Israel Geological Society

כנס החברה
הגיאולוגית הישראלית
ירוחם 2021

Abstract Book

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החברה הגיאולוגית הישראלית מודה לחברות ולמוסדות הבאים על תרומתם לכנס
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Department of Earth & Environmental Sciences
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חקר ימים ואגמים לישראל
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מו"פ מדבר וים המלח
Dead Sea & Arava Science Center
בחסות אוניברסיטת בן גוריון בנגב
Under the auspices of Ben-Gurion University of the Negev

The Fredy & Nadine Herrmann Institute of Earth Sciences
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מרכזת תכנים – מיכל סלע-אדלר

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ועדת ביקורת – אורי דור, נורית שטובר-זיסו, שמעון פיינשטיין

ועדה מדעית:

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תודות רבות לרבקה עיני ולעפרה קליין בן-דוד על תרומתן הרבה בארגון הכנס

עריכה: סיגל אברמוביץ, מיכל סלע-אדלר ולין הובר

תמונת שער: בועז לנגפורד

לוגו: נמרוד הס

Abelson M. (1), Nof R. (1), Calvo R. (1), Rosensaft M. (1), Yechieli Y. (1), Gavrieli I. (1), Bernstein M. (1), Baer G. (1)
Sinkhole susceptibility at future Dead Sea and groundwater levels

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Sinkhole formation along the Dead Sea requires dissolution of the subsurface salt layer by under-saturated groundwater. Dissolution and sinkhole formation will continue as long as groundwater level remains above the base of the salt layer. Three parameters determine where and when salt dissolution will continue or stop: (1) the depth of the base of the salt layer, (2) the groundwater level, and (3) the rate of groundwater level drop. We examine these parameters in 17 boreholes along the northern basin of the Dead Sea and find that while in the south, groundwater will drop below the salt layer in the coming decade, in the central (En Gedi) area this will occur between the years 2040 and 2060, and in the north only around 2090. The year when the groundwater level drops below the salt layer serves as a proxy for the time when salt dissolution stops and sinkhole susceptibility level decreases from high to low. Additional water that directly affect salt dissolution come from surface flashfloods that recharge by sinkholes in the main riverbeds. Salt dissolution by floodwater is independent of the regional groundwater level, and is likely to continue well after groundwater level drops below the salt layer. Its dissolving effect is limited to the riverbeds and a few hundred meters wide zone on each side of their banks. With the drop of groundwater below the salt layer and the desiccation of the salt layer, dissolution cavities that have not yet collapsed may remain within the salt layer. These cavities are not likely to continue growing by dissolution, however, the unstable sediments above them remain prone to future collapse, especially in the sediments of the alluvial fans, thus extending the period of high sinkhole susceptibility in these areas a few years beyond the time estimated above.

Adam A. (1,2,4), Haviv I. (1), Blumberg D. G. (2), Maman S. (3), Mushkin A. (4)
The topographic signature of Recurring Slope Lineae (RSL) on Mars hillslopes

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Recurring Slope Lineae (RSL) are dynamic, low-albedo, slope-parallel surface features on Mars that occur mainly on steep (>25°) slopes. RSL typically display seasonal dynamics as they appear during late Martian spring, progressively grow during summer, and subsequently fade as summer ends. RSL formation mechanisms remain under debate with proposed mechanisms involving either water/brines ('wet theories') vs. dry granular flows within a surficial dust layer ('dry theories'). In an attempt to distinguish between plausible RSL mechanisms, this study compares the topographic and morphologic characteristics of hillslopes with and without RSL. We suggest that a distinct topographic signature for RSL hillslopes would argue against the 'dry' RSL mechanisms, as RSL dynamics within a thin dust layer are not expected to significantly impact the hillslope-scale topography. In contrast, the presence of fluids on RSL hillslopes could conceivably accelerate rock weathering rates, which in turn may impact the hillslope-scale topography. Our analyses are based on HiRISE, CTX and HRSC digital terrain models (DTMs) together with

geomorphic mapping using high-resolution orbital images. We focus on inner crater hillslopes and compare the topographic characteristics of RSL vs. non-RSL slopes. In addition, in order to account for the potential influence of aspect-dependent solar irradiation on hillslope processes, we also applied our analysis on adjacent 'control' craters that are void of RSL activity. Preliminary results from Palikir (-41.6°/ 202.1°) and Rauna (35.2°/ 328°) craters reveal that the topographic slope distribution along crater walls with RSL activity is distinct from the slope distribution along crater walls void of RSL activity. Our results appear to support increased rock-weathering rates on crater walls that presently experience RSL activity.

Adellina C. (1), Beverly G. (1)
Preserved Shallow Offshore Paleosols of Caesarea: A Reconstruction of an Eroding Coastline

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Shifting coastal environments continuously shape human activity on and near the coast. The ancient Roman city of Caesarea Maritima, founded in 10 BC, was subjected to a changing coast for over 2,000 years which shaped its use and function throughout history. The construction of the city in 10 BC initiated a crucial relationship between its inhabitants and the sea, this connection was the keystone to its success and continuous occupation for 1,300 years. Research in the study area has shown the fluctuations in local sea level, the driving mechanisms, and archaeological evidence of human adaptation to an environment yet Caesarea Maritima's paleocoastlines have not been fully reconstructed. This study aims to reconstruct the various coastlines during the last 2,000 years and beyond as well as correlate geological events present in previous research.
The study will investigate the various coastlines of the Aqueduct Beach during the last 2,000 years and before as well as identify important geological events present there in the sedimentary record. This will be achieved through a sedimentological and micropaleontological analysis of a 4-meter core collected north of the ancient harbor 300 meters offshore. The analysis will include 1) A visual identification of significant sediment changes, contacts; 2) A Sedimentological analysis of 1 cm subsamples including grain size, TOC, foraminifera, and elemental composition 3) The statistical analysis including the correlation with other cores and archaeological sequences in the surrounding area. The purpose of which is to understand how the coast has changed throughout time and what natural and/or anthropogenic activities caused those changes.

Adem M. (1), Goodman-Tchernov B. (1), Lazar M. (1)
Shifting Life Assemblages along the Coastlines of Dead Sea: A Real-Time Analogue for Discrete Lake Level Change

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The dropping sea levels of about 1.3 m/y, have led to the formation of over 6000 sinkholes along the shoreline of the Dead Sea, a hypersaline inland lake bordering Israel, Jordan and the Palestinian Authority. The lowered lake levels have also shifted the location of the interface between incoming freshwater springs and the Dead Sea lake brine. The process of saltwater/freshwater intrusion in the sediments can lead to the formationof of cavities within which overlying and nearby sediments can collapse and form a sinkhole. Because of this, there is a range of pools and sinkholes along the coastline with varying salinity conditions from near fresh to hypersaline.

High salinity-tolerant fish species such as the Dead Sea toothcarp (subspecies of fish Aphanius dispar richardsoni) have been observed in close vicinity to the shoreline, within pools that were of higher salinity indicating very rapid shifts in the water chemistry. Nearbspring-fedfed ponds and marshes upstream from the Dead Sea have demonstrated the presence of high-tolerance foraminifera species. While the ratesea-levelvell change is measurable with GPS, the related biological transitions that occur along the brackish to hypersaline gradients where springs reach the Dead Sea have not been measured. The aim of this study is to understand the horizontal sequence of sediments and microfossils that follow the shift of lake level within the nearshore pools, and an association between particular high tolerance microfauna the and presence of the Dead Sea Toothcarp. Additionally, this study whether there is a clear sequence of properties that can be linked to lake level change around the Dead Sea and recognizable in the sediments. If such a sequence exists what is it potential for preservation and can it be used to recognize similar phases in the past.

Adam O. (1), Schneider T. (2), Enzel Y. (1), Quade J. (3)
Both differential and equatorial heating contributed to African monsoon variations during the mid-Holocene

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The Sahara was significantly greener 11-5 kya and during multiple earlier interglacial periods. But the mechanisms related to the greening of the Sahara remain uncertain as most climate models severely underestimate past wet conditions over north Africa. The variations in the African monsoon related to the greening of the Sahara are thought to be associated with the variations in the inter-hemispheric differential heating of Earth, caused by orbital variations. However, how orbital variations affect regional climate is not well understood. Using recent theory that relates the position of the tropical rain belt to the atmospheric energy budget, we study the effect of orbital forcing during the mid-Holocene on the African monsoon in simulations provided by the third phase of the Paleo Model Intercomparison Project (PMIP3). We find that energy fluxes in the African sector are related to orbital forcing in a complex manner. Contrary to generally accepted theory, orbital modulation of seasonal differential heating alone is shown to be a weak driver of African monsoon variations. Instead, net atmospheric heating near the equator, which modulates the intensity and extent of seasonal migrations of the tropical rain belt, is an important but overlooked driver of African monsoon variations. A conceptual framework that relates African monsoon variations to both equatorial and inter-hemispheric differential solar heating is presented.

Aharonov E.
A physical model of rock friction and its consequences for tectonics

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Experiments measuring friction at a variety of sliding velocities find that the value of the friction coefficient varies widely: friction is high and behaves according to the rate and state constitutive law during slow sliding, yet markedly weakens as the sliding velocity approaches seismic slip speeds. We introduce a physics-based theory to explain this behavior. Using conventional microphysics of creep, we calculate the velocity and temperature dependence of contact stresses during sliding, including the

thermal effects of shear heating. Contacts are assumed to reach a coupled thermal and mechanical steady-state, and friction is calculated for steady-state sliding. Results from theory provide good fits to the reported experimental results for quartz and granite friction at all velocity ranges and at varying confining stresses and ambient temperatures. Finally, we discuss the implications of our new model to frictional instabilities, earthquakes and the brittle ductile transition in the Earth.

Alkalay R. (1, 2), Katz T, (2), Herut B. (2), Bar Tz (3), Berman-Frank I. (3), Weinstein Y. (1)
Patterns of carbon export at the southeastern Levantine Basin

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The southeastern Levantine is a highly-sensitive ultra-oligotrophic marine basin, with very low primary productivity, therefore C export from the euphotic zone is expected to be very low. In this study, we present time series data from McLane automatic sediment traps and point current meters from the DeepLev marine station (50 km offshore Haifa, water depth of 1500m), which shed light on the patterns of C export in this basin.
Sediment trap observations between 2017-2020 suggest that the export of carbon in the deep Levantine Basin is controlled by lateral transport of particulate matter from the coast, mainly during winter events. Transport (PM loads) is larger at mid to deep water zones, compared with the surface. This was supported by 234Th data, which showed large excesses or deficits at depth (compared with its radioactive parent, 238U), indicating an intermediate to deep water lateral supply of particulate matter.
Turbidity (acoustic back scattered) measurements from Aquadopp current meter, located at 1310 m depth (representative of water column suspended matter), were in good correlation ($r= 0.82$; $p<0.001$) with POC collected in the 1,300m sediment trap. Statistical analysis of turbidity in relation with various environmental parameters suggests that export is mainly controlled by coastal stream discharge (Qishon R.), with suspension due to storm waves on the shelf being second in importance.

Armon M. (1), Dente E. (1,2,3), Shmilovitz, Y. (1,2), Mushkin A. (2), Cohen T. J. (4), Morin E. (1), and Enzel Y. (1)
Determining Bathymetry of Shallow Ephemeral Desert Lakes Using Satellite Imagery and Altimetry

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Drylands around the globe are characterized by interior drainage systems terminating at shallow desert lakes or playas. These remain mostly dry but fill up on episodic floods. Their floor topography is the basis for water volume estimates, water balance calculations, water resource management, and a key in understanding paleohydrology/climatology of such regions. However, being shallow, ephemeral, and remote, bathymetric surveys are scarce and radar-based remote sensing is practically inappropriate in such lakes. This study shows a new, remote-sensing-based method that derives bathymetry of shallow and ephemeral desert lakes from freely available and global datasets. We associate between frequencies of water occurrence, at 30 m pixel resolution, based on optical satellite data for >30 years and accurate elevation measurements from the new Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2). We

demonstrate the success of our method at three different desert lakes: (a) Lake Eyre (Australia), representing a complex lake system with multiple subbasins, (b) Sabkhat El-Mellah (Algeria), a much smaller lake in the Sahara never mapped for bathymetry, and (c) Lago Coipasa (Bolivia), which we mapped both before and during its inundation. The bathymetries of these lakes are now mapped with ~0.3 m error, whereas the Shuttle Radar Topography Mission (SRTM) yields an error of ~2.5 m. Our method complements other remotely sensed, bathymetry-mapping methods as it can be applied to remote lakes with no in-situ records, lakes consisting of subbasins, and flooded lakes. The proposed method can be easily implemented in other shallow lakes as it builds on publicly accessible global data sets.

Arvatz N. (1), Kamyshny A. (1), Feinstein S. (1), Amrani A. (2), Ronen Z. (3), Kutuzov I. (2)
Organic geochemical monitoring of the natural degradation of a recurring oil spills contamination in the shallow soil profile of the Evrona hyper-arid environment

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The Evrona Nature Reserve in the southern Arava valley has undergone two major oil spills in 1975 and 2014. This study commenced after the 2014 spill and aims to investigate the extent and rate of the natural degradation (i.e., natural remediation), the effective weathering processes in the upper soil profile (0-30 cm), and their variation with depth and time elapsed since the spills under hyper-arid conditions. Here we present preliminary assessment of results representing four years of monitoring during 2015-2018. Crude oil comprises a mixture of a large variety of compounds with differential resistance to an array of degradation processes. Hence the variations in concentration and composition of the residual oil provide useful proxies for the identification of polluting oils and evaluation of the effectiveness and magnitude of weathering processes in the soil profile.
The residual oil concentrations in the polluted soil samples were determined by thermal extractions (RockEval) and organic solvent extractions (Soxhlet). The extracted oils chemical composition was determined at two levels: bulk oil properties by column liquid chromatography (SARA fractionation) and spectral hydrocarbons molecular analysis by GC-MS.
Comparison of molecular signatures of biomarkers with high resistance to degradation, particularly from the hopanes group, testifies for the occurrence of residual polluting oils from both 1975 and 2014 spilling events. Moreover, pattern variations in the molecular ratios reveal differing proportions between the two polluting oils in the soil samples. In addition, variations in bulk fractions and molecular composition, also indicate natural degradation ranging between 0% to ~60%, mostly due to biological processes. The distribution in both proportions of the two contaminating oils and weathering levels in the soil profile appears to be very heterogenic. Nevertheless, we observe that the weathering magnitude is growing with the increase in the fraction of the 1975 oil proportion within the soil sample.

Ashkenazi L. (1,2) Katz O. (1) Abramovich S. (2) Almogi-Labin A. (1) Makovsky Y. (3) Gadol O. (3) Kanari M. (4) Hyams-Kaphzan O. (1)
Benthic foraminifera as indicators for recent sediments transport in the Eastern Mediterranean upper continental slope, offshore Israel

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A multi-proxy investigation of piston core DOR280 is presented. DOR280 was sampled from the headscarp of a landslide on the upper continental slope, northern central Israel. Benthic foraminiferal assemblages and taphonomy, alongside particle size distribution, were used to determine the provenance, transport distance and reoccurrence-time of mass wasting events. Radiocarbon ages revealed an age of ~600 Cal Yrs. B.P. for the core base, suggesting unexpectedly high average sedimentation rate of ~10 m/kyr. Computed Tomography shows two alternating sedimentary facies: Non-Laminated (NL) and Laminated (L). The L-facies also include 0 – 3.5 cm-thick High-Density Laminae (HDL). The NL-facies consist of unimodal fine-sediments dominated by clay minerals. Their foraminiferal assemblages are dominated by autochthonous species and low broken shells percentage. This indicates that NL-facies represents mostly in-situ hemipelagic deposition. The L-facies also record unimodal fine-sediments dominated by clay minerals, but their foraminiferal assemblages are dominated by allochthonous species and higher broken shells percentage, indicating contribution of transported sediments, originated from mid-shelf habitats. The HDL-facies consist of bimodal sediments comprised of silty-clay (~5 µm) and silty components (~40 µm), dominated by quartz and calcite; as well as poorly preserved allochthonous foraminiferal species and high broken shells percentage. Thus, the HDL represent significant contribution of mid-shelf-origin sediments and are interpreted as turbidite-like mass transport events.
The temporal distribution of the 27 HDL-events is nonrandom, which could have been triggered by earthquakes, tsunami, winter-storms or sediment load related to high-stand Nilotic episodes. However, mechanisms controlling the observed mass transport in the Dor Disturbance still need furthur study. DOR280 is the first high resolution studied piston core from the upper continental slope, offshore Isreal. The use of benthic foraminifera reveals transported sediments within the core and enables an assessment regarding their source. The sediments accumulation rate reported here is higher than previously known, thus have implications on evaluation and mitigation of marine geo-hazard in the studied area.

Atencio B. (1), Ram R. (1), Burg A. (2), Yechieli Y. (2),(1), and Adar M. E (1).
Groundwater recharge, mixing, and dilution processes in the Nubian Sandstone Aquifer in the edastern Negev Desert, Israel.

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2. Geological Survey of Israel, 32 Yesha'ayahu Leibowitz, Jerusalem, Israel

Past publications suggest that the mainly confined deep Nubian sandstone aquifer (NSA) contains fossil water with negligible contemporary recharge through the limited outcrops area. The latest publications based on krypton, carbon, chlorine, and oxygen isotopes in the NSA over the northern Negev suggest a significant recharge of young (and perhaps even contemporary) water through the nearby outcrops, namely the NSA is not entirely fossil. In addition, a substantial contribution of very old salty water from deep-seated highly pressurized groundwater reservoir was identified. These findings raise the question of whether it is also supported by hydrochemistry and by the regional hydrogeological structures. To this end, we followed the hydrochemical and isotopic evolution along the eastern flow path of the aquifer from Shizafon (in the southern Negev), along the western edge of the Arava Valley toward the outlet of the NSA south of the Dead Sea. We fit a mixing cells model (MCM) for several end-component scenarios to examine the feasibility of hydraulic connectivity of the NSA to potential recharge zones and neighboring

aquifers with distinct hydrochemistry and isotopic composition. The MCM results of most scenarios clearly show that the northern part of the flow path in the NSA is not entirely confined and that the rejuvenation of groundwater age is a result of (1) groundwater flows from overlying younger water bodies in the Judea and the Mishash formations, probably through fracture systems (2) groundwater recharge through the northern Negev NSA exposures that flow towards the Arava along the Ramon and Zin fault zones. In addition, the water balance could not be obtained without a small, yet significant amount of old salty water type as depicted in Zofar 20 well. In conclusion, the NSA under the central and northern Negev is not an absolutely fossil groundwater system, but rather a dynamic system with complex interrelations with different water-bearing formations.

Avni Y. (1)
Long-term stability of major drainage divides versus breaching of divides during drainage re-organization: examples from the South America continent and the Israel – Sinai micro plate

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The debate regarding the stability of drainage divides over geological time scales is one of the most important issues in geomorphology, and play a major role in landscape evolution processes and models. One group of scholars is arguing on constant migration of drainage divides triggered by the development of asymmetric conditions (topographic gradients, lithology, each) along the divide, while other group is pointing on their long stability, subjected to some modifications.
Here we present evidences for long-term stability of major drainage divides in two continents – South America and the Israel – Sinai microplate.
The Pacific – Atlantic major drainage divide situated along the Andean mountain range in Cordillera Blanca, Peru, is almost stable over the last 10-6 Ma. This major divide has maintained on its present position, although the large drainage asymmetry observed among drainage basins draining the region and the regional humid climate (over 1000-500 mm/y).
The main cliff systems in Sinai and Southern Israel (e.g. Tih, Egma, Ramon, Loz) are accommodating the main drainage divides between the Mediterranean, Suez and Eilat gulfs and the Dead Sea. These cliff systems are demonstrating large asymmetry in their lithological composition and topographic gradients. However, their location is almost stable over the last 20-10 Ma, presenting very minor cliff retreat and divide migration through time ranging 101-102 m.
However, large drainage modification that occurred in the Negev such as in the Paran and Neqarot drainage basins are attributed mainly to tectonic tilting of large areas toward the developing Dead Sea Transform. The eastward tilt, coupled with local faulting, has change the regional inclination regime and effected large drainage basins (102 – 103 km2). Minor drainage modification at scale of 0.1-2 km2 are attributed to local gravitational processes such as landslides and cliff collapse, locally effecting the original, almost stable, drainage divide.

Babad A. (1) Burg A. (2) Adar E. (3)
Hula valley hydrogeological system

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Recently water wells, discharge large amount of water from the Jurassic and Cretaceous aquifers. It is common to assume that these aquifers drain the recharge water from the Hermon Mountain and the

south of Lebanon area. The finding from these wells point on two major inferences: first it is huge high quality water storage second the groundwater flow pattern is from the regional aquifers to the Hula valley fill.
The Hula Valley graben is highly complex geological structure which is part of the active Dead-Sea transform fault. The graben alluvial fill compose of many sediments, which are differ in their hydrological properties and create highly heterogeneous hydrogeological system. These system groundwater inlet and outlet flux as well as the inter graben flow regime are detective by the geological structure and the fault system in the graben.
Understanding of the geological structure had done by geological interruption of the exist data. Integration of this finding along with hydrological, Hydrochemical and isotopic data allow us to achieve more comprehensive hydrogeological understanding of the complex groundwater system of the Hula Valley.

Baer G. (1), Swaed I. (1), Nof R. (1), Bernstein M. (1), Gavrieli I. (1)
Recharge and discharge of floodwater in sinkholes along the Dead Sea: implications for long-term geomorphological changes

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Using light detection and ranging (LiDAR), interferometric synthetic aperture radar (InSAR), drone photography, time-lapse cameras and water chemistry, we document floodwater recharge by streambed sinkholes, groundwater flow paths, brine discharge through shoreline sinkholes, and landscape changes during the years 2011-2020. We find a positive correlation between annual subsidence at the Ze'elim fan and the corresponding total floodwater volume measured at a hydrometric station upstream. However, even when assuming attainment of salt (halite) saturation by the runoff water as they recharge and flow in the subsurface, their potential salt dissolution comprises only 8%-60% of the total salt dissolution estimated from observed subsidence. The remainder of the salt dissolution is mostly by aquifer-fed groundwater. Groundwater discharged at the Ze'elim shoreline is highly heterogeneous, with a wide range of salinities and Na/Cl ratios (0.4-0.8). The groundwater salts are composed of interstitial salts from the sediments exposed due to the Dead Sea level drop, and the 10,000 yr old subsurface salt layer, dissolved by fresh groundwater and floodwater. While most of the surface runoff in the Ze'elim fan is recharged by streambed sinkholes, most of the Hever runoff continues at the surface down to the Dead Sea, with only a small fraction being recharged by sinkholes along this flow path. This difference is attributed to the fine-grained sediments and low-gradient stream profiles in Ze'elim, which enable water accumulation and recharge in sinkholes, in contrast with the higher-gradient Hever profiles, which allow carrying of coarse gravel that eventually fills the sinkholes. Subsidence and streambed-sinkholes occur in a number of other streams draining to the Dead Sea. Further examination of their gradients and lithologies may indicate whether the dominating process will be drainage or downstream runoff of floodwater, implying on the future incision of the Dead Sea riverbeds and the associated hazards.

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Assessment of effective infiltration in the deep arid vadose zone of the Negev, Israel

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The Israeli national site for radioactive waste is situated in the Yamin Plain, within the Negev desert. Estimation of water recharge to the ~500 m deep vadose zone underlying the site is crucial for assessing risks related to contaminants transport. However, estimation of water fluxes in deep arid vadose zones is a challenging task because of their small magnitude and the lack of a direct measurement technology. Studies conducted in a deep arid vadose zone in Nevada, USA point to complex transient flow dynamics, in which the direction of water flow in the top of the vadose zone is upward while in the rest of the section water flows downwards to the water table.
In this study we present a combination of techniques which are used to obtain an initial evaluation of the water dynamics in this environment. These techniques include profiles of water content, leachable chloride; soil texture; and numerical modeling. The water content of both boreholes revealed an extremely dry environment, with low saturations and high pore-water chloride concentrations. Peak chloride concentrations did not coincide in the two boreholes, raising the question whether these peaks are connected to water fluxes or to changes in soil texture.
Numerical simulations were then used to solve water flow and solute transport. Input parameters, including chloride deposition rate, precipitation rate, and surface run-off fraction were varied to fit the measured chloride profiles. Results indicate very small water fluxes of less than 1 mm/yr in the bottom of the vadose zone. In addition, chloride mass in the profile is less than expected based on estimated chloride deposition rate and published records of paleo-rain. These results suggest either a delayed climate shift to dry conditions and/or a partial input of the 4 g/m2/yr of deposited chloride, possibly due to runoff.

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Beachrock Exposers for Interpretation of Coastal Landscape Evolution in Israel

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In the dynamic intertidal sandy environment, rocky elements such as beachrock, can be used for evaluating sands transportation and erosion rates. Constantly exposed beachrock deposit is necessarily an indicator of erosive conditions that may result from various factors, especially construction of marine structures, sea levels fluctuations and sand quarrying from the beach. Previous studies demonstrated that the initial lithification of beachrock beds occurs under the cover of coastal sediment, during relatively stable conditions of the sea level, and that exposure of the buried beachrock, in the swash zone, is following the erosion of the overlying unconsolidated sediments.
The current research focuses on in-situ beachrock beds formed since the sea level has reached the present level about 4 kyr ago. Outcrops at the Sharon and the Carmel beaches (Israel) were investigated in attempt to assess the causes for their formation and exposure and to understand them in terms of coastal morphodynamics, and temporal stages. We use combination of field measurements and sedimentological analysis of samples (including particles and cement characterization using thin section petrography, SEM, XRD, and POSL methods) Together with OSL dates to describe outcrops characteristics in various beach-types. The results indicate that the granular composition of beachrock samples investigated correlates (generally) with the free sediment at the intertidal zone and reveal morphological patterns, which are various in nature. We show case studies to demonstrate the correlation between beachrock occurrences morphodynamical processes as they appear in the swash zone along the Israeli coastline landscape.

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Potential source rock evaluation and their thermal maturity in the Permian-Triassic-Jurassic strata, onshore, central Israel

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Despite the efforts to identify potential source rocks and their role in petroleum systems throughout Israel, significant lack of knowledge still exist. The "Judea Graben" is a conceptual deep geological structure, sprawling N-S through the Hebron and Samaria highs and holds thick Permian-Triassic-Jurassic strata, which was not sufficiently explored for potential source rocks. The current study focuses on quantifying the organic richness, hydrocarbons generation potential, kerogen type and the kerogen maturity stage of the Permian-Triassic-Jurassic (P-T-J) strata onshore central Israel. So far, c.a. 650 cutting samples, from 6 boreholes (David 1A, Devora 2, Gaash 2, Ramallah deep 1, Ma'anit 1A, and Meged) located within the study area, covering the P-T-J succession, were analyzed using Rock-Eval 6 analyzer. Overall, four organic rich intervals were identified: 1. The Permian section in David 1A borehole, exhibits very good organic richness and poor HC generation potential. 2. The Middle Triassic intervals in Ma'anit 1A borehole, classified as fair - good organic richness, with poor HC generation potential. 3. The Upper Triassic interval, which occurs in all examined boreholes, classified as fair - good organic richness with poor - good HC generation potential. 4. Two organic rich intervals correlate to Lower and Upper Jurassic, situated in Meged boreholes and classified as fair to good organic richness with poor - fair HC generation potential.
The results so far suggest that in central Israel (David 1A vicinity), organic matter deposition and preservation was favored in the Permian Period, similar to the previously studied Negev area. Moreover, a regional deposition and preservation of organic matter occurred during the Late Triassic, initiating potential source rock with mixed marine and terrestrial organic facies. On the other hand, no regional organic richness was observed throughout the Jurassic succession in the study area.

Barnea Cohen O. (1), Hofstetter R. (2), Agnona A. (1)
Microearthquake observations at 2 borehole stations around the Sea of Galilee

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During July-August 2018, intense seismic activity occurred underneath Lake Kinneret (Sea of Galilee) and its vicinity. In the following months the seismic activity continued though on a lower scale. In this project, we use high-quality waveforms recorded by two recently installed (May 2018) deep borehole stations (depth ~530 m), K10B and MB1I on the west and south-east sides of the lake, respectively, operated by the Geophysical Institute of Israel. We take advantage of the background noise reduction at the deep boreholes to lower the magnitude threshold of observed earthquakes occurring in the Sea of Galilee, which are not observed by the on-surface stations of the Israel Seismic Network (ISN). During July-December 2018, circa 80% of the recorded earthquakes at the boreholes were not detected by the ISN. We intend to relocate the events (hypocenters) using cross-correlations with the ISN stations. By relocating the micro-earthquakes, we opt to improve mapping of active faults, study fault types, and analyze the stress regime.

Barnea Cohen O. (1), Makovsky Y. (2) Tibor G. (3), and Agnon A. (1)

Multi-stranded slip distribution of the Dead Sea Transform in the Northern Gulf of Aqaba/Eilat

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The proximity to the cities Eilat and Aqaba, straddling the northern margin of the Gulf of Aqaba/Eilat (GOAE), underscores the tectonic system forming the gulf. Over the past forty years, patches of the fault systems have been mapped. However, the complexity is yet un-resolved. This work aims to elucidate the complete pattern, using data acquired by a dense single-channel seismic survey across the northern GOAE (NGOAE), tied with previous studies. The dominant fault in the NGOAE is the Evrona Fault, the southern section of the Dead Sea Transform. Also, two marginal faults bound the NGOAE from east and west, Aqaba, and Eilat respectively. We show that the Evrona system splays into several strands that cut young sediments, indicating that the modern slip is distributed. We found that the blocks bordered by the strands contain different sediments, evidence of strike-slip movement. Smearing of layers near the faults testifies for oblique-normal slip. A similar slip type is detected on the two eastern faults, Aqaba and West Aqaba. Our map of the Eilat Fault features three normal stepping faults. We calculate a 0.9-1.5 mm/yr slip-rate across the Eilat Fault during the Holocene, based on an extensively dated coral unit. We hypothesize that the Evrona, Eilat, Aqaba, and West Aqaba Faults merge to become a single oblique fault at depth. The oblique-slip leads to slip-partitioning towards the free-surface, evident as a negative flower structure. Based on the new mapped faults and earthquakes catalog, we predict earthquakes' distribution in the NGOAE using the Coulomb stress changes model. A future rupture is likely in the extension of the Evrona Fault to the northern gulf; its triggered aftershocks are predicted to hit Eilat and Aqaba cities.

