προ του 1959 είναι επικίνδυνα, καθώς και τα προηγούμενα χρόνια υπήρχαν όχι μόνο προδιαγραφές, αλλά και μια μεγάλη εμπειρία. Το κτίριο της Βουλής, το Πανεπιστήμιο Αθηνών, είναι κτίρια 150 ετών*». Ο πρόεδρος του ΟΑΣΠ σημειώνει ότι σίγουρα υπάρχουν σεισμικά τρωτά κτίρια, κτίρια που δεν έχουν συντηρηθεί, που έχουν εγκαταλειφθεί, που αλλάζουν κάθε τόσο χρήσεις, αλλά και πως «*βάσει της εμπειρίας μας από τους προηγούμενους σεισμούς, σε έναν μεγάλο σεισμό θα υπάρξουν επιπτώσεις, σε γενικές γραμμές, ωστόσο, ο δομημένος ιστός θα συμπεριφερθεί θετικά*».

Αναφορικά με τα δημόσια κτίρια, εκ των οποίων μόλις το 25% έχει ελεγχθεί, δηλαδή περίπου 18.000 κτίρια, ο καθηγητής επισημαίνει ότι από τα υπόλοιπα κτίρια υπάρχουν πολλά που είναι κενά, δεν χρησιμοποιούνται δηλαδή, αλλά και αυτά τα οποία χρησιμοποιούνται δεν σημαίνει ότι είναι επικίνδυνα – για παράδειγμα, η Βουλή είναι ένα από τα δημόσια κτίρια τα οποία δεν έχουν ελεγχθεί. Ο Οργανισμός Αντισεισμικού Σχεδιασμού και Προστασίας, λέει ο κ. Λέκκας, προσπαθεί να επιταχύνει τις διαδικασίες ελέγχων, καθώς αυτοί είναι στην ευθύνη του εκάστοτε ιδιοκτήτη, π.χ. για τα γραφεία και τις υπηρεσίες του υπουργείου Οικονομικών αρμόδιο είναι το συγκεκριμένο υπουργείο κ.λπ. «*Σε κάθε περίπτωση*», προσθέτει, «*η συντήρηση των δημόσιων κτιρίων είναι και θέμα πόρων. Σε πολλά θέματα υπάρχουν ανάγκες, και περισσότερες Μονάδες*

Εντατικής Θεραπείας χρειαζόμαστε, και ασθενοφόρα, και καλύτερους δρόμους, αλλά στο τέλος της ημέρας δίνονται προτεραιότητες σύμφωνα με τις εκάστοτε οικονομικές δυνατότητες της Πολιτείας, δυνατότητες οι οποίες δεν είναι απεριόριστες».

Μπορεί να γίνει πρόγνωση σεισμού;

Όχι μόνο η ελληνική αλλά και η παγκόσμια επιστημονική κοινότητα προσπαθεί να προχωρήσει την υπόθεση της πρόγνωσης των σεισμών. Συχνά, τόσο Έλληνες όσο και ξένοι επιστήμονες και ερευνητικές ομάδες στέλνουν μελέτες για προγνώσεις στην αρμόδια επιτροπή του ΟΑΣΠ, αποτελούμενη από περισσότερους από 20 επιστήμονες του ευρύτερου κλάδου, οι οποίες διερευνώνται. Υπάρχουν όμως κι εκείνοι που καπηλεύονται αυτήν την κατάσταση, λέει ο κ. Λέκκας, που κάνουν μία πρόγνωση την οποία δεν καταθέτουν στον ΟΑΣΠ αλλά έρχονται στη συνέχεια και υποστηρίζουν ότι είχαν προβλέψει το τάδε σεισμικό γεγονός, επικαλούμενοι δημοσίευσή τους σε κάποια διεθνή ιστοσελίδα. «*Υπάρχει και θέμα ατομικής ευθύνης*», λέει ο πρόεδρος του ΟΑΣΠ, «*αν έχεις κάτι, να το καταθέσεις στις αρμόδιες αρχές της χώρας σου*».

«*Σε κάθε περίπτωση*», καταλήγει ο καθηγητής, «*πρόγνωση δεν υπάρχει ούτε και θα υπάρξει στα επόμενα χρόνια. Αλλά κι όταν θα υπάρξει, δεν ξέρουμε αν θα είναι επιχειρησιακά αξιοποιήσιμη*».

Μνημεία, διατηρητέα, εγκαταλειμμένα κτίρια

Στο πρόσφατο βιβλίο του «**Κατασκευές από τοιχοποιία, αποτίμηση και επεμβάσεις για σεισμικά φορτία**» (εκδ. Εργονόμος), ο **Κωνσταντίνος Σπυράκος** αναφέρεται στον κίνδυνο που αντιμετωπίζουν τα κτίρια από τοιχοποιία, μεταξύ αυτών όλα τα μνημεία και τα διατηρητέα. «*Ο τελευταίος ισχυρός σεισμός στην Αττική έγινε τον Ιούλιο του 2019 και ήταν 5,3 Ρίχτερ, δηλαδή ήταν 18 φορές ασθενέστερος από το σεισμό των 5,9 Ρίχτερ το 1999 στην Πάρνηθα. Τι διαπιστώσαμε από τον σεισμό του Ιουλίου του 2019; Πολλές αστοχίες στους τοίχους (ρωγμές και πτώσεις) αλλά και καταρρεύσεις και σοβαρές βλάβες σε εγκαταλειμμένα κτίρια, όπως το μνημείο του Ταινιόδρομου Κράκαρη στον Πειραιά. Αντιλαμβανόμαστε ότι σε έναν ισχυρότερο σεισμό θα έχουμε μεγαλύτερα προβλήματα*», λέει ο κ. Σπυράκος. Μνημεία, μας υπενθυμίζει ο καθηγητής, είναι κατασκευές συνήθως παλαιότερες των 100 ετών που έχουν χαρακτηριστεί ως τέτοια από το Υπουργείο Πολιτισμού, ενώ διατηρητέα είναι τα κτίρια που έχουν χαρακτηριστεί έτσι από το Υπουργείο Περιβάλλοντος λόγω των ιδιαίτερων αρχιτεκτονικών τους χαρακτηριστικών, π.χ. τα νεοκλασικά. «*Από αυτά, περίπου 20.000 ανήκουν σε ιδιώτες, δηλαδή το 0,8% του συνολικού φορολογούμενου δομημένου περιβάλλοντος, πολλά από τα οποία είναι εγκαταλειμμένα*», λέει ο κ. Σπυράκος, επισημαίνοντας ότι θα πρέπει να δοθούν κίνητρα από την Πολιτεία για τη συντήρησή τους, γιατί σιγά-σιγά θα χάσουμε όλο τον αρχιτεκτονικό μας πολιτισμό. «*Συνήθως σε ένα εγκαταλειμμένο κτίριο πέφτει πρώτα η στέγη, μετά μπαίνουν νερά, διαβρώνονται οι τοίχοι και καταρρέουν και εκείνοι. Αν, δηλαδή, προστατευθεί η στέγη και γίνουν μερικές ακόμα αναγκαίες επεμβάσεις το κτίριο θα σωθεί και οι επεμβάσεις προστασίας δεν είναι τόσο δαπανηρές όσο νομίζουν πολλοί*», επισημαίνει.

Την ίδια στιγμή, στον δήμο της Αθήνας υπάρχουν περίπου 1.400 εγκαταλειμμένα κτίρια, αρκετά εκ των οποίων ετοιμόρροπα και επικίνδυνα για τους περαστικούς. Τα περισσότερα από αυτά ανήκουν σε έναν ή σε περισσότερους ιδιοκτήτες, οι οποίοι κατά τον νόμο είναι υπεύθυνοι για τη συντήρησή τους,

αναφέρει ο **Γιώργος Αποστολόπουλος**, αντιδήμαρχος Δόμησης και Κτιριακών Υποδομών. Κάποια λίγα, τα οποία ύστερα από αυτοψία ειδικών, παρουσία εισαγγελέα, κρίθηκαν επικινδύνως ετοιμόρροπα και κατεδαφίστηκαν από τον δήμο, αφού υπήρξε επικοινωνία με τον/τους ιδιοκτήτες. Τα έξοδα κατεδάφισης χρεώθηκαν σε εκείνους. Σύμφωνα με τον κ. Αποστολόπουλο, τις επόμενες εβδομάδες αναμένεται να δοθεί σε διαβούλευση σχέδιο νόμου του Υπουργείου Περιβάλλοντος για την αντιμετώπιση του προβλήματος των εγκαταλειμμένων κτιρίων, αλλά και της συντήρησης των διατηρητέων, σε όλη τη χώρα.

Ήξερες ότι...

Ο σεισμός με τις μεγαλύτερες ανθρώπινες απώλειες στην Ελλάδα συνέβη στις 3 Απριλίου 1881 στη Χίο, όταν σκοτώθηκαν 3.550 άνθρωποι. Ο επόμενος πιο καταστρεπτικός σεισμός έγινε το 1953. Είχε μέγεθος 7,2 Ρίχτερ και επίκεντρο την Κεφαλονιά την οποία, μαζί με τη φωτιά που ακολούθησε, σχεδόν ισοπέδωσε, όπως και τη Ζάκυνθο. Ήταν 455 οι νεκροί στη Ζάκυνθο, 386 στην Κεφαλονιά και ένας στην Ιθάκη. Επίσης, το 1999 υπήρξαν 143 νεκροί στην Αθήνα από τον σεισμό 5,9 Ρίχτερ με επίκεντρο την Πάρνηθα, ενώ το 1978, στη Θεσσαλονίκη, 45 άνθρωποι έχασαν τη ζωή τους σε σεισμό 6,5 Ρίχτερ.

Ο Ευθύμης Λέκκας είναι ο πρόεδρος του Οργανισμού Αντισεισμικού Σχεδιασμού και Προστασίας / Ο Κωνσταντίνος Σπυράκος είναι καθηγητής Αντισεισμικών Κατασκευών στο ΕΜΠ / Ο Γιώργος Στασινός είναι πρόεδρος του ΤΕΕ / Ο Βασίλης Μπαρδάκης είναι πρόεδρος του Συλλόγου Πολιτικών Μηχανικών Ελλάδας / Ο Γιώργος Αποστολόπουλος είναι αντιδήμαρχος Δόμησης και Κτιριακών Υποδομών του Δήμου Αθηναίων.

(Τάκης Σκριβάνος / ATHENS VOICE, 23.09.2020, https://www.athensvoice.gr/greece/680711_antehei-i-athina-ena-megalo-seismo)

The Jimei landslide: inducing reactivation of an ancient failure through tunneling

It is well-established that poorly planned or inappropriate tunneling can induce landslides. This is particularly the case when the tunnel penetrates an ancient landslide, which most frequently occurs because the features of the existing but dormant mass movement were not identified at the ground investigation stage. Once movement is initiated it is difficult and expensive to re-establish stability.

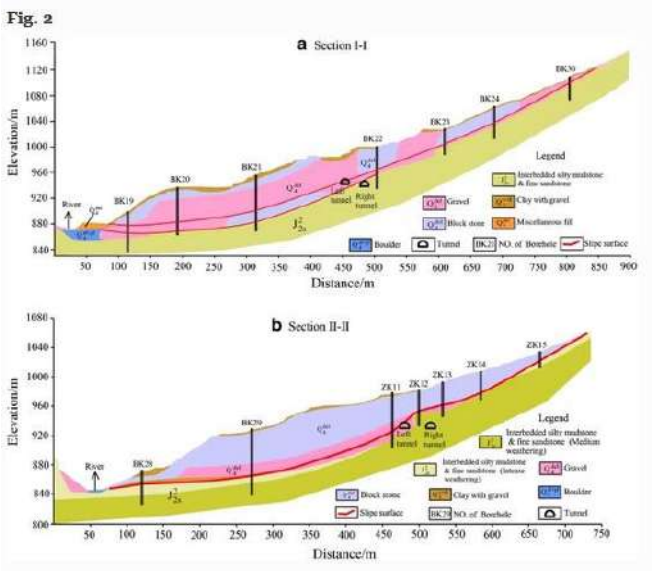
In a new paper in the Arabian Journal of Geosciences, Wang et al. (2020) describe the impact of a twin bore tunnel on an ancient landslide in Gulin County in Sichuan Province, China. The tunnels were bored as part of a highway construction project. They penetrated the two lobes of the ancient Jimie landslide, which was reactivated as a consequence.

The image below, from Google Earth, shows the site, located at 28.059, 105.676. The image is from 2019, so post-dates the mitigation of the problems.

Google Earth image of the aftermath of the Jimie landslide reactivation in China

The paper suggests that these features were identified as landslides prior to construction, and that the aim had been to locate the tunnels in bedrock below the shear surface. However, the tunnel appears to have penetrated the landslide mass, inducing reactivation, which caused serious deformation in one of the tunnels. Note that, as the image above shows, the landslide is occupied by houses and a school, so reactivation has significant implications.

Wang et al. (2020) provide the following cross-section in the paper. This is a large slope failure – 11 million cubic metres in volume and up to about 73 m in depth:



Cross-sections through the Jimie landslide, provided by Wang et al. (2020). Note the location of the tunnels.

The paper goes on to simulate the effects of mitigating the landslide through removal of a portion of the upper part of the landslide to reduce the driving force. The paper simulates the excavation of 1.3 million cubic metres.

Perhaps surprisingly the paper does not really describe what was actually undertaken at this site, but the Google Earth image appears to show that a substantial portion of the landslide was removed. The 2019 Google Earth image shows traffic on the road, so it appears that the mitigation was successful.

Reference

Wang, Z.F., Shi, F.G., Li, D.D. *et al.* 2020. Tunneling-induced deep-seated landslides: a case study in Gulin County, Sichuan, China. *Arabian Journal of Geosciences* **13,** 1039. https://doi.org/10.1007/s12517-020-06048-5

(THE LANDSLIDE BLOG, 5 October 2020, https://blogs.agu.org/landslideblog/2020/10/05/jimie-landslide-1)

Tunneling-induced deep-seated landslides: a case study in Gulin County, Sichuan, China

Zhong Fu Wang, Feng Ge Shi, Dong Dong Li & Haoyuan Li

Abstract

The excavation of a highway tunnel revived an ancient landslide in Gulin County, Sichuan Province, China, which resulted in many severe problems such as ground surface cracks, tunnel deformation, and supporting structure damage. This pa-

per focused on the interaction between the old landslide and the tunnel. First, the engineering geological conditions and deformation characteristics of the ancient landslide were determined on the base of field geological survey and geological prospecting. Second, the calculation parameters of the sliding body and sliding zone were obtained by back analysis to the surface deformation monitoring data. Finally, the failure mechanism of landslide due to tunnel excavation was discussed by three-dimensional numerical simulation, and the effect of proposed reinforcement measures was evaluated. The investigation results show that the ancient landslide consists mainly of gravel and block stones, and the major reason for the landslide failure is that the tunnel is exactly across the ancient landslide belt. The sliding surface below the left tunnel is gentle, and the thick sliding body prevents the upper body from sliding largely. Therefore, the deformation of the sliding body mainly occurred in the region above the tunnel. The calculated overall deformation range and value for the sliding body by back analysis are in good agreement with the field survey results and slope deformation monitoring data. According to the tunnel construction period and deformation characteristics of the sliding body, it is suggested to remove some part of the sliding body above the tunnel. The numerical simulation results show that, after removal, the sliding body and tunnel are small in deformation and are stable. The research results in this paper not only keep the tunnel under good construction and operation but also ensure the people and their property, which saves much construction cost and provide a valuable reference to similar projects.

https://link.springer.com/article/10.1007/s12517-020-06048-5

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

ΕΛΛΗΝΙΚΗ ΕΠΙΤΡΟΠΗ ΣΗΡΑΓΓΩΝ και ΥΠΟΓΕΙΩΝ ΕΡΓΩΝ (Ε.Ε.Σ.Υ.Ε.)