Benaltabet T. (1,2), Lapid G. (1,2), Torfstein A. (1,2)
Seawater Pb concentration and isotopic composition response to daily time scale dust storms in the Gulf of Aqaba, Red Sea

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Lead (Pb) is a primary tracer of natural and anthropogenic processes in the marine environment, with atmospheric deposition being one of its main sources to open ocean surface waters. However, the impact of short-term (daily) dust storms on the oceanic water column is poorly constrained due to the typically low sampling temporal resolution in open ocean settings. The Gulf of Aqaba (GoA), northern Red Sea, is a deep oligotrophic water body surrounded by hyper-arid deserts with no major tributaries, and hence its surface waters receive limited terrigenous input, except from settling atmospheric dust. The GoA is highly accessible and therefore provides the opportunity to study the dynamics of seawater Pb chemistry across abrupt and short periods of enhanced atmospheric deposition.
Here, we report a highly resolved time series of vertical profiles of dissolved Pb concentrations and isotopic compositions across daily-timescale dust storm events that occurred during 2018. GoA Pb concentrations range between 19-85 pmol kg-1, and the isotopic compositions of 206Pb/207Pb and 208Pb/206Pb are in the range of 1.163–1.190 and 2.062–2.093, respectively. These compositions reflect a mixture of multiple end members: seafloor sediments, open Red Sea waters and anthropogenic aerosols. The results show that dust storms impose strong perturbations of seawater compositions towards the anthropogenic aerosols end member, inducing short-term increases of up to 54% in the upper

water column Pb inventory. We propose a short-term dissolution-scavenging mechanism, whereby upon dust-seawater impact, the majority of the aerosol's soluble anthropogenic phases rapidly dissolve, while simultaneously, Pb is re-adsorbed onto the sinking dust mineral particulates. Post dust storm Pb leaching and scavenging rates are modeled, yielding quantitative constraints on the connection between increasing dust loads and seawater Pb compositions. Our findings demonstrate the short-term Pb response to dust storms and should be applied when interpreting open ocean surface water Pb patterns.

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Preliminary results of carbonate rock strength using hyperspectral imaging

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This research aims to define new empirical relations between hyperspectral signature of rock surfaces and their geo-mechanical characteristics. We intend to develop proxy tools for classifying the quality of the rock mass where access is restricted or constrained.
In rock mechanics research, remote sensing technologies are mainly used for mapping surface geometry and rock discontinuities. However, the characterization of mechanical properties of the intact rock by these techniques are not developed yet. In this study, hyperspectral remote sensing technology is implemented using optical and thermal spectral regions. The hyperspectral remote sensing technology, which enables the identification and recognition of objects based on the spectral absorption features of a specific chemical attributes, can remotely distinguish different types of rocks using stationary or airborne platforms. Assuming that the chemical and physical attributes of rock are correlated to the material strength, we aim to find the spectral-based model for assessing rock strength remotely. Cylindrical rock samples of different carbonate formations were collected from outcrops. The samples were measured in the visible and infrared (VNIR-SWIR-LWIR) regions using point and imaging hyperspectral remote sensors. The uniaxial compressive strength of the rock samples was determined and analyzed. Preliminary results show that the correlation between rock strength and their spectral signature enables the assessment the carbonate rock strength remotely.

Ben-Dor G. (1), Kurzon I. (2), Tsesarsky M. (1)
Local shear-wave splitting due to crustal seismic anisotropy in northern Israel

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Shear-wave splitting is a phenomenon by which SH- and SV- waves, emitted from a seismic source, undergo a separation along their path due to seismic velocity anisotropy. This anisotropy is the product of a distinct alignment within the medium (fluid-filled cracks, mineral alignment, etc.), introducing two different, orthogonal, seismic velocities; one parallel to the alignment and the other perpendicular. As a result, S-waves that pass through an anisotropy area experience a splitting process, manifested by a distinct time delay between the two orthogonal phases. Therefore, aside from a measurable time delay, S-waves sustaining a splitting process, exhibit polarization in the fast and slow velocity directions, providing a way to measure the alignment direction of the anisotropy area. Measurements of splitting properties reflect the last region of seismic anisotropy encountered by the wave, thus, identifying consistent splitting properties of various areas using a good azimuthal coverage may help characterize

this phenomenon. Since fabric alignment within the crust is often associated with the local stress regime, shear-wave splitting studies may help to better understand stress distributions along active faults. Using records from the newly constructed ISN we present measurements of shear wave splitting parameters caused by local earthquakes at the northern part of Israel between the years 2018-2021. Several unique regions are identified, characterized by distinctly consistent polarization directions, recorded at several different stations with good azimuthal coverage, indicating the presence of local crustal anisotropy areas. Our results are compared to several local geological and structural features, exploring their possible contribution to the observed seismic anisotropy. Forming these comparisons may help to better understand the stress distribution along active faults in the northern part of Israel and help to characterize areas with a larger probability of rapturing.

Ben Dor Y. (1), Marra F. (1,2), Armon M. (1), Enzel Y. (1), Brauer A. (3,4), Schwab M.J. (3), Morin E. (1)
Dead Sea sediments reveal the seasonal to decadal hydroclimatic variability during opposing late Pleistocene climates in the Levant

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Annual to decadal-scale hydroclimatic variability is a dominant climatic characteristic embedded in local climate. Studying this variability is crucial for understanding climate and its derivatives such as hydrological processes and water availability. However, studying variability at these scales is limited by the availability of relatively short records, whereas model simulations relaying on modern dynamics could miss some of its aspects. Here we study annual to decadal hydroclimatic variability in the Levant using two sedimentary sections retrieved from the depocenter of the Dead Sea, which has been continuously recording environmental conditions throughout the late Pleistocene. We focus on two, ~700-years long series of annually-deposited laminated intervals (i.e., varves) representing two episodes of opposing mean climates expressed as lake-level rise and fall, respectively, at 27 and 18 Ka. These two series comprise alternations of authigenic aragonite precipitated during summer and flood-derived detrital laminae deposited during winter. Within this record, aragonite laminae serve as a proxy of annual inflow and epilimnion dilution, whereas detrital laminae comprise sub-laminae that record individual flooding events. The two series depict distinct characteristics with increased mean and variance of annual inflow and frequency of flooding events during “wetter”, with respect to the “dryer”, conditions. In addition, decades of intense flood frequency (i.e., clusters) are identified, suggesting shifts between centennial-scale climatic regimes, which are particularly pronounced during wetter conditions reflected by rising lake levels. The combined application of multiple time series analyses indicates that episodes of falling lake levels are characterized by multiple pronounced quasi-periodic components with periodicities of 2-4, 6-8 and ~12 years, whereas the rising lake level episode presents weaker, less-persistent periodical components with similar periodicities. Combining these observations with modern synoptic-scale hydroclimatology indicates periods dominated by different key synoptic systems that govern rainfall, annual inflow, and flood frequency in the eastern Mediterranean over centennial time-scale.

Ben Dor Y. (1), Stein M. (1), Ben Shalom Y. (1), Goring-Morris N. (2), Erel Y. (1)
The soils of the Fazael Formation and their potential contribution to the Neolithic agricultural revolution in the Jordan Valley

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The Neolithic agricultural revolution (NAR) is related to the early domestication of crop plants and the establishment of a sedentary-agrarian lifestyle in the Fertile Crescent during the early Holocene. Albeit many years of research, the key drivers of the Neolithic agricultural revolution and the underlying conditions that made it possible are still debated. Previous studies focused on climatic, anthropological, social and botanical aspects that could have supported the NAR. Nevertheless, one of the prerequisites for successful cultivation and domestication of wild plant species are fertile soils and sufficient freshwater. Here, we focus on the soils and related environmental conditions that accompanied the establishment of key settlements in the southern Jordan Valley during the Neolithic: Jericho, Gilgal and Netiv Hagdud. These settlements are located on top of and in close proximity to the Fazael Formation, which overlies the last glacial Lisan Formation. The Fazael Formation, which accumulated during the early Holocene (~11-6 cal ka BP), comprises fine detrital sediments derived from the remobilization of soils that developed on the carbonate hills of Samaria. We speculate that the accumulation of these remobilized soils supported the transition of the Natufian people of the Jordan Valley into a sedentary-agrarian lifestyle during the Neolithic period. We analyzed sediment samples of the Fazael Formation from several of the Pre-Pottery Neolithic sites in the vicinity of Jericho, and measured several soil fertility-indicators including: soil texture, water content, exchangeable cations composition, sodium and potassium adsorption ratios, as well as available phosphorus and sulfur.

Ben Dor Y. (1), Vainer S. (1, 2)
HIPSTER: A High-resolution Integrated Program for modeling Sand Transport in Eolian Realms using OSL and cosmogenic nuclides (Cosmolian)

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The extensivity of sand dunes in continental interiors makes the understating of their morphodynamical properties and time of appearance valuable for palaeoenvironmental reconstructions and for the interpretation of landscape evolution. Nevertheless, the study of eolian landscape evolution at the million-years timescale is hampered by the complex interaction of factors determining dune migration and the inherently self-destructive nature of their chronostratigraphy, thus limiting the applicability of traditional luminescence-based dating methods for configuring processes beyond ~300 Ka. In this study, we present a standalone program that simulates eolian transport based on luminescence-derived chronologies coupled with numerical modelling of cosmogenic nuclides accumulation. This integrative approach reveals ancient phases of sand irruption and provides a data-based scheme facilitating the morphodynamical study of eolian processes over multiple timescales. We present a case study of the program application by analyzing data from the Australian Simpson Desert that unfolds multiple pulses of eolian vitality at 3.8-3.4, 2.9-2.5, and 1.5-1 Ma, corresponding to drastic changes in environmental settings. The synchronicity of the results with the established environmental framework exemplifies the applicability of process-based modelling in constructing a timeframe of key landscape evolution events in arid environments by studying eolian landforms. Finally, the relationships between model parameters used to determine environmental settings and sand migration patterns make the program a powerful tool to further investigating triggers and mechanisms of eolian processes.

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Evidence for Spindle-Shaped Pull-Apart Basins in the Southern Arava, Dead Sea Transform, and Potential Implications on Geohazards

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The Southern Arava Valley is the southernmost terrestrial section of the Dead Sea Transform (DST). The It is now widely accepted that the left-lateral relative movement along the DST amounts to a slip of about 107 km in the Arava Valley, comprised of two main phases. Recent re-evaluation of the Southern Arava based on compilation of all the seismic and gravity data coupled with water wells information generally agrees with previous studies, showing two main basins: Evrona Basin in the south and Yotvata Basin in the north. Yet, a modified setting of the main faults is suggested.
The Evrona Basin is bordered to the west by two main faults, Eilat and Evrona, that form down-stepping blocks. The Evrona Fault continues to the NNE across the international border while the Eilat Fault splays to the NNW and merge with the western boundary fault of the Yotvata Basin. This marks Yotvata as a spindle-shaped pull-apart basin, contrary to previously suggested rhomb-shaped basin, and might indicate a setting of underlapping master fault geometry. A notable implication of this is the absence of an E-W transverse fault at the southern end of this basin. Water well data indicate that those bottomed in the pre-rift strata are located to the west of the marginal faults, while those to the east are bottomed in the post-rift strata. This setting may imply on other basins in the DST. Unfortunately, none have been covered by 3D seismic surveys and the existing sparse data may impair exact configuration.
The Southern Arava is seismically less active than the Gulf of Eilat or the Dead Sea; currently, the few earthquakes in this segment during the past 50 years are of a magnitude of about 3 with average focal depth of 15 km. the suggested geometry may imply on predicting future activity.

Ben Moshe L. (1), Enzel Y. (2), Eyal H. (1,2), Dente E. (3), Lensky N. (1)
Increased deviation of the Dead Sea tributaries from steady-state and practical recommendations for infrastructure planning under such changing environment

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Alluvial channels are at a steady state when the sediment flux arriving to each point along the channel bed from upstream is equal to the flux leaving it downstream; i.e., there is no net incision or aggradation along the channel. At steady state, channel slopes depend mainly on water and sediment fluxes. When steeper slopes are imposed on channels, they will incise their unconsolidated sub-strata until reaching their respective steady-state slopes. Due to the forced Dead Sea (DS) regression, a steep bathymetry is emerged at tributary outlets into the DS and the channels exhibit extremely fast incision. This incision is accompanied by banks collapses, channel widening, and sinuosity modifications. Formation of sinkholes within few of the channels, and the draining of flood water into them, resulted in accelerated channels incision, additional bank collapses, and expansion of the sinkhole fields. Due to the continuous exposure of steeper-than-steady-state bathymetry, channels slopes and longitudinal profiles convexity increase, demonstrating substantial deviation from steady state. Practically, the channels are 'accumulating' potential incision and even its acceleration in the coming future. Therefore, incision will continue in the coming decades to centuries, even if the lake level will stabilize. The continuous incision poses a threat to

highway 90, which crosses the streams over culverts and bridges, or by ford crossings. These facilities should be adapted to the region's unique and fast changing conditions. Their planning cannot rely on the common approaches implemented in stable environments. We recommend that these facilities will be planned for a time span determined by the discrete deviation of each stream from its calculated steady state. Furthermore, we recommend incorporating protection facilities that will favor sediment accumulation in the channel that will promote a return to steady-state slope downstream of highway 90.

Ben-nun Levanon H. (1,2), Burg A. (2), Gavrieli I. (2), Bartov Y. (3), Livshitz Y. (4), Starinsky A. (1), Reznik I.J (2).
Saline groundwater in Mt. Scopus Group in the Southern Golan Heights: sources and geochemistry

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Water samples collected from deep research boreholes drilled into Mt. Scopus Group (Taqiye, Ghareb and Mishsah Formations) in the Southern Golan Heights were analyzed for various chemical and isotopic compositions. The water samples were found to have relatively high salinities (TDS of 6,000-20,000 ppm), low Na/Cl (<0.8) and Mg/Ca (<0.4) equivalent ratios, and a Ca-Chloride composition (Ca>(HCO3+SO4)). δ18OV-SMOW values are relatively depleted ~-7‰. This unique composition is suggested to be derived from mixing of at least two end-members: (a) Dead Sea Rift brines, which have originally evolved from seawater that transgressed into the Dead Sea Rift during the Pliocene and underwent evaporation, mineral precipitation and water-rock interactions; (b) Freshwater originating from recharge at higher altitudes.
Due to the large salinity differences between the two end-members, the ionic ratios are dictated by the brine. The low Mg/Ca ratios further imply that the brines that intruded the Mt. Scopus Group, were formed during the early evolutionary stage of the Dead Sea Rift (lagoonary stage), coeval to the precipitation of the Sedom Formation. The depleted isotopic composition of the groundwater suggests that the brines were since strongly diluted by freshwater that recharged at high altitudes (>1000 m), most likely on the Hermon Mountain in the north or on a similar elevated ridge in Syria. Further research is underway in order to determine the time sequence of these hydrological events and their relation to the regional geological history.

Ben-shalom R. (1) and Orion N. (1)
What is geoethics?

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אילו סטנדרטים אתיים צריכים להנחות את יחסי הגומלין של האנושות עם כדור הארץ? מהו התפקיד החברתי של מדעני כדה"א בהקשר זה, כאנשי מקצוע וכאזרחים? גיאואתיקה התפתחה כדי לענות על שאלות אלו. גיאואתיקה נובעת מהמודעות לכך שהאנושות משנה את המערכות הטבעיות שבהן היא פועלת וחיה וכי יש לקחת בחשבון בדחיפות פרספקטיבות אתיות לגבי האתגרים העומדים בפני האנושות - כגון הפחתת רמות זיהום, שימוש בר-קיימא באנרגיה ובמשאבי טבע, הגנה מפני מפגעים טבעיים וטיפול באיומים סביבתיים עולמיים. המושג גיאואתיקה משמש כמסגרת לכלל הנושאים וההתלבטויות האתיות הקשורות למחקר ולפרקטיקה בתחום מדעי כדה"א. כיום, הגיאואתיקה מוכרת יותר ויותר כנושא עולה ומתפתח במדעי כדה"א. קהילה גדלה והולכת של חוקרים, אנשי מקצוע ומוסדות עוסקת בשנים האחרונות בתהליך משותף שנועד לקבוע מהם הנושאים העיקריים של הגיאואתיקה על ידי הגדרת תכנים, מונחים, שיטות, כלים וחזון משותף. תהליך משותף זה כבר ייצר יסודות רעיוניים, מבוססים ומסגרת מתפתחת ליישום מעשי במגוון הולך וגדל של תחומי

מדעי כדה"א. גיאו-אתיקה עוסקת בהשלכות האתיות, החברתיות והתרבותיות של ההכשרה, המחקר והפרקטיקה במדעי כדה"א, וכן בתפקידם החברתי, ובאחריותם של העוסקים בתחום. התחום תורם להכוונת החוקרים והחברה כולה לבחירת התנהגות אחראית שתבטיח את עתיד האנושות על פני כדור הארץ. לפיכך, היא חשובה והכרחית בכל מקום שבו פעילות אנושית מתקשרת עם מערכת כדור הארץ. היא עשויה לעזור להגדיר מחדש התנהגויות, להגביר את המודעות האנושית לדרכי חיים חלופיות, ואף להוביל למודלים כלכליים חדשים של צמיחה והתפתחות. בתקופתנו מתחדדת ההכרה בחשיבות שיש לכך שאזרחים יכירו ויבינו מידע מדעי בנוגע לבעיות גלובליות (כגון שינויי אקלים, ניצול משאבים או דרכי הגנה על המגוון הביולוגי והגיאולוגי) ולסיכוני טבע באזורי מחייתם. לפיכך, זו אחריותם של מדעני כדה"א הן לתקשר ידע מדעי בצורה בהירה, שתהיה מובנת לציבור והן לשתף פעולה עם מקבלי ההחלטות. מקרה רעידת האדמה בלקווילה, (L'Aquilla , איטליה, 2009) ממחיש בצורה שאיננה משתמעת לשתי פנים את החשיבות שיש לתחום זה.

Ben-Yosef E. (1), Omri Yagel O. (1), Harlavan Y. (2), Seri H.(3), Lewinsky J.(3), and Ben-Dor Evian S. (3)
Pharaoh's copper: Using geochemistry to identify the source of copper of post-imperial Egypt (11th - 10th century BCE)

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To date, the only reliable method for identifying the geological source of the copper in copper-based artifacts is based on lead isotopes analysis (LIA). Although not without challenges, this method is commonly used in archaeological research to reconstruct ancient trade connections and track diachronic changes in the metal economy of a given society. Here we present results of research on Egyptian copper supply in the period that followed the collapse of the New Kingdom, when Egypt was no longer an empire. We analyzed the elemental and lead isotope composition of four bronze "shabti" statuettes from the Israel Museum, dated to the reign of Psusennes I (ca. 1056-1010 BCE, 21st Dynasty). The results indicate that these artifacts are based on copper from the Aravah. This observation strengthens other recent evidence for the important role of Timna Valley and Wadi Faynan in the global metal economy at the turn of the 1st millennium BCE - a much contested period in the archaeology of the region, as it is the time when, according to the Bible, ancient Israel emerged. In addition, we analyzed two other metal objects from the Israel Museum, dated to the 24th and 25th Dynasties (8th c. BCE). The results revealed a marked change in Egyptian copper metallurgy in both the composition (from Cu with traces of Sn to leaded copper with traces of As) and the supply chain (the Arabah ores are excluded). The large quantities of lead within these artifacts mask the lead signature of the copper, thus limiting the use of LIA to the identification of the geological origin of the lead itself. This issue and other methodological challenges, including the importance of establishing a shared, open-access database of pertinent chemical data, will also be discussed (cf., Ben-Yosef 2018, Provenancing Egyptian metals: A methodological comment. Journal of Archaeological Science 96: 208-215).

Beyth M. (1), Mushkin A. (1), Calvo R. (1)
A suggested correlation between the Neoproterozoic magmatic rocks of Mt. Timna and Mt. Amram

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The mountains of Amram and Timna are the most northern blocks of the exposed Arabian-Nubian Shield west of the Dead Sea Transform. Both blocks were exposed by Neogene-Quaternary uplift. The Amram Igneous Complex (AIC) is built of volcanic rhyolite with minor hypabyssal intrusions and the Timna Igneous Complex (TIC) is composed of a wide spectrum of plutonic rocks. Both complexes are intruded by rhyolite,

andesite and composite dykes. The TIC and AIC magmatic complexes are older than 580 Ma except for unique dolerite dykes, which intrude both complexes in an ~E-W orientation.
Two magmatic cycles were suggested for the igneous rocks of the AIC. The older of these cycles consisting of Alkali Granites and Amram Rhyolites was dated to 606 Ma. The TIC is characterized by a quasi-stratigraphic magmatic cell, with a wide spectrum of plutonic rocks from olivine-norite to A-type alkali granite, formed 610 Ma ago in an old I type 625 Ma granitic crust. The TIC was later intruded by younger 600 Ma quartz-monzodiorites.
The magmatic rocks of the AIC and TIC are shallow intrusions of mantle derived monzonite parent magma. The A-type alkali granite of the older cycle at both AIC and TIC are the feeder of the Amram Rhyolite. The quartz-monzodiorite of the TIC is the equivalent of the Monzonite and Quartz Syenite of the AIC, both enriched in xenoliths from the older cycles. More intensive pre-peneplain uplifting due to faulting and deeper erosion of the TIC may explain the missing Amram Rhyolite at the TIC and the magmatic cell and granite porphyry in the AIC exposure. The Zefunot E-W Fault separating between the northern and southern blocks of the AIC supports such peneplain uplift. This suggested correlation may contribute to the enigma regarding the characteristics of the northern most tip of the Arabian Nubian Shield.

Bialik O. M. (1), Bookman R. (1), Saar R. (2), Taha N. (2), and Antler G. (3)
Tropical storm induced disturbance of deep water porewater profiles, Gulf of Aqaba, March 2020

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Storms have long been recognized as a force that agitates sediments, even in deep water. Where in shallow water sediment mixing and transport is dominantly by wave actions, in deep water the impact is primarily by flows of suspended sediments. While such flow/transport events have been studied extensively sedimentologically, their impact of porewater chemistry is very poorly understood. The March 2020 tropical storm which impacted the Gulf of Aqaba (GoA) offered a unique aperture to investigate this particular topic and to present insights into seafloor process, with implication for understanding sedimentary records. Detailed sedimentological, mineralogical and porewater analyses were carried out on two sets of short cores collected on a transect from 270m to 700m water depth before (February) and after (July) the storm on the western margins of GoA. The sediment in all the cores was found to be composed primarily of quartz, feldspar, and biogenic carbonates. Following the storm in the summer, the fraction of quartz and feldspar increased on the expense of the calcite fraction. Grain size exhibit some difference before and after the storm, notably in the deepest location at 700m with a shift for larger grain size in the upper 1.5 cm of the core, which suggests an addition of courser material. 210Pb activities show similarities in the profiles with the exception of the mid-slope profile which exhibit a shift to higher activities in the upper 3 cm. Notably, in the winter core, the upper 2 cm present a near-constant activity whereas in July it exhibits a slope. Both Fe and NOx exhibited a marked shift in the aftermath of the storm. NOx concentrations increases in the top 5 cm of all the cores and the ferruginous zone shallowed in both the top and bottom of the slope. We postulate that the storm event remixed the top of the sediment column and infused it with fine material. This filled burrows and decreased the diffusive coefficient across the sediment-water interface, limiting the exchange of ions. As a results, the porewater trapped in the sediment had matured along the terminal electron acceptor chain.

Bialik O. M. (1), Samankassou E. (2); Meilijson, A. (3,4), Waldmann, N. D. (3); Steinberg J. (5) Karcz K. (6) and Makovsky, Y. (3,7)
Sea level and climatic forcing on the life cycle of short-lived early Cenomanian volcanic atolls of Mt. Carmel, northern Israel

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Volcanic atolls host exceptionally important marine ecosystems in the modern oceans. Yet, due to limited exposures, fossil atolls are poorly constrained. Multiple drowned Cretaceous volcanic atolls have been reported in the Pacific, but less information exists regarding those in the Tethys. Here we report on two early Cenomanian age volcanic atolls outcropping in Mt. Carmel, along the eastern Levant margin. These atolls are a few kilometres in diameter and differ significantly in facies from their surroundings, dominated by chalky calcareous mudstone and wackestone. The atolls are composed of grainstone, floatstone, rudstone and bafflestone facies, dominated by molluscans, notably gastropods, rudists, oysters and other bivalves. This assemblage is heterotropic with minimal protozoans such are Corals and green algae. The studied sections of these atolls display a full succession, beginning with aggradation and ending with drowning. Age constraints for the volcanic phases suggest that deposition occurred within a relatively short time interval (<1Myr) and the sequence represents a keep-up to give-up transition, within rising global and local sea-level trends. The heterotrophic assemblage and the inability of these atolls to keep-up with rising sea level is attributed here to a suppressed carbonate factory, either due to drowning, turbidity and/or nutrient excess. Local climatic forcing likely drove the suppressing conditions by strong storms, intensive waves and increased nutrient supply through regional weathering.

Bigio L. (1), and A. Angert (1).
Using phosphate oxygen isotopes to identify dust, pollen and ash, atmospheric-P sources

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Atmospheric aerosol deposition is a significant source of phosphorus (P) in many ecosystems worldwide. The Saharan desert is the major dust source on earth and it contributes atmospheric P to terrestrial ecosystems. In non-desert areas primary biological aerosol particles (including pollen), and particles emitted from wildfires and coal combustion are also an important source of P. Here we present the use of the oxygen stable isotopes in phosphate, δ^{18}OP, as a marker for the main atmospheric P sources. In addition, we evaluated the possible isotopic fractionations in desert dust sources, which could affect the soil δ^{18}OP before transport. The data from Israel desert soils demonstrated that biological activity in desert crusts can have a small effect on the δ^{18}OP of desert soils. However, biological crusts are not considered a major dust source, and Saharan dust sampled in Israel and Puerto Rico had a δ^{18}OP similar to apatite

minerals derived from sedimentary phosphorites, suggesting the dust source had little or no biological activity. Saharan dust storms sampled at Puerto Rico were found to have δ^{18}OP values in the resin fraction of (average ±SE) 22.5 ±0.3‰, similar to Saharan dust sampled in Israel. Furthermore, the δ^{18}OP in Saharan dust was distinctive from pollen (25.6 ±3.4‰,), and wildfire ash (15.5 ±0.4‰). Hence, the δ^{18}OP can be used as a marker for identifying atmospheric P sources and estimating its importance to the global P cycle.

Bookman R. (1), Mor-Federman T. (1), Herut B. (1,2), Harlavan Y. (3), Taha N. (1), Stein M. (3), Almogi-Labin A. (3)

Hydro-climate controls on the Nile Littoral Cell development during the Holocene

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The Nile Littoral Cell (NLC) sediments serve as a recorder for transport processes and provenance. Grain size distribution, chemical composition, and eNd and 87Sr/86Sr ratios together with marine derived variables analyzed from two radiocarbon-dated cores, represent the variations in the regional Saharan – Levantine hydroclimatic conditions in the past ~8.5 ka BP.
During the early Holocene (~ 8.5 to 5.5 ka cal BP), coarse sands from the Nile Delta were recycled along the NLC as a result of post glacial sea level rise. Fine fractions that accumulated in the Nile Valley and surrounding deserts during previous glacial arid periods were remobilized by increased runoff related to the African Humid Period (AHP) wetter conditions. For a short period at ~ 8.4 to 8.0 ka cal BP and in correspondence with the abrupt 8.2 ka cooling event, an increase in dust with pedogenic phases was recycled in sediments transported to the NLC. The termination of the AHP and the drying of the Ethiopian Highlands resulted in the increase of the basaltic Blue Nile signature. Sediments were supplied by the Nile, increasing water column productivity and creating a distinct mud belt along the NLC at water depth exceeding ~35 m. These trends differ considerably from those observed in the eastern Mediterranean deep water in association with sapropel S1.
In the past 2000 years, the decreasing intensity of the Nile flow and Levant aridification opened the way for higher relative contribution of aeolian detritus from the nearby lands, as reflected in the 87Sr/86Sr record. The southern core is affected by material derived from Nilotic sources, while the northern by inputs from surface cover of the nearby lands, e.g., mountain soils and desert losses. The coarsening of the upper most part of the record is a consequence of halting of the Nile seasonal flooding in the modern period.

Brokovich E. (1), and Nissim I. (1)

The second bi-annual update of the Offshore Oil and Gas Exploration and Production Strategic Environmental Assessment (SEA).

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With the conclusion of the Offshore Oil and Gas Exploration and Production Strategic Environmental Assessment (SEA) in 2016, it was recommended that a bi-annual update of the SEA is needed and will cover the sector's progress, knowledge gaps reduction and the establishment of a monitoring program for the deep sea. At the end of 2018 the first bi-annual report was published and here we elaborate on the second.

Since 2018 another license bidding process was finished and winners for three block groups were announced. Seismic surveys were performed in two blocks and one lease. Five wells were drilled in the Karish field, and the pipeline to shore was laid and awaits the arrival of the FPSO last quarter 2021. The Leviathan Platform started production at the end of 2019, Tamar platform went through a significant upgrade to reduce 98% of air emissions and the Meri-B subsea systems and wells are awaiting decommissioning. New exploration drilling are planned in a few blocks.
The SEA habitats map was updated recently with areas rich in pockmarks and with expansions in the Palmahim disturbance. More information at these areas awaits analysis.
The national monitoring program was established and currently 4 million NIS are invested each year by the ministries of Energy and Environmental Protection. About 1 Million NIS are invested each year in academic research to help close the knowledge gaps identified in the SEA. Additional research is based on the monitoring programs of the gas companies to understand the influence of different drilling methods on the environment and the subsequent required buffer zone from sensitive areas.

Bronshtein N. (1), Levi E. (1), and Mushkin A. (2).
Cavity detection using geophysical methods – feasibility study above a bell cave in the Beit-Guvrin region, central Israel.

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Cavity detection by geophysical methods presents a considerable challenge. In this work a multi-disciplinary feasibility survey was conducted above an archeological bell cave near Kibutz Beit-Guvrin in Central Israel. The objective was to test the detection capabilities and resolution of different geophysical methods.

The cave that was used for the survey is a bell-cave with 3 rooms excavated in Chalk bedrock capped by a thick layer of Nari. The cave can be easily accessed below a rock shelf and has 2 vertical shafts connecting the lower two room with the surface.
In order to accurately map the dimensions and subsurface extension of the cave a high-resolution, cm-scale LIDAR scan was acquired. The scan included seven different locations inside and above the cave that were merged to produce a full 3D rendition of the cave and the surface above.
The geophysical surveys conducted along a 96 m line, located above the deepest room of the cave, included Gravity, Frequency Domain Electro Magnetic (FEDM), Electrical Resistance Tomography (ERT) and Seismic Refraction/Reflection methods.
The gravity method showed the most significant anomaly overlapping the cave location whereas the ERT method detected the cave but with a less indicative anomaly. The results of the other methods did not yield sufficient indication using conventional processing.
Future work will include 3D gravity and ERT surveys in order to fully explore feasible detection resolutions. Other processing approaches will also be examined to improve detection with all other methods.