Η Ομάδα Νέων (Young Members Group) της ΕΕΣΥΕ συνδιοργάνωσε με την αντίστοιχη ομάδα νέων του Tunnelling Association of INDIA διαδικτυακή διάλεξη με θέμα **"SEISMIC RESPONSE, DESIGN & RISK ASSESSMENT OF TUNNELS"** με ομιλητή τον Δρ. **Κυριαζή Πιτιλάκη**, Ομότιμο Καθηγητή ΑΠΘ, Πρόεδρο της Ευρωπαϊκής Ένωσης Σεισμικής Μηχανικής την Τετάρτη 7 Οκτωβρίου 2020.

https://www.youtube.com/watch?v=vFePv5766jY&feature=emb_logo

International Society for Soil Mechanics and Geotechnical Engineering

ISSMGE News & Information Circular October 2020
https://www.issmge.org/news/issmge-news-and-information-circular-october-2020

1. 2021 TERZAGHI ORATION – News from the ISSMGE President Charles Ng

I am very pleased to announce that Professor Antonio Gens from the Universitat Politècnica de Catalunya in Spain has been selected as the 2021 Terzaghi Orator. Professor Gens was selected from a pool of 16 outstanding nominations including 5 former Rankine Lecturers. After reviewing the abstracts of proposed case histories including photographs submitted by 6 finalists and consultation among some distinguished peers in our Society, I had the privilege to select Professor Gens to be our next Orator although the decision was extremely difficult since we had so many outstanding candidates. I am absolutely confident that Professor Gens will deliver an excellent lecture in Sydney in 2021. Please join me in congratulating Professor Gens**.**

2. ISSMGE AWARDS – Deadline extended

Due to the COVID-19 Pandemic the Awards Committee in consultation with the President has decided to extend the submission deadline to 30 November 2020. Nominations should be submitted to the Secretary General.

3. TC - NOMINATIONS

These TCs are actively seeking nominations for members from the Member Societies. Please make sure that your Member Society representative is aware of your interest in joining either of these Committees.

TC107 - Tropical Residual Soils
TC214 - Foundation Engineering for Difficult Soft Soil Conditions.

4. WEBINARS

The following webinar was recently added to the ISSMGE educational resources available from the website:

- Prof. Pijusch Samui: "Machine Learning in Geotechnical Engineering

5. ISFOG 2020 – Proceedings now available

The proceedings for ISFOG 2020 (a specialist conference on offshore geotechnics held under the auspices of TC209) have just been released. The conference itself has been postponed to late 2021, but the decision was taken to make the proceedings available this time - to ensure the material comes out in a timely fashion, and to honour the commitment of authors to the conference. The link to purchase the proceedings is at https://www.isfog2020.org/proceedings. The cost is USD150.00 and will be deducted from the cost of your conference registration. Registration will open to the public in June 2021. Registrants will be contacted closer to that date and given instructions on how to obtain credit for the purchase of the proceedings.

6. CORPORATE ASSOCIATES' PRESIDENTIAL GROUP:

The August 2020 update of Corporate Associates' varied and exciting activities around the world can be found here https://www.issmge.org/corporate-associates/corporate-associates-presidential-group. Why and how to join as a Corporate Associate are detailed in https://www.issmge.org/corporate-associates/why-how-to-join.

7. BULLETIN

The latest edition of the ISSMGE Bulletin (Volume 14, Issue 4, August 2020) is available from the website https://www.issmge.org/publications/issmge-bulletin/vol-14-issue-4-august-2020

8. FEDERATION OF INTERNATIONAL GEO-ENGINEERING SOCIETIES (FedIGS)

The Federation of International Geo-Engineering Societies (FedIGS) is a collaborative association of international professional societies in the field of "Geo-Engineering" and serves to facilitate cooperation among them. It has launched its revamped website, which can be viewed at https://geoengineeringfederation.org/.

The cooperating societies forming the FedIGS Board are:

- International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)
- International Society for Rock Mechanics and Rock Engineering (ISRM)
- International Association of Engineering Geology and the Environment (IAEG)
- International Geosynthetics Society (IGS)

FedIGS also has a number of Joint Technical Committees:

- JTC1 Natural Slopes and Landslides
- JTC2 Representation of Geo-Engineering Data
- JTC3 Education and Training

Further details about the FedIGS can be found at www.geoengineeringfederation.org.

9. ISSMGE ONLINE LIBRARY – OPEN ACCESS

The ISSMGE Online library (https://www.issmge.org/publications/online-library) is in continuous development – please note the following additions:

1st (2007) and 7th (2019) International Symposium on Geotechnical Safety and Risk

10th International Symposium on Field Measurements in Geomechanics (FMGM2018)

25th European Young Geotechnical Engineers Conference

10. ISSMGE FOUNDATION

The next deadline for receipt of applications for awards from the ISSMGE Foundation is the 31st January 2021. Click **here** for further information on the ISSMGE Foundation.

11. CONFERENCES

For a listing of all ISSMGE and ISSMGE supported conferences, and full information on all events, including deadlines, please go to the Events page at https://www.issmge.org/events. However, for updated information concerning possible changes due to the corona-virus outbreak (ie. postponements, cancellations, change of deadlines, etc), please refer to that specific event's website.

As might be expected, many events have been rescheduled and we update the Events page whenever we are advised of changes.

The following are events that have been added since the previous Circular:

ISSMGE Events

XXV CONGRESO ARGENTINO DE INGENIERÍA GEOTÉCNICA – CAMSIG - 26-05-2021 - 28-05-2021 Parque del Conocimiento - Posadas, Misiones, Argentina; Language: Spanish; Organiser; Sociedad Argentina de Ingeniería Geotécnica; Contact person: Andres Ayala; Address: Av. Ulises López, N3300 Posadas; Email: camsig2020.misiones@gmail.com, secretario@saig.org.ar; Website: https://camsig2020.com/

Non-ISSMGE Events

Buchanan Lecture – Texas A&M University - 06-11-2020 - 07-11-2020 Zoom virtual, College Station, United States; Language: English; Organiser: Texas A&M University; Contact person: Jean-Louis Briaud; Email: briaud@tamu.edu; Website:

ISRM International Society for Rock Mechanics and Rock Engineering

News
www.isrm.net/noticias/?tipo=1&todas=1

Prof. Manuel Romana passed away

On 26 March 2020, our colleague Prof. Manuel Romana Ruiz has passed away.

Throughout his long professional career, Professor Romana became one of the greatest exponents of Rock Mechanics both in Spain and internationally. He developed the so-called Slope Mass Rating (SMR), one of the most used geomechanical classifications focusing slope stability.

He was elected president of the Spanish National Group of the ISRM (SEMR) in 1980 and was in office for more than 20 years.

The ISRM and the rock mechanics community deeply regret his loss.

Indonesian available at the ISRM glossary

Indonesian available at the ISRM Rock Mechanics and Rock Engineering Glossary, which now has 17 languages

Rock Engineering Practice , a complete video course by Professor Jian Zhao available from the ISRM website

Rock Engineering Practice , an on-line course by Professor Jian Zhao, provides an introduction to rock mechanics practice. The course on-line course, and covers 4 parts: Site In-

vestigation and Testing; Rock Slope Engineering; Rock Foundation Engineering; Underground Rock Excavations.

The lectures are given by Professor Jian Zhao, who has been teaching rock mechanics and rock engineering since 1990, first at Nanyang Technological University of Singapore, then at Ecole Polytechnique Fédérale de Lausanne of Switzerland, and currently at Monash University in Melbourne of Australia. He is a Fellow of the International Society for Rock Mechanics since 2015.

Website: https://www.isrm.net/gca/index.php?id=1480

ISRM Commission on Rock Dynamics Seminar Series 14-23 October

The ISRM Commission on Rock Dynamics announces a Seminar Series on Rock Dynamics and Applications with the following lectures:

Derek Elseworth
Title: Triggered Seismicity and Permeability Evolution in Faulted and Fractured Reservoirs
14 Oct. 2020, 12:00 GMT

Laura J. Pyrak-Nolte
Title: Linking Macro-Scale Information to the Micro-Scale
16 Oct. 2020, 13:00 GMT

Heping Xie
Title: Conceptualization and Preliminary Study of Engineering Disturbed Rock Dynamics
23 Oct. 2020, 01:00 GMT

Jian Zhao
Title: Rock Strength and Failure Behaviour Observed under Triaxially Confined Impact
23 Oct. 2020, 02:00 GMT

The seminar is open for free to ISRM members and public:
ZOOM ID: 447 820 8610, Password: 123456

Greenwich Tunnel Boring Machine Delivery – The abridged story

Speakers: Robert Margariti-Smith – Tunnel Manager – CVB & Conor McQuade – Project Manager – Mammoet

This presentation covers the challenges, the highs and the lows encompassing the planning and execution for the delivery of the Greenwich Tunnel Boring Machine through the streets of south London.

A whistle stop (and hopefully engaging) tour through the challenges, the highs and the lows encompassing the planning associated with transportation of a complete 520t Tunnel Boring Machine shield on Self Propelled Modular Transporters through the streets of urban London to the Greenwich Site and the final execution.

Looking at interfaces with local authorities, utility companies, TFL, 3rd party stakeholders, Traffic Management teams, designers & trial runs.

Thursday, 15th October 2020, Streaming Link:
https://youtu.be/CXOs_EsttQ0

https://www.youtube.com/watch?v=CXOs_EsttQ0&feature=youtu.be

The ICOLD General Assembly will be held as videoconference on November 30, 2020. The Symposium on Sustainable Development of Dams and River Basins organized by INCOLD will take place virtually as well on 24 February 2021. https://icold2020.org

Geotechnical engineering update

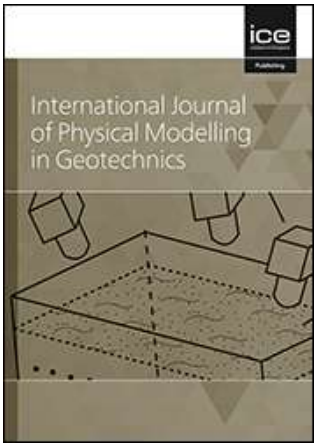
FREE TO READ

Giroud Lectures are now free to read

The Giroud Lecture was established by the International Geo-

synthetics Society (IGS) in 1994 in recognition of the invaluable contributions of Dr. J.P. Giroud to the technical advancement of the geosynthetics discipline and his central role in the development of the IGS.

After a lecture is given, it is written as a paper and published in *Geosynthetics International*. These resulting papers are now free for you to read. Read them all



Geotechnical design for offshore wind turbine monopiles

The latest issue of *Géotechnique* covers this important topic and is free to read for the next month. Read now

Physical modelling of landslides

Read this *International Journal of Physical Modelling in Geotechnics* themed issue in collaboration with the International Society for Soil Mechanics and Geotechnical Engineering. Read now

Editor's picks

Each issue, the editor of *International Journal of Physical Modelling in Geotechnics* highlights his must reads. Take a look back at this year's:

Effect of installation method on static and dynamic load test response for piles in sand

Axial response of short pile due to tunnelling-induced soil movement in soft clay

Development of a fault simulator for soils under large vertical stress in a centrifuge

Centrifuge model tests of earthquake-induced submarine landslide

Centrifuge tests for evaluation of submarine-mudflow hydroplaning and turbidity currents

Bearing capacity under increasing undrained shear strength

NEWS

Celebrating Open Access week at ICE Publishing

This year's theme of 'open with purpose: taking action to build structural equity and inclusion', we look at our Gold Open Access journal *Geotechnical Research*. Read more

Reviewing for ICE Publishing journals

Celebrating the vital role our peer reviewers play in our journals. We also look at the experiences of our reviewer and how you can become one. Find out more

EVENTS

Yeager Airport Reinforced Soil Slope Failure – lessons learned

5 November 2020, webinar

This webinar will cover the forensic investigation performed, the causes of the failure and lessons learned.

It is a joint event with the International Geosynthetic Society (IGS) UK Chapter, and is free to attend. Find out more

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

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

3rd Conference of the Arabian Journal of Geosciences (CAJG), 2-5 November 2020, Sousse, Tunisia, https://cajg.org (online)

Postponed Fourth GeoMEast©2020 International Underground Structures Conference (IUSC), 8-12 November 2020, Cairo, Egypt, http://underground.geomeast.org

Cutting Edge Conference Advances in Tunneling Technology, November 10-11, 2020, www.ucaofsmecuttingedge.com

CouFrac2020 goes fully virtual!! CouFrac 2020 - International Conference on Coupled Processes in Fractured Geological Media: Observation, Modeling, and Application, November 11-13, 2020, Seoul, Korea, http://coufrac2020.org

Postponed 10th International Conference on Scour and Erosion (ICSE-10), November 15-18, 2020, Arlington, Virginia, USA, www.engr.psu.edu/xiao/ICSE-10 Call for abstract.pdf

BEYOND A TUNNEL VISION The second European conference on tunnel renovation, November 27th 2020, https://beyondatunnelvision.eu

ASIA 2020 Eighth International Conference and Exhibition on Water Resources and Renewable Energy Development in Asia, 8-10 December 2020, Kuala Lumpur, Malaysia, www.hydropower-dams.com/asia-2020

Online 6th ICFGE 2020 Forensic Geotechnical Engineering & Geo-Disaster Documentation, December 10-12, 2020 IIT Delhi, India, http://tc302-issmge.com

Postponed ISGPEG 2020 International Conference on Innovative Solutions for Geotechnical Problems in Honour of Prof. Erol Guler, 2021, Istanbul, Turkey, www.isgpeg2020.org/en

BSGC 2020 is going virtual! 14th Baltic Sea Geotechnical Conference 2020 Future Challenges for Geotechnical Engineering, 18-20 January 2021, Helsinki, Finland, www.ril.fi/en/events/bsgc-2020.html

NGM 2020 is going virtual! Nordic Geotechnical Meeting Urban Geotechnics, 18-20 January 2021, Helsinki, Finland, www.ril.fi/en/events/ngm-2020.html

17th World Conference ACUUS2020 Deep Inspirations, 3-4 February 2021, www.ril.fi/en/events/acuus-2020.html

XIII International Symposium on Landslides - Landslides and Sustainable Development, 21-26 February 2021, Cartagena, Colombia, www.scg.org.co/xiii-isl

2021 GEOASIA7 - 7th Asian Regional Conference on International Geosynthetics Society, March 1-4, 2021, Taipei, Taiwan, www.geoasia7.org

This British Tunnelling Society "BTS 2020" Conference and Exhibition, March 2nd-3rd, 2021, London, United Kingdom, www.btsconference.com.

3rd International Symposium on Coupled Phenomena in Environmental Geotechnics, 17 – 19 March 2021, Kyoto, Japan, https://cpeg2020.org

International Conference on Challenges and Achievements in Geotechnical Engineering, 31.03.2021 – 02.04.2021, Tirana, Albania, Erdi Myftaraga, emy@greengeotechnics.com

EUROENGEO 3RD EUROPEAN REGIONAL CONFERENCE OF IAEG, 8 - 12 April 2021, Athens, Greece, www.euroengeo2020.org

AFRICA 2021 Water Storage and Hydropower Development for Africa, 13-15 April 2021, Lake Victoria, Uganda, www.hydropower-dams.com/africa-2021

Rocscience International Conference 2021
April 20th - 21st, 2021, virtual
www.rocscience.com/learning/rocscience-conference

In celebration of Rocscience's 25th year as a company, we will be hosting our first technical conference on April 20th- 21st, 2021.

Rocscience is pleased to invite geotechnical industry academics and practitioners to participate in the first version of the Rocscience International Conference on Numerical Modelling. The conference, which will take place online on April 20–21, 2021, is themed as "The Evolution of Geotech: 25 Years of Innovation". The objective is to analyze and discuss the latest innovations in applied geomechanics and emerging technologies with the potential to revolutionize the field.

Topics

- Tunnelling in challenging environments
- Open pits slope stability
- Numerical modelling of high-stress environments
- Settlement and Foundation Engineering
- Artificial intelligence and virtual reality technologies in geotechnical engineering
- Advancements in probabilistic analysis of slopes
- Advancements in three-dimensional geotechnical analysis
- Dynamic and Liquefaction Modelling
- Discrete fracture network modelling of rock masses

2nd Vietnam Symposium on Advances in Offshore Engineering – Sustainable Energy & Marine Planning, 22-24 April 2021, Ho Chi Minh City, Vietnam, https://vsoe2021.sciences-conf.org

16th International Conference of the International Association for Computer Methods and Advances in Geomechanics – IACMAG - CHALLENGES and INNOVATIONS in GEOMECHANICS, 03-05-2021, Torino, Italy, www.symposium.it/en/events/2020/16th-international-conference-of-iacmag?navbar=1

ATS 2020 AUSTRALASIA TUNNELLING CONFERENCE, 10th – 13th May 2021, Melbourne, Australia, https://www.ats2020.com.au

EUROGEO WARSAW 2020 7th European Geosynthetics Congress, 16-19 May 2021, Warsaw, Poland, www.eurogeo7.org

TISOLS Tenth International Symposium on Land Subsidence, Living with Subsidence, 17-21 May 2021, Delft - Gouda, the Netherlands, www.tisols2020.org/tisols2020

7th International Conference on Industrial and Hazardous Waste Management 18 - 21 May, 2021, Chania, Crete, Greece, http://hwm-conferences.tuc.gr

2020 CHICAGO ICTG International Conference on Transportation Geotechnics, May 23 - 26, 2021, Chicago, Illinois, USA, http://conferences.illinois.edu/ICTG2020

Fifth International Conference on New Developments in Soil Mechanics and Geotechnical Engineering, 27 – 29 May 2021, Nicosia, Northern Cyprus https://zm2020.neu.edu.tr/

Joint meeting of ISSMGE TC201 and TC210, ICOLD TC E and TC LE "Dams and Levees: Particle Movements – Case Studies, Experiments, Theory", June, 2020, Budapest, Hungary, www.isc6-budapest.com

6th International Conference on Geotechnical and Geophysical Site Characterization "Toward synergy at site characterisation", June 2021, Budapest, Hungary, www.isc6-budapest.com

2021 ICOLD MARSEILLE - ICOLD 27th Congress - 89th Annual Meeting Sharing Water: Multipurpose of Reservoirs and Innovations, 4 - 11 June 2021, Marseille, France, https://cigb-icold2021.fr/en/

International Airfield and Highway Pavements Conference, June 6-9, 2021, Austin, Texas, USA, www.pavementsconference.org

MSL 2021 The 1st Mediterranean Symposium on Landslides SLOPE STABILITY PROBLEMS IN STIFF CLAYS AND FLYSCH FORMATIONS, 7-9 June 2021, Naples, Italy, https://medsymplandslides.wixsite.com/msl2021

9th International Conference on Computational Methods for Coupled Problems in Science and Engineering (COUPLED PROBLEMS 2021), 13-16 June 2021, Sardinia, Italy, coupledproblems_sec@cimne.upc.edu

Rapid Excavation and Tunneling Conference RETC2021, June 13-16, 2021, Las Vegas, Nevada, USA, www.retc.org

Cities on Volcanoes 11 - Volcanoes and Society: environment, health and hazards, 14-18 June 2021, Heraklion, Crete, https://pcoconvin.eventsair.com/volcanoes11

EGRWSE 2020 - 3rd International Conference on Environmental Geotechnology, Recycled Waste Materials and Sustainable Engineering, 17-19 June 2021, Izmir, Turkey, www.egrwse2020.com

2nd ICPE 2021 The Second International Conference on Press-in Engineering, 19-21 June 2021, Kochi, Japan, https://icpe-ipa.org/

1st International Conference on Sustainability in Geotechnical Engineering, ICSGE, 27-30 June 2021, Lisboa, Portugal, http://icsge.lnec.pt/#

IS-Cambridge 2020 10th International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground, 28 June to 01 July 2021, Cambridge, United Kingdom, www.is-cambridge2020.eng.cam.ac.uk

ICONHIC2021: THE STEP FORWARD - 3rd International Conference on Natural Hazards & Infrastructure, 22 – 24 June 2021, Athens, GREECE, https://iconhic.com/2021

DFI Deep Mixing, 5-8 July 2020, TBD, Gdansk, Poland, www.dfi.org/DM2020

II International Seminar "Tailings and Waste Rock Disposal", July 12 – 14, 2021, Lima, Peru, www.geoingenieria.org.pe

7th ICRAGEE International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, 12-17 July 2021, Bengaluru, India, http://7icragee.org

GEOCHINA 2021 - 6th GeoChina International Conference Civil & Transportation Infrastructures: From Engineering to Smart & Green Life Cycle Solution, July 19 to 21, 2021, Nan-Chang, China, http://geochina2021.geoconf.org

PanAm Unsat 2021 3rd Pan-American Conference on Unsaturated Soils, 25-28 July 2021, Rio de Janeiro, Brazil, https://panamunsat2021.com

37th General Assembly of the European Seismological Commission, September 2021, Corfu, Greece, www.escgreece2020.eu

ACE 2020 14th International Congress on Advances in Civil Engineering, September 2021, Istanbul, Turkey, www.ace2020.org/en

XVIth International Congress AFTES 2021 Underground, a space for innovation, 6 to 8 September 2021, www.aftes2020.com

COMPLAS 2021 is the 16th conference of the COMPLAS Series.

The COMPLAS conferences started in 1987 and since then have become established events in the field of computational

plasticity and related topics. The first fifteen conferences in the COMPLAS series were all held in the city of Barcelona (Spain) and were very successful from the scientific, engineering and social points of view. We intend to make the 16th edition of the conference another successful edition of the COMPLAS meetings.

The objectives of **COMPLAS 2021** are to address both the theoretical bases for the solution of nonlinear solid mechanics problems, involving plasticity and other material nonlinearities, and the numerical algorithms necessary for efficient and robust computer implementation. **COMPLAS 2021** aims to act as a forum for practitioners in the nonlinear structural mechanics field to discuss recent advances and identify future research directions.

COMPLAS 2021 will be dedicated to the memory of professor D. Roger J. Owen, who passed away on January 13 2020. Prof Owen was an eminent scientist in the field of computational mechanics. He was also the founder of the COMPLAS conferences and co-chair of all previous editions of the conference since 1987.

COMPLAS 2021 is a Thematic Conferences of the European Community on Computational Methods in Applied Sciences (ECCOMAS) and a Special Interest Conference of the Internat. Association for Computational Mechanics (IACM).

Conference Topics

- Advanced Material Models
- Artificial Intelligence Techniques
- Big Data Analytics Techniques
- Biomechanics
- Blast problems
- Composites
- Computational Material Design
- Contact Problems
- Damage, Fracture and Fatigue
- Data Driven Constitutive Models
- Environment and Geosciences
- FEM and Particle-Based Methods
  (Discrete Element Methods, Material Point Methods, SPH Methods, Meshless Methods, Particle Finite Element Method, etc.)
- Forming Processes
- Geo-Science
- Geomechanics
- Granular Materials Processes
- High Velocity Impact
- Industrial Applications
- Machine Learning Techniques
- Model Reduction Techniques
- Multi-Body and Non-Linear Dynamics
- Multi-Fracturing Solids
- Multi-Physics Problems
- Multi-Scale Material Models
- Nano-Mechanics
- Parallel Computing
- Real Time Computing Techniques

Conference Secretariat

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Jordi Girona, 1-3 (08034), Barcelona, Spain
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RMEGV 2021 - 5th International Workshop on Rock Mechanics and Engineering Geology in Volcanic Fields, 9÷11 September 2021, Fukuoka, Japan, https://ec-convention.com/rmegv2021

SYDNEY 7iYGEC 2021 7th International Young Geotechnical Engineers Conference A Geotechnical Discovery Down Under, 10-12 September 2021, Sydney, Australia, http://icsmge2021.org/7iygec

SYDNEY ICSMGE 2021 20th International Conference on Soil Mechanics and Geotechnical Engineering, 12-17 September 2021, Sydney, Australia, www.icsgme2021.org

International Conference on Textile Composites and Inflatable Structures (MEMBRANES 2021), 13-15 September 2021, Munich, Germany, https://congress.cimne.com/membranes2021/frontal/default.asp

EUROCK TORINO 2021 - ISRM European Rock Mechanics Symposium Rock Mechanics and Rock Engineering from theory to practice, 20-25 September 2021, Torino, Italy, http://eurock2021.com

ARMS11 11th Asian Rock Mechanics Symposium, Challenges and Opportunities in Rock Mechanics, 21-25 October 2021, Beijing, China, www.arms11.com

EURO:TUN 2021 Computational Methods and Information Models in Tunneling, October 27th - 29th, 2021, Bochum, Germany, http://eurotun2021.rub.de

5TH World Landslide Forum Implementation and Monitoring the USDR-ICL Sendai Partnerships 2015-2015, 2-6 November 2021, Kyoto, Japan, http://wlf5.iplhq.org

ISFOG 2020 4th International Symposium on Frontiers in Offshore Geotechnics, 8 – 11 November 2021, Austin, United States, www.isfog2020.org

2021 GEOASIA7 - 7th Asian Regional Conference on International Geosynthetics Society, November 22-26, 2021, Taipei, Taiwan, www.geoasia7.org

ICGE – Colombo – 2020 3rd International Conference in Geotechnical Engineering, 6-7 December 2021, Colombo, Sri Lanka, http://icgecolombo.org/2020/index.php

WTC 2021 World Tunnel Congress 2021 - Underground solutions for a world in change, 16-19 May 2021, Copenhagen, Denmark, www.wtc2021.dk

GeoAfrica 2021 - 4th African Regional Conference on Geosynthetics - Geosynthetics in Sustainable Infrastructures and Mega Projects, 21 February 2022, Cairo, Egypt, https://geoafrica2021.org

ICEGT-2020 2nd International Conference on Energy Geotechnics, 10-13 April 2022, La Jolla, California, USA, https://icegt-2020.eng.ucsd.edu/home

LARMS 2021 – IX Latin American Rock Mechanics Symposium Challenges in rock mechanics: towards a sustainable development of infrastructure, 15 – 18 May 2022, Asuncion, Paraguay, https://larms2021.com

CPT'22

5th International Symposium on Cone Penetration Testing
8-10 June 2022, Bologna, Italy

The Italian Geotechnical Society (AGI) and the University of Bologna are pleased to announce the 5th International Symposium on Cone Penetration Testing, CPT'22, to be held in Bologna, Italy, on June 8-10, 2022. CPT'22, organized under the auspices of the ISSMGE Technical Committee TC102, follows the successful symposia held in Delft, The Netherlands (2018), Las Vegas, Nevada USA (2014), Huntington Beach, California USA (2010) and Linköping, Sweden (1995).

As tradition of the CPT events, which foster a lively debate on recent advancements on cone penetration testing, the Symposium aims at providing Researchers, Practitioners and Contractors with a unique opportunity of sharing up-to-date knowledge in equipment, testing procedures, data interpretation and related applications, as well as discussing emerging solutions and new ideas with the largest gathering of world's experts, academics and non-academics, working in the broad and dynamic area of CPTs.

Organizer

Italian Geotechnical Society (AGI) and University of Bologna (endorsed by TC102)

Contact Information

Contact person: Susanna Antonielli (AGI),
Prof. Guido Gottardi (University of Bologna)

Email: guido.gottardi2@unibo.it,
Email: agi@associazionegeotecnica.it

Eurock 2022

Rock and Fracture Mechanics in Rock Engineering and Mining
13÷17 June 2022, Helsinki, Finland

Contact Person: Lauri Uotinen
E-mail: lauri.uotinen@aalto.fi

3rd European Conference on Earthquake Engineering and Seismology (3ECEES), 19-24 June 2022, Bucharest, Romania, https://3ecees.ro

9th International Congress on Environmental Geotechnics
Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges
26-29 June 2022, Chania, Crete island, Greece
www.iceg2022.org

The 9th International Congress on Environmental Geotechnics is part of the well established series of ICEG. This conference will be held on an outstanding resort in the town of Chania of the island of Crete in Greece. The theme of the conference is "Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges" and will highlight the leadership role of Geoenvironmental Engineers play on tackling our society's grand challenges.

Contact Information

- Contact person: Dr. Rallis Kourkoulis
- Email: rallisko@grid-engineers.com

UNSAT2022
8th International Conference on Unsaturated Soils
June or September 2022, Milos island, Greece

XII ICG - 12th International Conference on Geosynthetics, September 18 – 22, 2022, Rome, Italy, www.12icg-roma.org

28th European Young Geotechnical Engineers Conference and Geogames, 15 – 17 December 2022, Moscow, Russia https://t.me/EYGEC2020

88th ICOLD Annual Meeting & Symposium on Sustainable Development of Dams and River Basins, April 2023, New Delhi, India, https://www.icold2020.org

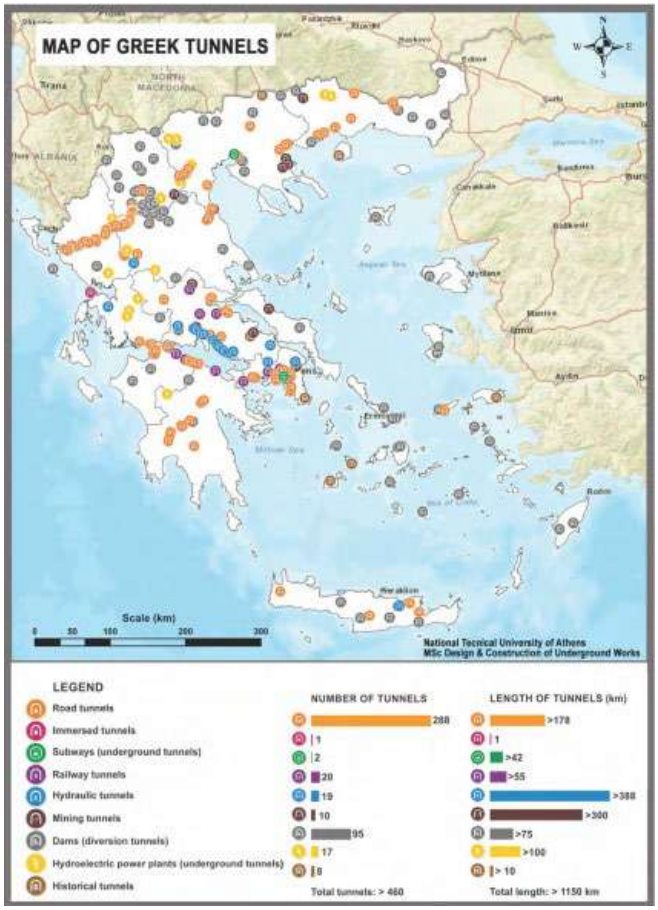
15th ISRM

International Congress in Rock Mechanics
9÷14 October 2023, Salzburg, Austria

Contact Person: Prof. Wulf Schubert
E-mail: salzburg@oegg.at

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Σήραγγες της Ελλάδας



Ο ηλεκτρονικός χάρτης των ελληνικών σηράγγων και υπογείων έργων αναπτύχθηκε στο πλαίσιο της διεκδίκησης του Παγκόσμιου Συνεδρίου Σηράγγων (World Tunnel Congress – WTC) του 2023 από την Ελληνική Εταιρεία Σηράγγων και Υπογείων Έργων. Τα δεδομένα συλλέχθηκαν και αποτυπώθηκαν στο χάρτη από μέλη του ΔΠΜΣ – ΣΚΥΕ (Επίκ. Καθ. Β. Μαρίνο και Αν. Καθ. Α. Μπενάρδο) σε μια προσπάθεια να υπάρξει μια ολοκληρωμένη εικόνα για τα έργα που έχουν κατασκευαστεί και λειτουργούν στην Ελλάδα. Ουσιαστικά, αποτυπώνει την εντυπωσιακή αύξηση του όγκου των υπογείων έργων στη χώρα, τα οποία έχουν κατασκευαστεί και λειτουργούν τα τελευταία 25 χρόνια.

Οι σήραγγες που παρουσιάζονται διακρίνονται και διαχωρίζονται έχοντας μια βασική κατηγοριοποίηση ανά τύπο έργων (οδικές, σιδηροδρομικές, υδραυλικές), όπως επίσης και με βάση το μήκος των έργων (μεγαλύτερο ή μικρότερο των 500μ). Επίσης, έργα ιδιαίτερης σημασίας, όπως αυτό της Εγνατία οδού, έχουν ενταχθεί στο χάρτη διατηρώντας την αυτόνομη παρουσίασή της. Τέλος, παρουσιάζονται ιστορικά υπόγεια έργα ιδιαίτερης σημασίας, ενώ έχουν ενσωματωθεί τα βασικά υπόγεια μεταλλευτικά κέντρα της χώρας, στα οποία έχουν δημιουργηθεί – και συνεχίζουν να κατασκευάζονται – εκατοντάδες χιλιόμετρα σηράγγων και στοών.

Πέρα από την χωρική παρουσίαση των έργων, δίνονται επιπλέον βασικά στοιχεία και πληροφορίες για τα έργα. Στόχος είναι να υπάρξει ο συνεχής εμπλουτισμός της βάσης δεδομένων με νέα στοιχεία για να μπορεί να αποδωθεί μια ολοκληρωμένη και πολυεπίπεδη πληροφόρηση για τις σήραγγες και τα υπόγεια έργα του Ελλαδικού χώρου.