Chaldekas O. (1), Vaks A. (2), Haviv I. (2), Gerdes, A. (3,4), and Albert R. (3,4)
Major ~6 Ma uplift phase along the western margin of Dead Sea Transform as revealed by U-Pb geochronology of speleothems

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The timing of vertical motions adjacent to the Dead Sea Transform (DST) plate boundary separating the Arabian plate from the Sinai sub-plate is not yet firmly established. We utilize LA-ICP-MS U-Pb geochronology of phreatic and vadose carbonate cave deposits (speleothems) to constrain paleo-groundwater levels along the western margin of the DST and provide a proxy for the timing of large-scale incision and tectonic uplift. Phreatic speleothems (mammillaries and cave rafts) form when caves are located at, or slightly below the groundwater level. When the caves are tectonically uplifted above the groundwater table or canyon incision causes groundwater level to decrease, deposition of phreatic speleothems stops and vadose speleothems (stalagmites, stalactites and flowstone) grow instead. Permanent transition between phreatic and vadose speleothems can therefore reflect tectonic or geomorphic events.
Hundred-two U-Pb ages were obtained from 35 speleothems from three sites across a 150 km long north-to-south transect. Age constraints from all three locations indicate that phreatic deposition began at ~14-9 Ma and ended around 6 Ma. In contrast, vadose speleothems continued to grow intermittently from 6 Ma till Late Quaternary. These results suggest the groundwater levels decreased abruptly at ~6 Ma and didn't flood the caves again. About 150-200 m of incision took place along the Soreq Valley and the Meyshar canyon during this period.
We associate the lack of post 6 Ma phreatic speleothems with enhanced river incision, driven by uplift and folding of the western margin of the DST, as an inland morpho-tectonic base level formed in the Dead Sea area. This timing corresponds with a change in the Euler pole, which describes the movement of the plates along the Dead Sea fault. The quasi-uniform growth period of the phreatic speleothems suggests relatively stable groundwater levels between 14-9 to 6 Ma with limited vertical tectonic movements during this period.

Coddington J. (1), and Ben-David R. (1)
Shallow Shazar Tunnels Cross section Summary of geological findings as a tool for Continuous engineering design

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Since 2016 until 2019 Roved Geology carried out sequential reporting of the geological section throughout the tunneling process of the Shazar Tunnels. These 2 tunnels span over 250 meters in length, 20 meters in width and ~30 meters high. The top of these tunnels was excavated 6-10 m below the Shazar Boulevard (Jerusalem entrance). A continuous reporting of the geological conditions implemented the Q-Barton grading system. An online system of communication with the tunnel engineers was carried out to enable engineers to update tunnel support, especially on weathered areas.
Geology – the entire Project area is located within the Weradim Fm. which is composed primarily of dolomite and dolomitic-limestone. The layer inclinations are sub-horizontal with a slight southwesterly orientation.
Weathering - Heterogeneous artificial filling is commonly found at the surface with a thickness reaching several meters. Below the artificial fill a thin clayey Terra Rosa type soil is commonly found, with a distinct shift to intact rock after 1-3 meters. The rock is usually weathered at the top of the section and gradually improves with depth. Numerous small to medium sized cavities were identified while excavating, but also 3-4 large cavities of volume ranging 150-900 m3, were detected.
Methodology –
a. Grading of the exposed faces according to the Q-Barton rock mass grading system.

b. online report to tunneling engineers enables to provide immediate support solutions in case of varying rock mass conditions
c. The grade given to a section was affected by proximity to junctions or portals resulting with lowering of the Q grade by X2 or X3.
Main Conclusion - The karst phenomena causes abrupt changes in rock mass quality. This requires fast reaction both by the onsite geologists and by the engineers to minimize risks, prevent loss of time on the excavation advancement and tunnel support.

Cohen A. (1), Abramovich S. (1), Hyams-Kaphzan O. (2), Almogi-Labin A. (2) and Teutsch N. (2).
Tracking anthropocene signals in the Eastern Mediterranean using benthic foraminifera

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The Anthropocene footprint is particularly prominent in Mediterranean coast of Israel that has been exposed to rapid changes due to human actions. Among these, are: 1. The clear rise in sea surface temperatures (SST), particularly since the 80's, which is part of the global warming, 2. The damming of the Nile River, the main siliciclastic sediment supplier in our region until ~55 years ago, 3. The opening of the Suez Canal since 1869, that allowed mainly a unidirectional migration of Indo-Pacific organisms into the Mediterranean (i.e. the Lessepsian invasion) and 4. The increase in using marine resources off the Israeli coast.
In this study we used the geochemical signatures of foraminiferal shells and their assemblages composition as proxies for the footprint of the extent and the effects of Anthropocene in the in Mediterranean coast of Israel. Our study was based on a short core (25 cm) that was sampled in 2009 off Bustan HaGalil (Northern Israel) at 36 m water depth. Previous 210Pb dating of this core, up to 7 cm, indicates oldest age 1879 and an average sedimentation rate of 0.05 cm y−. Age extrapolation of the rest of the core suggest that it spans the last 500 years. Previous geochemical analyses of this core indicate a clear Anthropocene signals as revealed by peak in Hg concentrations at 1990 (2 cm), and substantial increase in the CaCO3 content from 20% to 80% at the top 10 cm of the core. Nearly 180 different genera and species of benthic foraminifera were identified in the studied core. The most distinct faunal pattern observed in this core is the gradual increase in species richness per depth (from ~50 to ~100), during the last ~200 years, but particularly since 1950's. This This increase cannot be solely attributes to the Lessepsian invasion since only two species are recognized as true Lessepsian. On the other hand, statistical analyses of the assemblages did not reveal a significant correlation with depths, indicating that the foraminiferal abundances were quite homogenous throughout the core. Geochemical proxies of the one of the dominant species A. beccarii, revealed several trends: Mg/Ca, Sr/Ca, Ba/Ca and Mn/Ca shows an increase trend toward the present, while traces as Cd/Ca, Co/Ca, Cu/Ca and U/Ca show higher ratios at deeper parts of the core, probably due to both the damming of the Nile and the construction of marine structures along the southeastern Mediterranean coasts. The δ18O and δ13C values reported in this study spread on a range of ~1.0‰, between -0.64‰ and 0.34‰, and ~5.0‰, between -3.46‰ and 1.53‰, respectively, with a minimum value at a depth of 20 cm (~ year 1620), which clearly captures the end of the distinct global cold climatic event, the Little Ice Age (LIA). All the mentioned findings reflect an ecologically stable environment at Bustan-HaGalil core area, at the last 500 years, which can be used as a reference site to subsequent studies.

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A new method for rapid evaluation of organic and pyritic sulfur content and $\delta^{34}S$ values in petroleum Source Rocks

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The evaluation of sulfur (S) concentration and isotopic ratio ($\delta^{34}S$) of pyrite-S and organic-S in petroleum source rocks has many geochemical applications. For example, organic-S concentration affects organic matter (OM) preservation by forming S cross-linkages between sedimentary organic compounds. The $\delta^{34}S$ values of pyrite is a proxy of the depositional environment and its redox state. Further, when organic-rich rock is buried and exposed to thermal stress (catagenesis), S affects the hydrocarbon (oil and gas) generation kinetics. $d^{34}S$ values are also used for oil-oil and oil-source rock correlations. Therefore, S provides essential information about depositional environments and petroleum systems' potential. In this study, we developed a methodology that enables rapid (one hour) analysis of organic-S and pyritic-S concentrations and $\delta^{34}S$ values by coupling a new Rock-Eval model (RE-7S) to a MC-ICPMS. Until recently, measurement of $\delta^{34}S$ and S concentrations in OM and pyrite required a stepwise labor-intensive wet chemistry procedure. Our new method allows the production of data simply and rapidly, thus extending measurement resolution (e.g., increasing the sampling in a geological depth profile or cross-section). Furthermore, the instruments' high sensitivity relative to the wet chemistry technique stretches the measurement capability in S-lean source rocks that were rarely analyzed before. Indeed, we applied the method on various suite of source rocks representing a broad spectrum of natural heterogeneity and S concentrations. For example, the samples vary in their mineralogy (e.g., carbonate, silicate), type of OM (Type I, II, and II-S), and ages (from late Devonian to Eocene). Our new method can enhance source rock evaluation and their link to petroleum systems.

Czas J. (1), Navon O. (1) and Weiss Y. (1)
CO_2 in brown diamonds from Colorado

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Diamond formation has long been attributed to mantle metasomatism, an open system interaction of mantle rocks with CHO-rich melts/fluids that percolate through them. In the most prominent model diamond crystallisation is linked to redox reactions between wall rocks and CHO fluids, involving either reduction of carbonates or oxidation of carbohydrates. While solid CO2 inclusions in diamonds were previously described, their nature and formation mechanism are still unknown. In this study we investigate diamonds from the George Creek and the Sloan kimberlites in the Colorado-Wyoming State Line district, USA. The diamond colours range from red/brown-yellow to colourless and often show complex patterns of intergrowth between the colours. Twenty coloured diamonds were selected for this study. Polished diamond slices were analysed via infrared spectroscopy. These diamonds typically contain low to no detectable nitrogen (often a common impurity in diamond). Absorption related to CO2 (dominant peaks at 2376 and 650 cm-1) is observed in all diamonds, with absorption intensity closely linked to the intensity of the diamond colour. No such absorption was found in the colourless zones of the diamonds. To further investigate the nature of CO2, the diamonds were examined via transmission electron microscopy. We identified small (1-15 nm) inclusions, which are either randomly distributed

within the diamond, form inclusions tracks, or are associated with dislocation loops. Qualitative compositions of inclusions were obtained using electron dispersive spectroscopy, they carry mainly oxygen, most probably as CO2, but also nitrogen and sulphur. Oxygen and nitrogen typically occur together, while sulphur is in distinct zones within the inclusion.
Pure CO2 is reactive in the mantle and calls for unique circumstances. An alternative to trapping, is forming the inclusions by exsolution of oxygen and nitrogen. Understanding the nature of the inclusions will provide valuable insight into diamond formation and the deep carbon cycle.

Dagan I. (1,2), Cohen E. (1), Peled A. (1), Bar-Nes G. (1,2)
Development of sustainable building materials based on industrial waste and quarrying materials

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The concrete industry is known to leave an enormous environmental footprint on planet earth due to the vast amount of natural resources needed to produce billion tons of concrete each year and the massive emissions of carbon dioxide involved. Therefore, the development of supplementary sustainable materials partially or fully replacing the Ordinary Portland Cement (OPC) is essential. Using waste-based materials to replace OPC not only reduces the costs and energy required for the production processes but offers an additional environmental benefit by reducing the waste disposal volumes and overall ecological hazard involved. Therefore, this approach would also provide an efficient, green disposal path for quarry or industrial waste, which currently poses an environmental problem.
This lecture will present several studies aiming at the development of building materials using waste materials and quarrying waste.
The effects of the addition of dolomite-based quarry-dust (QD) waste material as a filler in CEM-I and FA-based geopolymeric mixtures were studied. This study showed that unused QD may be integrated at high replacement rates (up to 40% by weight) in both CEM-I and FA-based systems, showing good and, in some cases, even significant improvement in their engineering properties. Nevertheless, the vulnerability of these QD containing products to acidic conditions must be carefully considered.
An additional approach was the use local oil shale ash (PAMA Ltd, Israel) as a main component in the development of novel, valuable, building materials. Oil shale ash (OSA) is rich in calcium content and therefore possesses self-cementing properties. Local OSA and OPC were used alone or combined (80%wt OSA + 20%wt OPC) to prepare paste samples. The highest compressive strength was obtained for the OSA + OPC admixture with values of 26.3 ± 0.6 MPa, emphasizing the high potential of OSA to be utilize as a new sustainable building material.

Dahan O. (1)
Vadose Zone Monitoring as a Key to Groundwater Protection

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Currently, monitoring programs designed for groundwater protection are mainly based on information from observation wells. This, however, creates a paradox, since identification of pollution in well water is clear evidence that the groundwater is already polluted. The poor state of contaminated aquifers all over the world, and the inability, in practice, to fully remediate contaminated aquifers suggest that groundwater monitoring alone has failed to provide the vital information required to prevent

groundwater pollution. That said, groundwater pollution initiates on the land surface, and the contaminants have to traverse the unsaturated zone, long before reaching the water table. Therefore, monitoring programs that can provide real-time information on the hydraulic and chemical state of the unsaturated zone are essential for achieving early warnings of pollution potential and providing imperative protection from pollution hazards.
Currently, most of the commercially available monitoring technologies are rather limited in their capability to provide early alerts of pollution processes taking place deep in the unsaturated zone, above the water table. Accordingly, monitoring technologies for the unsaturated zone have to be engineered as "off-the-shelf" commercial products, made available for application by practitioners in all fields of hydrology. From scientific and technological points of view, such ambitions are not out of reach. Yet they require an urgent call for a revolutionary shift in monitoring focus, from the groundwater itself to the unsaturated zone above it.

Dalal S. (1,2,3), Stein M. (2,3), Bookman R. (1), and Lazar B. (2)
Mechanisms of ^{234}U enrichment in waters of carbonate terrains - Dead Sea watershed

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The isotopic activity ratio 234U/238U in groundwater and runoff is controlled by various processes such as: water-rock interaction, dissolution and precipitation mechanisms, α-recoil processes and mixing of various water types. Our aim is to describe and formulate the processes that dictate the 234U/238U activity ratios in the waters from the Dead Sea watershed. To achieve our goal, one dimension steady state-advective transport model for 234U and 238U was conducted, supposing the retardation factor is only related to the precipitation of uranium-carbonate complexes. We sampled and analyzed various spring waters, from Dan springs that discharge Mt. Hermon to Ein Gedi saline springs discharging the Judea Mt aquifers, and runoff waters over the Judea Mt.
U concentrations ranged between 2·10-4 mg·L-1 and 1·10-4 mg·L-1 and 234U/238U activity ratios ranged between 1.8 and 1.1 in Dan spring and Ein Gedi saline waters, respectively. The high 234U/238U ratios are observed mainly in low TDS low-U waters. Waters with higher U content have generally TDS above several hundred mg·L 1. Such waters, collected from different carbonate terrains, follow an excellent linear trend of 234U=1.4·238U (r2=0.99, isotope concentrations in activity units).
The results suggest that 234U enrichment in waters in carbonate aquifers, is controlled either by direct α-recoil mechanism, in low TDS waters, or by the interaction between the groundwater and aquifer's rocks (weathering) in high TDS groundwater. Furthermore, it is possible that the rather uniform 234U/238U activity ratio in high TDS waters may indicate that 1.4 is a steady-state activity ratio for the water/rock interaction mechanism for waters flowing through carbonate rocks.

Darvasi Y. (1)
Shear-wave velocity measurements and their uncertainties at six industrial sites

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This study assesses the variability in determinations of shear-wave (VS) profiles for a suite of methods made at six industrial sites. The methods include active (multi-channel analysis of surface waves - MASW), as well as passive (refraction microtremor - ReMi) and extended spatial autocorrelation - ESAC). The purpose is to ascertain the effect of the higher level of ambient noise on the results obtained by the different methods, as only a few of these many methods are commonly used for site characterization. The measured dispersion curves are in fair mutual agreement. The percentage ratio of the standard deviation to the mean (the average coefficient of variation) for the dispersion curves varied from 2.5% to 12.6%. In contrast, over the VS - depth domain, the average shear-wave velocity profiles to a depth z (VS,Z) vary from 11.6% to 16.5% among the various methods at the different sites. This indicates that the variance among the individual methods can lead to significant misinterpretation of the shallow subsurface, while the average VS,Z is much more robust. This reaffirms its use (mainly as VS,30) in building codes and within ground motion prediction equations (GMPE). Our study focused on surface-wave measurements in noisy industrial environments, where the signals processed are typically complex. Despite this complexity, our results suggest that such tests are also applicable to industrial zones, where the noisy environment constitutes an energy source.

Darvasi Y. (1) Laugomer B. (2), Shicht I. (2), and Agnon A. (1).
Accessible remote sensing techniques for geo-archaeological research

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2. Enso ltd.

The Roman theater in Tiberias is a well-preserved relic of the period and as such, is a promising venue for demonstrating archaeo-informatics research. A geological fault runs through the theater, offsetting and tilting structural elements in several locations. A Moslem neighborhood constructed above the demolished theatre has been dated Abbasid to Fatimid. This has been taken as evidence that an earthquake destroyed the theatre during the mid-8th century. The theater is thus an exceptional site for demonstrating geo-archaeology studies as well.
The research presented is conducted by the Neev center for geoinfomatics at the Hebrew University of Jerusalem in collaboration with Enso – a small company founded by two geologists. We set out to test the use of accessible and fast remote sensing techniques for surveying deformations at archaeological sites. To achieve this goal, two mutually complementing technologies are simultaneously used. A handheld LiDAR (Light Detection and Ranging) system is used to scan the site and produce a 3D point cloud, while a UAV (Unmanned Aerial Vehicle - or drone) is used to create a colored 3D model of the site. Both datasets are georeferenced using the same ground control points and the same GPS RTK system. The resulting level of precision is very high - under 3 cm. The simultaneous use of the two co-registered datasets allows for a high degree of spatial context. Measurements of architectural elements under vegetation, including cavities that continue into the subsurface, open a world of possibilities. The use of the aforementioned technologies is enticing as they make accessible (both logistically and financially) spatial datasets of high resolution and relative accuracies of under 3 cm.

Darvasi Y. (1), Agnon A. (1), Wechsler N. (1), Buzaglo Y.A. (2), Shiran A. (3), and Alexander C. (3)
Integrated geophysical research for structural mapping and micro-zonation – A case study at Margaliot fault, Kiryat Shmona

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2. Terralog Innovation ltd.
3. Amos Shiran ltd.

Planning construction over a steep slope associated with suspected fault activity requires a high spatial definition of fault strands. Following indications for a previously undetected fault, and in order to map the south section of Margaliot fault in better resolution, we acquired and integrated geophysical and geoengineering data sets. The main objectiveswere to determine a more accurate location for the Margaliot fault and to uncover the activity of this segment. Due to the proximity of the segment to the city of Kiryat Shmona,it is desired to study it as a probable source of geological and seismic hazard.
Margaliot fault extends from west of Kiryat Shmona to east of Margaliot village. It then curves north to parallel the Rom fault, the source of the earthquake that devastated the region 1/1837. Hence, Margaliot fault is one of the significant sources of seismic hazard in northern Israel. According to the geological map, in the area of interest the fault crosses mostly colluvial talus and shallow-seated landslides. To locate and map the fault at the subsurface, we used the standard geophysical methods. These include seismic refraction, seismic downhole, multi analysis of surface waves (MASW), refraction microtremor (ReMi), horizontal-to-vertical spectral ratio (HVSR), boreholes, and paleoseismic trenches. In addition to the more common methods, we acquired data using two innovative methods: structural magnetic mapping with a drone and trapped seismic waves. These methods are particularly advantageous for the high definition fault mapping is required and given the steep slopes encountered. The integrated results lead to a more accurate fault map of this area and reveal a secondary fault branch oblique to the main one. According to clay sliding surfaces found in the paleoseismic trenches, the secondary fault may have been active recently, although we could not detect surface expression of offset.

Darvasi Y. (1), Shicht I. (2), Laugomer B. (2), Ryb U. (1), Agnon A.(1)
The role of laterally propagating crevices in the process of land sliding: Capturing field data by drone-borne LiDAR and photogrammetry

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Gravity sliding is ubiquitous process where slopes are high and discontinuities control rock strength. Mutual interlocking of discontinuous rock masses maintains slope stability. If the growth of a crevice at the head of an incipient slide is lateral, then the sliding mass loads the crevice tip that in turn propagates to increase the load. This allows a single crevice to grow and release the interlocking that has maintained stability.
Such an instability mechanism seems to act on a landslide that we recently discovered outside Jerusalem. We have surveyed the slide from drone and ground by LiDAR and photogrammetry. The two datasets were co-registered (RTK GPS), allowing nominal precision and accuracy of <5 cm. One critical advantage of the LiDAR method is its ability to penetrate vegetation. This allows sampling points on soil, giving direct information on earth movements.
The slide spans over 300 x 70 m2 and the natural slope ranges 30-40°. While the decollement develops over the marine Cretaceous Moza Formation, the sliding mass is a chaotic amalgamation of carbonatic fragments, showing size up to several meters across. The fragments were derived from the Aminadav Formation that elsewhere conformably overlies Moza Formation. We interpret this to indicate that the slide is rejuvenating an older slide that formed during the incision of the topography several hundred thousands years ago, similarly to numerous sites on the Judean Hills. This slide was triggered by road excavations during the mid 1990’s.

We have discovered a 120 meters long crevice, with a meter scale aperture. The active crevice is circa 20 meters behind the scar at the head of the slide. Once the crack propagates the entire span of the slide, the next phase of downhill transport is ready to commence. Repeating surveys will permit monitoring of cervace and slide development.

Dembo N. (1), Hamiel Y. (2), Granot R. (1)
Mechanical contrast and asymmetric distribution of crustal deformation across the northern Dead Sea fault system

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2. Geological Survey of Israel, 32 Yesha'ayahu Leibowitz, Jerusalem, Israel

The distribution of permanent deformation near strike-slip plate boundaries and the underlying controlling variables are commonly poorly understood. Here we examine the crustal deformation across the northern Dead Sea fault system based on paleomagnetic observations and mechanical modeling. We focus our investigation on the region of the Lebanese restraining bend where the fault system strikes obliquely to the general Sinai-Arabia plate motion. We construct a series of crustal elasto-plastic models in which kinematics is based on geodetic measurements, and the geometry of the plate boundary is constrained by gravity data. Both the observed regional vertical axis rotations and the model results display significant counterclockwise rotations (as much as ~50°) confined to the northern Sinai microplate located west of the bend. On the other hand, relatively minor rotations (<~10°) are displayed for the adjacent Arabian plate. Our results, validated by structural evidence, suggest that the northern Sinai microplate is mechanically weaker than the adjacent crust of the Arabian plate. This mechanical contrast, along with the oblique convergence and change of slip rate along the Dead Sea fault system, is required to simulate the observed rotations. We propose that the crustal mechanical contrast across plate boundaries is a key parameter responsible for the distribution pattern of permanent vertical axis rotations.

Dente E. (1), Katz O. (1), Crouvi O. (1), and Mushkin A. (1)
The Geomorphic Effectiveness of Landslides

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Landslides are key drivers of landscape evolution and have a major impact on natural hazards in areas of steep topography, such as mountains, valleys, and coastal cliffs. Whereas previous studies focused on the statistical probability of landslides, their geomorphic impact (i.e. effectiveness) on the evolution of the landscape was rarely quantified. Here, we suggest a new framework for examining the geomorphic effectiveness (GE) of landslides, based on the common analysis of the sedimentary impact of fluvial processes. Focusing on an extensive inventory of ~1100 cliff-collapse events (documented with airborne LiDAR) that occurred between 2014-2019 along Israel's 30-km-long Sharon coastal cliff in the Eastern Mediterranean, we found that the accumulated erosion volume of the largest (10^3-10^4 m^3) and rarest collapses is similar to the accumulated erosion volume of the more common mid-range collapses (10^2-10^3 m^3). The small (<102 m3) most probable and frequent collapses along the cliff account for only a few percent of the total eroded cliff volume, i.e., they have negligible GE. We applied this approach on global (and one Martian) landslide inventories and found that landslides triggered by rain tend to be controlled by large deep-seated slides that strongly skew their GE peak towards the largest and rarest magnitude events. In landslide inventories where rain or groundwater seepage were not dominant

factors, the GE is typically controlled by more common mid-range shallow slides. We propose that GE analysis is essential for better understanding the impact of landslides on landscape evolution under various triggers and can help improve hazard mitigation efforts.

Dutta S. (1,2), Chattopadhyay D. (3)
Response of shallow marine bivalve fauna to climatic and tectonic shifts: Insights from Oligocene – Early Miocene shellbeds of Kutch, India

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With the high rate of continuing extinction, identification of environmental stressors and their impact on organisms becomes crucial. Studying recent ecosystems provide a short-term perspective on such ongoing interaction but due to the unprecedented rise in anthropogenic activities, predicting the future of marine ecosystem becomes uncertain. Investigating fossil records allows us to establish a natural baseline for environmental and ecological change on a long-term scale which is crucial for developing such predicting models. Among different environment, tropical shallow-water habitats are extremely important because of characteristic high biodiversity and vulnerability to climate change. Hence, examining the response of the coastal ecosystem to global climate change is crucial and demands immediate attention. In this study, we utilized a ~9 million year-long coastal fossil record of the Oligocene -Early Miocene shellbeds of Kutch, Western India to examine the: 1) regional nature of climatic conditions and 2) paleoecological changes in the bivalve community (if any) in response to various global level paleoenvironmental and paleogeographical changes. The marine successions of Kutch basin are represented by three formations—Maniyara Fort (Chattian), Khari Nadi (Aquitanian) and Chhasra (Burdigalian) spanning Oligocene -Early Miocene. Stable isotope (δ18O) and trace metal (Mg/Ca) compositions indicate a post-Aquitanian decrease in (a) salinity and (b) salinity difference between two species from different depths in the water column with time. Additionally, decrease in TOC and δ13COM and disappearance of coral and associated faunal assemblages indicates an increase in terrigenous input in the marine system after 20 My and corresponds to the onset of strengthening of southeast Asian monsoon system. Except the freshwater influx, other environmental parameters remained stable throughout the stratigraphy of Oligocene -Early Miocene of Kutch. The bivalve faunal structure and composition remained stable throughout this period as well implying limited effect of global climatic and tectonic events on the tropical marine system.

Dutta S. (1,2), Saar R. (2), Lavie Z. (1), Vered G. (2,3), Antler G. (1,2)
A method for in situ collection of pore water in coastal environments

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Coastal environments accounts for 50% of earth's total carbon transfer to marine sediment. The top part within the sediment column just below the sediment – water interface accounts for high chemical and biological reaction which immensely influences the carbon and other elemental cycle in the ocean. These reactions influence the chemical composition of the sediment and pore water. Due to relatively larger

grain size of the sediment in some coastal environments, sediment mixes quickly making collection of pore water extremely difficult. Here, we present a simple method utilizing rhizon samplers to collect in situ pore water from coastal environments from the Gulf of Aqaba, Red Sea. We conducted a tracer experiment to assess the overlying water contamination and demonstrate the threshold amount of sample to be collected. We present two case studies where we measured: (1) the iron concentration of pore water and observed peaks wherever the sediment was red in appearance and (2) the change in alkalinity and concentration of phosphate, ammonium and nitrate with time for seagrass meadows. Each study demonstrates the expected trend in geochemical signature changes in pore water and hence independently validate the rhizon sampler method for collecting pore water from marine sediments. Therefore, we suggest that at a nascent stage, the rhizon sampler method demonstrates high potential for easy collection of pore water for various geochemical studies.

Elad M. (1,2), Hartman G. (2), Cronin B.T. (3), Agnon A. (4), Makovsky Y. (1,5)
Turbidity current interaction with a polygonal fault system: a mechanism for intra-slope sand entrapment

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Turbidity currents and their associated depositional products (turbidites) are sensitive to seafloor topography. Numerous fine-grained continental slopes and basin-floor environments worldwide are host to polygonal fault systems (PFSs), which can significantly alter the seafloor topography. PFSs usually form extensive arrays of non-tectonic normal faults that stretch out over vast areas. Despite the abundance of these fault systems, very little is known about their impact on the sediment gravity flow part of deep-water depositional systems. The current study addresses this interaction, aiming to identify the influence of PFSs on: (1) formation of intra-slope accommodation space and local gradient changes, (2) establishment of preferential turbidity current pathways, and (3) the architecture of slope turbidite systems.
We use a high-quality 3D seismic dataset covering an area of ~3320 km2, above the western Demerara Rise margin, offshore Suriname. The Demerara Rise is a prominent submarine plateau characterized by high relief, which has long generated subaqueous sediment gravity flows. We focus on two stratigraphic intervals within the Neogene clastic sequence. The younger interval is characterized by slope failures that gradually transitioned downslope into turbidity currents. Using seismic attribute analysis, we delineate the architectural elements of this turbidite system and demonstrate that it is clearly affected by the intra-channel faults. High amplitude anomalies, likely associated with coarser grained sediment, terminate abruptly against these faults, thus indicating sand-prone ponding on the updip flanks of the faults. Moreover, we show that the coarser sediments bypass the fault laterally where the fault-throw is sufficiently small. The older system shows the narrowing of the primary fairway, and a lateral shift of secondary pathways in response to the barrier faults. Our findings imply that PFSs can significantly constrain the presence and stratigraphic configuration of sand-prone turbidites in slope settings, and therefore must be taken into consideration in deep-water exploration activities.

Elazar O. (1), and Weiss Y. (1)

Extension tectonics and mantle metasomatism in the North Atlantic Craton mirrored in diamond microinclusions.

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More than 800 kimberlite bodies are known in Canada. Among these >70 kimberlites were recently discovered at Chidliak, a new diamond district on the Hall Peninsula of southern Baffin Island, Nunavut. Here we report the compositional variation of high-density supercritical fluids (HDFs) in a suite of diamonds from the ~142 Ma Chidliak CH-7 kimberlite pipe. The HDF composition of all diamonds fall within the silicic to low-Mg carbonatitic array, attributed to eclogitic paragenesis. However, we distinguish between three main diamond populations based on color, nitrogen aggregation states and HDF chemistry: 'Group IaA' diamonds are translucent with cubic morphology, carry nitrogen solely in A-centers and contain low-Mg carbonatitic compositions; 'Group IaAB' have gray hue, nitrogen in A- and B-centers (with %B≈15) and silicic to low-Mg carbonatite HDFs; and 'Group Ib/IaA' with yellow color, nitrogen in A- and C-centers (%C≈10-20%) and silicic HDF compositions. These differences between the three populations of diamonds indicate formation during different metasomatic events, which we correlate with various lithospheric extension episodes since the Proterozoic. Based on major and trace element similarities, we suggest a genetic link between the formation of Group IaAB to old metasomatism relating to olivine lamproites volcanism ca. 1400 Ma. The event in which Group Ia/A diamonds is less constrained and might be related to aillikites/carbonatites volcanism (590–555 Ma). Group Ib/IaA are related to a young metasomatic event based on the presence of C-centers, temporally related to the kimberlite eruptions between 139-157 Ma. The Type Ib/IaA silicic HDFs may account for phlogopite modal metasomatism which is linked observed seismic anomalies. Our new data reveal three distinct metasomatic episodes in the North Atlantic craton.

Elhadad A. (1), Vapnik Y.(1), Elisha B.(1), Golan T.(1), and Katzir Y.(1)
The timing and setting of copper mineralization in the Timna Igneous Complex: Fluid Inclusions and thermochronological evidence

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The scarce copper mineralization, hosted by felsic to intermediate rocks in the Timna igneous complex, comprises chalcocite and covellite, altered to malachite, atacamite and chrysocolla. The Cu-sulfides are thought to have been precipitated from relatively low-temperature (150-170°C) hydrothermal fluids, followed by hydrous alteration involving copper remobilization. The origin of the mineralizing solutions is unclear, having been derived from either hydrothermal-magmatic, sedimentary, or mixed fluids. Our field and petrographic observations show that sulfides occur as chalcocite-covellite lamellae, engulfed by green copper hydrates, replacing feldspar phenocrysts. Copper mineralization also fills voids, either pockets or veinlets, and coexists with surprisingly large (100-500ɥm) barite, zircon and rutile crystals. Microthermometric study of Fluid Inclusions (FI) reveals two main fluid types as affiliates to copper mineralization: (1) secondary FI assemblage emanating from phenocryst-copper veinlet interfaces and primary inclusions in secondary quartz, both characterized by low salinity of 0-11 wt%. NaCl and low to moderate homogenization temperatures (Th) of 115-256°C and (2) pseudo-secondary assemblages containing an immiscible fluid pair, comprising a relatively high salinity 30-35 wt%. NaCl fluid trapped at 130-270°C, and a low density CO_2-rich inclusions with overlapping, 260-327° C, Th range. U-Pb ages of gangue zircon and rutile are 610±5 and 605±6 Ma, respectively, in agreement with previously determined magmatic crystallization ages of the Timna alkaline plutons . U-Th/He rutile, zircon and apatite

ages indicate cooling below ~260°C at 609±26 Ma, ~170°C at 400-300 Ma and ~90°C at 10-11 Ma, respectively. This suggests that early mineralization was triggered by fluid immiscibility of a hydrothermal-magmatic fluid, followed by several hydrothermal events, resetting lower-temperature He chronometers. These late events also caused radiogenic Pb-loss and common Pb contamination in zircon. Measurement of $\delta^{34}S$ in copper sulfides using SIMS, along with laser-ablation analysis of the immiscible fluid pair inclusions, will shed light on the origin of the ore-bearing fluids.

Eliezri I. (1) and Flexer A. (1)
The Ramat Hasharon Geological Museum

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The Ramat Hasharon is the only museum in Israel dedicated to the field of Geology and Earth Science. The Museum's main purpose is to expose the public to geological knowledge and stimulate curiosity and enthusiasm about nature and science.
The Museum's activity concentrate on three layers:
1. The Museum's permanent display - a display of high-quality diverse minerals from around the world. The permanent display is intended for professionals and visitors and is enhanced by the training provided on-site.
2.Temporary exhibitions concentrating mainly on art and design in topics related to geology, nature, environment, minerals, and gems.
3. Cultural and educational activities: guided tours of the museum intended for teachers, schools and educational institutions, activities for families on weekends, special events related to geology and nature, activities with school children during vocations, lectures directed to the public, gallery talks, etc.

Eliyahu-Behar A. (1,2), Yahalom-Mack N. (3), Stepanov I. (1), and Brauns M. (2)
Osmium isotope analysis as an innovative tool for provenancing ancient iron-based metals

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The transition from bronze to iron use is one of the most intriguing technological developments in human evolution. In the Levant this started at the end of the late Bronze Age and culminated during the Iron Age. However, despite the growing number of archeometallurgical research over the past few decades, the question of provenance remains unanswered.
In general, the provenancing of metals heavily relies on the application of geochemical analysis, accompanied by the compilation of a database of geological ore sources in order to shed light on social, political and economic aspects of past societies. For example, chemical and lead isotope analysis (LIA) are routinely applied for the provenancing of lead, silver and copper-based alloys.
The use of osmium isotopes has been previously suggested for the provenancing of iron. Its highly siderophile geochemical nature of Os, results in an enrichment in the metallic phase during metal production, thus renders it an excellent tracer in archeometallurgical studies of iron production and use. This suggestion was further studied by a set of systematic, bloomery iron-smelting experiments utilizing selected rich iron ores from the Negev. Attempts were successful, and three iron blooms were produced and further worked to form a bar ingot. The 187Os/188Os ratio measured for the ores, blooms and metal produced in the experiments show that the 187Os/188Os ratio is preserved from ore to metal, with no

isotopic fractionation. In addition, enrichment/depletion of osmium content was observed in the transition from ore to metal and from ore to slag. This observation has potential significance for our ability to differentiate between the various process steps and emerges as a robust and promising tool for the provenancing of archaeological ferrous metals.

Elyashiv H. (1,2), Bookman R. (1), ten Brink U.S. (3), and Huhn K. (2)
How do sediments physical properties precondition submarine mass movements? Insights from 3D numerical modelling.

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Direct observations of submarine mass movements are almost impossible to achieve. Field observations and statistical analysis of mass movements' deposits suggest that preconditioning factors to failure such as the sediments shear strength may control the initial size, location and dynamics of the sliding complex. However, such link between pre-slide sediment conditions and the resulting mass movements has not been well established. To understand the potential key role of sediments as a controlling factor of the dimensions and kinematics of mass movements, we used the Discrete Element Method to simulate and test such link. A 3D slope model starting as an undeformed and at rest slope, was generated containing sediments composed of an assemblage of granular particles. Failure was triggered by a progressively increasing slope angle. Two numerical 'sediments' were tested simulating typical sand and clay physical behaviours. Additionally, low and high peak strength scenarios were applied to each type to investigate different post depositional consolidation conditions such as seismic strengthening. Failure was observed in all experiments as slope oversteepening increased. Slope evolution created segmentation into upper and lower slope sections in which the factor of safety was reached locally. Massive failures in terms of volume and widespread distribution were mainly observed in high peak strength 'sandy' slopes and low peak strength 'clayey' slopes.
These results confirm field observation, in particular differences between submarine mass movements observed along seismically active or passive margins. Additionally, particular sediment type and shear strength further promote the initiation of large mass movements.

Engelberg S. (1,2), Marco S. (2), Sagi A. (1), Shaar R. (3), Ginat H. (4)
Evolution stages of the Gulf of Elat – Paleomagnetic constraints

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The deposition, relative age, and deformation of the Eilot and Garof Quaternary Formations are studied. These units which cover areas in the Elat region, including in the city itself, were deposited during the development of the Elat-Aqaba Basin. Therefore, they contain important knowledge for reconstruction of the tectonic conditions and the evaluation of the associated deformation since. Due to the clastic nature of the sediments, radiometric dating is not feasible, therefore we use paleomagnetism to impose age constraints. We present the paleomagnetic record of Eilot Fm. thickest exposed outcrop, as well as

measurements in other outcrops of Eilot and Garof Fms.
Eilot Fm. Mostly included fine-grain clastic and evaporites deposited in shallow water bodies. The Garof Fm. is primarily an alluvial fan, unconformably overlying the Eilot Fm. We find that the lower strata of the Eilot Fm. were deposited in a reversed magnetization period, while the upper strata were deposited in a normal magnetization period. The existence of reversed magnetization layers combined with the outcrop locations and their lacustrine composition, indicate that Eilot Fm. deposition age is older than the last reversal 0.78 Ma and preceded the significant subsidence of the head of the Gulf of Elat. The Eilot and the Garof Fms. near the Elat port are sharply tilted and crosscut by sets of N-S and NE-SW-oriented faults, indicating significant deformation during and after the deposition of the Garof Fm. The NE-SW-striking normal faults along the western borders of the sea are interpreted as western branches of the active Elat fault.

Enzel Y. (1), Armon M. (1), Ben Dor Y. (1), Dente E. (1) Ori Adam (1), Jay Q. (2)
The unbearable lightness of shifting monsoonal precipitation in North Africa during the Holocene

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Published compilations of lacustrine, marsh, spring, fluvial, and botanical evidence reveal a substantial latitudinal rain-belt shift during the early–middle Holocene into the Sahara, proposed to be associated with the North African summer monsoon. However, these substantial shifts are not predicted by recent and earlier global climate models (GCMs) for the same interval. Instead, GCMs indicate a maximum rain-belt northward shift of ~5o (~500 km) to ~21oN, and thus fail to reproduce the proposed larger field-based latitudinal shift that would have provided the entire Sahara with necessary amounts of monsoonal rainfall required for the compiled geological evidence.
Moreover, the only models that accommodate a substantial precipitation shift into the entire Sahara are those initialized with conditions favoring increased rainfall, including increased pre-assigned lakes (facilitating moisture recycling northward), vegetation and soil moisture (modifying albedo), and dust (impacting rainfall), all a-priori favoring increased precipitation, presumed to dominate North Africa. The problems of modeling such large shifts and the missing energy necessary to produce them, based on insolation alone, could indicate that the culprit for this data-modeling discrepancy may not rest with the numerous and repeated modeling efforts, but perhaps and instead stems from over interpretation of geological records. We propose that a re-examination of geological data collected from multiple sites, underlying this comparison, is warranted. In this presentation, we advocate, that indeed, field data, support a shift of the North African monsoonal rain belt to ~20-21oN. Farther north, the data are not robust enough to securely support such claims. These claims are based on the limited availability of ages and on a weak correlation with previous studies, with the probable exception of the westernmost Sahel and Sahara. Thus, we suggest that currently, GCMs' results for this region should be preferred over the scarce field evidence for a wetter interval.

Erel Y. (1), Pinhasi R. (2) Coppa A. (3), Ticher A. (4), Tirosh O. (1), and Carmel L. (5)
Lead in albacore revisited: A cautionary call concerning the forecasted increase in metal production and use

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Forty years ago, in a seminal paper published in Science, Settle and Patterson used archaeological and historical data to estimate rates of worldwide lead production since the discovery of cupellation, approximately 5,000 years ago. Here, we recorded actual lead exposure of a human population by direct measurements of the concentrations of lead in petrous bones of human individuals representing approximately 12,000 years of inhabitation in Italy. This documentation of lead pollution throughout human history indicates that, remarkably, much of the estimated dynamics in lead production is replicated in human exposure. Thus, lead pollution in humans has closely followed anthropogenic lead production. This observation raises concerns that the forecasted increase in production of lead and other metals might affect human health in the near future.

Eshed Y. (1), Ashckenazi-Polivoda S. (3), Winters G. (3), Antler G. (1,2), Abramovich S. (1)
Benthic foraminifera associated with seagrass as a model ecosystem for monitoring environmental changes

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Natural marine ecosystems are increasingly exposed to multiple natural and anthropogenic stressors. These ecosystems are experiencing substantial environmental changes, that are associated with human-related activities. Monitoring of natural and human-induced processes is commonly done by "model" organisms that serve as sensitive indicators of their ambient environments. Such an opportunity is given independently by two well-known bioindicators, seagrass Halophila stipulacea, and benthic foraminifera. This study is aimed to establish the use of the coupling between benthic foraminifera associated with the seagrass H. stipulacea as a novel biomonitoring tool in the Gulf of Aqaba-Eilat as a case study. It is based on one-year monthly ecological and environmental monitoring of two sites affected by different stressors, representing the urbanized area of the North beach, and a nature reserve area of South beach. Monitoring of these two sites includes characterization of the benthic foraminiferal assemblages, analysis of the grain size distribution, measurements of H. stipulacea leaf area and biomass, and carbon and nitrogen stable isotopes analyses of the leaves and the roots.
So far, nine sampling campaigns have been carried out, starting from January 2020 and until November 2020. The preliminary results indicate differences between the foraminiferal assemblages, which are expressed by both the composition and abundances of dominant species- south beach foraminiferal analysis shows higher numerical abundance compared to the north beach analysis; however, north beach analysis shows higher species diversity. Leaf area and biomass measurements exhibited both higher leaf area and biomass in the north beach compared to the south beach, and grain size distribution changes significantly as a result of location, with a higher percentage of large particles in the south beach, and mostly small particles in the north beach.

Eshel T. (1), Gilboa A. (2), Yahalom-Mack N. (3), and Erel Y. (4)
Debasement of Silver throughout the Late Bronze – Iron Age Transition in the Southern Levant: Analytical and Cultural Implications

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The study of silver, which was an important means of currency in the Southern Levant during the Bronze and Iron Age periods (~1950–586 BCE), revealed an unusual phenomenon. Silver hoards from a specific, yet a rather long timespan, ~1200–950 BCE, contained mostly silver alloyed with copper. This alloying phenomenon is considered here for the first time, also concerning previous attempts to provenance the silver using Pb-isotopes. Eight hoards were studied, from which 86 items were subjected to chemical and isotopic analysis. Results show the alloys, despite their silvery sheen, contained high percentages of Cu, reaching up to 80% of the alloy. The Ag-Cu alloys retained a silvery tint using two methods, either by using an enriched silver surface to conceal a copper core or by adding arsenic and antimony to the alloy. For the question of provenance, we applied a mixing model that simulates the contribution of up to three endmembers to the isotopic composition of the studied samples. The model demonstrates that for most samples, Pb-rich copper from local copper mines in the Arabah (Timna and Faynan) probably contributed lead to the alloys. Contextualizing these results, we suggest that the Bronze Age collapse around the Mediterranean led to the termination of silver supply from the Aegean to the Levant at the beginning of the 12th century BCE, causing a shortage of silver. The local administrations initiated sophisticated alloying methods to compensate for the lack of silver – a suspected forgery. It is further suggested that following the Egyptian withdrawal from Canaan around the mid-12th century BCE, Cu-Ag alloying continued, with the use of copper from Faynan instead of Timna. The revival of long-distance silver trade is evident only ~950 BCE when silver was no longer alloyed with copper and was imported from Anatolia and the West Mediterranean.

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Tsunami-derived sediments identified in the destruction sequence of an 8th century warehouse in Caesarea Maritima, Israel

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Coastal tsunami deposits that are preserved onshore have rarely been reported for the coastline of Israel. According to offshore sedimentological records, a tsunami struck the coast of early Islamic Caesarea Maritima, likely coinciding with a major earthquake in 749 CE. Anomalous sand and shelly layers from the same time period were reported by archaeologists in structures and other areas near the shore, and interpreted in many ways, including construction fill, dune development, and general abandonment. Unfortunately, no sediments were collected nor analyzed from those excavations. Recently, an area with this same deposit was freshly excavated. This allowed it to be studied and analyzed in detail to determine

its taphonomic history. The deposit is comprised of a thick, well-sorted sand layer with semi-articulated sequences of building stones followed by independent matrix-supported building stones. The entire deposit is sandwiched between an underlying early-eighth century floor and abandonment layer and above by a late-eighth century floor, thereby constraining its age to the 8th century CE. Two sediment cores from the deposit, as well as reference samples representative of various nearby depositional environments, have been analyzed for grain size distribution, foraminiferal assemblage, and relative age by portable luminescence (POSL). The comparative reference samples were collected from active coastal dunes, a Crusader construction fill, and storm-derived and shallow marine sands. The combination of results indicates that the sandy deposit was formed from the transport of offshore marine sediments during a high-energy inundation event, and does not resemble other known types of onshore sand deposits in the area. The results of this study will contribute to the understanding of high-energy tsunami deposits preserved on land in Caesarea Maritima, provide geographical constraints to enhance coastal inundation models and hazard/risk area maps, and more broadly contribute to the understanding of tsunami sedimentological studies in geoarchaeological contexts.

Eyal H. (1,2), Enzel Y. (1), Mieburg E. (3), Vowinkel B. (4), Ganot Y. (5), Shufan E. (6), and Lensky N. G. (2)
How does coastal gravel get sorted under stormy longshore transport?

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Wave storms transport and sort coarse gravel along coasts. This is a fundamental process especially under climate change associated with sea-level variations and increased storm frequency and intensity. Limited information on intra-storm clast motion restricts theory development for coastal gravel sorting and coastal management under stormy longshore transport. Here, we (i) used novel ‘smart boulders’ equipped with loggers recording underwater, real-time, wave-related, intra-storm clast motion, and (ii) measured longshore displacement of varied-mass marked boulders during storms coevally with measurements of wind and wave forcing. We utilized the unique Dead Sea setting where rapidly falling water levels allow isolating boulder transport and sorting dynamics during individual storms. Guided by these observations, we developed a new theoretical model, based on fundamental physical-scaling laws and quantified the critical wave height entraining a certain clast mass. Then, we obtained an expression for the longshore clast displacement under the impulse of a given wave, governed by pressure-induced fluid forces. Finally, we formulate and discuss the sorting by wave-height distributions of individual storms, showing that sorting is a direct manifestation of regional hydroclimatology.

Finkel M. (1), Erel Y. (2), Gopher A. (1) and Ben-Yosef E. (1)
Geochemical characterization of flint in the Negev and Aravah Valley: Linking prehistoric sites and potential sources of raw materials

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Geochemical characterization of flint from prehistoric quarries (extraction and reduction sites) and natural flint outcrops, as a reference for linking flint tools in prehistoric sites to their geological sources, was thus far conducted in the Carmel, Lower and Upper Galilee, and the Qesem Cave- Modi'in area. The results have demonstrated the importance of this method/procedure for the reconstruction of lithic economies of prehistoric communities (from the Paleolithic hunters-gatherers to the Neolithic–Chalcolithic farmers). This includes strategies of raw material procurement, the specificities of raw material selection for the production of selected tool types, inter- site connections and more. The research presented here expands the existing geochemical database by adding flint samples from southern Israel. It includes geochemical characterization of flint from the Neolithic quarries of Har Gevim and Ramat Tamar (Turonian), flint from several flint knapping workshops (reduction sites) by the quarries from several late prehistoric periods and flint from natural outcrops (mostly Upper Cretaceous and Eocene). The results enable differentiating between flint sources of different geological ages, and in cases also between different formations of the same age. We intend to compare the geochemical characterization of the flint from those possible sources to that of flint tools from Neolithic and Early Bronze Age sites in Faynan (northern Jordanian Aravah Valley) in order to track possible connections between these sites and flint sources to the west. It should be noted that the new data not only enable addressing archeological questions, but have the potential to contribute to issues related to the geology of flint, such as its varying deposition environments (in time and space) and other sedimentological insights.

Finzi Y. (1), Avni S. (1), Ganz N. (1), Limon Y. (1,2)
Geosystem Services and Geoethical Dilemmas in Nature Conservation in the Negev Craterland Geopark

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Geoheritage encompasses geologic features, at all scales that are considered to have significant scientific, educational, cultural or aesthetic value. Geo-sites are sites that present significant geoheritage and offer insights into the evolution of the Earth, life and science, and are therefore important for research, teaching or recreation.
The Makhteshim Country features numerous unique geologic phenomena and a rich cultural and natural heritage which showcases the everlasting struggle of life in arid and hyper-arid climate conditions. The Dead Sea and Arava Science Center is promoting the establishment of the Negev Craterland Geopark in the Makhteshim Country. Such a Geopark would provide scientific knowledge as a substantial element for nature conservation, geoheritage protection, environmental education, and geotourism development. These and other benefits to local communities and international visitors (and researchers) are part of the Geosystem services which are undervalued in national nature conservation policies.
The presentation will introduce an emerging interdisciplinary understanding that even though nature comprises both biotic and abiotic elements, the position of the latter in international nature policy, including the ecosystem services approach, is confused and insufficient. We will demonstrate this systemic 'bio-bias' using Geoethical dilemmas of nature conservation in the Negev Craterland Geopark.

Frucht E. (1), Levi Z. (1), Calvo R. (1), Avirav V. (1), Salamon A. (1)
Development of a template for post-processing, summarizing and presenting the results of a tsunami loss assessment

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Tsunamis are a natural hazard with great potential for destruction and loss of life. The State of Israel is located along the easternmost Mediterranean coast which has experienced a considerable number of tsunami events throughout history. Thus, tsunami risk in Israel must be evaluated and it is necessary that the decision-makers and emergency authorities prepare ahead of time for such a hazard. The development of loss and casualty scenarios is a key tool for assessing and mitigating tsunami risks. However, to date, such capabilities had not been developed in Israel.
The Geological Survey of Israel (GSI) took the lead and adopted the new tsunami module of the Hazus system. This is probably the first time that this module was implemented outside the United States. This report presents the work that was done at the GSI in order to apply the Hazus tsunami module and address the need to develop working methods and tools for conducting tsunami loss scenarios. The first part of this report proposes a comprehensive workflow for the development of Hazus tsunami scenarios, from preparing the input, through running scenarios and analyzing the results, including post processing of the final products. In addition, the report summarizes the theoretical and technical background and details the sequence of steps required to complete Hazus tsunami loss scenarios. The second part of the report focuses on the development of tools that can expand the ability to process the built in Hazus results. The new tools provide flexibility in summarizing the results and illustrating the outcomes in such a way that enables the end user to understand the extent of the expected casualties, damage and its consequences.
The Hazus tsunami module, combined with the tools built in the current framework, enable to examine a wide range of tsunami scenarios, locate and illustrate risk areas in terms of human loss, structural damage and economic loss. Moreover, the present form of the tsunami module combined with the new tools, make it possible to produce evacuation maps that can be used to examine the already existing evacuation routes and assembly zones, and formulate rescue strategies.
Overall, the findings and tools presented in this report provide the ability to process scenarios of tsunami loss assessments in Israel, thereby support and assist decision makers and emergency authorities to formulate a strategy to mitigate future tsunami risk as well as to improve the response in future events.

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Developing Tsunami Loss Scenarios - Bat Galim Case study, Israel

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The extensive lost of human lives and building damage sustained during past tsunamis drove development of the first tsunami risk assessment in Israel. The assessment focused on a simulated tsunami generated by an Mw 8.2 earthquake along the eastern Cypriot Arc (about 200 km NW of Haifa) in Bat Galim, the most vulnerable neighbourhood in the city of Haifa, situated along the Mediterranean coast in northern Israel. This tsunami event is considered a worst-case scenario and it was used to derive the same hazard in both coarse and high resolution. Exposure data were taken from the National Archives of the Survey of Israel and was verified with a field survey. Two approaches were taken to derive vulnerability models for the study: first, several Damage Criteria (DC) were developed based on information from past tsunami events; second, damage functions were applied using the Hazus Tsunami Model (HTM), a multi-parameter

loss estimation tool built using detailed engineering knowledge. Risk was considered the product of hazard, exposure, and vulnerability.
Following several parametric studies and sensitivity tests, we produced loss assessment results from the two most realistic model outcomes and arrived at conclusions meaningful for tsunami preparedness in northern Israel. Most importantly, we note that the loss of life far surpasses building damage. Increasing community preparedness is the simplest and most cost-effective way to sharply reduce the risk of casualties during a tsunami. We also note that upgrading the seismic design of existing structures according to required standards in Israel will decrease vulnerability to tsunamis and expand possibilities for vertical evacuation.
This assessment demonstrates that a simple DC approach is useful for preliminary investigation in cases of limited data. The HTM however, requires detailed preparation and data inputs but produces more realistic loss estimates. These insights may aid others during future implementation of tsunami loss modeling in threatened coastal communities.

Frumkin A. (1), Dimentman C. (2), and Naaman I. (1)
Geologic Reconstruction of the Levant by Living Fossils

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The Ayyalon - Nesher Ramla system combines hypogenic karst with endemic subterranean fauna. The unique faunal assemblage utilizes chemosynthetic food web based upon H2S within the ascending plumes of hydrothermal water. We attempt to constrain the regional biogeography and the age of the hypogene system using subterranean extant ’living fossils’, combined with related taxa in the Dead Sea Rift and Mediterranean, as well as geological evidence and previously published molecular phylogenetic data. The molecular evidence of Typhlocaris ayyaloni and T. salentina suggested that Ayyalon - Nesher Ramla aquatic system age is > 5.8 Ma. Evidence from Dead Sea Rift and East Mediterranean biogeographic evolution of aquatic fauna indicates isolation of the rift water bodies from the Mediterranean ~7 Ma. The high endemism of terrestrial troglobites at Ayyalon - Nesher Ramla caves indicate longer isolation age, most probably ~14 Ma – the end of the last transgression which inundated the lower Shefela region. We show that the Ayyalon terrestrial fauna of tropical origin invaded the subsurface warm, humid, and food-rich habitat, escaping middle Miocene surface aridization. Shefela sinkholes preserving middle Miocene sediments share similar features with Nesher Ramla sinkholes, suggesting that they share the same formation processes ~14 Ma, and implying a minimum age of the sulfidic hypogenic aquifer.

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Geochemical Evaluation of Mesozoic Source Rocks in the Continental Shelf of Israel

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Recent discoveries of large Cenozoic gas reservoirs offshore Israel, Cyprus, and Egypt sparked renewed interest in hydrocarbon exploration throughout the Levant. Several assessments for hydrocarbon resources were recently conducted, pointing to potential Mesozoic sources for oil and gas. However, since most source rock evaluations relied on geophysical and petrophysical approaches, direct geochemical evaluation of the source rocks is pivotal. To this end, ~560 cuttings samples from the Mesozoic section of 9 wells in the Israeli continental shelf were collected and analyzed using RockEval 6 for organic richness, hydrocarbon generation potential (GP), and kerogen type. The geochemical evaluation revealed several organic-rich intervals in the continental shelf. Those that are classified as good source rocks (Total Organic Carbon > 1wt.%) include the Jurassic in Yam-3, Ashqelon-2 and Haifa Bay-01; Lower Cretaceous (Gevaram Fm) in Yam Yafo-01, Yam West-01, Haifa Bay-01, Yam-03 and Ashqelon-02; Upper Cretaceous Dalya Fm in Yam-03, and the Ein-Zeitim Fm in Yam Yafo-01, Yam West-01, and Bravo-01. Based on the newly extended geochemical database, the following is suggested: (1) our results show that previous petrophysical estimations exceed the measured organic richness, leading to an overly optimistic evaluation. (2) An in-depth examination of RockEval pyrograms reveals that major parts of the high organic richness measured in the thick (~1000m) Jurassic and Lower Cretaceous intervals of Yam-03 and Ashqelon-02 wells are attributed to hydrocarbon fluids rather than kerogen. (3) Upper Albian-Turonian organic-richness measured in Yam 03 expands the boundaries of known organic-rich deposition of these ages (Dalya Fm.) westwards, exceeding previously measured values of organic richness and hydrocarbon generative potential. (5) The data shows that the Ein-Zeitim Fm in Yam Yafo-01 and Bravo-01 (Type II-III) include different kerogen from the inland Ghareb Fm)Type IIS(. The geochemical database gathered lays the foundations for regional depositional correlations and thermal maturation evaluation.

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Spatio-Temporal evolution of the Owl retrogressive slide complex from high-resolution geophysical observations.

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Prevalent on continental margins, submarine retrogressive sliding may have significant consequences for geohazard evaluation. We demonstrate the importance of a detailed investigation of retrogressive slides' complexity to constrain their characteristics, such as collapse pattern, transported volume, and reoccurrence interval. We coupled multichannel sub-meter resolution seismic profiles with a 5-m resolution bathymetry to investigate the Owl slide-complex offshore Israel. Bathymetrically, this retrogressive slide-complex comprises a ~1.7 km2 primary scar, two secondary scars, incised 500 m upslope of the primary headscarp, and tertiary scars along its lateral margins. The primary scar is underlain by six vertically stacked chaotic lobes, interpreted as mass transport deposits (MTDs), interbedded between intervals of continuous reflections, representing in-situ sedimentation. The lobes basal surfaces form unconformities, connected with headscarps of the Owl complex in a retrogressive pattern; each basal surface etches upwards, truncating the previous headscarps. The complex is underlain by a regional unconformity, correlated with the last glacial maximum transgressive Surface-A. Four faults are imaged

beneath Surface-A and produce its stepping geometry, hereditary to the bathymetry. One of these faults, offsets Surface-A beneath the primary scar headscarp, while the other faults are truncated by Surface-A. We suggest that the Owl slide complex formed through a successive collapse of 4- 6 retrogressive events, occurring between ~16-~1 ka BP, with a ~3 kyrs reoccurrence interval and quiescence for thousands of years in between. We argue that over-steepening of the headscarp by the previous event preconditioned the following failure, additional sediments accumulation of several meters was required before each failure could occur. The initial failure event was possibly facilitated by the faulting that affected Surface-A, while the pre-established stepping morphology of Surface-A determined subsequent collapses. The consecutive retrogressive events show a linear decrease in size, representing the healing effect of landslides in continental slopes' evolution.

Gal E. (1), Russak A. (2), Sivan O. (1)
Redox changes in coastal aquifers due to salinization and freshening events

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It has been shown that the salinization and freshening of coastal aquifers influence the dynamics of globally important major ions and nutrients in the fresh-saline interface (FSI) zone. As this interface often acts as an oxycline between the oxic fresh water above it and the anoxic saline groundwater below it, we also tested the effect of salinization and freshening on the redox potential of the saline groundwater and the FSI, and specifically on the redox status of iron and manganese. We present a geochemical model of salinization and freshening of an aquifer using phreeqC software and a python code with different parameters that simulate the natural environment in the coastal aquifer of Israel. This is along with column experiments under anaerobic conditions with sediments from the coastal aquifer of Israel and salinization and freshening scenarios. Redox dynamics is a significant factor to the water characteristics and management in the aquifer and it may affect the coastal seawater composition and the potential use of saline groundwater for desalination.

Gardosh M. (1), Lippman S. (1), Golan E. (1), and Levant D. (1)
Conducting International bid rounds for petroleum rights offshore Israel

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Since 2017 the Ministry of Energy is conducting international bid rounds for exploration rights in the Israeli EEZ in the Mediterranean Sea. Israel had been extremely successful in developing its offshore hydrocarbon resource. Since the first discovery well, Noa-1, in 1999, ten gas fields were found and four of them were developed and connected to the shore through fixed production platforms. The small, Mari-B and Noa gas fields are depleted already. But the large Tamar and Leviathan fields are producing and providing about 70% of the energy for electricity in Israel as well as exporting gas to Egypt and Jordan. The development of the Karish gas field through an FPSO facility will follow in coming years. The amount of gas produced between 2004 and 2020 is ~100 BCM and the annual production in 2020 was ~ 15 BCM. Royalties paid to the government in 2020 exceed 1 Billion NIS.
Until the late 2000's exploration rights were granted to investors that submitted license applications in an "Open Door" mechanism. Following a period of freeze of activity, the Ministry of Energy have decided to

open its maritime area to new exploration through competitive, international bid round campaigns; in line with international practice. As a first step the maritime area was subdivided to 72 blocks, each of maximal size of 400 km2. Selected blocks with identified exploration potential were offered in three bid rounds concluded in 2017, 2019 and 2020. As a result of this effort 19 exploration licenses were awarded, some of them to international oil companies that were not previously active in Israel. Preparations for the bids include assessment of environmental risks, compilation of data packages which highlight potential plays and exploration targets and marketing in international and local professional events. To support this activity, the Ministry sponsor regional studies and research projects related to the offshore petroleum resources. The bid round system has proved to be successful in increasing competition, attracting new investments and exposing the Israeli oil and gas potential internationally.