Μπορείτε επίσης να κατεβάσετε το χάρτη των Ελληνικών Σηράγγων σε εκτυπώσιμη μορφή (μέγεθος A4, pdf)

https://www.tunnelling.ntua.gr/greek_tunnels/?fbclid=IwAR04zb_6gOGAvpvo3UL0q_tn9AUEPfjxJWEn8sGUxRi4PjeJew35uNyfqfY

Alaska's new climate threat: tsunamis linked to melting permafrost

Scientists are warning of a link between rapid warming and landslides that could threaten towns and tourist attractions

In Alaska and other high, cold places around the world, new research shows that mountains are collapsing as the permafrost that holds them together melts, threatening tsunamis if they fall into the sea.

Scientists are warning that populated areas and major tourist attractions are at risk.

One area of concern is a slope of the Barry Arm fjord in Alaska that overlooks a popular cruise ship route.

Research has found that over the last 30 years landslides in Alaska's Glacier Bay correspond with the warmest years.

The Barry Arm slide began creeping early last century, sped up a decade ago, and was discovered this year using satellite photos. If it lets loose, the wave could hit any ships in the area and reach hundreds of meters up nearby mountains, swamping the popular tourist destination and crashing as high as 10 meters over the town of Whittier. Earlier this year, 14 geologists warned that a major slide was "possible" within a year, and "likely" within 20 years.

In 2015, a similar landslide, on a slope that had also crept for decades, created a tsunami that sheared off forests 193 meters up the slopes of Alaska's Taan Fiord.

"When the climate changes," said geologist Bretwood Higman, who has worked on Taan Fiord and Barry Arm, "the landscape takes time to adjust. If a glacier retreats really

quickly it can catch the surrounding slopes by surprise – they might fail catastrophically instead of gradually adjusting."

After examining 30 years of satellite photos, for instance, geologist Erin Bessette-Kirton has found that landslides in Alaska's St Elias mountains and Glacier Bay correspond with the warmest years.

Warming clearly leads to slides, but knowing just when those slides will release is a much harder problem. "We don't have a good handle on the mechanism," Bessette-Kirkton said. "We have correlations, but we don't know the driving force. What conditions the landslide, and what triggers it?"

Adding to the problem, global heating has opened up water for landslides to fall in. A recent paper by Dan Shugar, a geomorphologist at the University of Calgary, shows that as glaciers have shrunk, glacial lakes have grown, ballooning 50% in both number and size in 18 years. In the ocean, fjords lengthen as ice retreats. Slopes that used to hang over ice now hang over water.

Over the past century, 10 of the 14 tallest tsunamis recorded happened in glaciated mountain areas. In 1958, a landslide into Alaska's Lituya Bay created a 524-meter wave – the tallest ever recorded. In Alaska's 1964 earthquake, most deaths were from tsunamis set off by underwater landslides.

To deal with the hazard, experts hope to predict when a slope is more likely to fail by installing sensors on the most dangerous slopes to measure the barely perceptible acceleration of creeping that may presage a slide.

(Erin McKittrick / The Guardian, Sun 18 Oct 2020, https://www.theguardian.com/environment/2020/oct/18/alaska-climate-change-tsunamis-melting-permafrost?CMP=share_btn_tw)

Rapid worldwide growth of glacial lakes since 1990

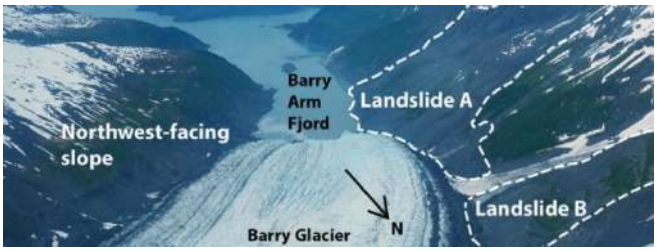
Dan H. Shugar, Aaron Burr, Umesh K. Haritashya, Jeffrey S. Kargel, C. Scott Watson, Maureen C. Kennedy, Alexandre R. Bevington, Richard A. Betts, Stephan Harrison & Katherine Strattman

Abstract

Glacial lakes are rapidly growing in response to climate change and glacier retreat. The role of these lakes as terrestrial storage for glacial meltwater is currently unknown and not accounted for in global sea level assessments. Here, we map glacier lakes around the world using 254,795 satellite images and use scaling relations to estimate that global glacier lake volume increased by around 48%, to 156.5 km^3, between 1990 and 2018. This methodology provides a near-global database and analysis of glacial lake extent, volume and change. Over the study period, lake numbers and total area increased by 53 and 51%, respectively. Median lake size has increased 3%; however, the 95th percentile has increased by around 9%. Currently, glacial lakes hold about 0.43 mm of sea level equivalent. As glaciers continue to retreat and feed glacial lakes, the implications for glacial lake outburst floods and water resources are of considerable societal and ecological importance.

Nature Climate Change **volume 10**, pages 939–945 (2020)

Massive, slumping mountainside in Barry Arm poses risk of catastrophic landslide and mega-tsunami, Alaska



A slow-moving landslide of an entire mountainside in Alaska's Barry Arm area may generate a mega-tsunami if the land suddenly collapses into the narrow fjord. Research findings show that the collapse would generate 11 times more energy and release 16 times more debris than the 1958 Lituya Bay landslide and mega-tsunami, which had a magnitude of 7.8, dropped 40 million cubic yards of land, and triggered a 524 m (1 720 feet) wave believed to be the tallest in modern history.

An entire mountainside near the Barry Glacier has been found to be slowly and subtly shifting. One of the witnesses who noticed the slow event was Valisa Higman, an artist with Alaska's Chugach National Forest.

While hiking in 2019, she noticed some fractures on a cliff overlooking the Barry Arm fjord. Out of curiosity that the slope might be in the process of collapsing, she took a photo of the area and sent it to her brother, Bretwood Higman-- a geologist with Ground Truth Alaska.

He then inspected the area with Google Maps, noting that cracks were indeed evident but there was no strong evidence of an impending landslide, apparently. Until he looked at the bigger picture and found that a landslide may be possible in the area.

Barry Arm area, June 2019. Image credit: Valisa Higman

A few months later, Ohio State researcher Chunli Dai was able to gather alarming results while working on a NASA-funded project to develop new methods in automatically detecting landslides in the Arctic.

Dai made use of a high-resolution dataset called ArcticDEM and machine learning to automatically locate and mark landslides. After surveying the Barry Arm area, she found that the entire mountainside near Barry Glacier was slowly moving.

"If the giant, slow-moving landslide were to suddenly collapse into the narrow fjord below, it would generate an extremely large tsunami because of the way the fjord's shape would amplify the wave," NASA warned.

September 13, 2013. Image credit: LANDSAT-8/OLI

August 24, 2019. Image credit: LANDSAT-8/OLI

2020 imagery. Image credit: Google

Dai explained, "Based on the elevation of the deposit above the water, the volume of land that was slipping, and the angle of the slope, we calculated that a collapse would release sixteen times more debris and eleven times more energy than Alaska's 1958 Lituya Bay landslide and mega-tsunami."

The said event had a magnitude of 7.8 and triggered a rockslide of 40 million cubic yards into the narrow inlet of Lituya Bay. The impact was heard 80 km (50 miles) away.

The abrupt water displacement led to a mega-tsunami that swept away trees to a maximum elevation of 524 m (1 720 feet), which was believed to be the tallest wave in modern history.

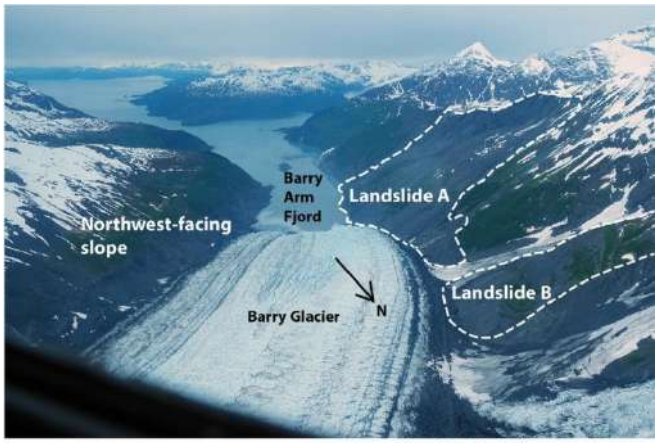
The size of the landslide Dai reported was enormous, and NASA noted that it was far bigger than any other known landslides in Alaska. "With the wider perspective from Landsat, the movement of the slope was impossible to miss. You can see a whole section of the mountain between Cascade Glacier and Barry Glacier slumping toward the water."

After seeing the Landsat images, Bretwood was also alarmed and since then, he has been coordinating with relevant partners to evaluate the risk.

"We have learned a tremendous amount about this hazard, and I think we have done a good job of getting the word out about it. But there are still a lot of really interesting and important scientific questions that we are only barely starting to investigate," he said.

"For instance, why did the landslide stop slipping in 2017, and does that mean it is less likely to collapse in the short term? Also: can we expect to see a sharp increase in this type of hazard as more and more glaciers retreat?"

"These are fairly unusual events, and scientists have only started studying the connections between glacial retreat and landslide tsunamis in the past few decades," he added. "We don't have a very long or deep record to look at yet."



Annotated photo showing landslide areas of Barry Arm Fjord, Alaska. Image credit: Gabe Wolken

Julie Celestial / THE WATCHERS, October 11, 2020, https://watchers.news/2020/10/11/barry-arm-landslide-mega-tsunami-alaska)

Large 'impressive' landslide hits Eyjafordur, Iceland

A large, "impressive" landslide occurred in the Eyjafordur area of northern Iceland on Tuesday, October 6, 2020. Local reports said a similar landslide has not occurred in the area since 2006. Slope failures continue to occur at the site as of Friday, October 9.

Sveinn Brynjólfsson, a geoscientist at the country's meteor-

ological office, described the landslide as "huge" and "impressive", adding that the massive chunk of land that fell was surprising, considering that there has not been much rainfall.

Sveinn noted that the earthquake in the Tjornes fault zone could possibly be the reason behind the landslide. "Yes, that [earthquake] cannot be ruled out."

No injuries were reported as the slide stopped about 100 m (300 feet) from a nearby residential area.

However, reports said a water source for farms was likely to have been destroyed.

A farmer, who witnessed the event, told Iceland Monitor that such a massive landslide has not happened in the area in 14 years, or since before 2006. During that year, a number of landslides damaged residential buildings and destroyed two structures.

"[There was] such a huge noise and then I saw up on the hill that it was this huge landslide that came down there."

Police officials, along with experts from the Icelandic Meteorological Office, were called on the site to assess the situation. Authorities said it is possible that more landslides could occur as slope failures are still observed as of Friday.

(Julie Celestial / THE WATCHERS, October 11, 2020, https://watchers.news/2020/10/11/large-impressive-landslide-hits-eyjafordur-iceland)

Landslides and roads – recent examples

The recent extreme rainfall in Vietnam has triggered a large number of damaging landslides, with high levels of loss of life. Less well reported is the impact of these landslides on the road network of the country. VNExpress has a nice article today with a gallery of images of the damage caused by these landslides. It reports that:

The government has to spend some VND350 billion ($15 million) to repair national highways that have been destroyed by landslides during the recent floods in the central region.

The image below, which has the following caption *"A section of National Highway 12A between Khe Ve Intersection and Cha Lo Border Gate in Minh Hoa District, Quang Binh Province was hit by landslide on October 19. Some 450 meters of it have been destroyed while a 100-meter stretch sank",* is a good example:

An example of landslide damage caused to a road in Vietnam

This is a classic image of landslide damage. But the damage does not have to come from below. This image shows the impact of slope instability in materials above the road bench:

An example of landslide damage caused to a road in Vietnam

The caption for this landslide is as follows: *A hill collapsed on a section of National Highway 49 in Thua Thien-Hue Province.*

Meanwhile, parts of India continue to suffer from the effects of extreme rainfall too. The image below was shared on Twitter by Devakishor Soraisam (@devakishor). It shows a section of the NH2 highway between Senapati and Lairouching in Manipur, NE India. This is an interesting landslide as the retaining wall at the rear of the road bench has remained intact. I wonder if the cause was tipping of fill on the downslope side to widen the road bench, oversteepening and loading the slope?

A landslide on NH2 between Senapati and Lairouching in Manipur. Image tweeted by @devakishor.

(Dave Petley / THE LANDSLIDE BLOG, 26 October 2020, https://blogs.agu.org/landslideblog/2020/10/26/landslides-and-roads-recent-examples)

The underground 'Parthenon' protecting Tokyo from floods

KASUKABE, Japan: It has been called Japan's underground "Parthenon", a cavernous complex charged with protecting Tokyo and surrounding areas from catastrophic flooding - a risk experts warn is growing as climate change advances.

Above ground, there is little to give away the cathedral-like feat of engineering that forms the main reservoir of the Kasukabe flood tank, the largest facility of its kind in the world.

The immense structure - deep enough in some parts to hold the Statue of Liberty - funnels away and redirects excess water from storms and typhoons, protecting one of the globe's most populous capitals.

Soaring pillars weighing 500 tonnes each support the main reservoir, a bare concrete tank the length of two football fields.

Staff members at the facility in Saitama, north of Tokyo, are on constant alert, especially during Japan's rainy and typhoon seasons from June to late October.

In Tokyo alone - a city cut through by more than 100 rivers - there are more than ten underground reservoirs and three flood tunnels, and more flood-protection structures are being built

It has been called Japan's underground 'Parthenon', a cavernous complex charged with protecting Tokyo and surrounding areas from catastrophic flooding -- a risk experts warn is growing as climate change advances

"In this area, torrential rain, typhoons and even daily rainfall can cause damage by submerging houses and roads," the site's chief, Nobuyuki Akiyama, told AFP.

The reservoir has helped reduce the number of homes affected by water damage in nearby areas by around 90 per cent, he said.

In Tokyo alone - a city cut through by more than 100 rivers

- there are 10 other underground reservoirs and three flood tunnels, and more flood-protection structures are being built.

And in western Japan's Osaka, a flood facility similar to the Kasukabe reservoir is being built at a cost of 366 billion yen (US$3.5 billion). Construction is scheduled to finish in 2044.

But experts warn more may be needed, as global warming makes what were previously once-a-century storms increasingly common, and catastrophic.

"Japan ... has a climate in which floods and heavy rain tend to occur frequently," says Kei Yoshimura, professor of meteorology at the University of Tokyo and expert on river flooding.

"But on top of that, now global warming is advancing," Yoshimura told AFP.

MORE TYPHOONS

In recent years, the rainy and typhoon seasons have brought regular destruction.

Massive flooding and landslides killed more than 80 people in west Japan this July, and a typhoon last year killed nearly one hundred people in the country's east.

Japan's Meteorological Agency says the number of typhoons a year that threaten Tokyo has jumped 1.5 times in the last four decades.

Japan's anti-flood systems are considered world-class, with the country having learnt bitter lessons from several mammoth disasters after World War II

The Kasukabe reservoir is connected to a 6.3km tunnel and the system can release accumulated water into the nearby Edogawa river at a rate equivalent to discharging a 25m swimming pool every second, with the power of a jumbo-jet engine.

Built in 2006, at a cost of 230 billion yen (US$2.2 billion), the facility swings into action around seven times a year.

Excess water flows in automatically, and operators pump it out from the main tank when it approaches capacity, Akiyama said.

This year it had already been used seven times by September, with water discharged twice after an unusually long rainy season, he added.

Official studies credit the single facility with having saved 148 billion yen in disaster clean-up costs so far.

Japan's anti-flood systems are considered world-class, with the country having learnt bitter lessons from several major disasters after World War II.

But experts including Yoshimura say that infrastructure alone isn't enough, especially with advancing climate change, and Japanese authorities have stepped up efforts in recent years to remind citizens to evacuate homes early when requested.

The Kasukabe system accepts visitors when it isn't in use, in part to promote the importance of disaster management.

"This underground facility is great but it's only one defence measure," Toru Tamai, a 79-year-old pensioner who attended a recent tour, told AFP.

"I live on low ground, so floods are a clearer and more present danger than any other natural disasters," he added.

"In the end, you can't count on anyone but yourself."