Ganz N. (1), Finzi Y. (1), and Avni S. (1)
Why geologists should care about geopark? / Science and community LIVE in The Negev Craterland Geopark

1. Dead Sea and Arava Science Center, Mitzpe Ramon branch, Mitzpe Ramon 80600, Israel

Global geoparks are territories with geological heritage of international significance that implement strategies for holistic management, promotion and sustainable development that are respectful of local traditions and desires. Geoparks promote the links between geological heritage and all other aspects of the area's natural and cultural heritage. Geoparks provide geo-scientific knowledge as a substantial element for nature conservation, geoheritage protection, environmental education, and geotourism development and proper management.
The Makhteshim Country features numerous unique geologic phenomena and a rich cultural and natural heritage which showcases the everlasting struggle of life in hyper-arid climate conditions. As a result of its exceptional geodiversity, the Makhteshim Country is also home to various endemic plants and animals. To support geo-conservation and to strengthen the peripheral communities and their connection to their environment, the Dead Sea and Arava Science Center is leading a community effort to establish the Negev Craterland Geopark.
Global geoparks promote and enhance research by serving as a platform for the preservation of local knowledge and base for collaborations with researchers from many disciplines. The Craterland Geopark will foster scientific research and cooperation with universities and research institutes, stimulating valuable interactions between the geoscientists and the local community. Also, as a result of continuous joint work with the local authorities and various organizations located in the area, bonds of trust and understanding are formed and as a result, these organizations help in various ways to continue scientific activities in the area.
The presentation will present several past, present and future projects, highlighting opportunities to get involved and contribute through research, residency, outreach and educational programs. We welcome creative new ideas for activities that would help connect science, nature and the local community.

Garfunkel Z. (1), Gardosh M. (2)
The Middle Triassic to Middle Jurassic development of the Levant margin of Israel and adjacent part of the Levant basin

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Integration of recently obtained information from the Levant margin in Israel and the adjacent basin allows developing new insights regarding their early evolution. The shaping of the basin's thin crust is constrained to the Middle Triassic or earlier. The middle Anisian to early Norian differential tectonic activity in the platform likely occurred while the adjacent basin existed already. This activity greatly slowed down, or even ceased, in the following 40-45 Ma period when a regional hiatus occurred in most of the platform. A new phase of subsidence and faulting of the platform began in the late Liassic, but there is no clear change of the deformation pattern. By the end of the Bathonian a ca. 1.5 km high and ca. 10 km wide submarine continental slope was already well outlined in the southern coastal plain of Israel, which implies even greater water depth farther offshore, compatible with the finding of deep offshore boreholes. In the Mt Carmel and nearby areas, a local depression subsided since mid-Carnian times, at least ca. 2.5 km relative to its surrounding and was the site of continuing intense volcanism during ≥30 Ma until the end of the Triassic. Regional subsidence and deposition were renewed in the Middle Jurassic, but the pattern of vertical motions and deformation changed compared with the previous period. The multi-phase tectonic evolution of the Levant margin is related to the complicated regional history of northern Gondwana periphery in the Early Mesozoic.

Gat D. (1), Cytryn E. (2), Reicher N. (1), Alayof M. (1), Shechter S. (1), Tarn M. (3), Wyld B. (3), Murray B. (3), Rudich Y. (1)
The biogeography of atmospheric dust in the East Mediterranean – structure and function of microbial communities in the atmosphere

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Dust storms have been recognized as carriers of microorganisms of distinct community compositions, over great distances, crossing oceans, and bridging between continents. The East-Mediterranean is a crossroad of dust storms from different sources, e.g., the Saharan, Arabian, and Syrian Deserts. Each of these sources was shown to carry a different composition of the airborne microbiome.
A meta-analysis of airborne metagenomes collected from different source locations demonstrated desert dust's role in changing the atmospheric microbiome composition and functional profile. Specific functions such as antibiotics resistance, methanogenesis, and biodegradation of organic pollutants were linked to atmospheric dust in the Mediterranean, compared with other aerosol types.
A particle-size resolved analysis of the airborne microbiome from various sources showed that the microbial community of coarse size-class particles (10µm ≥ D50 ≥ 3.2µm) is most sensitive to changes in the dust source. In contrast, the microbial community of fine size-class particles (0.6µm ≥ D50 ≥ 0.3µm) is relatively stable and represents the local microbiome. Moreover, differences in the bacterial and fungal community compositions imply different mechanisms of emission and dispersion for these microorganisms.
Understanding the atmospheric transport of microorganisms can shed light on their possible contribution in colonizing pristine environments, replenishing oligotrophic environments and dissemination of health-relevant microorganisms.

Gazit N. (1), Vainer S. (1,2), Matmon A. (1)
End-member interpretations of $^{26}Al/^{10}Be$ burial ages: examples from the Kalahari Basin, southern Africa.

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2. Institute of Earth Surface Dynamics, University of Lausanne, Lausanne, 1015, Switzerland

Interpreting the concentrations and ratios of the cosmogenic radio-nuclides (CRN) ^{26}Al and ^{10}Be as in terms of burial duration depends on geological considerations and the regional context of the samples. After sediment burial, both CRN production and ^{26}Al/^{10}Be ratio decrease significantly. After reaching a minimum ratio value (which depends on the absolute concentrations and depth of burial), the ratio increases until it reaches a secular equilibrium state at the value of ~3.4. When measuring an ^{26}Al/^{10}Be ratio <=3.4, two age interpretations can be given (a "short path" and a "long path"), separated by millions of years.
Here we present two sites in the Kalahari Basin (southern Africa). In the first site, ^{26}Al/10Be ratios range between 1.92 and 2.4 and ^{10}Be and ^{26}Al concentrations are in the order of 10^5-10^6 atoms gr-1 quartz. The most probable age interpretation at this site is the "short path" solution, as the "long path" interpretation would require unrealistically high initial CRN concentration at burial. The “short path” interpretation yields burial ages that range between 1.4 and 2.6 Ma (depending on the pre-burial ^{26}Al/^{10}Be ratio). At the second site, ^{10}Be concentrations are very low (low 10^4 atoms gr-1 quartz). The accuracy of ^{26}Al measurements does not allow calculating the ^{26}Al/10Be ratio with confidence and we assume that all ratios at this site are at secular equilibrium (3.4). At such low concentrations, the most probable age interpretation is the "long path" solution and the corresponding burial age is greater than 10 Ma. The "short path" interpretation would require very low initial CRN concentrations at burial, implying extremely rapid erosion rates that are uncharacteristic to the southern African environment.

Gedulter N. (1), Thomas C. (2), Ariztegui D. (2), Torfstein A. (1,3), Levin N. (4), Agnon A. (1), Darvasi Y. (1), Francos N. (5)
Mapping Dead Sea Stromatolite Reefs: Hyperspectral Remote Sensing and the Search for Life in Extreme Environments

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3. Interuniversity Institute for Marine Sciences, Eilat, Israel
4. Department of Geography, The Hebrew University, Jerusalem, Israel
5. The Remote Sensing Laboratory, Department of Geography and Human Environment, Tel-Aviv University, Tel Aviv, Israel

Stromatolites represent some of the most ancient forms of life on Earth, bearing information regarding the primitive environment in which early life has appeared and evolved. The quest to shed light on such processes on livable planets has motivated thorough investigations of stromatolites. Currently, the main practical attraction regarding these stromatolite textures is analogies with potential life and fossils on Mars.
Stromatolites are laminated bio-sedimentary structures formed by sediment trapping and binding of microbially-assisted mineral precipitation. They are generally created by photosynthetic activity of anaerobic microbial communities in shallow water environments. At the Dead Sea these communities comprise halophiles surviving under extremely arid environmental conditions.
In order to understand the formation of ancient Dead Sea stromatolites, we sampled modern microbial communities living in ponds, supplied with fresh-water seepages, on the retreating Ein-Gedi shore. Our research focuses on aragonite forming-microbial mats, more likely to build-up on fossil stromatolites, thereby preparing the ground for studies of the primary chemical and isotopic compositions. Microsensing

techniques assist in determining how the bioactivity of these organisms may lead to the formation and the preservation of biosignatures and textures in fossil stromatolite reefs.
The Dead Sea shoreline is suited for our research as stromatolite reefs there offer a testing ground for developing integrated methods for identifying sites of geobiological interest. Detecting and mapping formations of ancient life forms can contribute to better deciphering the paleo-environmental conditions that had governed the Dead Sea area. In particular, we seek diagnostics to securely identify microbial mats that lived near lake shoreline environments.
We use remote sensing and in-situ hyperspectral technologies for characterization of biosignatures inherent to stromatolites and living microbial mats. We commenced developing spectral detection for automated mapping from drone and satellite imaging.

Geiger S. (1)
Turning challenges into opportunities: Training geoscientists and reservoir engineers for a low-carbon energy future

1. Institute of GeoEnergy Engineering, Heriot-Watt University, Edinburgh UK

Geoscience and reservoir engineering education is encountering unprecedented challenges: We are now in the transition from fossil fuels to low-carbon energy sources, and the only debate is the speed at which this transition occurs. As a result, engaging with the oil and gas industry, which has traditionally hired a major part of the graduates in geoscience and reservoir engineering, is increasingly scrutinised by university stakeholders. At the same time, data science and artificial intelligence become increasingly important in geoscience and reservoir engineering, and are replacing traditional (field-based) activities. Geoscience education has also been criticised because of its lack of equality, diversity, and inclusion. Universities, especially those that have a long and successful heritage in providing geoscience and reservoir engineering training and research related to oil and gas production, have to adapt to these challenges and need to reimagine and reinvigorate their curricula. Using the Institute of Petroleum Engineering at Heriot-Watt University, which has recently rebranded itself as the Institute of GeoEnergy Engineering, as an example, I will discuss how we can turn these challenges into new opportunities that allow us to make lasting contributions in teaching and research that help to decarbonise energy production by building on our historical strengths in geoscience and engineering and adapting curricula to become more inclusive.

Gelband D. S. (1,2,3), Starinsky A. (1), and Stein M. (1,2)
Formation of Lacustrine Dolomite from the Late Miocene of Northern Israel
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2. Geological Survey of Israel, 32 Yesha'ayahu Leibowitz, Jerusalem, Israel
3. Department of Science Teaching, Weizmann Institute of Science, Rehovot, Israel.

The study focuses on the formation of lacustrine dolomite in the late Miocene lakes of Northern Israel. These lakes deposited the sediments of the Bira (Tortonian) and Gesher (Messinian) Formations that comprise sequences of dolostone and limestone. Dolostones are bedded, consist of small-sized (<7 µm), Ca-rich (52 to 56 mol %) crystals with relatively low ordering degrees, and present evidence for replacement of $CaCO_3$ components. Limestones comprise wackstone to mudstone matrix, freshwater macrofossils, and intraclasts (mainly in the Bira Formation). Sodium concentrations and isotope compositions differ between limestones and dolostones: Na= ~100-150; ~1000-2000 ppm; $\delta^{18}O$= -3.8 to -1.6‰; -2.0 to +4.3‰; δ13C= -9.0 to -3.4‰; -7.8 to 0‰ (VPDB), respectively. These results indicate a

climate-related sedimentation during the Tortonian and early Messinian. Wet conditions and positive freshwater inflow into the carbonate lake led to calcite precipitation due to intense phytoplankton blooms (limestone formation). Dry conditions and enhanced evaporation led to precipitation of evaporitic $CaCO_3$ in a terminal lake, which caused an increased Mg/Ca ratio in the residual waters and penecontemporaneous dolomitization (dolostone formation). The alternating lithofacies pattern reveals eleven short-term wet-dry climate-cycles during the Tortonian and early Messinian. A shift in the environmental conditions under which dolomite formed is indicated by a temporal decrease in δ18O of dolostones and Na content of dolomite crystals. These variations points to a decreasing evaporation degrees and/or an increased mixing with meteoric waters towards the late Messinian. A temporal decrease in $\delta^{13}C$ of dolostones and limestones and appearance of microbial structures in close association with dolomite suggest that microbial activity had an important role in allowing dolomite formation during the Messinian. Microbial mediation was apparently the main process that enabled local growth of dolomite under wet conditions during the latest Messinian.

Gelband S. D. (1), and Orion N. (1)
Integrating Geoethics Values and Skills into Geoscience Higher Education in Israel

1. Department of Science Teaching, Weizmann Institute of Science, Rehovot, Israel.

The new field of geoethics emerges from the need to consider ethical perspectives and dilemmas associated with geoscience research and practice in relation to humanity interaction with the Earth systems. Geoethics deals with the responsibilities that professional geoscientists have towards the society and the Earth systems. These responsibilities include, among others, transmitting relevant information and knowledge to industry, authorities, and citizens in an effective way; assuring sustainable exploration of geo-resources; and providing solutions to global environmental challenges. As a new concept, geoethics still has a low profile among the geoscience community. Integrating geoethical values and skills into the higher education of geoscience might be an effective way to raise the awareness of this new field. This study is the first educational research on geoethics aspects and indicates the transition from the conceptual stage towards evidence-based data. We explore the factors that influence the attitudes of geoscience students towards geoethics by using a multi-method approach entailing both qualitative (interviews; observations) and quantitative (Likert-type questionnaire) data collection and analysis. This will be done by applying educational interventions within selected academic courses and studying their influence on the students' attitudes towards geoethics. The educational intervention includes learning activities and tasks on geo-ethical, social and cultural issues related to various Earth science phenomena and dilemmas that commonly appear worldwide. The outcomes of the study shed light on how integration of geoethics principles may influence the geoethics attitudes of future geoscientists. The educational activities developed during the study are available and allow Israeli and international geoscience lecturers to integrate geoethics aspects into their existing courses.

Giladi A. (1), Kanari M. (1), Katz T. (1), and Tibor G. (1)
Monitoring sediment transport and grain size dynamics along the Israeli continental shelf with multibeam bathymetry and backscatter data
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In 2017, the Israel Oceanographic and Limnological Research (IOLR) started conducting annual seafloor monitoring cruises onboard the R/V “Bat-Galim”, to evaluate the rate of erosion/deposition and the influence of man-made infrastructures on the seabed along the Israeli continental shelf south of Akko. The monitoring program includes a multibeam (Kongsberg EM2040 operated at 400-kHz) and sub-bottom

(Knudsen 3260 Chirp) survey along 13 transects across the shelf, from WD 10-100m. The multibeam acoustic return intensities (BS) were used, along with sediment samples from a box-core in selected reference areas to calibrate the grain size mode at the seafloor.
The analysis of the bathymetric surfaces from the consecutive years 2017-2020 shows that the shelf is stable in terms of sediment processes except along the marine infrastructures and natural seafloor features (e.g. rocky bottom outcrops) where patterns of sediment accumulation and erosion are observed. The variability along the marine infrastructures is mostly seen in the shallow water (less than 30m) where measured, vertical yearly changes of accumulation/erosion were up to +/-0.4m. The calibration of the multibeam BS enabled grain size mode evaluation ranging from very fine gravel (-1 phi) to clay (9 phi). Additional in-situ sampling validated the reliability of the grain size classification method for the Israeli, continental shelf. Accordingly, we show that the Israeli continental shelf south of Haifa Bay is characterized by a sandy seafloor strip at WD 0-35m and a muddy strip that extends west up to WD 100m (in agreement with previous studies). Gravelly areas are identified at the coast-parallel Kurkar outcrops, in water depths of 10-15m and 35-40m and in some places even at WD of 90m. This demonstrates that grain size classification by BS is likely to be a very useful and fast method for monitoring changes in seafloor characteristics over large areas over time.

Ginat H. (1), Iris D. (1), and Shani A. (1)
Sustainable development alongside conservation in wilderness landscapes

1. Hevel Eilot regional council, Israel

Hevel Eilot's vision to realize and develop the area's pioneering "settlement dream" is based on values of community cohesion, cooperation and mutual aid. Compatible economic development, aimed to benefit the area while considering the environment, is paramount. Suitable development must regard the needs of the developing human society in the region alongside its natural resources, including the unique desert landscape.
Development of any kind requires the implementation of long-term plans in various areas:
- Agricultural programs in suitable areas
- A masterplan for tourism in which sustainable conservation is maintained alongside conservation development of tourist sites
- Renewable energy - efficient use of the solar power in suitable areas- Well-planned, region specific industry development
Along with these plans, we are preparing conservation development plans that create employment opportunities through rehabilitation and treatment of hazards. This masterplan aims to treat copper mining hazards, date waste and more.
Our biggest challenge, as leaders of Hevel Eilot, is to combine the various plans in an efficient and orderly way. Our goal is to achieve controlled, intelligent and supervised use of our agricultural, tourism, energy and industry resources. We strive for smart development of the untouched "Land of Genesis", which we are blessed with and where we chose to live. Therefore, we have prepared a plan for open spaces that balances the needs of development and the needs of conservation.
Aside from long-term planning that will help make the right decisions, tailored education is very important. When learning and teaching, the natural characteristics of the primeval land and the restriction of development alongside conservation should be emphasized. Thus, we will become deeply familiar with the near space as part of the region we belong to. It is our right and duty to continue living in our wilderness landscape, while keeping it natural and sustainable.

Golan R. (1), Nachshon U. (2), Katzir R. (2), Sharabi G. (3), Gavrieli I. (3)

Ashalim wadi pollution as evident in soil chemical composition

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2. Institute of soil, water and environmental sciences, Agricultural Research Organization, Volcani Center, Israel
3. Geological Survey of Israel, 32 Yesha'ayahu Leibowitz, Jerusalem, Israel

On June 2017, estimated 250,000 m3 of concentrated acids and phosphogypsum slurry, drained from an industrial pond of the ICL-Rotem phosphorous industry, into Ashalim ephemeral stream, at the southern Judean desert, leaving behind dead animals and plants, as well as acidic cisterns and polluted soil. The present work focuses on the upper Ashalim stream, characterized by sandy alluvial riverbed derived from the Hazeva Formation. Here the contamination event can be identified through several new morphological features that, including white phosphogypsum, consolidated crusts and whitish sands. Field and laboratory investigations were carried out in order to identify the prominent contaminants, their spatial distribution, transport mechanisms and geochemical availability and potential mobility. The main contaminants in the stream are F, SO4, PO4, and Na along with heavy metals, particularly Cd, Cu, Mo, Al, Fe, Zn and 226Ra. Spatial analyses indicate that there is a difference in the chemical characteristics of the contaminated sediments in the thalweg and alluvial terraces, which are related the morphology and contamination depth. These agree with a mechanistic explanation that relate to the course of events, whereby much of the phosophogypsum in the slurry was deposited on the terraces and the F-rich acid interacted with the sediments and precipitated its byproduct in the thalweg. The findings signify major change in the chemical characteristics of the habitat; increased soil salinity and elevated levels of fluoride, nutrients and metals. These findings explain and support the findings from the ecological monitoring program that point to the initiation of metal bioaccumulation, along with high biological crusts and vegetation stress in the upper part of the stream. In light of these, the INPA concluded that active habitat restoration is required.

Goldblatt J. (1), Shiner M.E. (1), Klein-BenDavid O. (1,2), Bar-Nes G. (2,3), Peled A. (3)
Sorption of Cesium in high-and low-pH cementitious pastes

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The accepted disposal method for low- and intermediate- radioactive waste is near surface disposal, where the waste is solidified using Ordinary Portland Cement (OPC) matrices. In order to improve the matrices retention, the sorption mechanism of different radionuclides should be understood. In addition, the pH contrast between OPC matrices (pH>12) to that of the environment can enhance radionuclide leaching from the matrix. Therefore, the pH of the OPC can be lowered by adding reactive SiO2, affecting its physical, chemical and retention properties.
In this work, the sorption ability of Cs (Cesium), a common ion in radioactive waste streams, was examined in five cementitious systems. d. The cementitious formulations are based on OPC and Alite (3CaO·SiO2, the major phase in OPC), where amorphous silica was added to replace the binder in the low-pH systems. Two sources of reactive SiO2 with different grain sizes were tested to compare between their effect on matrix sorption capability.

The cementitious pastes were crushed for phase analyses (TGA, XRD, BET) and sorption experiments were conducted. The crushed matrices were placed in tubes with solutions at different Cs concentrations (0.1-1000 ppm) at 1/10 liquid to solid ratio. The tubes were rotated end over top for 29 days to achieve chemical equilibrium. Analytes concentrations in the solutions were then measured using ICP-OES and ICP-MS.
The results show that low-pH systems exhibited higher partition coefficients (Kd) to Cs, in comparison to high-pH systems (17-430 and 0.1-4.3 [ml/g], correspondingly). This two-order of magnitude difference is due to the fact that SiO2 addition leads to a more negative surface charge, increasing the sorptivity to cations. Furthermore, low-pH OPC paste prepared with nano silica showed higher Kd values (26-430 [ml/g]) relative to a similar paste prepared with densified silica fume (28-123 [ml/g]), due to the higher surface area and reactivity of the nano silica.

Goodman-Tchernov B.
Reviewing the State of Knowledge of Red Sea Tsunamis

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Following the 2004 Indian Ocean Tsunami, awareness and concern over tsunami threat drove efforts to better understand and evaluate risk in coastal areas worldwide. The vast body of research since then has improved the understanding of how and where paleotsunami deposits are discernable on the landscape, and changed our understanding of many tsunami-related sedimentological fingerprints. The Red Sea is speckled with areas of recent rapid coastal development, partnered with a general lack of data regarding past tsunamis—a combination that could lead to major loss-of-life in the case of a tsunami event. This dearth of information is of concern, and has a few possible causes. First, tsunamis could, in fact, be very rare in the region and therefore this absence of data is a reflection of the hazard risk. Alternatively, the written records of events in the area are sparce, and therefore unavailable for reference, thus presenting a false impression of 'low-risk'. Lastly, research on the physical remains and the conditions in which large-magnitude tsunamis are produced is still in its infancy, and therefore a proper assessment is still preliminary and with improved means of recognising and identifying paleo events, a more accurate paleo record will develop. This presentation will provide a review of tsunami-related knowledge from the Red Sea region generally, highlighting work to date in the GOA.

Gordin Y. (1), Vinegar H. J. (2), Canning A. (3), and Hatzor Y.H. (1)
Rock physics study of the organic-rich carbonate Ghareb and Mishash formations using well logs and laboratory core data

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2. Vinegar Technologies, LLC, Bellaire, TX
3. Emerson, Paradigm Geophysical Ltd., Herzliya, Israel

High-resolution reservoir models are typically based on the inversion of seismic data to calculate the seismic layer properties such as P- and S-wave impedances, density, Poisson's ratio, Vp/Vs ratio, etc. The challenge is to establish strong and reliable geostatistical relations between these seismic layer properties and petrophysical properties using both well logs and laboratory measurements. Rock physics templates (RPT) are collections of graphs such as cross-plots, which display the obtained seismic layer properties along with developed rock physics models (RPM), constrained by the local physical properties. Using RPTs

along with RPMs can be valuable to delineate the spatial distribution of key rock properties such as lithology, porosity, and pore fluid saturation in the petroleum system.
In this study, we developed RPTs and RPMs to predict the organic richness (Total Organic Carbon, TOC) and thermal maturation of organic-rich carbonates from the Golan basin, Israel, using well logs and laboratory core measurements. These organic-rich carbonates are unique in their relatively low diagenetic stage, a wide range of porosity (10-30 %), and early thermal maturation (from immature to early oil window). Our workflow first identifies the organic-rich layers (high TOC) from the Lamda-Rho vs. Mu-Rho RPT along with rock physics models, which are based primarily on the modified lower Hashin-Shtrikman bounds (MLHS) and Gassmann's fluid substitution equations. Next, the RPT of Vp/Vs ratio vs. acoustic impedance (AI) is used to delineate the porosity, brine saturation, and degree of thermal maturation in the organic-rich sections. The degree of organic maturation was confirmed using Rock-Eval pyrolysis data. The observed relationships are quite robust based on the detailed, high-quality laboratory and log data. However, our conclusions may be limited to the early stage of maturation and diagenesis of organic-rich carbonates, as at higher maturation and diagenesis the trend of changes in physical properties can vary significantly.

Granot R. (1) Edut R. (1), Kanari M. (2), Giladi A. (2), Tibor G. (2)
Deep-tow magnetic survey of the Herodotus Basin: implications for the crustal structure

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2. Israel Oceanographic & Limnological Research Ltd., Tel-Shikmona, Haifa, Israel

The Herodotus Basin, found west of the Levant Basin, preserves an old oceanic crust covered by ~12 km of sediments. This setting provides an ideal test case to investigate the influence of post-accretion sedimentation on the thermal structure of the oceanic crust and its magnetization. Here we present results of a 150 km-long deep-tow magnetic profile that we collected during November 2019 aboard the R/V Bat Galim. The new Ben Gurion University Compact Deep-Tow Magnetic System was deployed using the standard co-axial CTD sea cable, permitting real-time acquisition of the magnetic field strength, depth, altitude, and CTD water properties data. The system was towed at an average speed of 1.8 kt (1.0 m/s) and depth of 3050 to 2300 meters, controlled by onboard winch to maintain altitude of ~200 meters (on average) above the seafloor. We also towed two sea surface total-field Overhauser sensors set up in a longitudinal gradiometer mode aimed to calibrate the deep-tow fluxgate sensor and evaluate the influence of external magnetic fields. The track line was designed to follow seafloor spreading direction and to be oriented nearly perpendicular to the previously mapped magnetic lineations. The deep-tow and sea surface magnetic anomalies provide constraints on the geometry of the magnetic source layer and indicate that the top of the layer is located at depth of ~15 km beneath the seafloor. This in turn suggests that the magnetization of the upper oceanic crust has been erased due to thermal heating from above. Furthermore, the shape of the anomalies provides constraints on the thermal structure of the lower oceanic crust which in turn is related to the seafloor spreading rates that prevailed at the time of crustal accretion.

Granot R. (1), Katz O. (2), Kanari M. (3), Hyams-Kaphzan O. (2), Kurant S. (2), Hamiel Y. (2)
New constraints on the kinematics of the western Sinai Microplate

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The tectonic nature of the Sinai Microplate's western boundary, straddling across the western edge of the Levant Basin, is clouded with uncertainties. Early studies suggested that the western edge of Sinai is fully connected to the African plate, thus concluding that Sinai is a sub-plate. Later, bathymetric analyses of prominent features found along the western Sinai have suggested that, in-fact, this area is a plate boundary that accommodates dextral motion between the African Plate and Sinai Microplate. However, this inference contradicts geological and geophysical observations from across the Gulf of Suez, the southern continuation of the same plate boundary. Here we present preliminary results from a recent geophysical cruise that we conducted aboard the R/V Bat Galim during May 2020. We focused our investigation on one of the major faults, oriented in a NW-SE direction (located ~80 km southwest of the Eratosthenes Seamount), creating the plate boundary. We collected high resolution shallow multichannel seismic reflection data complemented with multibeam bathymetry data. We also acquired two piston cores near the trace of the fault. These observations unravel the shallow three-dimensional structure of the fault system whereby number of curved and steeply dipping normal fault segments are splayed from the main fault trace in a westerly direction. These secondary faults display a back-tilted and step-like morphology which overall create a negative flower structure. This structure is best explained by sinistral motion acting along the master fault.
Independently, we present an updated Africa-Sinai Euler pole based on the motion of GPS stations recorded between 1996 and 2019. The results suggest that Sinai is moving in a northwesterly direction relative to Africa (1.7-1.9±0.9 mm/yr) along the plate boundary. Focal mechanism solutions calculated for the recent earthquakes occurring in this region (Mw>4.5) agree with the geodetic constraints and suggest that the western boundary of Sinai has been, and still is, accommodate sinistral motion relative to Africa.

Gropp J. (1), and Halevy I. (1)
Sustaining microbial activity through methane production in energy-limited environments

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Anaerobic microbial production of methane (methanogenesis) is a byproduct of energy conservation in methanogens and is one of the most ancient metabolisms on Earth. Methanogens can utilize electron donors such as H2 and acetate to produce chemical energy and biomass, even in the most extreme conditions of temperature, salinity, pH and energy availability. Methane is a potent greenhouse gas and more than half of the annual emissions of methane to the atmosphere are due to microbial activity, with the ocean contributing ~10 Tg of methane per year. In the recent decades a growing body of work was dedicated to study methanogenesis in lab cultures, but these lab cultures are typically orders of magnitude more active than methanogens in marine environments, thus hampering the interpretation of methanogenesis in these environments.
To bridge this gap, we developed a metabolic-isotopic model of methanogenesis. The isotopic composition of methane is often used to trace its sources and the rate of its formation, but this relation so far remains empiric and lacks mechanistic explanations. Our model can predict the cell-specific rate of methanogenesis and the hydrogen and carbon isotopic compositions of methane for predefined concentrations of methane, DIC and H2. This can be used to decipher isotopic signals of methane from various environments. Our model was initially calibrated to lab cultures and was modified to predict methanogenic activity in energy limited environments, where methane production rates are too slow to ever measure in a lab culture experiment.
We found that in most marine sediments that are limited by sulfate, methanogenesis is expected to advance in a slow cell specific rate, that is only barley above the threshold of minimal microbial activity.

This is supported by the isotopic compositions of methane that are often close to isotopic equilibrium with the surrounding DIC and H2O. Our results may be useful in future interpretations of the modern methane cycle, and also in reconstructions of ancient carbon cycles in Earth's history.

Halevy. I (1)
Deep-time records of seawater $\delta^{18}O$ and climate: The irony
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The isotopic composition of O in seawater ($\delta^{18}O$) is a fundamental property of Earth's oceans, which is key to paleoclimate reconstructions and to our understanding of the origin of water on Earth, the water-rock reactions that govern seawater chemistry, and the conditions under which life emerged. Despite more than five decades of research, the coupled long-term geologic history of seawater temperature and $\delta^{18}O$ remains a topic of intense debate. The problem exists because the $\delta^{18}O$ values measured in marine sedimentary rocks (e.g., carbonates, cherts) reflect both their temperature of formation and the $\delta^{18}O$ of the seawater from which they formed. This duality has prevented a unique interpretation of a long-term secular increase in $\delta^{18}O$ values recorded in marine sedimentary rocks, which can be used to infer either much warmer (>70ÆC) early oceans, much more ^{18}O-depleted seawater, or a combination of the two.
We addressed this problem with a new record of $\delta^{18}O$ in iron oxides formed in shallow marine environments through time. The new record shows that the long-term secular increase observed in the $\delta^{18}O$ values of various marine precipitates is due to enrichment of seawater in ^{18}O rather than in a gradual cooling of Earth's oceans. I will discuss possible drivers of the change in seawater $\delta^{18}O$ and implications, including the inference that Earth's climate has been mostly warm and stable over the past 3.5 billion years, implying the existence of efficient climate stabilization feedbacks. Finally, one of the most extreme climate episodes in Earth history, the Neoproterozoic "Snowball Earth" events, is recorded in some of our iron oxide samples, providing unique observational constraints on the hydrological cycle during these events.

Hamdani I. (1,2), Aharonov E. (1), Olive J.A. (3), Parez S. (4), Gvirtzman Z. (1,2)
Initiating salt tectonics by tilting: Viscous coupling between a tilted salt layer and overlying brittle sediment

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Young salt basins often exhibit a shelf/slope region of extension and a deeper domain of contraction. The upslope normal faults in such salt tectonics systems are often associated with the pinchout edge of the buried salt layer. Although the spatial correlation between the normal faults and the salt pinchout was previously observed, the mechanism was not fully explained. The Levant basin, which is a young and mildly deformed salt basin, provides an opportunity to analyze a simple salt tectonics system driven by basin margin tilt, and the formation of the normal faults. This work presents analytical and numerical modeling of the coupled viscous salt and overlying visco-plastic sediment layer. Results suggest the viscosities of both the sediment overburden and salt, as well as their thicknesses, control the deformation of the

coupled layers. The visco-plastic deformation mechanism explains quantitatively the position of faulting and observations of the temporal evolution of brittle deformation in the Levant basin margin. It predicts that the largest stress in the overburden arises above the salt edge, driving normal faulting at that location. Our model also places quantitative constraints on the effective viscosity of the overburden (5*10^19–5*10^20 Pa s), which is consistent with experimentally-determined creep laws. Our results contribute to the understanding of halokinematics in young salt basins and will allow better assessment of geological hazards related to salt related deformation.

Hamiel Y. (1) and Piatibratova O. (1)
Spatial variations of slip and creep rates along the Dead Sea Fault and implications to seismic hazard assessment

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The interseismic deformation along the Dead Sea Fault (DSF) is analyzed using 23 years of GPS measurements obtained from 209 campaign and 60 continuous stations. This GPS dataset is probably the longest record and the densest dataset for the DSF and the Levant region. We use inversion models to infer the spatial variations of slip and creep rates along the DSF. Our results indicate that part of the tectonic motion is transferred from the DSF to the Carmel-Gilboa Fault System (CGFS). We find that the left-lateral strike-slip motion along the DSF decreases in a rate of 0.9±0.4 mm/yr, from ~4.8 mm/yr south to the intersection with the CGFS, to ~3.9 mm/yr north to this intersection. Along the CGFS the left-lateral strike-slip motion ranges between ~0.3-0.5 mm/yr and the extension rate between ~0.6-0.7 mm/yr, indicating a total slip rate vector of 0.8±0.4 mm/yr in the DSF direction, in agreement with the reduction of slip rate along the DSF near the intersection with the CGFS. Shallow creep is found along the southern and central sections of the Dead Sea basin and the northern Jordan Valley section of the DSF, with creep rates of 3.4±0.4 and 2.3±0.4 mm/yr, respectively. These creeping sections were identified as areas with thick Halite layers at the shallow subsurface, suggesting that shallow creep behavior along the DSF is govern by the presence and mechanical properties of the Halite. Seismic hazard analysis suggests that moment magnitudes of M7.3 and M6.8 were accumulated along the southern Arava Valley and the northern Jordan Valley since the last large earthquake in these sections, respectively.

Hamiel Y. (1), Katz O. (1), and Avni Y. (1)
Spatial and temporal reconstruction of faulting near the intersection of the Dead Sea Fault and the Carmel-Gilboa-Faria Fault System

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The intersection between the plate-boundary Dead Sea Fault (DSF) and the major intraplate Carmel-Gilboa-Faria Fault System (CGFS) is generally treated as a ~35km wide deformation belt, stretched between the Faria and Gilboa faults. Here we present spatial and temporal analysis of faulting near this intersection. Our analysis is based on new geological mapping as well as geodetic and seismological observations. It indicates northward migration and localization of the intersection with time since the Early Miocene and the currently active intersection is located at the northern extension of this deformation belt, localized to the southern boundary of Beit She’an Valley, near the Gilboa Fault. We mapped new outcrops of Miocene, Pliocene and Pleistocene rock-units as well as faults and reconstructed the evolution of deformation. Two main tectonic phases were identified in this area: Early- to Middle Miocene and Late-Miocene to the present. During the first phase, the DSF and several grabens in the NW direction within the Sinai plate were developed. During the second phase, most of the deformation along

the CGFS was migrated northward and concentrated along the southern sector of the Beit She'an Valley. Small-scale northward migration and localization of deformation near the southern boundary of Beit She'an Valley was also identified during the second phase. The currently active CGFS is marked by a clear lineament, which initiates at a right-lateral stepping and a change in the strike of the DSF near the uplifted area of Tel Al-Qarn and crosses the whole Jordan Valley in the NW direction. Faults from the second deformational phase reveals both sinistral and normal faulting and are accompanied by the development of a wide fault-zone.

Harel E. (1), Goren L. (1), Shelef E. (2), Crouvi O. (2), and Ginat H. (4)
Drainage reorganization disrupts scaling between drainage area, valley width, and slope

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Valley width is a fundamental morphological property of rivers. Changes in valley width affect flood hazards, sediment mobility, bedform evolution, and landscape evolution. Defining and measuring the width of valleys and channels is far from trivial, and river's drainage area is widely used as a proxy for the width, due to the commonly documented power-law relationship between width and drainage area. Under transient conditions, the river's slope is also shown to influence variations in channel width, leading to the following relation: W=Kb*(A^b)*(S^c) , where W, A and S refer to channel width, drainage area and slope, respectively, and Kb, b, and c are calibration constants.
Drainage reorganization induces gradual or abrupt changes in drainage area along basins. While changes in the drainage area may trigger modifications of the slope and width to the new hydrological conditions, the timescales over which the slope and width respond to the new conditions may be long and not necessarily synchronous. Therefore, we hypothesize that following reorganization, the calibration constants could significantly deviate relative to their expected range, based on global compilations. The deviation of 'Kb' and 'b' could become even more substantial when 'W' is substituted to valley width, which is expected to adjust even slower than the channel.
To test our hypothesis, we classified drainages in the southeastern Negev and Arava according to the reorganization mode that they experienced. Then we measured the area, slope, and valley width of the drainages from high-resolution DEMs, and computed the best-fit calibration constants for each drainage by applying a multivariate regression.
Our results show that the W-A-S scaling in reorganized valleys and basins deviate significantly from their globally observed relations. Moreover, the deviations in 'Kb' and 'b' are mostly consistent with the mode of reorganization that was initially attributed to the affected streams.
We propose that the deviations in the W-A-S scaling could assist in identifying recent reorganization and pointing to its mode. Furthermore, our findings are important for valley width predictions and models of landscape evolution in regions that experienced recent drainage reorganization.

Harel M. (1), Amit R. (2), Porat N. (2), and Enzel Y. (1)
Revised concepts of middle to late Quaternary accretion of the Coastal Plain, Israel and its coast-parallel eolian (kurkar) ridges
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The evolution of coastal sandy environments during Quaternary are dynamic and develop under sea level changes on shallow shelves. Coast parallel ridges, considered as “barriers”, and associated with trellis drainage patterns, are typical to both on-land and submerged wide flat shelves (e.g., in southwestern Australia, southern Africa, and the southeastern Mediterranean). However, the process of their formation is still unclear and as in many other worldwide coastal areas is biased by studying limited exposures mostly along a present coastal cliff. Here we present new insight on the geological structure and spatial development of east Mediterranean coastal plain with the aim to define a better paleo-shores position, reconstruct dune dynamics, and evaluating coastal erosion rates of sandy barriers, their formation and preservation. We use spatial landscape analysis, together with extended stratigraphy, adding sedimentary and pedogenic analysis of the relict ridges and their bounded trough fills. We document the previous interglacials coast-parallel dunes and ‘ridge’, now buried, as a cyclic deposition system: (a) coastal erosion (i.e. previous cliff formation) into formerly accreted shore and coastal plain; (b) formation of shore-parallel dune and backshore wetlands; (c) advancing coastal dune field, associated with either high sea level or shallower shore position burying terrestrial landforms. We document the dynamics of these systems during interglacial and glacial cycles. This framework enables further paleo-environmental reconstruction and global correlation with similar depositional environments.

Harlavan Y. (1), Davidovich U. (2), and Porat N. (1)
Tracing the source of Ghassulian beads from N. Ze'elim
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Green-glazed beads found in Ghassulian contexts (Late Chalcolithic, LC) are the current study's focus. These tiny beads can shed light on studying the copper sources and production associated with LC metallurgy. Based on SEM observations, the beads are made of synthetic enstatite paste coated/glazed with copper, representing cross-craft pyro-technological interactions. Beads separated from two cloth bags of the N. Ze'elim hoard were grouped according to their color; white, grey, and green. The green beads' Cu coating was assumed to include trace amounts of Pb; hence it was extracted using Aqua Regia solution for lead isotopic composition. The residue from this procedure and the white and gray beads were grounded and dissolved under clean laboratory conditions. Results show that synthetic enstatite beads and the Cu-coating form a linear array where the Cu extracts form the radiogenic endmember, and the synthetic enstatite bulk beads form the common lead end member.
The current results are compared to the Pb isotopic composition of known ores of ancient mining sites, which identify a probable origin of the Cu while excluding other origins. On both plots, 207Pb/204Pb vs. 206Pb/204Pb and 207Pb/204Pb vs. 208Pb/206Pb, the following mines were eliminated; the Taurus and North Central Anatolia, Egypt and Sinai, Cyprus, Oman, and many others. As for the Arabah mines, although data fall on the Faynan MBS mines trend line, the Cu coated beads fall within the Amram mine values, which are set between the Rehavam and Timna values. As for the synthetic enstatite, no known specific data exist, and comparison yielded no results.

Henig H. (1), Katzir Y. (1), Vapnik Y. (1), Yudalevitz Z. (1)
The origin and evolution of continental alkaline magmatism: Geochemical modelling and melt inclusion study of the Cretaceous Ramon volcanics, Israel

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The Lower Cretaceous volcanic rocks exposed in Makhtesh Ramon, Israel, are known under the general term "Ramon basalt". This diverse silica-undersaturated alkaline suite comprises alkali olivine basalt, basanite, olivine nephelinite and melilite-olivine nephelinite. Despite their age, the rocks are fresh and magmatic structures such as lava flows and sub-volcanic bodies, are well preserved. The Ramon alkaline lavas are part of the 'Levant magmatic province' – a Lower Cretaceous regional intraplate magmatism recorded from Lebanon to Egypt.
Given the lack of apparent tectonic control, the Ramon magmatism was interpreted to represent a mantle plume, but neither lithospheric stretching nor deep mantle origin is evident. Trace elements and Radiogenic isotope ratios indicated OIB-like affinity for the Ramon volcanics, allegedly derived from the Arabian lithosphere, whereas asthenospheric contribution was not identified. If a single mantle source is invoked, then the wide range of lava compositions requires a plausible explanation for the differentiation mechanism controlling the assemblage.
This research focuses on one volcanic edifice, the Ga'ash Hill, an eroded volcano exposing its subvolcanic bodies and magmatic diversity over a relatively small area. Field relations, petrography and geochemical data reinforced by modelling using MELTS algorithm unfold the volcanic evolution from the explosive stage to the emplacement of the sub-volcanic bodies. Partial-melting of a garnet-lherzolite source at variable extent can account for the lava compositional spread of the suite. Melt inclusions trapped in olivine phenocrysts show onset of crystallization at 1230-1300°C for all rock types, implying refractorization of a single source. In the next stages of the study, a set of advanced micro-analytical techniques (SEM-EDS, SIMS, TIMS, LA-ICP-MS, XANES) will be applied to the melt inclusions to provide insights on the primary melt and mantle source compositions, both chemically (trace elements, Sr and Nd isotopes) and physically (pressure, temperature, fO2). This will allow a more comprehensive view of the source-to-surface process that generated the Ramon volcanics.

Hill I. (1), and Westendorf-Lahouse R. (1)
The role of oil and gas in the transition to a lower carbon world
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Oil and gas will continue to play a critical role to meet the world's energy demand. The global oil and gas industry is committed to help meeting the energy demand while also playing a significant role in achieving a lower carbon future and supporting the Paris Agreement goals: by reducing the carbon footprint of its operations, by providing cleaner energy, and by developing low carbon technologies. The International Association of Oil & Gas Producers (IOGP) is supporting its global membership in all these efforts.

Inbar M. (1)
Floods in israel-1948-2020. A spatial analyses and total fatalities and economic damages

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Natural disasters includes earthquakes, volcanic events, floods, landslides, hurricanes and hailstorms, drought and forest fires. They have common characteristics:
1 They occur by natural processes, and may be accelerated and increased by human activities, like large floods or landslides.
2 High magnitude, with scales for the magnitude
3. They occur suddenly and usually last for a short time, and unpredictable in some cases like earthquakes or with short warning time like in volcanic eruptions.

4. Cause human victims and large economic losses. Droughts are an exception and they are prolonged events.
Vulnerability is a crucial factor in natural disasters, The total risk (R) is a function of the number of victims and affected elements (E), the hazard (H) magnitude and the vulnerability (V)R=f (H , E, V) Public fear is mostly on earthquakes and volcanic eruptions, but more than 50% of the victims and economic losses in the world in the last century were produced by floods.
The study covers 180 events, with 85 fatalities and about 3-4 milliard shekel for the total period. Two exceptional events occurred in the Mediterranean climate part of the country: 1969 in the northern areas with a recurrence interval of 1:200 years and in 1992 in the central and northern areas with a recurrence interval of 1:120 years.
The trend in the last years and probably in the future is an increase in the number of fatalities and economic losses mainly in the populated coastal areas due to an increase in population, infrastructure and buildings. Human errors in floods events were the main cause for fatalities.
In urban areas natural landscapes change rapidly into hydrological impervious areas, increasing peaks of runoff during flooding events

Isaacson S. (1), Avrahami Y. (1), Rottman S.R. (2), Storz-Peretz Y. (3)
Using remote sensing spectral indices to map and monitor the distribution and frequencies of flash floods in arid regions

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Deserts are characterized by high spatial and temporal variability of precipitation resulting in high spatio-temporal variation of floods occurrences. Adjacent drainage basins or even adjacent channels within a single basin may differ significantly and unpredictably in the number of floods per year. These arise the need for high spatial and temporal resolution mapping of the dynamics of flash floods occurrence and distribution in the active channels. Currently, data on flash floods is collected using in-situ water level measurements and hydrometric stations. Those stations are usually positioned in main channels, neglecting the smaller basins and small channels within the large basins. Consequentially there is a lack of information on the distribution of the flash floods, their frequencies and magnitudes, which limit our understanding of catchment scale processes. Remote sensing is a powerful tool to cover large areas with high temporal and spatial resolution. The aim of this research is to develop a remote sensing technique to map and monitor flash floods in arid regions.
Because of the short duration (few hours to one day) of flash floods that characterize arid ephemeral streams (wadis), a post- flood index must be applied. We used IWA's (Israel water authority) hydrometric stations data during three hydrological seasons (2017-2020) in the Negev as ground-truth for image processing of Sentinel-2 satellite images. The results indicated high signal of flood extent when using SWIR (short wave infrared) spectral indices such as MNDWI and LSWI indices two to three days after flood.
This type of monitoring is essential for infrastructure planning, drainage management and river rehabilitation as well as ecological interface. It is also the base for validating models predicting flash floods which save humane lives and properties.

Jaijel R. (1,2), Goodman Tchernov BN. (3), Biton E. (2), Weinstein Y. (1), Katz T. (1)

Optimizing a standard preparation procedure for grain size analysis of marine sediments by laser diffraction(MS-PT4SD)

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Grain size distributions are a useful physical measurement in marine geoarcheological studies, and marine sedimentological studies in general. By measuring sediment grain size in different archeological layers one can differentiate between different depositional phases, and learn about the geological and geomorphological history of a site. Grain size results can also provide a more profound understanding of the human-environment interaction and mutual influences at a certain site, and even mark periods of abandonment or extensive human activity. Laser diffraction spectrometry is a very common method for grain size measurements due to its ability to provide fast, accurate, and high resolution results. Prior to preforming grain size analysis in such a system, pretreatment of the sediment samples is required in order to dissolve aggregates and remove organic material. Currently there are different pretreatment methods for different sediments, but no inclusive and standard method is applicable across many types of the latter. This can be an obstacle when trying to compare results from a certain site to another, or even between different studies at the same site, as different scholars might use different pretreatment methods. In this study we recommended on a unified marine sediment pretreatment protocol -'PT4SD', which is applicable in geoarcheological studies as well. The recommended protocol was defined following a systematically testing and comparing of commonly applied digestion and dispersion pretreatments, on a wide spectrum of marine sediments. Different protocols were tested to find the most precise, reliable, and consistent results across all samples. The final suggested protocol reduces the needed amount of sediment for analysis, reduces handler bias, and the overall digestion time. We propose that using 'PT4SD' as a standard pretreatment protocol will greatly benefit sedimentological and geoarcheological laboratories individually, as well as encourage and improve the depth of cross-study comparability, thereby improving collective research as a whole.

Jaijel R. (1,2), Katz T. (2), Weinstein Y. (1), Biton E. (2)
A look at an Israeli submarine canyon

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Submarine canyons are important conduits between the shallow shelf and the deeper sea, serving as a preferred pathway for dense water cascading, and sediment transport down the slope. Not much is known about the physical and sedimentological mechanism working within the Israeli submarine canyons, which are found in its northern area. The study presented hereby comes to describe these mechanism by analyzing the results of two mooring stations that were placed in the thalweg of a submarine canyon offshore Haifa, Israel. The systems were deployed in October 2019, for a period of eight months. One mooring system was placed next to canyon head, while the other was placed in the deeper part of the same canyon. Both moorings had the same instrumental setup along its ~55m line, recording both physical and sedimentological proxies within the canyon by the following devices: CTD next to sea bottom with an OBS; standalone thermometers at different heights along the mooring line; one sediment trap near bottom and one at the top of the mooring line; ADCP at the top of the mooring (facing down) with a turbidity meter attached to it. During the deployment and recovery of the moorings additional data was

collected including a high-resolution mapping of the canyon (in both cruises), collection of short sediment cores, extraction of piston cores, and bulk sediment that was used for calibration of instruments in the lab. Along with the general dynamics described from the results, we have detected a few sediment transport events, which are currently under study in order to define the mechanism that triggers them. Another aspect of the study looks at the results from the quantitative side, for both sediment transport and physical water properties, calculating the fluxes of different proxies.

Jewison E. (1), Katzir Y. (1), Vapnik Y. (1)
Melt inclusion study in the Golan Heights

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The Golan magmatic province is located in the northernmost part of Israel, in close relation to both the Dead Sea fault and the Harrat ash Shaam volcanic province (HAS). This geographic ambiguity of the Golan basalts, at the northwestern end of the HAS, whose magmatism is related to the Arabian mantle plum and close to the Dead Sea Transform, a large-scale boundary fault reflects its largely unknown cause and source. In this tectonic setting, since neither clear extension nor plum contribution is evident, the cause of melting and the sources of magmatic melt are unknown.
This study aims to unravel the composition of the parental melts of these basalts and therefore better understand what drives melting in this region. Melt inclusions are small pockets of melts trapped during crystal growth and reflect chemical information about the environment it was trapped in. Melt inclusions have thus become primary sources of direct information concerning physical and chemical characteristics of magmatic systems at depth. Here, we present melt inclusions data from the Plio-Pleistocene volcanic bodies from the Golan Heights. Samples ranging from 3-4 Ma to recent, show bulk composition ranging from alkali-basalt to basanite. Once re-heated and homogenized into glass these inclusions are suitable for various analytical methods in order to retrieve their chemical and isotopic composition. In this study, melt inclusions were homogenized at temperatures of 1280°C. Raman spectrometry enabled the identification of CO2 as the main component of the gas bubble remaining after homogenization, in four localities in the Golan Heights. Trace elements compositions revealed that all samples show a continuous decrease of normalized concentration from La to Lu. Moreover, the basanites samples are enriched in REE in comparison to the alkali basalt. Finally, the highest percentage of partial melting is identified in the cover basalt (3-4Ma) versus Plio-Pleistocene alkali basalt.

Kamai R. (1), Yagoda-Biran G. (2)
A new ground-motion model for seismic hazard analysis in Israel

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Ground motion models (GMMs) are a key component in seismic hazard analysis. In data-rich regions, these models are mostly empirical, relying on the ever-increasing ground-motion databases. However, in areas in which strong-motion data is scarce - other approaches for ground-motion estimates are sought, including, but not limited to, the use of simulations to replace empirical data. In Israel – despite a clear seismic hazard posed by the Dead-Sea Fault (DSF), the instrumental record is sparse and poor, leading to the use of global models for hazard estimation in the building code and all other engineering applications. In this study we present a new state-of-the-art GMM, based on the available empirical data on one hand and on seismological simulations on the other hand. Earthquake data is used to constrain region-dependent model components, while global models are used to constrain region-independent

components, such as large magnitude scaling and nonlinear site effects. The Ground Motion Model (GMM) is based on five alternative ground-motion databases – one empirical and four that are simulation-based, calibrated to the available data. Two host models are used as alternative formulations, such that a total of ten alternative models are first developed in the Fourier Amplitude Spectra (FAS) domain, capturing the full range of parametric and modelling uncertainty. Then, the Random Vibration Theory (RVT) approach is used to convert the median backbone model into response-spectral domain, so that it is more accessible and applicable for engineering analyses. In the response-spectral domain, additional components are added, to create a robust, engineering-oriented model, suitable for hazard estimations and based on the existing available earthquake data measured in Israel. Finally, a comparison is made to other models, currently used for hazard calculations within the Israeli building code and other engineering applications.

Kamai T. (2), Hershko S. (2), Munwes Y. (2), and Farber E. (4)
On a recent subsurface heating in Tel-Aviv residential area

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We report on elevated subsurface temperatures and their impact on the surrounding structures in Tel-Aviv residential area. We present site observations and analysis results, based on sampled and in-situ temperature measurements, complemented with theoretical modeling of heat transfer.
The event occurred during December 2020 through January 2021. In mid-December, a local resident from a basement apartment reported on high temperatures in the apartment walls. On the morning of Dec. 31st, steam appeared on and above the surface between buildings, residents were evacuated, the area was closed and its electrical power supply was shutdown. The steam was diagnosed as water vapor without significant toxicants. Three electrical cables, located between 1 and 1.5 m below the surface were identified as the potential heat source.
During Jan. 1st and 2nd, we began digging pits in the area, downward to the cables, while measuring temperatures between 40 and 60 °C in the exposed pits and the surrounding area with a FLIR camera. On Jan. 3rd, four holes were auger-drilled down to ~3 m below the surface, sampling the temperatures of the extracted cores during drilling. Temperature sensors were installed in three of these holes at depths between 70 and 90 cm, and the holes were filled with the extracted media, providing for continuous in-situ temperatures from these locations.
The spatial distribution of soil temperature displayed a peak around the location of the cable structure. Subsurface temperatures above the cable structure were relatively high, up to the near surface, as result of the above-surface air that acted as an insulator. This insulation also explains the high temperatures in the buildings' walls, which served as routs for heat transfer from the surface. Spatiotemporal temperature distribution from heat transfer simulations validated these observations and enabled estimation of the source that initiated the event.

Kamhaji Gafny L. (1), Abelson M. (2), Shaar R. (1), and Agnon A. (1)
Significant paleomagnetic rotational pattern at the Gabbro province recorded OCC's initial stage during Solea spreading activity, Troodos ophiolite

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Oceanic Core Complexes (OCC's) develop by exhumating the deep lower crust and/or mantle rocks to the ocean floor. The exhumation involves tectonic slip on a major low-angle normal fault (detachment fault), with examples mapped at modern slow and ultra-slow spreading centers. The OCC fault mechanism was mainly investigated at mature structures by geophysical tools, whereas in-situ measurements are sparse. Here we present the results of a paleomagnetic survey on the Gabbro province around Amiandos, Troodos OCC's suggested detachment fault (Nuriel et al. 2009). The in-situ information is applied to test hypotheses of magma-starved oceanic spreading and detachment fault models. Dense sampling comprises 38 Paleomagnetic sites along two main transects: East-West across the suggested OCC footwall and hanging wall; North East-South West along the central Solea graben axis. Comparison of the ChRM vector with the Troodos mean vector (TMV) revealed significant gradual rotations, divided into three tectonic domains. The tilted domains show rotation about a horizontal axis and conform with OCC's tectonic model in its initiation stage. The rotation implies the shallowing of mantle rocks, which probably dictated the Troodos localized diapir. This research complements previous studies yielding a complex deformation map of the lower crust in oceanic RTI.

Kanari M. (1), Reshef M. (2), Giladi A. (2), Goodman-Tchernov B. (3), Katz T. (1), Tibor G. (1)
Investigating the activity of Quaternary faults in the deep Levant Basin: preliminary results from Ultra-High-Resolution Seismic reflection offshore Atlit

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Continental margins are sites for extensive human activities and infrastructure that are related to oil and gas exploration and other economic developments. In the past two decades the Levant deep basin undergoes rapid development due to extensive hydrocarbon production and its related infrastructure. Marine infrastructures are susceptible to potential geological hazards such as earthquakes, mass sediment flows, and active faulting. In the frame of a larger scale study aimed to investigate potential geohazards in the deep basin, we carried out a 24h pilot study to investigate a representative deep basin strike-slip fault 40 km offshore Atlit (N Israel) to determine its activity, using multi-channel Ultra-High-Resolution Seismic reflection (UHRS) and piston coring.
The seismic survey took place onboard R/V Bat-Galim on August 2020 and included collection of 65 km of seismic reflection data using the 48-channel Geo-Sense light-weight UHRS coupled with a Geo Marine Survey Systems Sparker Geo-Source 400, between water depths of 1250-1450 m. Additionally, 50 sq. km of high-resolution multibeam bathymetry and a 3-m piston core were collected. The processed UHRS data revealed about 300-350 ms (230-280 meter) of seismic data with tens of cm vertical resolution. Preliminary results of the detailed multi-channel UHRS data reveal elevated and depressed structures that were created by the strike-slip fault. Mapping several reflectors across the fault, up to the top of Yafo Formation, show lateral variations in the strata's thickness, suggesting recent lateral offset units. The near-surface units were sampled by a 3-m piston core. The core analysis (still in progress) will include radiocarbon dating for determination of the age of the sediments.

The use of UHRS together with high resolution multibeam mapping calibrated with in situ sampling for studying fault activity in the deep basin is a powerful tool for investigating basin floor dynamics and potential geo-hazard to marine infrastructures.

Katz T. (1), Katsman R. (1), Kalman A. (1), and Goodman-Tchernov B. (1)
Evolution of intermittently deposited flood sediments on the continental shelf in the Gulf of Aqaba-Eilat
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The evolution and preservation of flood deposits on continental shelves is influenced by the dynamic relationship between punctuated discharge events and post-deposition mixing and removal that are not well constrained. The hyper arid Gulf of Aqaba-Eilat is a low-energy environment wherein incoming floods from ephemeral rivers are infrequent (~1 yr-1), and deposition from other sources is minor; providing a perfect setting for studying post-flood deposition processes on the continental shelf. Post-event evolution of flood deposits on the inner shelf were examined by In situ observations and a numerical model. We show that the sediment-water interface shifts with respect to a base location beneath the mixed layer, steeply rising during floods (up to several centimeters d-1) and gradually subsiding owing to winnowing of fine particles thereafter. These shifts, which do not typically preserve in the long-term sediment record, reoccur at rates that are orders of magnitude faster than the multiannual sedimentation rate. Adding winnowing to the commonly used biodiffusion (bioturbation) model shows how in combination, these two processes govern the profile evolution of fine flood sediment, causing the sediment to coarsen from the top down and shape a subsurface peak in the fines. When long time periods pass between floods; mixing and winnowing erase the peak of fines, gradually coarsening the entire mixed layer. Each event restarts this top-down coarsening such that when floods are frequent, overlaying sequences of fine peaks will form in a “saw tooth formation”. We suggest that this model and the concepts presented here can help to better understand post-event dynamics in calm, marine depositional areas that are primarily governed by punctuated deposition events and continuous winnowing.

Kempe Y. (1), Weiss Y. (1), and Navon O. (1)
Time-temperature relations and formation history of diamonds from the Venetia and Voorspoed Mines, South Africa
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Diamonds act as ancient time capsules, encasing secrets from the Earth’s mantle for many millions of years. Due to diamond physical and chemical strength, they efficiently preserve high-density fluid (HDF) microinclusions that link to early volatiles-involved processes in the Earth’s mantle. These HDFs are effectively the only available direct samples of deep mantle metasomatic fluids. They preserve their unique chemical record and thus allow to trace the sources of deep mantle fluids and identify the processes that shape their nature. The diamonds also carry nitrogen, which aggregates over time from single atoms to couples (A-centers) and finally to quadruplets (B-centers). The aggregation rate depends on the diamond initial nitrogen content, and the time/temperature history of the diamond residence in the mantle. This process is very sensitive to temperature and can indicate changes in the thermal state of the subcontinental lithospheric mantle over time. Together with HDF compositions, it can unravel geological history, thermal conditions during metasomatic events and the relation of such events to the

regional tectonics and volcanic history. Here we report data from Voorspoed and Venetia mines in South Africa, two localities that have not been investigated for their diamond HDF composition. The unique characteristic of both Voorspoed and Venetia diamonds is their unusually high N aggregation state. All nine Venetia diamonds present high-Mg carbonatite HDFs, while the 15 Voorspoed diamonds reveal three populations that differ in their nitrogen aggregation and HDF composition. A carbonatitic-silicic group containing 11-30% B-centers, a saline group containing 5-16% B-centers, and a single high-Mg carbonatitic diamond with 0% B-centers. The distinct nitrogen aggregation of the three fibrous diamond populations in Voorspoed and the lack of clear major element evolutionary trends or intermediate compositions between the different HDF types suggest different time-temperature formation histories. We suggest that most Voorspoed diamonds formed during 4 metasomatic events during continuous cooling of the lithosphere. The oldest episode took place between 2-3 Gyr as a result of a major thermal perturbation, whereas the following three occurred in the cooling lithosphere between 200-600 Myr, 30-90 and <30 Myr before kimberlite eruption at 131 Ma.

Kenigsberg C. (1), Titelboim D. (2), Ashckenazi-Polivoda S. (3), Hyams-Kaphzan O. (4), Herut B. (5), Almogi-Labin A. (4), Kucera M. (6), and Abramovich S. (1)
Thermo-hyaline threshold and the future proliferation of symbiont bearing foraminifera as ecosystem engineers

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Tropical calcifiers are key organisms for understanding marine ecosystem responses to global changes. Specifically, holobionts organisms such as corals and Large Benthic Foraminifera (LBF) represent a complex biological system for coping with the expected environmental changes. This study separately evaluates the thermohaline tolerance of one of the most common cosmopolitan LBF species, Amphistegina lobifera, and its diatom symbionts to natural and extreme salinities under optimum and warm temperatures. The tolerance of Peneroplis, a Rhodophyta bearing LBF, known to occur in warm hypersaline regions, has also been evaluated. Amphistegina lobifera and its diatoms symbionts exhibit optimal performance at the salinity of 39 and 25ºC. Those were significantly reduced in all other salinities and 32°C. Complete inhibition of calcification rates are evident at 32ºC at the salinities 45 and 50 at both temperatures. The symbionts appear more resilient than A. lobifera for hypersalinity. Peneroplis exhibit higher tolerance to warm temperature and hypersalinity but display a slower calcification rate compared with A. lobifera. Our results exemplify that further radicalization of extreme thermohaline environments will result in an overall ecological turnover from Amphistegina to Peneroplis dominated assemblages and, consequently, a decrease in carbonate production LBF.