(can, 12 Oct 2020, https://www.channelnewsasia.com/news/asia/tokyo-floods-underground-parthenon-typhoon-climate-change-13261844)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

Bridges with limb-inspired architecture can withstand earthquakes, cut repair costs

Using expert feedback, researchers can now quantify the benefits of new bridge designs that are more earthquake-resistant

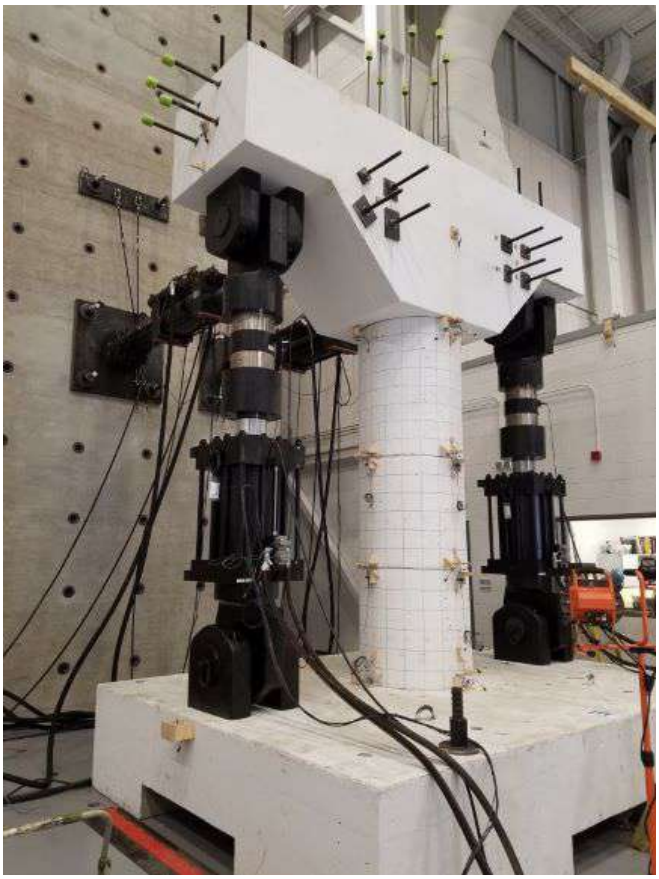
Structural damage to any of the nation's ailing bridges can come with a hefty price of billions of dollars in repairs. New bridge designs promise more damage-resistant structures and, consequently, lower restoration costs. But if these designs haven't been implemented in the real world, predicting how they can be damaged and what repair strategies should be implemented remain unresolved.

In a study published in the *Journal of Structural Engineering*, Texas A&M University and the University of Colorado, Boulder researchers have conducted a comprehensive damage and repair assessment of a still-to-be-implemented bridge design using a panel of experts from academia and industry. The researchers said the expert feedback method offers a unique and robust technique for evaluating the feasibility of bridge designs that are still at an early research and development phase.

"Bridges, particularly those in high-seismic regions, are vulnerable to damage and will need repairs at some point. But now the question is what kind of repairs should be used for different types and levels of damage, what will be the cost of these repairs and how long will the repairs take — these are all unknowns for new bridge designs," said Dr. Petros Sideris, assistant professor in the Zachry Department of Civil and Environmental Engineering. "We have answered these questions for a novel bridge design using an approach that is seldomly used in structural engineering."

Most bridges are monolithic systems made of concrete poured over forms that give the bridges their shape. These bridges are strong enough to support their own weight and other loads, such as traffic. However, Sideris said if there is an unexpected occurrence of seismic activity, these structures could crack, and remedying the damage would be exorbitantly expensive.

To overcome these shortcomings, Sideris and his team have developed a new design called a hybrid sliding-rocking bridge. Instead of a monolithic design, these bridges are made of columns containing limb-inspired joints and segments. Hence, in the event of an earthquake, the joints allow some of the energy from the ground motion to diffuse while the segments move slightly, sliding over one another rather than bending or cracking. Despite the overall appeal of the hybrid sliding-rocking bridge design, little is known about how the bridges will behave in real-world situations.



Specimen of the hybrid sliding-rocking bridge column tested in the Center for Infrastructure Renewal's large-scale experimental facilities

"To find the correct repair strategy, we need to know what the damages look like," said Sideris. "Our bridge design is relatively new and so there is little scientific literature that we could refer to. And so, we took an unconventional approach to fill our gap in knowledge by recruiting a panel of experts in bridge damage and repair."

For their study, Sideris, Dr. Abbie Liel, professor at the University of Colorado, Boulder, and their team recruited a panel of eight experts from industry and academia to determine the damage states in experimentally tested hybrid sliding-rocking segment designed columns. Based on their evaluations of the observed damage, the panel provided repair strategies and estimated costs for repair. The researchers then used that information to fix the broken columns, re-tested the columns under the same initial damage-causing conditions and compared the repaired column's behavior to that of the original column through computational investigations.

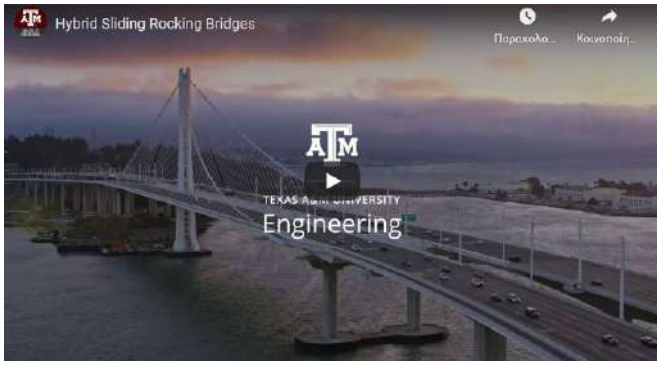
The panel found that columns built with their design sustained less damage overall compared to bridges built with conventional designs. In fact, the columns showed very little damage even when subject to motions reminiscent of a powerful once-in-a-few-thousand-years earthquake. Furthermore, the damage could be repaired relatively quickly with grout and carbon fibers, suggesting that no special strategy was required for restoration.

"Fixing bridges is a slow process and costs a significant amount of money, which then indirectly affects the community," said Sideris. "Novel bridge designs that may have a bigger initial cost for construction can be more beneficial in the long run because they are sturdier. The money saved can then be used for helping the community rather than repairing infrastructure."

This work is funded by the National Science Foundation.

Other contributors include Dr. Jakub Valigura, former graduate student researcher from the University of Colorado, Boulder and Dr. Mohammad Salehi, former graduate student in the civil and environmental engineering department at Texas A&M.

(Vandana Suresh / Texas A&M - Engineering, October 26, 2020, https://engineering.tamu.edu/news/2020/10/bridges-with-limb-inspired-architecture-can-withstand-earthquakes-cut-repair-costs.html)



https://www.youtube.com/watch?v=icxsgSvEoZ8&feature=emb_logo

Seismic Repair Assessment of Hybrid Sliding–Rocking Bridge Columns through Integrated Experimentation and Expert Panel Solicitation

Jakub Valigura, Mohammad Salehi, Abbie B. Liel, and Petros Sideris

Abstract

Due to the large number of bridges that will need upgrade, retrofit, or replacement in coming years, there is an increasing need for seismic bridge design techniques that are compatible with accelerated bridge construction (ABC). This study examines one promising column design strategy, the hybrid sliding–rocking (HSR) system, which incorporates precast segmental columns with unbonded post-tensioning, and both rocking and sliding joints. The goal of the study is to evaluate damage states and identify repair strategies for these columns through integrated experimental testing and expert panel solicitation. The expert panel methods use two different established group solicitation techniques to identify seismic repair objectives for bridges and to propose repair strategies for HSR columns that are consistent with these objectives. In parallel, a series of large-scale pseudo-static cyclic tests at the Texas A&M University Center for Infrastructure Renewal are carried out on a HSR column. The column is then repaired, based on the guidance of the expert panel, and tested again. The results show that the column experiences limited damage, consisting of spalling of concrete near the rocking joints, and up to 4% drift (consistent with hazard levels with return periods greater than 4,500 years). This damage can be repaired with grout and a carbon fiber reinforced polymer jacket. Most of the residual drift can be recovered by recentering sliding joints. The panel found that the HSR columns were less damageable than conventional columns and promising for application in high seismicity areas. The damage states and repair strategies identified will facilitate future performance-based engineering assessments of the new HSR columns

https://ascelibrary.org/doi/10.1061/%28ASCE%29ST.1943-541X.0002776

New insights show factors that trigger earthquakes

A new study by François Xavier Passelegue, a scientist at ENAC's Laboratory of Experimental Rock Mechanics (LEMR), has provided new insights into the origins of earthquakes, showing that the speed and intensity with which seismic waves cultivate after a quake depend mainly on forces taking place deep inside the rocks along a fault line.

"We know that rupture speeds can vary from a few millimeters per second to a few kilometers per second once nucleation occurs [the process by which a slip expands exponentially]. But we don't know why some ruptures propagate very slowly and others move quickly," said Passelegue.

"However, that's important to know because the faster the propagation, the quicker the energy that accumulates along the fault is released."

Passelegue developed an experimental fault with the same pressure conditions and temperature as an actual fault running 8 km (5 miles) deep. Sensors were installed along the fault to determine the factors causing slow versus fast propagation.

"There are lots of hypotheses out there-- most scientists think it's related to the kind of rock. They believe that limestone and clay tend to result in slow propagation, whereas harder rocks like granite are conducive to fast propagation."

For his study, Passelegue's model uses a complex rock, similar to granite. He was able to duplicate different types of slip, and he discovered that "the difference isn't necessarily due to the properties of the surrounding rock. A single fault can demonstrate all kinds of seismic mechanisms."

The experiments showed that the amount of energy discharged during a slip, and the length of time over which it is emitted, depend on the initial strain exerted along the effort.

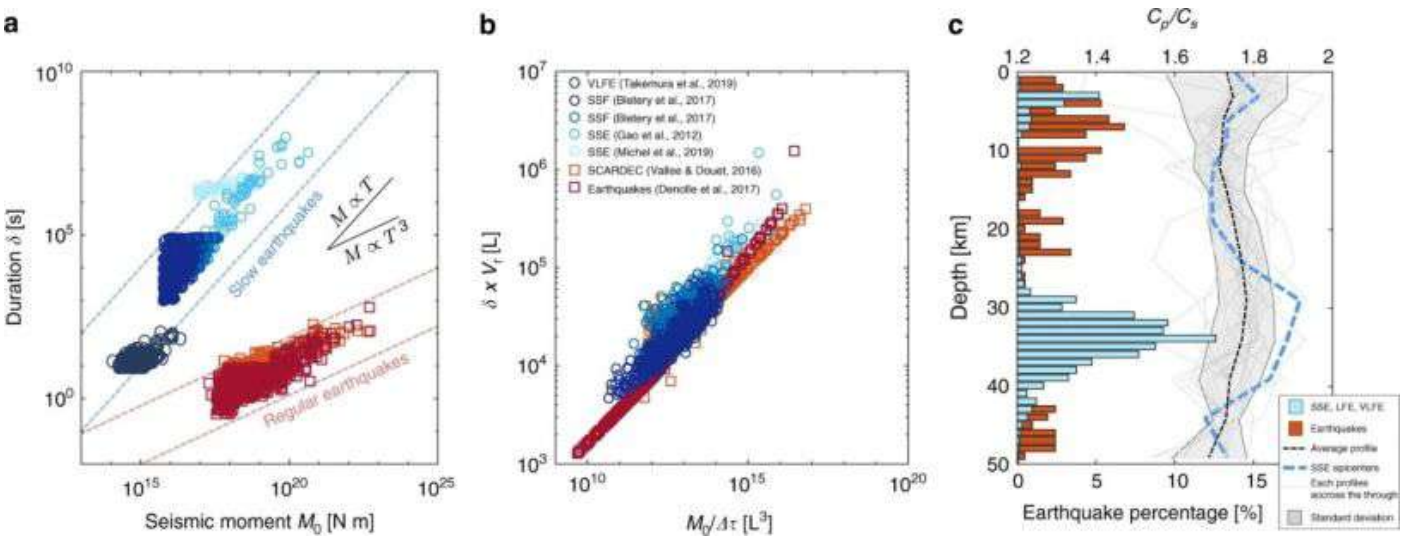


Fig. 1: Scaling relation between the different modes of slip.

a Scaling law for natural earthquakes observed from seismological or geodetical measurements. Blue circles correspond to slow slip events (so-called SSEs), deep low-frequency earthquakes (LFEs), very-low-frequency earthquakes (VLFEs) and slow slip fronts (SSF). Regular earthquakes are presented by the red circles. The source time functions used were downloaded from the SCARDEC database. Most of the data for regular earthquakes were taken from recent studies. The dashed lines correspond to the regular trend deduced from natural observations for both slow (blue dashed lines) and fast earthquakes (red dashed lines).

b Normalised scaling low assuming the average rupture velocity and the average static stress drop as determined in previous work for both regular and slow slip events.

c Hypocentral distribution of both slow and fast earthquakes in Japan. Lines present the wave velocity profiles obtained from the analyses of seismic and teleseismic waves in the subducting Philippine Sea plate in the Tokai district, Japan. The blue dashed line corresponds to the profile cross-cutting LFE hypocenters. The black dashed line corresponds to the average of all grey profiles obtained along the subduction trench. The grey area corresponds to the standard deviation.

By applying forces of various magnitudes, he found that higher strains triggered quicker ruptures, while lower strains triggered slower ruptures.

"We believe that what we observed in the lab would apply under real-world conditions too," he said.

"François is one of the first scientists to measure rupture speeds in rocks under the same temperature and pressure conditions that you find out in nature," said LEMR head Marie Violay.

"He developed a way to model the mechanisms physically--something that had never been done before. And he showed that all earthquakes follow the same laws of physics."

However, Passelegue warned that his model cannot be used to identify when or where an earthquake will happen. "We can identify how much strain there needs to be to cause a rupture, but since we don't know how much a fault is 'loaded up' with energy deep underground, we can't predict the rupture speed."

"Most people think that faults that have been stable for a long time will never cause a serious earthquake. But we found that any kind of fault can trigger many different types of seismic events. That means a seemingly benign fault could suddenly rupture, resulting in a fast and dangerous wave propagation."

Reference

"Initial effective stress controls the nature of earthquakes" - Passelegue, F. X. et al. - Nature Communications - https://doi.org/10.1038/s41467-020-18937-0

(Julie Celestial / THE WATCHERS, October 26, 2020, https://watchers.news/2020/10/26/new-insights-show-factors-that-trigger-earthquakes)

Initial effective stress controls the nature of earthquakes

François X. Passelègue, Michelle Almakari, Pierre Dublanchet, Fabian Barras, Jérôme Fortin & Marie Violay

Abstract

Modern geophysics highlights that the slip behavior response of faults is variable in space and time and can result in slow or fast ruptures. However, the origin of this variation of the rupture velocity in nature as well as the physics behind it is still debated. Here, we first highlight how the different types of fault slip observed in nature appear to stem from the same physical mechanism. Second, we reproduce at the scale of the laboratory the complete spectrum of rupture velocities observed in nature. Our results show that the rupture velocity can range from a few millimeters to kilometers per second, depending on the available energy at the onset of slip, in agreement with theoretical predictions. This combined set of observations bring a new explanation of the dominance of slow rupture fronts in the shallow part of the crust or in areas suspected to present large fluid pressure.

Nature Communications **volume 11**, Article number: 5132 (Published: 12 October 2020), https://www.nature.com/articles/s41467-020-18937-0

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΓΕΩΛΟΓΙΑ

Arizona Rock Offers Clues to the Chaotic Earth of 200 Million Years Ago

AUSTIN, Texas — A rock core from Petrified Forest National Park in Arizona has given scientists a powerful new tool to understand how catastrophic events shaped Earth's ecosystems before the rise of the dinosaurs.

The quarter-mile-long core is from an important part of the Triassic period when life on our planet endured a series of cataclysmic events: mountain-sized asteroids struck Earth at least three times, chains of volcanoes erupted to choke the sky with greenhouse gases and tectonic movement tore apart Earth's single supercontinent, Pangea.

Among the chaos, many plants and animals vanished in a shake-up of life on Earth that scientists have yet to explain, including some of the long-snouted and armored reptiles that ruled Pangea in that time.

The study, published today in *GSA Bulletin*, offers scientists a foundation to explain the changes in the fossil record and determine how these events may have shaped life on Earth.