Kessler N. (1)
Groundwater contamination by petroleum products in Israel

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Petroleum products are an important driving force behind the Israeli and the global economy. To support its widespread demand, Israel has a robust infrastructure for manufacturing, storing, transporting and supplying petroleum products; these include: 1600 km of national fuel-pipes, over 2100 gas stations, 35 oil-terminals and two refineries. Unfortunately, fuel leaks from underground tanks and pipes are prevalent, making petroleum one of the most common environmental pollutant. In over 85% of the gas stations, examined by Israel's Ministry of Environmental Protection, soil was contaminated due to fuel leakages. Over time, contaminated soils can cause groundwater contaminations, as the fuel migrates down until reaching the water table. Upon contact, soluble, aromatic compounds and fuel additives leach into the groundwater creating a plume of fuel-contaminated water. These soluble, petroleum compounds are highly toxic and can disqualify drinking-water at concentrations as low as a few micrograms per liter. Moreover, contaminated water emits toxic gases that enter buildings and cause severe indoor air pollution.
In the last 20 year, Israel's Water Authority has been conducting groundwater investigations in order to identify and map groundwater fuel contaminations. Over 300 contaminated sites have been identified, of which 200 are in the coastal aquifer. In most cases, natural attenuation, due to decomposition by soil bacteria, prevents the contamination from dispersing far off-site. In these mild cases, the contaminants concentrations are merely monitored until they are sufficiently low. However, in severe cases, where the contamination may limit drinking-water production or pose a threat to public health, the groundwater needs to be actively remediated. Remediation can be achieved by various technologies that are based on chemical, physical and biological attenuation processes. Up to dated, there are 34 sites in Israel that are undergoing active remediation while 11 sites have already reached their remediation goals.

Khalifa O. (1,2), Lazar, B. (1), Stein M. (1,2)
Geochemical evolution of Lake Lisan from interstitial soluble salts in cores of Dead Sea Deep Drilling Project and marginal outcrops

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Located on the transition between the climatic zones of the hyperarid Sahara deserts to the subtropical Mediterranean and being a terminal lake, the hypersaline Lake Lisan, the last glacial precursor of the Dead Sea, has been in the focus of extensive paleoclimate research during the past several decades. The sediments deposited from the lake comprise the Lisan Formation that consists mainly of sequences of laminated primary aragonite, silty detritus, and occasional gypsum.
Here, we report on the chemical compositions of interstitial soluble salts extracted from the sediments. The soluble salts represent the composition of the lake's brine solution. Samples were taken from the marginal terraces of the modern Dead Sea where the Lisan Formation is exposed and from sediments cores from the deepest floor of the lake recovered during the ICDP - Dead Sea Deep Drilling Project. Thus, the sampling provides information on the lake solutions in the deep and shallow limnological environments.
The measured ions are Ca2+, Mg2+, K+, Na+, Sr2+, Cl-, SO42-, Br-, NO3- and HCO3-. We focus on several ion ratios that correlate well with pore fluids composition extracted from the same section of the DSDDP deep core, such as Na/Cl and Mg/Cl (in eq). The Na/Cl changes from ~0.3 to 0.7 during times of halite dissolving (e.g. the last glacial period) and drops back to ~0.48 when halite is deposited (e.g. at the early Holocene). The Mg/Cl shows a mirror pattern (with max values of 0.5 and min of 0.2). These temporal changes reflect the gradual freshening of the deep hypolimnion along the last glacial period. During

periods of relative stability in the deep lake (MIS2), the shallow epilimnion composition varies in response to abrupt regional hydro-climatic changes such as the intervals of Heinrich events.

Klein M. (1)
"Data Correction" in Climate Change Studies

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A very common research topic nowadays is the study of climate change. The reader of the articles in their source and not only the one published in the mass media knows that in most cases the word: Corrected, Reported, Adjusted, Homogenized, Processed appears. The question of course is why a seemingly simple parameter for measurement like temperature or precipitation should go through the series before it can be used? Unless the authors of the article want to match the results to the answer they expect to find. Well-known and reputable research bodies explicitly write that they make such corrections. Examination of many examples shows that in all cases the amendment emphasized the fact of an increase in the measured temperature - is this a case? The lecture will present cases from Israel and around the world

Klein T. (1)
Geo-Ethics in practice: Introducing dilemmas in a course for graduate students. The case of forestry in Israel

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Geo-Ethics revolves all aspects related to our responsibility as Earth scientists on the sustainability of Earth systems at present and in the future. As such, we need to educate ourselves about the existing situation and dilemmas of the Earth systems related to our research; to educate our students to these dilemmas; and to actively share our data with the wider public through outreach. In my talk, I will present an example for Geo-Ethics in practice for my own field of research, namely forest science. Forestry and forest science are separate terms, however are co-dependent. Ideally, forestry is the application of forest science output across geographical landscapes. In reality, forestry is in constant overlap, and debate, with land management, nature conservation, and climate policy. In Israel, afforestation has been applied at large scales, with diverse consequences on biodiversity, landscaping, forest sustainability, and even politics.
In addition to my role as a PI, for the past five years I've been teaching a course to research students on tree physiology and forest ecology. The course includes a half-day field trip to a forest research station. This year I've taken the opportunity of the field trip to expose the students to geo-ethical issues related with forestry in Israel. Students are given a questionnaire to fill out during the ~1-hour bus ride to the site, where they are asked to observe the landscapes around them in terms of land-use, and, in the case of forest, in terms of estimated density, species, age, and health. Student reports are then shared and used to invoke discussion on the consequences of forestry on the aforementioned aspects, such as biodiversity, forest sustainability, and land ownership.

Klein-Ben David O. (1) Calvo R. (1), Peer G. (1), Freeze G. (3), and Sassani D. (3)
Borehole Disposal of Radioactive Waste in Israel

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The Israel Atomic Energy Commission is assessing intermediate-depth borehole (IDB) as a disposal strategy in Israel for spent nuclear fuel (SNF). With limited geological options for disposal, IDB disposal is being considered in the arid Yamin Plain (YP) region of the northeastern Negev desert. Waste emplacement is planned to be in the low permeability Ghareb Formation within the vadose zone, where the regional water table depth is estimated at a depth of ~550 m below surface. The Ghareb Fm. is up to 120 m thick at the west of the YP, and consists of three members containing oil shale (~70m), marl (~16m), and chalk (~30m). Recent advances in borehole disposal concepts (at depths from 30 to 5,000 m) increase confidence in the general safety and viability of the IDB concept. For countries with small waste inventory, IDB disposal is an alternative with economic efficiency over mined repository concepts. The concept for IBD consists of drilling a disposal borehole (or array of boreholes) within the vadose zone, emplacing waste packages and engineered barriers in the lower section of the borehole (the emplacement zone), and sealing the upper portion of the borehole (the seal zone) after all waste packages are emplaced (i.e., closure of the borehole). In the reference design each individual waste package is cemented in place prior to another waste package being emplaced above providing structural strength and isolation from the in-situ environment. The borehole seal system would consist of alternating layers of compacted bentonite clay and concrete, or other geomaterials compatible with sealing the borehole in the specific lithologies. The safety analyses (for both the operational and post-closure periods) for IDB disposal rely on the nature/characteristics of the host rock formation, as well as on the aridity of the vadose zone and the robustness of engineered barriers.

Kumar A. (1), Gavin D. (2), Waldmann N.D (1)
Paleoenvironmental reconstruction of western USA during the last ~13 Kyrs: insight from Lake Bells, Idaho

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Lakes are ubiquitous and their archives provide a wide spatial distribution from which paleoenvironmental records can be reconstructed. A multi-proxy record from Lake Bells (Idaho, eastern USA) provides a perspective on hydrology and ecosystem response to past climate change since at least the Last Glacial Maximum (LGM). The geochemical and sedimentological properties, organic content (Total Organic Carbon; TOC), magnetic susceptibility, and mineralogy were measured on a 15 m long core retrieved from Lake Bells, a 63m2 lacustrine system that developed in a small basin next to the St. Joe river. The aim of the current project is to utilize the sedimentary record to reconstruct the paleoenvironmental conditions of the region. The study shows that during 12,860 to 11,440 yr BP, high rate of organic matter accumulated in the lake (<30 mg cm-2 yr-1), probably in response to enhanced lake erosion or slope failures phenomenons during the Younger Dryas. The presence of well-dated tephra layers that correspond to Mount St. Helens, Mazama's volcanic explosions Glacier peak tephra (1980AD, 7,627 yr BP, and13,710 yr BP, respectively), provide excellent markers for a robust chronology, coupled by radiocarbon ages. The sedimentary record shows high values of detrital proxies during the early Holocene indicating enhanced terrestrial influx to the lake, probably in response to a warming climate. Proxies for low salinity conditions [Mg/(Mg+Ca)], higher values of weathering (CIA index) and behaviour of redox-sensitive elements (Fe/Mn) further supports this assertion. It appears that the 8.2 ka cold event is also identified in Lake Bells by a decrease in the detrital input to the lake (K/Al, Fe/Al and Ti/Al, a substantial decrease in the organic matter accumulation rate, which probably stand for meltwater pulses following the final collapse of the

Laurentide ice sheet. The appreciable increase in organic detrital content occurring during the late Holocene, coupled with high values to inorganic detrital proxies with improved sedimentation rates, demonstrate a direct response to increased humidity in the region and the associated growth of coniferous vegetation at higher elevations.

Kurtzman D.
Unsaturated-Zone Hydrology in Israel: a subjective review

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The unsaturated zone, overlaying Israeli aquifers is usually tens of meters thick, it has significant water and solute storage, as well as reactive capacity. Therefore, being the passage of water recharging the aquifers, the unsaturated zone has great impact on quantity and quality of aquifer water. This review gives a historical perspective of the unsaturated-zone hydrology in Israel, and elaborates some details of studies that focused on the impacts of the unsaturated zone on groundwater. These impacts include aquifer recharge rates under different soils and land uses and their temporal characteristics, aquifer salinization, aquifer contamination with nitrate, contamination with organic compounds and major-ion geochemistry.

Kutuzov I. (1), Said-Ahmad W. (1), Turich C. (2), Jiang C. (3), Luu N. (4), Jacksier T. (4), and Amrani A. (1)
The molecular and sulfur isotope distribution of volatile compounds in gases and condensates from the Triassic section of Alberta, Canada

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Volatile organic sulfur compounds (VOSC) are a family of compounds which exist in various geological settings including petroleum reservoirs where they often occur alongside H_2S. The study of their concentration and $\delta^{34}S$ values has the potential of providing a novel proxy for the origin of reservoir fluid and various in-reservoir processes such as sulfate reduction and thermal cracking. In this work we present the results of compound-specific S isotope analysis (CSSIA) of VOSC in two natural gas samples from the Triassic section of the Alberta Basin in Canada. For comparison, CSSIA was conducted for five condensate samples from adjacent wells.
The composition of C1-C3 alkanes in the Alberta Basin gas samples indicates they are of thermogenic origin while the associated H_2S (>5%) and CO_2 (<0.5%) link them with known sulfate reduction processes in the basin. The analysis of VOSC in the gas samples revealed similarity in the sulfur isotope composition for thiols (+18.5 - +19.7‰), sulfides (+19.5 - +23.4‰), and H2S (+15.6 - +16.2‰) suggesting an isotopic equilibrium during the reaction between H_2S and hydrocarbons in the reservoirs of both samples. In contrast, one of the gas samples contained alkyl thiophenes with distinct $\delta^{34}S$ values (+26.3 - +27.5‰) which are not in isotopic equilibrium with the H_2S and have likely originated from oil or bitumen. The molecular and isotopic analysis of condensates revealed several phases of thiol interaction with H_2S bearing similar $\delta^{34}S$ value as the H_2S in the studied gases. The $\delta^{34}S$ values of VOSC and H_2S in the studied samples are then used to identify the S sources in the studied section. This study demonstrates the potential of VOSC sulfur isotope analysis for the interpretation of origin, migration pathway and the relative time frame for in-reservoir processes impacting present day natural-gas properties.

Lang G. (1), ten Brink U. S. (1,2), Hutchinson D.R. (2), Mountain G.S. (3) and Schattner U. (1)
A full story: Post-rift accumulation patterns along the continental margin of the central-western Atlantic, Jurassic to present

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Sediment accumulation along continental margins is typically viewed and modeled in a 2-D cross-section from the sediment source on land to the deep sea sink. Using an unprecedented amount of seismic and borehole data along the Eastern North American Margin, we show that sediment depocenters shifted in both strike and dip directions over time. We divide the post-rift mid-Jurassic to present section into seven chronostratigraphic intervals, constrain the locations and dimensions of depocenters under the continental shelf, slope, and rise and volumetrically quantify the sediment accumulation rates. The Jurassic depocenters adhere to the syn-rift structure and its thermal subsidence loci, whereas the Cretaceous and Cenozoic depocenters disregard the inherited subsidence pattern. Instead, early, mid, and late Cretaceous shelf deltas migrate laterally, along the margin, relative to Jurassic depocenters. The margin-wide Cretaceous sediment flux overwhelmed the accommodation space available on the shelf, compelling river deltas to prograde seaward over the dead Jurassic shelf-edge reefs and build a vast system of lower slope aprons, reaching a peak in mid-Cretaceous. During the late Cretaceous, the northern margin segment, Georges Bank Basin, was uplifted, tilted, exposed and eroded. The relatively thin Paleogene section (<600 m in 46 Myr) is attributed to a decrease in the sediment flux due to a global sea level high, followed by an Oligocene hiatus and canyon incision. During the Neogene, deltas covered the Paleogene shelf, and deep-water contour currents supplied up to 3.5 km of sediments to the continental rise. Shelf subsidence was partially rejuvenated in Neogene time along 500 km of the mid-Atlantic shelf allowing the accumulation of up to 1500 m of deltaic sediments. Total ispoach volumes indicate a decreasing sediment flux from Jurassic to Paleogene, excepting the mid-Cretaceous sedimentation peak. Sediment flux increased in the Neogene, enhanced by deep ocean circulation and sediment transport.

Langford B. (1,2), Gayer A. (3), Frumkin A. (1), Cohen Ch. (4), Mushkin A. (2)
Piping and landscape evolution of the Kidron marls, Dead Sea basin, Israel

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The conventional definition of piping in earth science refers to sub-surface erosion in poorly consolidated soils by mechanical grain transport (i.e., with minor or without contribution of karst activity). This erosion mechanism typically creates elongated voids (pipes) with openings allowing for inlet and outlet of water. Although piping is a worldwide naturally occurring geomorphic phenomenon, it has been mostly studied in relation to civil engineering, while piping-development in natural conditions and the geomorphological

relationship between piping and landscape development has been rarely investigated. The hyper-arid conditions of the Dead Sea area support a slow piping-development rate and the preservation of piping features for relatively longer periods. These conditions facilitate a unique opportunity to follow the development stages of piping activity and to study the impact of the sub-surface piping erosion on geomorphic surface development over time.
This study was focuses on a few piping systems in the Lisan formation outcrops near the outlet of the Kidron gorge. Piping activity in this area created a complex surface geomorphology characterized by a pocked surface, blind streams, and cryptorheic ravines. The origin of the underground drainage is related to infiltration of surface runoff along joints and sub-surface sediment erosion in "grain-by-grain" mechanism. Joint enlargement and creation of a juvenile pipe leads to a positive feedback of higher water conductivity in the pipe and pipe enlargement. Subsequent collapses and events of sediment wash, eventually result in sinking of the surface. The maturation rate of the piping system depends on the local precipitation regime and the amount of runoff in the drainage system. 14C dating of sediment deposited within the largest piping cave in the study area indicates the beginning of its formation at ~1,400 yr BP and allows us to estimate the average rate of piping processes in this area.

Langford B. (1,3), Trubac J. (2), Vaks A. (3), Amrani A. (1), Frumkin A. (1)
Sulfuric Acid Caves in Southern and Eastern Israel - Indications from Cave Gypsum $\delta^{34}S$ Values

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Hypogenic limestone maze caves are the longest and most developed karstic features in the southern Levant. They formed below the water table, by deep water, that rose along tectonic lines, with no relation to the current climate or hydrology. Possible sources of water aggressiveness is dissolved H2S in the rising water, in a "Sulfuric Acid Speleogenesis" (SAS) process, that produces sulfate deposits with depleted $\delta^{34}S$ isotopic values, compared to those of the original source. In this study gypsum $\delta^{34}S$ values are used to clarify if SAS took place in the genesis of the hypogenic maze limestone caves in Israel, along with carbonic acid dissolution. The results show three populations: one with low $\delta^{34}S$ values (-16‰ to ~ 4‰), second with high $\delta^{34}S$ values (15‰ to 21‰) and third with intermediate values (~5‰ to 14‰). The first group indicates that some of the gypsum was deposited during the SAS process, the second group indicates gypsum deposition by evaporation within an existing cave, whereas the third group apparently represents the average $\delta^{34}S$ values of the sulphur contributions.
The results of this research show hypogenic speleogenesis either by carbonic acid and sulphuric acid. These caves were uplifted above the groundwater level at 6 Ma, what indicates that the climate was arid enough to preserve the original SAS-related gypsum in places. The geological frame enables to connect SAS caves discovered in Zohar-Kidod area to some nearby hydrocarbon reservoirs. Other SAS caves identified in this study are most likely related to microbial reduction of sulfate from deep Triassic layers.

Laor M. (1,2), and Gvirtzman Z. (1,2)
Classifying offshore faults for hazard assessment: The advantage of working in the marine environment

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The Israeli continental slope is dissected by numerous salt-related, thin-skinned, normal faults, forming tens meter high seabed scarps. However, this faulted zone is currently being crossed by pipelines transporting gas from offshore fields. This situation highlights the need to assess the hazard posed by these faults. Unfortunately, geohazards mitigation methodology in the marine environment lags tens of years after the well-established methodology onshore.
One possibility is to follow the onshore practice. In that case, a Holocene horizon needs to be detected in the sub-seabed; then, for each fault, the question of whether this horizon is displaced or not needs to be answered. This requires high-resolution seismic surveys and numerous coring that cannot be carried out for large regions.
Here we suggest a different approach. Instead of imitating the onshore practice, we take advantage of the unique opportunities available in the marine environment, where seismic data is superior in quality and quantity. Instead of investing huge efforts (multiple coring to a dated horizon) in finding whether or not each specific fault in the study area meets a pre-defined criterion of 'activeness,' we map the subsurface and determine the levels of fault hazard, based on the amount of recent displacement and the size of the fault plane. Instead of answering a yes-and-no question (active or not active), we classify faults into three hazard levels, highlighting "green" and "red" zones for master planning. A particularly red zone is the upper slope south of the Dor disturbance, where a series of big listric faults with large displacements rupture the seabed. Noteworthy, the sedimentation rate in this area is four times faster than the displacement rate, yet fault scarps are still a few tens of meters high. We suggest that this indicates seismic rupture rather than creep.

Lapid G. (1), Torfstein A. (1,2), Teutch N. (3), Erel Y. (1)
Constraints on the provenance and weathering rates of atmospheric dust from the U and Nd isotopic compositions of carbonate and silicate phases

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Atmospheric dust plays a key role in shaping global climate by affecting the radiation budget, modulating precipitation, and serving as a significant source of limiting trace metals to the oceans (e.g., Fe). At present, the primary source of atmospheric dust in the World is from the Sahara-Arabia desert belt. The mineral composition of dust varies both spatially and temporally, but can be generally divided into an Al-silicate phase, a carbonate phase and a water-labile phase, which often includes sea salts and anthropogenic elements.
Here, we report the composition of (234U/238U) and eNd, together with trace element concentrations of the Al-silicate and carbonate phases of dust samples collected in the Gulf of Aqaba, northern Red Sea, between the years 2009-2019. The sampling site is located between the Sahara and the Arabia Deserts and is subjected to frequent dust storms, whose source is identified through air mass back trajectories. While eNd values reflects the source composition, the (234U/238U) ratio is sensitive to the weathering history of the samples, which reflects the combined effects of their provenance, transport pathways and chemical weathering rates. Combined with new and published dust trace element compositions, we will discuss the characteristic weathering history of dust from distinct geographic sources across the Sahara-Arabia Deserts, and evaluate the implications for interpreting dust records in geological archives.

Lazar M. (1), Cline E. H. (2), and Yasur-Landau A. (3)
Tel Kabri – Did an earthquake lead to abandonment of the Middle Bronze Age settlement?

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Causes for abandonment of archaeological sites are often thought to be the result of climatic conditions, unsustainable use of land and resources, invasion, economic downturn, or a combination of these factors. Geological forces, such as earthquakes, can act as triggers for war or economic decline, and unless they are major events, usually do not lead to the total desertion of a site. For years there has been much speculation surrounding the abandonment of the Middle Bronze Age IIB palace of Tel Kabri, ca. 1700 BCE. There are no weapons, hoards of money and jewelry, or visible evidence for fire, which rules out hostile attack or conquest. There are also no indications of drought or environmental degradation that might have forced the inhabitants to vacate the site, nor mass graveyards to indicate a pandemic. It seems that the inhabitants simply walked away from the site. The current study uses micro-geoarchaeological methods to show that the demise of the palace was rapid, with walls and ceilings collapsing at once. Stratigraphic and structural data from five excavation seasons were reexamined, showing that at least nine Potential Earthquake Archaeological Effects are associated with the last occupation phase of the palace. All lines of evidence show that an earthquake damaged the palace to a degree where it was no longer economically viable to repair. This conclusion is compounded by the discovery of a 1–3 m wide trench that cuts through the palace for 30 m, which may be the result of ground shaking or liquefaction caused by an earthquake. This study shows the importance of combining macro- and micro-archaeological methods for the identification of ancient earthquakes, together with the need to evaluate alternative scenarios of climatic, environmental, and economic collapse, as well as human-induced destruction before a seismic event scenario can be proposed.

Lellouch A. (1)
Fiber-optic seismology in urban environments

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During the last decade, seismic sensing through optical fibers has become a reality. By analyzing the effect of seismic deformation on the fiber's optical response, state-of-the-art Distributed Acoustic Sensing (DAS) now offers a 1-meter sensor resolution for tens of kilometers of fiber. In other words, a single DAS system can record up to 40,000 data channels at once – two orders of magnitude more than the entire earthquake-monitoring seismic network in Israel.
In this talk, I will first introduce the underlying operating principles of DAS acquisition. These measurements are very different from conventional seismic sensors and need to be analyzed accordingly. We utilize the ambient seismic field, recorded on a standard telecommunication fiber deployed around the Stanford campus, to analyze subsurface properties using Rayleigh waves induced by traveling cars. Their analysis can be complemented by low-frequency sources: buses, trucks, and earthquakes. The same fiber can also be used to monitor highly granular traffic patterns, and, as we show, their reaction to the COVID-19 lockdown.

Letz O. (1), Siebner H. (1), Avrahamov N. (2), Egozi R. (3), Sivan O. (4), Angert A. (5), Vaks A. (6), and Dahan O. (1)

Isotopic and Geo-chemical evolution of rainwater percolating through the rocky outcrops of the Southern Judea mountains

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Groundwater water recharge of mountain aquifer requires a detailed knowledge of the hydrologic system and adequate monitor and modeling methods to determine water amount and water quality evolution. Mountain aquifers well known by their highly complex lithologic structure and surface morphology. These become more significant in dry climate regions (<300 mm rainfall/year) that are characterized by erratic rain pattern and extreme deep thickness of unsaturated zone. In this study we monitor the isotopic and geo-chemical evolution that affect the composition of the unsaturated porewater during deep infiltration, from surface to depth that is not affected from evaporation. The geo-chemical processes were characterized related to morphology and climate conditions in the southern part of the Judaea mountain. The research setup includes instrumentation of first order stream which characterized with two main typical geomorphologic setting: rocky terrain and deep soil along the stream channel. Each plot was instrumented with monitoring setup that include meteorological station and Vadose Zone Monitoring System (VMS) that enables continuous water content measurement and collection of unsaturated porewater from the vadose zone.
Fast increases in water content and arrival of depleted $\delta^{18}O$ (VSMOW) reveal quick and deep infiltration of rainwater during storm events while enriched $\delta^{18}O$ arrival indicate on slower infiltration of water that exposed to evaporation. In addition, the geo-chemical processes exhibited depletion in $\delta^{13}C$ (PDB) of rainwater during the infiltration (-19 to -11 ‰) which indicate on dominant of biogenic activities and relatively low rock-water interactions.
The study's results clearly exhibited different infiltration rates in each site. Fast infiltration at the rocky terrain and shallow infiltration across the deep soil site. Also, the rain pattern impact on the geochemical process and finally impact the groundwater quantity and quality.

Levi E. (1), Gal E. (1), Sivan O. (2), Yechieli Y. (3), Shalev E. (3), and Furman A. (4)
The advantage of using geoelectrical methods to locate a well; case-study from Michmoret Israel
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The use of Geoelectrical methods can add valuable data regarding water salinity prior drilling, especially in areas with fresh water/ saline interface (FSI). The present geophysical study is part of a general ongoing research project, studying the effect of saline pumping from a near shore well, on aquifer water quality and the FSI location. An important part of the project was to drill an observation well that crosses the FSI, in the vicinity of the existing pumping well. Therefore, a combined high resolution electrical resistance

tomography (ERT) and accurate time domain electromagnetic (TDEM) methods were applied at the proposed drilling site.
The geophysical measurements created 2D resistivity profiles that can clearly show the FSI location in phreatic sub aquifer "A", and indicate for the existence of sharp FSI in sub aquifer "B" about 50 m east to the existing well. The results were confirmed during dry air drilling by EC measurements and with water samples that were taken for geochemical analysis at the GSI lab.
For farther resistivity precise work, 72 electrodes were located around the borehole pipes. The electrodes will allow monitoring of the water salinity with borehole ERT measurements, data which can be used as an input for the hydrological modeling of the project.

Levenson Y. (1), Korngreen D. (2) Jurkovšek, B. (3), Kolar-Jurkovšek T. (4)
Coupling of Cathodoluminescence (CL) imaging and Electron Prob (EPMA) analysis showing Mg participation in CL in carbonates

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Cathodoluminescence (CL) imaging is often used for reconstructing the diagenetic history of sedimentary rocks. CL images demonstrate the differences in photonic emission from the material that is being excited by a cathode electron beam. In carbonate rocks, it is well established that the luminescence is usually caused by attendance of Mn in the carbonate lattice, instituting CL zones diagram based on Mn/Fe ratios, and by that links luminescence to oxidation-reduction precipitation environment and processes. In this study, we characterized a thin section of Middle Triassic marine limestone from the Prikrnica section, Dinarides, Slovenia. CL images of the thin section were generated using CITL Cathodoluminescence Mk5-2 apparatus at the GSI. Following the CL imaging, the same area was analyzed for elemental maps using the JEOL Superprobe EPMA with Energy-Dispersive X-ray Spectroscopyand wavelength-dispersive spectrometers at the Microbeam laboratory in the Hebrew University of Jerusalem.
The CL images show a unique pattern of two forms of differential CL response: dull-CL (DCL) in organogenic calcite and bright-CL (BCL) in the cement. While the Mg concentration map corresponds to the CL imaging, the Mn and Fe concentration maps were nearly uniform and did not show a pattern relates to the DCL-BCL appearances. Hence, we suggest that with a small presence of Mn and Fe (340 and 560 ppm respectively), an increase in Mg concentration enhances the local luminescence.
The incorporation of Mg into the lattice of calcite is not a function of redox process, but depends on Mg concentration, temperature, and salinity in the precipitating solution. Therefore, the results of this study challenging established methods, adding salinity as additional possible cause for CL activation beside redox conditions. This unique observation of Mg involvement in CL efficiency maybe relevant to dolomite formation in the geological record and is a promising field of future research.

Levy Y., and Kiro Y.
Fluxes and resident times of circulated seawater in the aquifer, under different circulation factors

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Seawater circulation in the aquifer, the fresh-saline water transition zone, and submarine groundwater discharge (SGD) are well-researched topics in the coastal hydrology and oceanographic research fields.

However, one of the crucial subjects that have not been researched and quantified is the effect of different factors on water and solute fluxes and residence times in each circulation mechanism. Due to water-rock interaction, the seawater's fluxes and residence times in the aquifer may be a crucial component of the ocean chemical composition and nearshore ecology. Two of the main circulation mechanisms are density-driven flow and sea-level fluctuations (due to tides and waves). Each mechanism is characterized by typical water and solute fluxes and residence times. The hypothesized key factors affecting the circulation fluxes and residence times are the hydraulic gradient (that may change seasonally), hydraulic conductivity (and other hydrologic parameters), beach slope, tide and waves amplitude, dispersivity, and the distribution or the kinetic coefficients (for a reactive solute). This work examines the effect of the different factors on the water and solute fluxes and residence times. The hypothesized key factors that affect the circulation will examine, each separately and some combinedly. Numerical modeling of a theoretical coastal aquifer was applied, simulating the two fundamental circulation mechanisms, the fresh-saline transition zone and SGD. The sea-level fluctuation causes a much higher circulation rate and volume (per sea-floor length) but lower residence times.

Levy Y. (1,2), and Gvirtzman H. (1)
Leakage from the evaporation ponds of the Dead Sea Works toward the Dead Sea
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During the last forty years, a hydraulic gradient of more than 40 m over 10 km has developed between the evaporation ponds of the Dead Sea Works and the Dead Sea. Naturally, this hydraulic gradient has to force flow from the ponds to the Dead Sea. To prevent this leakage, in 2012 a vertical deep sealing wall was built along the ponds' embankment. Although, the preventing is not hermetic and the saline water still leaks. In this study, the leakage process was numerically simulated, based on mass balance and hydrological observations. The mass balance was calculated starting from 1980 to the present, the fluxes in the Marine Canal (the "secret river") were measured, and more evidence of the leakage and hydrological data (levels, pumping tests, chemical composition) were collected. The numerical modeling was calibrated based on all the above data. The model reconstructs the leakage volumes during the last forty years. The leakage volume increased from 20 mcm/year in the 1980s to 100 mcm/year before the sealing wall was built (in 2012), and from 60 mcm/year since the wall was established to 80 mcm/year today. Using the calibrated model, the leakage volume is predicted to increase in the next decades, mainly through the Ye'elim alluvial fan. The results show that all of the leakages flow toward the Dead Sea. The possible paths are the subsurface, the Marine Canal and the Arava stream.