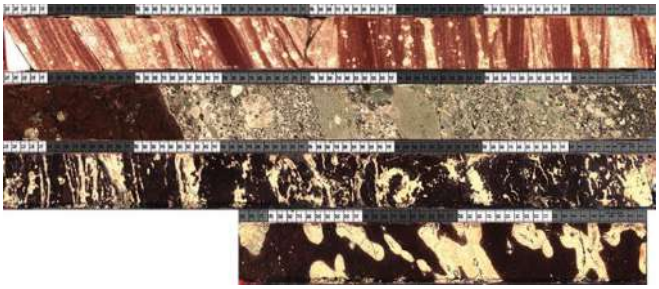
Before the rock core was recovered, most of what was known about the Late Triassic came from searching for signs of the Chinle Formation on rocky outcrops such as this one, found throughout Petrified Forest National Park. The rock layers that make up the formation were deposited during the Late Triassic Period.

By determining the age of the rock core, researchers were able to piece together a continuous, unbroken stretch of Earth's history from 225 million to 209 million years ago. The timeline offers insight into what has been a geologic dark age and will help scientists investigate abrupt environmental changes from the peak of the late Triassic and how they affected the plants and animals of the time.

"The core lets us wind the clock back when the Petrified Forest National Park was a tropical hothouse populated by crocodilelike reptiles and turkey-size early dinosaurs," said Cornelia Rasmussen, a postdoctoral researcher at the University of Texas Institute for Geophysics, who led the analysis that determined the age of the core. "We can now begin to interpret changes in the fossil record, such as weather changes at the time were caused by an asteroid impact or slow geographic changes of the supercontinent drifting apart."

The research overcomes the broken puzzle problem by recovering every layer in the order it was deposited. Scientists can then match those layers, like tree rings, with the fossil and climate record.

To find the age of each layer, the researchers searched the rock core for tiny crystals of the mineral zircon, which are spewed into the sky during volcanic eruptions. Zircons are a date stamp for the sediments with which they are buried. Researchers then compared the age of the crystals with traces of ancient magnetism stored in the rocks to help develop a precise geologic timeline.



A close up of the quarter-mile-long rock core that represents a continuous geologic record from 225 million to 209 million years ago. Cornelia Rasmussen, a postdoctoral researcher at the University of Texas Institute for Geophysics, has worked on the core since it was drilled from Petrified Forest National Park in 2013.

Petrified Forest National Park's paleontologist Adam Marsh said that despite a rich collection of fossils from the period in North America, until now there was little information on the late Triassic's timeline because most of what scientists knew came from studying outcrops of exposed rock pushed to the surface by tectonic movements.

"Outcrops are like broken pieces of a puzzle," said Marsh, who earned his Ph.D. from UT Austin but was not an author of the study. "It is incredibly difficult to piece together a continuous timeline from their exposed and weathered faces."

The research is the latest outcome of the Colorado Plateau Coring Project. The research and the coring project were funded by the National Science Foundation and the International Continental Scientific Drilling Program.

(UT NEWS, Jul 20, 2020, https://news.utexas.edu/2020/07/20/arizona-rock-offers-clues-to-the-chaotic-earth-of-200-million-years-ago)

U-Pb zircon geochronology and depositional age models for the Upper Triassic Chinle Formation (Petrified Forest National Park, Arizona, USA): Implications for Late Triassic paleoecological and paleoenvironmental change

Cornelia Rasmussen, Roland Mundil, Randall B. Irmis, Dominique Geisler, George E. Gehrels, Paul E. Olsen, Dennis V. Kent, Christopher Lepre, Sean T. Kinney, John W. Geissman, William G. Parker

The Upper Triassic Chinle Formation is a critical non-marine archive of low-paleolatitude biotic and environmental change in southwestern North America. The well-studied and highly fossiliferous Chinle strata at Petrified Forest National Park (PFNP), Arizona, preserve a biotic turnover event recorded by vertebrate and palynomorph fossils, which has been alternatively hypothesized to coincide with tectonically driven climate change or with the Manicouagan impact event at ca. 215.5 Ma. Previous outcrop-based geochronologic age constraints are difficult to put in an accurate stratigraphic framework because lateral facies changes and discontinuous outcrops allow for multiple interpretations. A major goal of the Colorado Plateau Coring Project (CPCP) was to retrieve a continuous record in unambiguous superposition designed to remedy this situation. We sampled the 520-m-long core 1A of the CPCP to develop an accurate age model in unquestionable superposition by combining U-Pb zircon ages and magnetostratigraphy. From 13 horizons of volcanic detritus-rich siltstone and sandstone, we screened up to ~300 zircon crystals per sample using laser ablation–inductively coupled plasma–mass spectrometry and subsequently analyzed up to 19 crystals of the youngest age population using the chemical abrasion–isotope dilution–thermal ionization mass (CA-ID-TIMS) spectrometry method. These data provide new maximum depositional ages for the top of the Moenkopi Formation (ca. 241 Ma), the lower Blue Mesa Member (ca. 222 Ma), and the lower (ca. 218 to 217 Ma) and upper (ca. 213.5 Ma) Sonsela Member. The maximum depositional ages obtained for the upper Chinle Formation fall well within previously proposed age constraints, whereas the maximum depositional ages for the lower Chinle Formation are relatively younger than previously proposed ages from outcrop; however, core to outcrop stratigraphic correlations remain uncertain. By correlating our new ages with the magnetostratigraphy of the core, two feasible age model solutions can be proposed. Model 1 assumes that the youngest, coherent U-Pb age clusters of each sample are representative of the maximum depositional ages and are close to (<1 Ma difference) the true time of deposition throughout the Sonsela Member. This model suggests a significant decrease in average sediment accumulation rate in the mid-Sonsela Member. Hence, the biotic turnover preserved in the mid-Sonsela Member at PFNP is also middle Norian in age, but may, at least partially, be an artifact of a condensed section. Model 2 following the magnetostratigraphic-based age model for the CPCP core 1A suggests instead that the ages from the lower and middle Sonsela Member are inherited populations of zircon crystals that are 1–3 Ma older than the true depositional age of the strata. This results in a model in which no sudden decrease in sediment accumulation rate is necessary and implies that the base of the Sonsela Member is no older than ca. 216 Ma. Independent of these alternatives, both age models agree that none of the preserved Chinle Formation in PFNP is Carnian (>227 Ma) in age, and hence the biotic turnover event cannot be correlated to the Carnian–Norian boundary but is rather a mid-Norian event. Our age models demonstrate the powers, but also the challenges, of integrating detrital CA-ID-TIMS ages with magnetostratigraphic data to properly interpret complex sedimentary sequences.

(GeoScienceWorld, GSA Bulletin, Research Article, July 20, 2020, https://pubs.geoscienceworld.org/gsa/gsabulletin/article-abstract/doi/10.1130/B35485.1/588168/U-Pb-zircon-geochronology-and-depositional-age)

Before plants or animals existed, this 250,000-ton rock fell in the mud. Here's how we know

Generations of scientists have visited this ancient landscape, and now they may have discovered the oldest rockfall yet found on land.

This aerial view shows the coastal cliffs at Clachtoll in northwest Scotland. The giant ancient boulder sits along the shore on the right side of the image, forming a hill along the small beach in front of the building.

Rain and winds buffeted the northwestern Scottish coast as Zachary Killingback inspected a rock stuck in the mud. It wasn't just any old stone: Weighing in at nearly a quarter of a million tons and measuring longer than a jumbo jet, the boulder had careened to its position some 1.2 billion years ago, which means it may be the oldest rockfall yet found on land.

Killingback, a master's student at England's Durham University at the time, wanted to know just what happened in the few catastrophic seconds when the humongous boulder gave way. Rocks have fallen off cliffs ever since Earth was cool enough for rock to form, but few ancient rockfalls have been found in the geologic record. This one in Scotland offers a window into what was happening on the planet before animals took their first breaths, before plants stretched roots

into the ground, before modern continents had even taken shape.

As a team describes in a new study published in the journal *Geology*, the boulder plunged less than 50 feet into watery sediments, the force of impact cracking the rock and injecting mud into the fractures. While the cliff it fell from has eroded away, the rockfall remains. Every rock has a story, and scientists are tasked with taking what's known about our planet's many physical processes to tease out tidbits of its past.

"It does show you how much amazing detail you can pull out of one block of rock if you approach it really carefully," says Cara Burberry, a structural geologist at the University of Nebraska-Lincoln who was not involved in the study. "They've documented it really beautifully."

Geologic Disneyland

Northwest Scotland is a wonder to take in, with turquoise waters washing into small beach alcoves nestled along the coast. The rolling landscape records billions of years of our planet's history as supercontinents formed and broke up, and rivers and lakes ebbed and flowed.

"It's geology Disneyland for the Brits," says Alex Webb, a geologist at the University of Hong Kong who was not involved in the study.

Generations of scientists have visited this ancient landscape, now a popular site for undergraduate field excursions. "If it wasn't for COVID, I'd be on these very outcrops today," says study author Bob Holdsworth, a structural geologist at Durham University.

During one of these student trips, Holdsworth and his colleagues noticed that something was off with a block of rock near the village of Clachtoll. The boulder is part of the Lewisian gneiss, rock as old as three billion years that was squeezed under intense pressure as it formed, causing minerals to align in stacked layers known as foliation. Across most of the region, these layers trend northwest-southeast. But the boulder's layers are rotated 90 degree

The boulder, longer than a jumbo jet, sweeps along the foreground in this image taken in 2010.

Holdsworth and his colleagues had an inkling that the rotated layers and other curious features of the rock's fractures might be the result of a precipitous plunge, but they needed more data to make the case. So Killingback took on the challenge for his master's thesis research.

Gathering clues in the field

The site of the rockfall was Killingback's favorite field trip as an undergraduate student. Organized excursions with his classmates were often challenging for Killingback, who is autistic. Navigating through crowds of students, processing rapid-fire instructions, and the barrage of sensory stimuli in the field presented constant obstacles.

The Clachtoll trip, however, was different. Rather than a professor guiding them through the geologic sights, he says "you were sort of let loose—I loved it so much."

He returned for his master's work in September 2016 to carefully map the boulder's structure. The wind tore through the hills as rain pounded down, but Killingback worked through each task as efficiently as he could before dashing back to the safety of his car to review notes and plot next steps. Even in his vehicle, the winds made themselves known. "I thought I was going to blow away every night," he says.

On his last day in the field, undergraduates on a trip flooded the site. Killingback finished up his work as the group scampered over the rocks, then he returned to the lab to reconstruct a glimpse into the planet's ancient past.

A destructive descent

The geologic story Killingback and his colleagues unraveled goes a bit like this: Some 1.2 billion years ago, a basin was forming in what is now Scotland's northwest coast. Lakes filled the region, and rivers rushed through, laying down layers of jumbled rocks and red sediment. A mighty earthquake may have shook the ground, perhaps from land stretching into the basin, and the boulder fell off a cliff. It twisted slightly as it fell, causing its internal layers to orient at a right angle to the rest of the rocks of the region.

When the rock landed, cracks emanated from its top and bottom. Today the cracks are filled with red mud, and slight differences provide evidence of the fall. The sediment in cracks on the top is layered, a sign that it was progressively washed into the crevices over time. The cracks on the bottom, however, have no such layering and are filled with much finer sediment, pointing to a rapid injection from the force of impact. Burberry calls this pattern a "smoking gun" for the rockfall.

The rock slid on impact, evidenced in part by a large crack through the front of the boulder, Killingback says. The team also took small cores of the rock to the lab to test how much force it takes to pull the rock apart. That figure helped determine how far the rock fell: likely less than 50 feet.

"How have we not noticed this before? It makes so much sense," says geologist Catherine Mottram of the University of Portsmouth, England, who takes her undergraduate students to the region every year but was not part of the study team.

"I've literally sat on that [boulder] several times and eaten my lunch."

Stories hidden in the rock

For Killingback, the biggest challenge was translating his ideas into a written report—a difficulty not uncommon for autistic people. "I essentially think in pictures," he says. "I had my entire thesis in my head ... like a silent documentary."

Turning that mental film into a written tale took him another two years, he says. "I was just secretly wishing someone would invent a technology for me to plug a USB stick into my head and download it all."

Killingback devised coping strategies, including explaining the various bits of the study to his mother and then immediately writing down his words. In the end, it paid off, resulting in an illuminating study.

"It's a kind of unique opportunity to see a process which we know is always happening but we rarely see preserved in the rock record," says Christopher Jackson, a geologist at Imperial College London who was not involved in the new research.

Part of the fun of geology is the detective work involved in identifying each rocky clue. In Killingback's paper, Webb says, "the joy of figuring this out sort of bleeds off the page."

(Maya Wei-Haas / National Geographic, October 7, 2020, https://www.nationalgeographic.com/science/2020/10/huge-rock-fell-in-the-mud-billion-years-ago-how-we-know)

A bigger splat: The catastrophic geology of a 1.2-b.y.-old terrestrial megaclast, northwest Scotland

Z. Killingback, R.E. Holdsworth, R.J. Walker, S. Nielsen, E. Dempsey, K. Hardman

Rockfalls are relatively little described from the ancient geological record, likely due to their poor preservation potential. At Clachtoll, northwest Scotland, a megaclast (100 m × 60 m × 15 m) of Neoarchean Lewisian gneiss with an estimated mass of 243 kt is associated with basal breccias of the Mesoproterozoic Stoer Group. Foliation in the megablock is misoriented by ~90° about a subvertical axis relative to that in the underlying basement gneisses, and it is cut by fracture networks filled with Stoer Group red sandstone. Bedded clastic fissure fills on top of the megablock preserve way-up criteria consistent with passive deposition during burial. Sediment-filled fractures on the lateral flanks and base show characteristics consistent with forceful injection. Using numerical calculations, we propose that rift-related seismic shaking caused the megablock to fall no more than 15 m onto unconsolidated wet sediment. On impact, overpressure and liquefaction of the water-laden sands below the basement block were sufficient to cause hydrofracturing and upward sediment slurry injection. In addition, asymmetrically distributed structures record internal deformation of the megablock as it slowed and came to rest. The megablock is unrelated to the younger Stac Fada impact event, and represents one of the oldest known terrestrial rockfall features on Earth.

(Geology, v. 49, https://doi.org/10.1130/G48079.1, GeoScienceWorld / Geology / Research Article, September 18, 2020, https://pubs.geoscienceworld.org/gsa/geology/article/doi/10.1130/G48079.1/590929/A-bigger-splat-The-catastrophic-geology-of-a-1-2-b)

Geologists raise the speed limit for how fast continental crust can form

Study suggests parts of the Sierra Nevadas formed in a "geologic instant," more than twice as fast as previously thought.

The Tehachapi Mountains, within the Sierra Nevada and where the research was done, are relatively dry and rugged. Outcrops in this terrain are much scarcer than in the higher elevations of the Sierra Nevada.

Although we can't see it in action, the Earth is constantly churning out new land. This takes place at subduction zones, where tectonic plates crush against each other and in the process plow up chains of volcanos that magma can rise through. Some of this magma does not spew out, but instead mixes and morphs just below the surface. It then crystallizes as new continental crust, in the form of a mountain range.

Scientists have thought that the Earth's mountain ranges are formed through this process over many millions of years. But MIT geologists have now found that the planet can generate new land far more quickly than previously thought.

In a paper published in the journal *Geology*, the team shows that parts of the Sierra Nevada mountain range in California rose up surprisingly fast, over a period of just 1.39 million years — more than twice as fast as expected for the region. The researchers attribute the rapid formation of land to a massive flare-up of magma.

"The really exciting thing about our findings is, with new high-precision geochronology, we were able to date how quickly that crust-building process happened, and we showed that this large volume of new crust was emplaced at an extremely rapid rate," says the study's lead author Benjamin Klein PhD '19, who carried out the research as a graduate student in MIT's Department of Earth, Atmospheric and Planetary Sciences (EAPS). "It was sort of an instant. It was a little over 1 million years, but in geologic times, it was super fast."

Klein's co-authors are Associate Professor Oliver Jagoutz and Research Scientist Jahandar Ramezani, both in EAPS.

A rocky outcrop similar to those analyzed by the researchers from a deeper portion of the crust.

A complete cross-section

The Sierra Nevada mountain range is a product of the collision of two tectonic plates: the westward-moving North American Plate and what at the time was the Farallon Plate, which ground slowly under the North American Plate, eventually sliding entirely into the Earth's mantle.

Around 100 million years ago, as both plates collided, they created first a chain of volcanos, then a towering mountain range that is today the Sierra Nevada.

"What is today the West Coast of the United States probably looked, back then, like the Andes today, with high elevations and a chain of large volcanos," Klein says.

For their study, the researchers concentrated on a geologic feature in the Sierra Nevada known as an intrusive suite — a large volume of rock that originally formed deep in the Earth's interior. Once crystallized, the rocks form a new, vertical column of continental crust.

They focused in particular on the Bear Valley Intrusive Suite, a unique formation in that it represents the vestiges of new continental crust that is today exposed on the surface, as a 40-mile stretch of granite. These rocks, which today lie horizontally along the mountain range, originally formed as a vertical column. Over time, this tower of new continental crust eroded, stretching and tilting into its current horizontal configuration.

"The Bear Valley Intrusive Suite gives us a complete cross-section of what these magma plumbing systems underlying large volcanos looked like, where normally we would have a limited snapshot," Klein says. "That allows us to think much more completely about how quickly new crust was being built."

A speed limit for new crust

The team collected rock samples across a region of the Sierra Nevada Batholith and brought them back to MIT to analyze their composition. They were able to determine the age of nine samples, using uranium-lead geochronology, a high-precision dating technique pioneered by the late MIT Professor Emeritus Sam Bowring. From each sample, the researchers isolated individual grains of zircon, a common mineral in rocks that contains uranium and some lead, the ratio of which scientists can measure to get an estimate of the rock's age.

From their analyses, Klein and his colleagues discovered that the age of all nine samples spanned a surprisingly short range, of just 1.39 million years. The team calculated an estimate for the amount of magma that must have crystallized to form the new crust that the samples represent. They found that about 250 cubic kilometers of magma likely rose up from Earth's interior and transformed into new crust — in just 1.39 million years.

"That's about two-and-a-half times faster than previous estimates for crust formation in the Sierras, which is a pretty big difference," Klein says. "It gives us a maximum speed limit for how quickly these things can actually happen."

Klein says that given the speed of this new crust formation, the likely cause was a magma flareup, or sudden burst of magmatic activity.

"The entire batholith was constructed in almost 200 million years, but we know over that period of time, there were periods when it was highly active and periods that were quieter, with less new material added," Klein says. "What we were able to show in this area was that, at least locally, the rate at which magma was brought in is much faster than the average rates that have been documented in the Sierras."

Geologists have thought that magma flare-ups occur as a result of unusual activity in the Earth, such as tectonic plates suddenly colliding at a faster rate. According to everything researchers have documented about the Bear Valley Intrusive Suite, however, no such activity transpired at the time the mountain range formed.

"There's no obvious trigger," Klein says. "The system is pretty much going along, and then we see this big burst of magma. So this challenges some basic notions in the field, and should inform how people think of how quickly these things could be happening today, in places like the Andes or the volcanos in Japan."

This research was supported, in part, by the National Science Foundation.

Paper

Paper: "High-precision geochronology requires that ultrafast mantle-derived magmatic fluxes built the transcrustal Bear Valley Intrusive Suite, Sierra Nevada, California, USA"

(Jennifer Chu / MIT News Office, October 5, 2020, https://news.mit.edu/2020/fast-continental-crust-form-1005)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΠΕΡΙΒΑΛΛΟΝ

Μεγάλο Θανατικό: «Βρέθηκε» το φαινόμενο που σχεδόν αποστείρωσε τη Γη

Η μαζική έκλυση CO2 από ηφαίστεια άλλαξε τη βιόσφαιρα σε μια στιγμή

Το κύμα μαζικής εξαφάνισης σήμανε το τέλος της Πέρμιας περιόδου και την έναρξη της Τριαδικής

Συνέβη πριν από 252 εκατομμύρια χρόνια, όταν ένα κατακλυσμικό συμβάν αφάνισε από τον πλανήτη την πλειονότητα των ζωντανών οργανισμών –ήταν το μεγαλύτερο κύμα μαζικής εξαφάνισης που έχει ζήσει ο πλανήτης, και τώρα ίσως μάθαμε επιτέλους την αιτία.

Περίπου τα τρία τέταρτα των χερσαίων ειδών και το 95% των θαλάσσιων εκτιμάται ότι χάθηκαν από προσώπου Γης κατά την Πέρμια Εξαφάνιση, περισσότερο γνωστή ως «Μεγάλο Θανατικό». Προσκρούσεις αστεροειδών, απελευθέρωση μεθανίου από τους ωκεανούς και δραματικές κλιματικές μεταβολές έχουν ενοχοποιηθεί για το δραματικό συμβάν, ωστόσο μέχρι σήμερα όλες οι θεωρίες παραμένουν αναπόδεικτες.

Ερευνητές από την Ιταλία, την Γερμανία και τον Καναδά αναφέρουν τώρα στο **Nature Geoscience** ότι βρήκαν «οριστική απάντηση» και προσδιόρισαν την αλληλουχία γεγονότων που οδήγησαν στην πλανητική καταστροφή.

Αλυσιδωτή αντίδραση

Η μελέτη τους εστιάζει σε μια πηγή πληροφοριών που μέχρι σήμερα είχε προφανώς αγνοηθεί: απολιθώματα βραχιόποδων, θαλάσσιων οργανισμών που φέρουν κέλυφος και μοιάζουν με μαλάκια.

«Πρόκειται για οργανισμούς σαν αχιβάδες που επιζούν εδώ και πάνω από 500 εκατ. χρόνια. Μπορέσαμε να εξετάσουμε καλοδιατηρημένα απολιθώματα από τις νότιες Άλπεις, τα οποία αποτέθηκαν στον πυθμένα ρηχών παράκτιων περιοχών του ωκεανού της Τηθύος πριν από 252 εκατ. χρόνια και κατέγραψαν τις περιβαλλοντικές συνθήκες λίγο πριν και κατά την έναρξη του κύματος εξαφάνισης» εξηγεί η Δρ Χάνα Γιουρίκοβα του Κέντρου Ωκεανογραφίας «Χέλμχολτζ» στη Γερμανία.

Σύγχρονες τεχνικές επέτρεψαν την ανάλυση ισοτόπων του στοιχείου βόριου στα απολιθώματα, η οποία έδειξε ότι η αρχή της Πέρμιας Εξαφάνισης σημαδεύτηκε από απότομη αύξηση της οξύτητας του ωκεανού (πτώση του pH). Δεδομένου ότι η οξύτητα του νερού εξαρτάται άμεσα από τη συγκέντρωση διοξειδίου του άνθρακα, η ανάλυση επέτρεψε τον προσδιορισμό της διακύμανσης του ατμοσφαιρικού CO_2.

Τα ευρήματα δείχνουν να επιβεβαιώνουν τη θεωρία ότι το Μεγάλο Θανατικό πυροδοτήθηκε από απότομη έκλυση διοξειδίου του άνθρακα σε μεγάλες ηφαιστειακές εκρήξεις στη Σιβηρία. Αντίθετα, η θεωρία ότι το συμβάν προκλήθηκε από την μαζική απελευθέρωση μεθανίου, το οποίο παρέμενε παγιδευμένο στον ωκεάνιο πυθμένα, δείχνει πλέον «απίθανη», λένε οι ερευνητές.

Ευτροφισμός

Σε επόμενη φάση της μελέτης, τα ευρήματα τροφοδοτήθηκαν σε μαθηματικά μοντέλα που προσομοιώνουν γεωχημικές διαδικασίες σε πλανητική κλίμακα. Το συμπέρασμα ήταν ότι η πτώση του pH του ωκεανού σκότωσε πολύ γρήγορα τους θαλάσσιους οργανισμούς που φέρουν ασβεστούχο κέλυφος, το οποίο μπορεί να σχηματιστεί μόνο σε συνθήκες υψηλότερου pH.

Η απελευθέρωση CO_2 οδήγησε παράλληλα σε δραματική αύξηση της θερμοκρασίας και στην ισχυροποίηση καιρικών φαινομένων που προκαλούν διάβρωση των πετρωμάτων. Λόγω της διάβρωσης, τα ποτάμια μετέφεραν από την ξηρά στη θάλασσα μεγάλες ποσότητες θρεπτικών συστατικών. Ως αποτέλεσμα, το νερό έγινε ευτροφικό επέτρεψε την υπερβολική αύξηση του φυτοπλαγκτού. Τεράστιες ποσότητες νεκρών κυττάρων του φυτοπλαγκτού αποδομήθηκαν από μικροοργανισμούς που καταναλώνουν οξυγόνο, μια διαδικασία που τελικά εξάντλησε το ζωογόνο αέριο στο νερό. Όσοι οργανισμοί επιζούσαν ακόμα στους ωκεανούς υπέκυψαν τελικά στην ασφυξία.

Η μελέτη δεν εξετάζει άμεσα το τι μπορεί να συνέβη στην ξηρά, δείχνει όμως ότι η απελευθέρωση CO_2 ήταν αρκετή για να διαταράξει τους κύκλους στοιχείων όπως ο άνθρακας το άζωτο και τελικά να επηρεάσει κάθε οικοσύστημα.

Μελλοντικές μελέτες θα μπορούσαν να αποκαλύψουν νέες λεπτομέρειες για τη μεγαλύτερη καταστροφή στην ιστορία της Γης. Ήδη όμως διαθέτουμε επαρκή δεδομένα για να πάρουμε το μάθημα: η αύξηση του ατμοσφαιρικού CO_2 που καταγράφεται μετά τη Βιομηχανική Επανάσταση είναι απολύτως πραγματική απειλή για το σύνολο της σημερινής βιόσφαιρας.

(in.gr, 20 Οκτωβρίου 2020, https://www.in.gr/2020/10/20/tech/megalo-thanatiko-vrethike-fainomeno-pou-sxedon-aposteirose-ti-gi)

Permian–Triassic mass extinction pulses driven by major marine carbon cycle perturbations

Hana Jurikova, Marcus Gutjahr, Klaus Wallmann, Sascha Flögel, Volker Liebetrau, Renato Posenato, Lucia Angiolini, Claudio Garbelli, Uwe Brand, Michael Wiedenbeck & Anton Eisenhauer

Abstract

The Permian/Triassic boundary approximately 251.9 million years ago marked the most severe environmental crisis identified in the geological record, which dictated the onwards course for the evolution of life. Magmatism from Siberian Traps is thought to have played an important role, but the causational trigger and its feedbacks are yet to be fully understood. Here we present a new boron-isotope-derived seawater pH record from fossil brachiopod shells deposited on the Tethys shelf that demonstrates a substantial decline in

seawater pH coeval with the onset of the mass extinction in the latest Permian. Combined with carbon isotope data, our results are integrated in a geochemical model that resolves the carbon cycle dynamics as well as the ocean redox conditions and nitrogen isotope turnover. We find that the initial ocean acidification was intimately linked to a large pulse of carbon degassing from the Siberian sill intrusions. We unravel the consequences of the greenhouse effect on the marine environment, and show how elevated sea surface temperatures, export production and nutrient input driven by increased rates of chemical weathering gave rise to widespread deoxygenation and sporadic sulfide poisoning of the oceans in the earliest Triassic. Our findings enable us to assemble a consistent biogeochemical reconstruction of the mechanisms that resulted in the largest Phanerozoic mass extinction.

Jurikova, H., Gutjahr, M., Wallmann, K. *et al.* Permian–Triassic mass extinction pulses driven by major marine carbon cycle perturbations. *Nat. Geosci.* (2020). https://doi.org/10.1038/s41561-020-00646-4

Nature Geoscience, 19 October 2020, https://www.nature.com/articles/s41561-020-00646-4

Waterspout outbreak and flooding hit southern Greece

(Celestial / THE WATCHERS, October 22, 2020, https://watchers.news/2020/10/22/waterspout-outbreak-and-flooding-hit-southern-greece)

Πώς η Γη απέκτησε το οξυγόνο της: Λύθηκε ένα μέρος του «μυστηρίου»

Για μεγάλο μέρος της 4,5 δισ. ετών «ζωής» της, η Γη ήταν αφιλόξενη: Ο κόσμος μας επέτρεψε την εμφάνιση πολυκυτταρικής ζωής αφού απέκτησε οξυγόνο- ωστόσο αποτελεί ακόμα ερωτηματικό το πώς ακριβώς ο πλανήτης μας απέκτησε την οξυγονούχα του ατμόσφαιρα.

«Αν το καλοσκεφτείς, αυτή είναι η πιο σημαντική αλλαγή που βίωσε ο πλανήτης μας στη ζωή του, και ακόμα δεν ξέρουμε πώς συνέβη» είπε ο Νίκολας Ντάουφας, καθηγητής Γεωφυσικών Επιστημών στο University of Chicago. «Οποιαδήποτε πρόοδος προς την κατεύθυνση αυτού του ερωτήματος είναι πραγματικά σημαντική».

Στο πλαίσιο νέα έρευνας που δημοσιεύτηκε στις 23 Οκτωβρίου στο Science, οι ερευνητές χρησιμοποίησαν μια πρωτοποριακή τεχνική για να ανακαλύψουν νέες πληροφορίες για τον ρόλο του ωκεανικού σιδήρου στην άνοδο της ατμόσφαιρας της Γης. Τα ευρήματα αποκαλύπτουν περισσότερα για την ιστορία της Γης και μπορούν να βοηθήσουν και στις έρευνες για κατοικήσιμους πλανήτες σε άλλα αστρικά συστήματα.

Οι επιστήμονες έχουν δημιουργήσει ένα timeline της αρχαίας Γης αναλύοντας πολύ αρχαίους βράχους: Η χημική σύνθεσή τους μεταβάλλεται ανάλογα με τις συνθήκες υπό τις οποίες σχηματίστηκαν. «Το ενδιαφέρον με αυτό είναι πως πριν τη "Μεγάλη Οξυγόνωση" (Great Oxygenation Event) που έλαβε χώρα πριν 2,4 δισ. χρόνια, βλέπεις στοιχεία στο timeline για αυτές τις μικρές εξάρσεις οξυγόνου, όπου φαίνεται σαν η Γη να προσπαθούσε να θέσει τις βάσεις για αυτήν την ατμόσφαιρα» είπε ο Άντι Χερντ, first author του επιστημονικού άρθρου. «Μα οι υπάρχουσες μέθοδοι δεν ήταν αρκετά ακριβείς για να αποκτήσουμε τις πληροφορίες που χρειαζόμασταν».

Αυτό που προκύπτει είναι ένα αίνιγμα: Εάν υπάρχει νερό, το οξυγόνο και ο σίδηρος σχηματίζουν σκουριά. «Τον πρώτο καιρό οι ωκεανοί ήταν γεμάτοι σίδηρο, που θα μπορούσε να "καταβροχθίζει" οποιοδήποτε ελεύθερο οξυγόνο υπήρχε» είπε ο Χερντ. Θεωρητικά, ο σχηματισμός σκουριάς θα κατανάλωνε όσο οξυγόνο περίσσευε, μην αφήνοντας αρκετό για τον σχηματισμό ατμόσφαιρας.

Ο Χερντ και ο Ντάουφας ήθελαν να δοκιμάσουν έναν τρόπο για να εξηγήσουν πώς μπορεί το οξυγόνο να συσσωρεύτηκε παρά το πρόβλημα αυτό: Ήξεραν πως μέρος του σιδήρου στους ωκεανούς συνδυαζόταν με θείο που προερχόταν από ηφαίστεια για τον σχηματισμό πυρίτη. Αυτή η διαδικασία απελευθερώνει οξυγόνο στην ατμόσφαιρα. Το ερώτημα ήταν πιο από αυτές τις διαδικασίες «νικάει».

Για τους σκοπούς αυτούς χρησιμοποιήθηκαν προηγμένες εγκαταστάσεις στο Origins Lab του Ντάουφας, για την ανάπτυξη μιας νέας τεχνικής για τη μέτρηση μικρών διακυμάνσεων στα ισότοπα σιδήρου, προκειμένου να διαπιστωθεί ποια πορεία ακολουθούσε ο σίδηρος. Σε συνεργασία με ειδικούς στο University of Edinburgh, χρειάστηκε να κατανοηθεί καλύτερα η πορεία του σιδήρου προς πυρίτη. Μετά, οι επιστήμονες χρησιμοποίησαν την τεχνική για την ανάλυση βράχων 2,6-2,3 δισ. ετών από την Αυστραλία και τη Νότια Αφρική.

Η ανάλυση έδειξε πως, ακόμα και σε ωκεανούς που μπορεί να «έτρωγαν» πολύ οξυγόνο για τη δημιουργία σκουριάς, συγκεκριμένες συνθήκες μπορεί να επέτρεψαν τον σχηματισμό αρκετού πυρίτη για να μπορέσει το οξυγόνο να ξεφύγει από το νερό και να σχηματίσει ατμόσφαιρα. «Είναι ένα πολύπλοκο πρόβλημα, με πολλά "κινητά τμήματα", αλλά ήμασταν σε θέση να λύσουμε ένα μέρος του» είπε ο Ντάουφας.

(ΝΑΥΤΕΜΠΟΡΙΚΗ, Τρίτη, 27 Οκτωβρίου 2020, https://www.naftemporiki.gr/story/1651418/pos-i-gi-apektise-to-oksugono-tis-luthike-ena-meros-tou-mustiriou)

Triple iron isotope constraints on the role of ocean iron sinks in early atmospheric oxygenation

Andy W. Heard, Nicolas Dauphas, Romain Guilbaud, Olivier J. Rouxel, Ian B. Butler, Nicole X. Nie, Andrey Bekker

The iron did it

What factors controlled the accumulation of atmospheric oxygen gas (O_2) early in the history of Earth? Heard *et al.* used high-precision iron isotopic measurements of Archean-Paleoproterozoic sediments, with ages between 3.8 billion and 2.3 billion years ago, and laboratory data about synthetic pyrites to show that pyrite, or iron sulfide, burial could have resulted in net O_2 export. These reactions therefore may have contributed to early episodes of transient oxygenation before the Great Oxidation Event that began about 2.4 billion years ago.

Abstract

The role that iron played in the oxygenation of Earth's surface is equivocal. Iron could have consumed molecular oxygen when Fe^{3+}-oxyhydroxides formed in the oceans, or it could have promoted atmospheric oxidation by means of pyrite burial. Through high-precision iron isotopic measurements of Archean-Paleoproterozoic sediments and laboratory grown pyrites, we show that the triple iron isotopic composition of Neoarchean-Paleoproterozoic pyrites requires both extensive marine iron oxidation and sulfide-limited pyritization. Using an isotopic fractionation model informed by these data, we constrain the relative sizes of sedimentary Fe^{3+}-oxyhydroxide and pyrite sinks for Neoarchean marine iron. We show that pyrite burial could have resulted in molecular oxygen export exceeding local Fe^{2+} oxidation sinks, thereby contributing to early episodes of transient oxygenation of Archean surface environments.

(*Science* 23 Oct 2020, Vol. 370, Issue 6515, pp. 446-449 DOI: 10.1126/science.aaz8821, https://science.sciencemag.org/content/370/6515/446)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

This Animation of How Bridges Were Constructed in 14th Century Prague is Amazing

https://www.youtube.com/watch?v=nJqD6qyi0Wk&feature=emb_logo

In this informative animation we learn how the iconic Charles Bridge was constructed in 1357. The historic bridge crosses the Vltava (Moldau) river in Prague, Czech Republic and is 516 metres (1,693 ft) long and nearly 10 metres (33 ft) wide. It was built as a bow bridge with 16 arches shielded by ice guards.

(Twisted Sifter, Oct 19, 2020, https://twistedsifter.com/videos/14-century-bridge-construction-in-prague-animation)

Old Chinese building 'walks' to new location to make way for Shanghai's new commercial centre

Chinese workers have finished relocating an old building in Shanghai using a novel "walking" method. The Lagena Primary School built in 1935 was moved to a new location on October 15, 2020, to make way for a new commercial centre in the city.

https://www.youtube.com/watch?v=Gwu4ovaSiQY

Acidente na Construção Civil

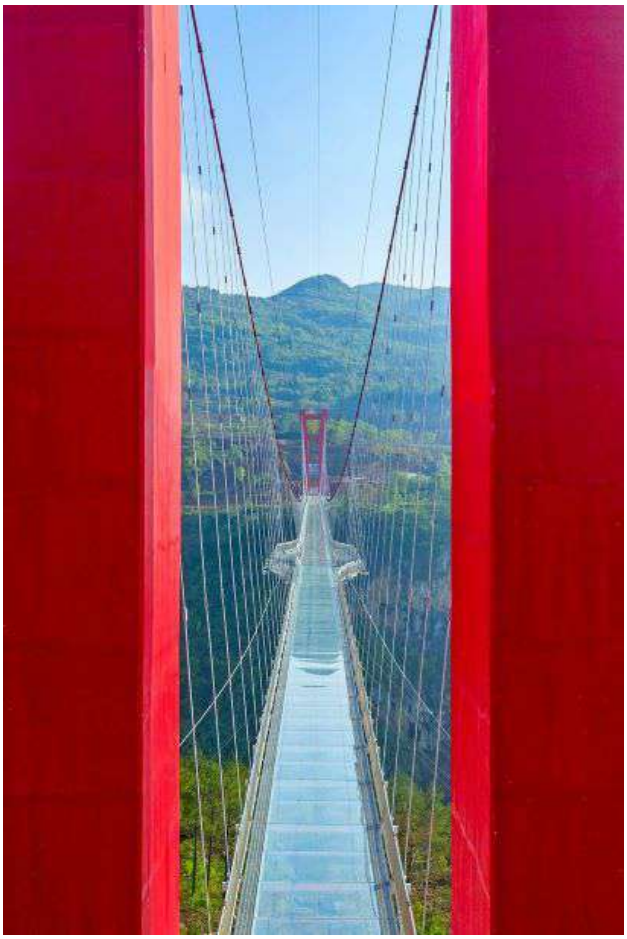
https://www.youtube.com/watch?v=h4y3bjkk7_g&feature=youtu.be

UAD completes the world's longest glass-bottomed bridge in Lianzhou, China

Measuring a staggering 1726 ft (526.14 m), this bridge design by UAD has smashed guinness world records as the world's longest glass-bottomed bridge. Located in Huangchuan three gorges scenic area in Lianzhou, China, the new landmark uses innovative construction methods and is designed to blend seamlessly into the incredible natural surroundings.

Described by UAD as '*a transparent corridor in the air*', the bridge is paved with three layers of 4.5 cm thick ultra-clear tempered laminated glass, the visible transmittance of which is 99.15%. The glazing endows the bridge deck with crystal-like luster, high transparency and refractive index. The glass, the guardrails composed of curved stainless steel bars, the bridge tower, and red main cables, together form a built landscape that combines the solid and the void, the modern and the classical.

Located in the southeast of China, Lianzhou is affected by frequent typhoons in summer. In addition, due to the large span and flexible structural system, the suspension bridge requires excellent wind resistance performance. Based on those considerations, the design team carried out wind tunnel testing and finite elements simulation, analyzed the main frequency and modes of vibration, and identified design parameters such as critical flutter velocity and the reasonable degree of enclosedness of guardrails, which provided strong support for optimizing the design and the maintenance of the bridge in the future.



In order to enhance lateral sustainability and wind resistance performance of the bridge, the designers adopted for an oblique wind-resistant cable system, which is fixed to concrete anchors. Moreover, considering the adverse influences that karstification and special residual silty clay exerted on the site, they ensured the safety performance of the bridge during design and construction phases.

Not one for the faint-hearted, the transparent bridge spans the cliffs and river below at a height of 659.5 ft (201 m). Its completion has already attracted a large number of tourists and is helping inject vitality into the local tourism industry. Based on respecting nature, clear planning and positioning, creativity, and the courage to push the limits, UAD's design aims to reactivate the natural environment and produce an innovative built landscape that contributes to the economic development of the area.

https://www.youtube.com/watch?v=sTRgnRFAGSg&feature=emb_logo

Project info:

Project Name: glass bridge in huangchuan three gorges scenic area
Pocation: Jiubei town, Lianzhou, Qingyuan city, Guangdong province, China
Design Firm: the architectural design & research institute of zhejiang university co., ltd. (UAD)
Design Team: Xie Xu, Sun Liangfeng, Wang Weilong, Dong Weiwei, Wu Pu
Completion: January 2020
Photography and video: Lianzhou Qingtian Tourism Development co., ltd.

(UAD, Sep 02, 2020, https://www.designboom.com/architecture/uad-worlds-longest-glass-bottomed-bridge-lianzhou-china-09-02-2020)

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Valdecilla Hospital-Santander Spain

"Mural piece by @pejac_art Valdecilla Hospital-Santander Spain From the artist: "SOCIAL DISTANCING" is a trompe l'oeil intervention that creates an illusion of a deep gaping crevice on a rigid surface of a cement wall. Made from countless human silhouettes that are trying to escape it, I wanted to represent the wound that this pandemic has left and do it as a tribute to health workers for their respect and solidarity towards the victims. While the image serves as a metaphor for the damage done by the pandemic, it also literally proposes Social Distancing as a way to fix them. In between the large crowd I included scenes of reunion, empathy, care, and love, suggesting a door to a better, hopeful future.

https://www.facebook.com/Artdailyofficial/videos/369719504176964

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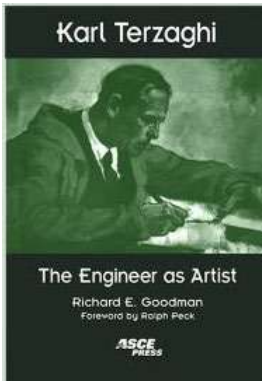
Εντυπωσιακή η πεζογέφυρα Κρηνίδων Νυμφών στον Πηνειό

Ένα εντυπωσιακό αποτέλεσμα επιφύλαξε η παρέμβαση του Δήμου Λαρισαίων στην πεζογέφυρα των Κρηνίδων Νυμφών στον Πηνειό.

Η ολοκλήρωση των εργασιών επίστρωσης του καταστρώματος της πεζογέφυρας με ένα νέο καινοτόμο υλικό (lumin αδρανή), επέφερε το τελικό αποτέλεσμα της αυτοφωτιζόμενης επιφάνειας. Το υλικό που χρησιμοποιήθηκε απορροφά την ηλεκτρομαγνητική ακτινοβολία στις ορατές, υπεριώδεις ή υπέρυθρες περιοχές κατά τη διάρκεια της ημέρας και εκπέμπει την συσσωρευμένη ενέργεια με τη μορφή φωτός μετά το σκοτάδι.

https://www.facebook.com/groups/1224710910891277/?multi_permalinks=3856236164405392&notif_id=1603593830521214&notif_t=group_activity&ref=notif

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ



Karl Terzaghi
The Engineer as Artist

Richard Goodman

Foreword by Ralph Peck

If civil engineering were a game, Karl Terzaghi had a right to lay down the rules--he had invented and established much of the groundwork. Terzhaghi (1883-1963) is one of the leading civil engineers of the 20th century and is widely known as the father of soil mechanics. His lifelong application of the principles established in his work took him throughout the world to engineering challenges in Communist Russia, Nazi Germany, America, and the entire post-war world.

Terzaghi's fame as a master engineer is well known but the story of his development, both personal and professional, has remained unexplored by most people. This first full-length, critical biography of a complex man draws upon his publications, hundreds of unpublished reports, thousands of private letters, and 82 volumes of previously private personal diaries.

This narrative shows Terzaghi's struggle to understand the phenomena observed on many major engineering projects. Through his own words we explore friendships, conflicts, jealousies, frustrations, and enormous successes. Terzaghi was an artist with constant focus, commitment, and genius. The exploration of his life, much of it amid the backdrop of turbulent Europe between the Wars, becomes an adventure that unfolds to entertain, educate, and stimulate.

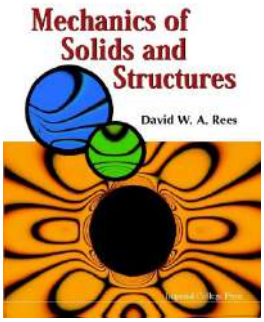
(ASCE Press, 1999)

Soil Mechanics

Hongjian Liao, Hangzhou Li and Zongyuan Ma

This book also doubles as a textbook with an explanation of basic theory, knowledge, and skills in soil mechanics as well as the most updated codes and standards in China. Also included are guidelines at the beginning of each chapter and English–Chinese–Japanese translations of frequently-used words and expressions in the Appendix. It aims to be a reference book for students and technical staff in civil engineering, hydraulic engineering, mining engineering, and transportation engineering.

(World Scientific, October 2020 https://doi.org/10.1142/10945)



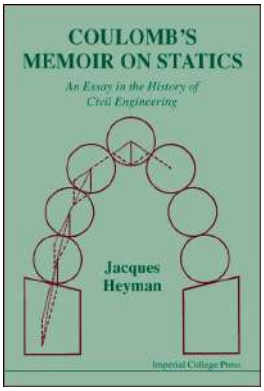
Mechanics of Solids and Structures

David W A Rees

The fifteen chapters of this book are arranged in a logical progression. The text begins with the more fundamental material on stress, strain and plane elasticity. There follows a full treatment of the theories of bending and torsion. Coverage of moment distribution, shear flow, struts and energy methods precedes a chapter on finite elements. Thereafter, the book presents yield and strength criteria, plasticity, collapse, creep, visco-elasticity, fatigue and fracture mechanics. Appended is material on the properties of areas, matrices and stress concentrations. Each topic is illustrated by worked examples and supported by numerous exercises.

The broad text ensures its suitability for undergraduate and postgraduate courses in mechanical, aeronautical, civil and materials engineering.

(World Scientific, April 2000 https://doi.org/10.1142/p187)



Coulomb's Memoir on Statics

An Essay in the History of Civil Engineering

Jacques Heyman

Coulomb read his *Essai* on 'some statical problems' to the French Academy in 1773. It is a document of great importance in the history of engineering since it laid the foundations of the modern science of soil mechanics and also discussed three other major problems of eighteenth-century civil engineering: the bending of beams, the fracture of columns and the calculation of abutment thrusts developed by masonry arches.

Professor Heyman's book makes the *Essai* accessible to a wide range of engineers and historians of technology. It is here reproduced in full with an annotated English translation, a chapter elucidating Coulomb's references and with full discussion of the technical problems it treats. It concludes with some brief historical notes on Coulomb's life and technical education in eighteenth-century France.

(World Scientific, December 1997 https://doi.org/10.1142/p046)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

https://www.issmge.org/publications/issmge-bulletin/vol-14-issue-5-october-2020

Κυκλοφόρησε το Τεύχος 5 του Τόμου 14 (Οκτωβρίου 2020) του ISSMGE Bulletin με τα παρακάτω περιεχόμενα:

TC Corner

- TC304 – the fifth ISSMGE Suzanne Lacasse Lecture
- TC305 – International Online Symposium on Historical and modern applications in ge-otechnical engineering

Major project

Conference reports

- 17ARC on Soil Mechanics and Geotechnical Engineering, Cape Town, South Africa
- Online Symposium on "Laterites and other Tropical Soils", India
- The 4th International Conference on Ge-otechnical Engineering, Tunisia

Hot news

- 2021 Terzaghi's Orator
- Named Fellow of Royal Academy of Engi-neering (RAE) in Geotechnical Engineering
- Bright Spark Award for ICSMGE2021

Event Diary

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IGS NEWSLETTER – October 2020

Helping the world understand the appropriate value and use of geosynthetics

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https://www.icevirtuallibrary.com/toc/jgein/27/5

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Papers

Influence of fibre morphology on the integrity of geofibre-reinforced soil barriers, P. V. Divya, B. V. S. Viswanadham, J. P. Gourc, 27(5), pp. 460–475

Strength and swelling properties of a waste tire textile fiber-reinforced expansive soil, M. Abbaspour, S. S. Narani, E. Aflaki, F. Moghadas Nejad, S. M. Mir Mohammad Hosseini, 27(5), pp. 476–489

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Performance of anchor in sand with different forms of geo-synthetic reinforcement, V. Kishor Kumar, K. Ilamparuthi, 27(5), pp. 503–522

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Centrifuge study of reinforced soil walls with different backfill compaction densities, P. Xu, K. Hatami, G. Jiang, 27(5), pp. 538–550

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https://www.sciencedirect.com/journal/geotextiles-and-geomembranes/vol/48/issue/5

Κυκλοφόρησε το Τεύχος 5 του Τόμου 48 (Οκτωβρίου 2020) του Geotextiles and Geomembrabes της International Geosynthetics Society με τα παρακάτω περιεχόμενα:

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