Lotem N. (1), Pellerin A. (1), Russak E.E. (1), Hasson N. (2), Anthony K.W. (2) and Sivan O. (1)
Methane production and consumption in thermokarst lake sediments

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The ongoing global temperature rise induces the thawing of permafrost soils in the arctic, allowing Pleistocene aged frozen organic matter to become available for microbial degradation and production of methane. This methane can play a key role in a positive climate feedback loop, as its global warming potential is ~28 times larger than the equivalent carbon dioxide. Our study focuses on the methane cycle in the sediments of thermokarst lakes, which are the rapidly expanding lakes forming as a result of thawing permafrost. Several cores were collected from the sediments of four thermokarst lakes in Alaska in two

seasons and methane production and consumption rates were quantified. The pathways for these processes were investigated by incubation experiments and geochemical pore-water profiles. Our results demonstrate that while methane production is vigorous in these sediments, methane oxidation is lower by two orders of magnitude. This implies that contrary to marine sediments, thermokarst lake sediments have little to no buffer mechanisms capable of attenuating methane production. Furthermore, our results show that methane production rates, pathways, and temperature sensitivity are dependent on the lithological units. The highest methane production and the strongest response to temperature were observed in organic-rich peat. This might be a result of the large organic content of this unit, a younger age of the organic matter, or its resident microbial community. It is crucial to further investigate these controls on methane production in thermokarst sediments in order to better evaluate the current and future methane emissions in the Arctic and its global climate feedback.

Lu Y. (1), Wetzler N. (2), Waldmann N. (3), Agnon A. (4), Biasi G (5), Marco S. (6)
A 220 kyr-long continuous large earthquake record from the Dead Sea Fault

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Large earthquakes (magnitude ≥ 7.0) are rare, especially along slow-slipping plate boundaries. Lack of large earthquakes in the instrumental record enlarges uncertainty of the recurrence time; the recurrence of large earthquakes is generally determined by extrapolation according to a magnitude-frequency relation. We enhance the seismological catalog of the Dead Sea Fault Zone by including a 220,000-year-long continuous large earthquake record based on seismites from the Dead Sea center. We constrain seismic shaking intensities via computational fluid dynamics modeling and invert them for earthquake magnitude. Our analysis shows that the recurrence time of large earthquakes follows a power-law distribution, with a mean of 1400 ± 160 years. This mean recurrence is notable shorter than the previous estimate of 11,000 years for the past 40,000 years. Our unique record confirms a clustered earthquake recurrence pattern and a group-fault temporal clustering model, and reveals an unexpectedly high seismicity rate on a slow-slipping plate boundary.

Maayani M. (1), and Kiro Y. (1)
Mechanisms of freshwater flow and geochemical interaction in a heterogenic coastal aquifer
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Freshwater is vital everywhere on Earth, especially in semi-arid and arid regions such as the Middle East, which suffers from a severe shortage of fresh water. In Israel, as in typical desert areas, most rainfall water reaches the sea through aquifers rather than rivers. Hence, understanding the mechanisms of freshwater flow and geochemical water-rock interaction within the aquifer is essential.
The research field site is located in Eastern Mediterranean coast in Northern Israel, between the border with Lebanon and the city of Acre, near Achziv. The beach aquifer's geology is presented by alterations between sandy layers and Quaternary layers of the brown hard calcareous sandstone with caverns, locally known as "kurkar". Underneath extends Upper Cretaceous carbonate unit.

Samples of water are being collected seasonally from different stages of the freshwater flow paths – freshwater wells onshore, coastal areas of water mixing, and seawater. Measuring the salinity, pH, temperature, and geochemical composition of each sample allows for reconstructing the water flow path. Preliminary results show a unique type of freshwater discharge. In contrast to the typical flow in a homogenic aquifer where there is a sea/freshwater mixing zone, the observed flow is through several freshwater offloading spots located perpendicular to the sea, on the shore, and 500 m away from the shore. These "freshwater tunnels" are echoed with significant deviations in temperature, Cl, Sr, U, and B concentrations, suggesting a particular form of interaction between the water with the rock along its way.

Manda S. (1), Titelboim D. (1,5), Ashckenazi-Polivoda S. (2), Almogi-Labin A. (3), Herut B. (4), and Abramovich S. (1)
Macroalgal habitat preference of benthic foraminifera: implications for future warming
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4.Israel Oceanographic and Limnological Research, Haifa, Israel
5. School of Earth Sciences, University of Bristol, Bristol, UK

Considering the thermal limits of coastal macroalgae habitats in the Eastern Mediterranean, it is important to study the response of the associated meiofauna in order to better understand the expected feedback of ecosystems to future warming. In this study, we characterized the benthic foraminiferal assemblages of two common types of macroalgae habitats (Turf and Coralline algae) along the Mediterranean coast of Israel. Our study is based on a one-year ecological monitoring of a thermally polluted station, representing near future warming, and an undisturbed environment. Our results show that most foraminifera species show a preference for specific macroalgal habitat. The existence of the common foraminifera species is not threatened by the expected disappearance of coralline algae habitats. However, their community structure will be impacted. Interestingly, the species that exhibited high abundances on coralline algae are highly thermally tolerant, thus this association might reduce their proliferation with warming.

Marig Y. (1), Karcz Z. (2), and Sorek N. (3)
The Tamar Emission Reduction Project

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The Tamar Project came online in March 2013, and since then has been the major supplier of natural gas to Israel. Tamar accelerated the gradual transition of power generation in Israel from diesel and coal to natural gas, and thus facilitated a dramatic improvement in the quality of air in the country. The main processing facility for the Tamar Project is an offshore platform, located approximately 25km west of Ashqelon. Since Tamar's natural gas is dry and sweet, i.e., over 98% methane and without material contaminants, it requires minimal treatment, which focuses on separating the gas from fluids, and desiccating it to the specifications required by the Israeli regulator. Phase separation at Tamar is achieved primarily by utilizing density differences at various temperature and pressure conditions, but ultimate desiccation is achieved by flowing the gas through Tri-Ethylene Glycol (TEG), which absorbs the water from the flowstream. The TEG is recycled by heating it to the point where the water evaporates.

A similar recycling-by-boiling process is performed on the platform for Mono-Ethylene Glycol (MEG), which is injected into the wells to prevent hydrates formation in the subsea system.
Following a dialogue with the environmental authorities, Tamar launched a massive effort to reduce pollutants emissions, by as much as 98%. the Tamar Emission Reduction Project, which started in 2017, included installing condensation units on the MEG and TEG reboilers, that would divert the condensed matter, which constitutes most of the pollutants, back into the fuel-gas stream. The project was executed from concept to start up in ~18 months and at a total cost exceeding $38MM. The system became fully operational on March 31, 2019. Periodic sampling conducted since shows over 98% reduction in BTEX and NMVOC emissions from the specified vents.

Markin M. (1), and Bookman R. (1)
A high-resolution Holocene record from the Dora pond and its significance to hydro-climatic conditions

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A ~20 m sequence of terrestrial and freshwater deposits from Dora, a pond at the central coastal plain of Israel, is the subject of a high-resolution multivariate study, which is aimed at identifying shifts in environmental conditions associated with paleoclimate changes. Detailed Optically Stimulated Luminescence (OSL) dating of the sedimentary sequence revealed that the Holocene period consists of fine-grained wetland sediments with varying amounts of aeolian sands, a period of soil formation in the interval from the end of the Holocene to 32 ka followed by an unconformity, and coarse sand accumulation between 90 and 80 ka.
Grain size distribution and end-member modelling allowed us to distinguish different types of sources of the pond's sequence that consist of recycled aeolian sands, fluvial inputs from the surroundings, and dust accumulation. Elemental data obtained using x-ray fluorescence provides a high-resolution multi-element analysis for the upper 5 meters that were dated to the Holocene. It was found that the strength of associations between the studied elements (Ti, Rb, K, Zr, Si, Ca, Sr, Mn, and Fe) shift over time and represent changes in the state of the pond, which are ultimately related to climate changes. The increase in fine-grained detritus, as also indicated by Ti, Rb, K and Zr / Rb, overlaps with independently established periods of lower pond productivity and is interpreted as more arid conditions. Periods with a lower fine detrital content and larger grain sizes coincided in time with periods of higher pond productivity. The heterogenic accumulation of the sediment sequence is explained by the changing role of various sources and transport processes, which at this stage are interpreted as reflecting hydro-climatic fluctuations.

Mart Y. (1)
Is There a "Sinai Micro-Plate"?
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The conventional tectonic model of the northern Red Sea province suggests that an active triple junction is located south of Sinai Peninsula. The 250 km of crustal extension and accretion that occurred in the Red Sea splits at that junction between ca. 150 km of extension across the Suez Rift, and 107 of sinistral displacement along the "Dead Sea Transform". That presumed "transform" was suggested to connect to the East Anatolian Fault, which absorbed some of the lateral displacement, while the rest distributed along faults in Lebanon.
Several observations cast doubt whether the Levant Rift is indeed a "transform"; whether did sinistral lateral displacement of 100 km take place along that structure. Furthermore, is it certain that the Suez Rift is an active tectonic plate boundary, and if not, does an independent Sinai microplate exist? Marine

geophysical surveys in the northern Red Sea did not find evidence for a tipple junction south of Sinai. They showed that the zone of axial tectonic activity swings eastwards south of Sinai and extends from the Red Sea into the Elat Rift. The Dead Sea and other internal basins along the rift, which indicated strike-slip displacement along the Levant Rift, could also be attributed to basins formed under oblique extension. Therefore, the Suez Rift was the northern extension of the Red Sea in the Miocene. Then a shift in the pattern of the tectonic activity occurred in the late Miocene, and the tectonic activity broke open the Levant rift. The Levant Rift is a prime e example of incipient oblique spreading center. Consequently, while Sinai was a part of the African plate in the Miocene, it is and integral part of the Arabian plate since the Pliocene.

Meilijson A.
Viruses and climate change; approaches to the study of viral activity in the geologic record

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The Anthropocene in which we live is marked by human driven climate change, affecting sea-surface warming, ocean acidification, ice melting, oceanic freshening, and changes in circulation/mixing regimes. These in-turn impact marine ecosystem structure and function, and thus regulate cycling of carbon and nutrients in surface oceans. The Consensus Statement “Scientists’ warning to humanity: microorganisms and climate change” documents the central role and global importance of microorganisms in climate change biology. It also puts humanity on notice that the impact of climate change will depend heavily on responses of microorganisms, which are essential for achieving an environmentally sustainable future. Marine viruses play an important role in oceanographic dynamics including carbon sequestration, biogeochemical cycles, and gas exchange between the ocean surface and the atmosphere. Marine viruses were found to interact actively with the present climate change and are a key biotic component that influences the oceans’ feedback on climate change.
While viruses clearly played an important role in Earth history, with a general agreement regarding their part in the beginning of life on Earth (the RNA World theory), we know next to nothing on their actual abundance or functionality due to their lack of a hard shell or lipids in the viral structure, which could be identified as fossilized remains. Viruses are known as agents of organo-mineralization in microbial mats, promoting the precipitation of minerals. DNA sequencing confirms the role of viruses in the evolution of ecosystems as biomass regulators, affecting grand- and small-scale evolution and extinctions. However, this technique is limited to the past ~500,000 years. Incorporation of the viral component into future ocean climate models could potentially rely on viral biosignatures such as the production of unique lipids and fatty acids within the glycerophospholipids originating from host phytoplankton and incorporated into the viral structure, creating a potential environmental virus biosignature.

Meilijson A. (1), Bialik O. M. (2), Makovsky Y. (2), Benjamini C. (3), Sepúlveda J. (4), and Waldmann N. D. (1)
The role of climate and sediment transport on organic carbon preservation in deep marine settings of the Eocene and the modern continental margin of Israel

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The amount of carbon stored in oceanic basins to a great extent depends on sedimentary transport of organic matter (OM) sourced in continental and shallow-marine settings. Climate is the main driver of the rate and energy of transport systems, and strongly influences carbon flux as well. This study addresses questions regarding past and present climatic variations and their influence on carbon fluxes through increased offshore transport.
The GPHS-1 core drilled in northern Israel, bottoming in the Early Eocene, includes 150 m of predominantly organic-rich carbonates (averaging 4.5% TOC), associated with displaced limestone units. Sedimentary features indicate downslope detachment, movement, and emplacement of sedimentary components into autochthonous chalk, sometimes multiple times. Associated dark organic-rich laminae and pore infillings are present in the porous limestone facies, and elemental analysis shows a high correspondence between preserved OM and continental derivation. Geochemical analysis indicate mixing of different types and sources of OM, and also a reoccurring affinity of OM composition to specific sedimentologic facies. Reconstruction of the depositional system of northern Israel indicates that it formed as canyon-mouth fan systems at the foot of a scalloped margin slope, bearing similarity to deposits at the foot of the modern eastern Mediterranean shelf, but in a mostly pelagic carbonate facies. Core GPHS-1 was deposited in a pelagic depositional environment similar to the drilled section of ODP Leg 160 in Hole 966F in the Eratosthenes Seamount, on the far western side of the Levant Basin. There were local variations in transport mechanisms, and the Israel section is richer in terrestrial, near shore, and reworked sediments and OM. Recent sediments of the basin-margin setting in the eastern Mediterranean reveal a parallel association between slide detachment surfaces/submarine channels and preservation of OM, in a hemipelagic siliciclastic setting.

Mershon R. B. (1), Navon O. (1), and Weiss Y. (1)
Microinclusions and Nitrogen Aggregation in Diamonds from Pulandian, China

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Metasomatic processes, whereby infiltrating mantle fluids and melts rich in volatiles and incompatible trace elements interact and alter mantle rocks, control diamond formation and impact the evolution of the continental lithosphere. Fibrous diamonds trap and preserve such fluids/melts in microinclusions during their growth, thus providing an opportunity to study and characterize pristine mantle metasomatic fluids.
A suite of fourteen diamonds from the Pipe-50 kimberlite of the Pulandian mine in the northeastern flank of the North China Craton was analyzed for their nitrogen concentration and aggregation and volatile content using FTIR and for the composition of their microinclusions by EPMA (major elements) and LA-ICP-MS (trace elements). The diamonds carry between 357 and 1063 ppm nitrogen in both A-centers (two N atoms replacing two C atoms) and B-centers (four N atoms around a vacancy) with 9-37 %B. On a total nitrogen vs. %B-centers plot, all diamonds fall along a single isotherm (assuming a similar residence time), suggesting that the diamonds have formed in a singular event and originate from the same depth in the lithosphere. In comparison to most fibrous diamonds that carry mostly A-centers, the Pulandian diamonds resided longer or formed deeper in the lithospheric mantle. Twelve diamonds bear high-magnesium carbonatitic microinclusions compositions, rich in MgO, CaO, FeO, K2O, and CO2, while one contains a saline composition rich in Cl, K, and Na. The high-Mg carbonatitic HDF is indicative of a carbonated peridotitic source, whereas the saline HDF suggests association with subducted oceanic crust. The

incompatible trace elements exhibit a “planed” pattern for the high-Mg carbonatitic composition and a “ribbed” pattern for the saline one.
Our finding joins earlier observations on the coexistence of saline and high-Mg carbonatitic mantle fluids, which indicates a peridotite source rock that was inundated with water from a subducting source. The “planed” trace element signatures resemble that of the Pulandian kimberlites, whereas the “ribbed” signature bears similarity to later erupted alkali basalts, suggesting a possible genetic relation at depth.

Mor Z. (1,2),Eyal H. (1,2), Bodzin R. (1),Sirota I. (1,2), Lensky N. (1)
Remotely Operated Vehicle (ROV) in the Dead Sea: Exploring sedimentation dynamics over the lake floor

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We present new observations from the Dead Sea lake floor, the only modern analog for deep, halite-precipitating basins, using Remotely Operated Vehicle (ROV, Deep Trekker Revolution). The ROV fills a knowledge gap regarding the processes leading to sedimentation of halite and detritus. These sediments are formed and accumulated rapidly at an average rate of ~0.1 m/year, however, these processes are highly dynamic and vary in time and space. The ROV enables to study of this active environment as it is equipped with a high-resolution camera providing videos, photographs, sampling arms providing a collection of sediment and water samples. The sonar and navigation system (USBL) enables to survey of a specific location and tracks it repeatedly. In the lecture, we will dive to the lake floor and observe the dynamics of this active sedimentary environment.

Morad D. (1,2), Sagy A. (2), and Hatzor Y. H. (1)
The role of initial roughness on friction dynamics

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Earthquake dynamics is strongly influenced by the initial geometry of the fault surface. Yet, the effects of surface topography on friction instability are still not well understood. Here we present an experimental setting of point-load displacement-control, which simulates fault-plane instabilities in the laboratory. Five direct shear experiments were performed on 10 cm long and 8 cm width Gabbro samples using different levels of initial surface roughness. The tests were conducted under constant normal stress of 5 MPa, with an imposed shear displacement rate of 0.01 mm/sec. Under those initial conditions, we observed that shear failure of the most rough interface (mean RMS = 1000 µm) was controlled by large scale fracturing, expressed by spontaneous and significant stress drop once ultimate shear resistance has been attained, followed by steady state sliding under a much lower residual shear stress level. Interestingly, sporadic stick-slip oscillations were observed during the steady state sliding phase. In contrast, lower roughness samples (mean RMS = 400 µm and lower) did not exhibit a significant stress drop, and post peak sliding was characterized by stick slip oscillations, the nature of which was found to be strongly related to the initial roughness profile.

Morag N. (1), Klein-Ben David O. (2,3), and Sandler A. (1)
Depositional environment and diagenesis of clays in the Ediacaran Zenifim Formation (southern Israel)

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Zenifim Formation is a thick arkose sequence, locally interbedded with volcanics, which was deposited on the northern outskirts of the Arabian-Nubian Shield (ANS) during the Ediacaran period. We have studied the clay mineralogy of Zenifim Formation in core samples from four boreholes along a ∼200 km transect in southern Israel (Negev area) in order to constrain its depositional environment and the late diagenetic/metamorphic processes that have affected it. In the southern Negev (Sinaf-1 borehole) the mineralogical composition of the clay fraction near the top of the formation, at 1000 – 1600 m depth, is dominated by ordered (R1-type) illite-smectite (I/S), unexpectedly accompanied by smectitic randomly interlayered (R0-type) I/S. In the central and northern Negev (Hameishar-1, Ramon-1 and Makhtesh Qatan-2 boreholes) the entire Zenifim section, extending from 1500 to 3400 m depth, is dominated by illite and minor I/S is always ordered and changes from R1- to R3-type with depth. This transition is deeper in Ramon-1 borehole than in Makhtesh Qatan-2 borehole. Chlorite and chlorite-smectite (Chl/S) occurs sporadically throughout the section in most boreholes. Overall, the variation of clay minerals composition along the Zenifim section reflects increased paleo-thermal gradient and/or burial depths toward the north, which is correlated with the formation of late Devonian - Carboniferous thermal structure over the Levant area. The pristine, I/S dominated clay assemblage found in the Zenifim section in southernmost Israel is remarkable given its relatively old age and offers a unique glimpse into the Ediacaran climate in the northern ANS, which resided at low latitudes at that time. This I-S dominated, kaolinite-lacking clay assemblage, together with relatively low chemical index of alteration values found for these sediments, reflect limited surface weathering of ANS basement rocks under cool and dry climatic conditions. The persistence of such climatic conditions within the (sub-)tropical belt during the middle Ediacaran is consistent with the Gaskiers global glaciation event.

Moshe N. (1,2), Katz O. (1),Torfstein A. (2,3), Kanari M. (4), Masque P. (5,6), Hyams-Kaphzan O. (1)
The history of the Nahariya Submarine Canyon, offshore northern Israel, from sedimentary down core records and foraminiferal analyses

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Submarine canyons are prominent features in continental slopes, playing an important role in sediment transport to the deep sea, as they form conduits for turbidity currents, in addition to landslides caused by their steep slopes. Such mass transport events could create geo-hazards and compromise infrastructures along the continental slope.
This research focuses on the Nahariya Canyon, which is part of a series of submarine canyons located along the continental slopes of the eastern Mediterranean, offshore northern Israel. Here, we report the results from a study of two piston-cores sampled in the canyon at water depths of 650m (NAC650, ~2.5m long) and 915m (NAC915, ~6m long). Chronologies were established based on ^{210}Pb, radiocarbon and OSL

dating, and the sediments were characterized by major and trace element concentrations, mineralogy, grain-size, and foraminiferal assemblages.
Our results show that both piston-cores are comprised of a top ~40cm thick interval capping of fine laminated mud, deposited over the last ~150-200 years, apparently reflecting hemipelagic sedimentation. This capping overlays a consolidated sequence in both cores, which in NAC650 is mostly homogenous, and dated to the previous glacial (>140 ka) and in NAC915 it consists of 70cm interval of mud clasts dated to 27-46 ka, a result of a down canyon mass wasting (debrite). Below that, the sediment is mostly homogenous and dated to the last glacial (>25 ka). Broken shells of shallow shelf foraminiferal species such as Ammonia spp. are found in water depths of 650m and 915m, indicating that allochthonous sediments are prevalent along the cores.
The cores suggest that the canyon is an erosive environment at least since the LGM. The Holocene is not represented in the records, probably due to the dominance of erosion processes, except for a thin layer of sediment deposited over the last two centuries that prevails along the entire canyon.

Muhedeen L. A. (1), Bialik O. M. (2,1), Waldman N. (1), Makovsky Y. (1,3)
Climate-driven changes in sediment supply and salt deformation focus seafloor gas seepage

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Sediments laden flows, driven by riverine outpour onto deep-sea fans, transmit nutrients and organic matter from terrestrial environments into the ocean deeps, playing an important role in Earth's biogeochemical cycles. The present day seafloor of the Nile fan is etched by discrete deep-sea channel levee systems, that drain in a general northward direction towards the Cypriot deep. Using multi-level seismic amplitudes extraction from 3D surveys across the Levant Basin, pervasive buried paleo-channel-lobe systems are revealed, extending tens of meters beneath the seafloor. These systems are characterized by high-amplitude / negative-polarity seismic reflectivity, hypothesized to represent gas bearing sand-prone deposits. Subtle narrow elongate seafloor ridges stretch perpendicularly to the channels, formed by deformation of the underlying Messinian salt. The channels are diverted between, and cut passages across, these ridges. Buried paleo-lobes appear to engulf the ridges, while stratigraphically overlaying buried paleo-channels, which continue undisturbed through some of these ridges.
We suggest that increased sediments supply, rapidly deposited the pervasive channel-lobe systems, which overwhelmed salt related deformation and partly buried the ridges. Subsequent decrease of sediments supply resulted in the burial of the lobe systems by sediments sheets along with focusing of the seafloor channels to discrete channel-levee systems. Continued deformation of the underlying salt resulted in renewed uplift of the ridges, leading to diversion of the active seafloor channels. The buried sand-prone systems became charged with predominantly microbial gas. Differential uplift of these systems focuses gas flow to the elevated areas, where seepage occurs due to breaching of the overburden or incision by later channels.
This conceptual model, and its verification by ROV surveying of several seepage sites, allowed us to predict potential seepage edifice based on available 3D seismic data. The distribution of predicted seepage was in turn used to form a model for the potential presence of rare seafloor habitats, to allow broad planning of seafloor conservation. Most recent AUV based synthetic aperture sonar (SAS) surveying verified the

seismic prediction methodology, and the conservation model at large, providing first of a kind visualization of the seepage edifice.

Naor R. (1,2), Gulick V.C. (4), Mushkin A. (1), and Halevy I. (2)
Subsurface volume loss and collapse due to surface infiltration of Osuga Valles' catastrophic floods, Mars

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Osuga Valles (OV) form a catastrophic system in which the flood events can be tracked from their chaotic origin down to their sink at terminal depressions. We have begun analyzing OV's terminal depressions, to understand their possible formation mechanism(s). The depressions' association with the outflow channels implies that there may be a link between the inflowing floodwater and the formation of depressions, hence the possibility of formation by surface collapse from subsurface dissolution, if such subsurface mineralogy existed.
Our mapping suggests that preliminary volume loss and collapse resulted from lower discharges of infiltrating flood waters prior to the onset of collapse. Subsequent collapse was likely due to additional higher discharge floods that drained directly into the forming depressions.
A terrestrial analog to OV's depressions may be the Ze'elim Fan Sinkholes near the Dead Sea, Israel. These sinkholes are located at the termini of flood channels. A suggested model for their formation is that ground-water dissolution of subsurface salt layers formed the initial surface collapse, followed by subsequent draining of floodwater through the collapsed region, which became the dominant subsurface salt dissolution agent and induced further surface collapse. However, for the OV's depressions, it is not clear whether the infiltrating flood waters removed the substrate volume by dissolving subsurface salt deposits, or by excavating rocks and melting ground ice. However, the region includes older valley networks, which terminate in this potential sedimentary basin, and implies that an evaporite-rich sedimentary basin previously existed at this site. We plan to estimate flood discharges using sediment transport equations and to assess the total subsurface volume loss by measuring and comparing the volumes of the depressions, channels, and chaotic sources. These calculations will help us to investigate the possible subsurface volume-changing processes that may have formed OV's depressions and possibly other Martian depressions.

Naor R. (1,2), Mushkin A. (2), Halevy I. (1)
The "juba" depressions as terrestrial analogs for planetary pit

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The nature of many pits on the surface of Mars and other planetary bodies remains poorly constrained due to the paucity of terrestrial analogs with similar characteristics. Collapse pit craters on the flanks of the Kīlauea volcano in Hawaii are typically considered to be the closest analogs. However, the stratigraphy and dynamic nature of the Kīlauea pit craters may not apply to many of the Martian pits. The possibility that Martian pits may constrain either volcano-tectonic or hydrological subsurface processes motivates the development and study of terrestrial analogs where such a linkage between the surface-subsurface can be tested in the field.
We present a new terrestrial analog for planetary pits. A series of depressions, locally named "juba," are situated on a basaltic plateau on the northwest margin of the Levantine volcanic field of Harrat Ash-

Shaam, in the vicinity of several Pleistocene cinder cones. The moderately sloping basaltic plateau is underlain by Meso-Cenozoic carbonates that record local tectonic stress fields.
To constrain the depressions' formation mechanism we acquired 0.25 m/pixel digital elevation models (DEMs) from airborne LiDAR of the depression field, as well as a cm-scale ground-based LiDAR scan of a bell-shaped pit with an interior hidden from aerial view. From the DEMs, we extracted morphometric and structural parameters of the depressions and their surroundings, and their spatial distribution. Our findings preclude formation of the depressions by meteorite impacts and phreatomagmatic explosions, and appear to be consistent with formation by collapse into subsurface voids. Some surface structures suggest the voids may have originated from volcanic or tectonic activity, but hints of a spatial correlation between the depression locations and karst-forming carbonate units may point to a karstic origin. We are currently investigating these two possibilities with a combination of detailed field mapping and tomographic methods.

Nativ R. (1,2,3) Turowski, J.M. (1), Laronne J.B. (4), Hovius N. (1,2), Goren, L. (3) Chang J.M. (5) Chen W. (6), Chang W.N. (7,8)
Constraining the Timing and Style of a Bedload Transport Event in a Boulder-bed Canyon using Seismic and Acoustic Signals

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Monitoring bedload flux in bedrock canyons during floods remains an outstanding problem in fluvial geomorphology, due to extreme hydraulic conditions and the risk to equipment and human life. Surrogate monitoring methods include the interpretation of seismic and acoustic signals generated by impacts of transported grains. Here we present seismic and acoustic data from two pairs of adjacent channel reaches in the Liwu river, Taiwan, that differ by the concentration of boulders, but otherwise share similar hydraulic conditions. In each of the locations (Shakadang and Baiyang) we have setup a field experiment where seismic sensors were deployed aside each of the boulder-bed - boulder-free channels. In Baiyang we have also installed a hydrophone, i.e., a microphone submerged in the water column. Our monitoring system recorded a flood during August 2019 where water stage rose from 1 to 3-4 meters within few hours. In Baiyang, bedload transport timing was resolved through manual listening to audio files recorded by the hydrophone. The bedload transport event lasted more than 78 hours and produced a counterclockwise hysteresis between the power of the acoustic signal and the water depth, not observed in the seismic signals. Signals generated by bedload impacts excited the hydrophone at frequencies of 600 to 3000 Hz, and the seismic sensor at the boulder-free stations at 18 to 30 Hz. In contrast, the highest seismic power at the boulder-bed channels peaked at a frequency band of 50 to 80 Hz, which is commonly not associated with bedload nor with water turbulence. The peak in the high frequency bands suggests that boulder-bed channels may differ in how bedload and turbulence are expressed in terms of the seismic

content. We hypothesize that the high frequency content may be a combination of enhanced turbulence with the proximity of the seismic station to the channel.

Navon H. (1), and Reshef M. (1)
Imaging shallow subsurface voids using VSP and RVSP prismatic arrivals

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Shallow subsurface anomalous bodies such as natural cavities or man-made voids can pose a security and safety threat. The motivation for this research is based on the need to accurately image these near surface anomalous bodies. The seismic method have demonstrated the most success up to date in addressing this problem, yet the highly heterogeneous nature of the shallow subsurface and interference from the near-surface make the task very challenging when using conventional seismic methods. Therefore, in this research subsurface acquisition such as VSP and RVSP configurations were used, utilizing the advantages of the unique dataset's content such as converted modes and prismatic arrivals.
A new modified imaging method was constructed based on the summation of prismatic arrival times which were calculated using Eikonal equation and Fermat's principle. First, various synthetic datasets simulating the shallow subsurface containing a void were tested to use this imaging method. After receiving satisfying results from the synthetic datasets, the new method was applied on field datasets. Most of the imaging results were reasonable and showed that the imaging method is applicable. Even so, the velocity model in the vicinity of the void needed to be adjusted in order to receive a better and well located image. Therefore, traveltime tomography was adjusted to invert prismatic reflections. The prismatic traveltime inversion was calculated for different possible void locations and then analyzed through corrected common receiver gathers. This new approach, based on shallow prismatic arrivals, allows us to more accurately evaluate the velocity values in the vicinity of the void, as well as to determine its correct location.

Navon O. (1), Elazar O. (1), Kessel R. (1) and Weiss Y. (1)
Melting of eclogites in the deep lithosphere

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Eclogites are ubiquitous in the sub-continental lithospheric mantle, as is evident in the proportion of eclogitic xenoliths and xenocrysts in the load of kimberlites, and in their relative abundance as mineral inclusions in diamonds. Most are derived from subducted oceanic basalts, but some may originate from subducted sediments or crystallization of deep basaltic magmas. The silicic to low-Mg carbonatitic high-density fluids (HDFs) trapped as microinclusions in diamonds are associated with eclogites. They resemble experimental near-solidus melt compositions in the eclogite-H2O-CO2 system and are associated with eclogitic mineral inclusions in the same diamond. The high concentrations of H2O, CO2, K and other incompatible elements represent enrichment by ~500 over primordial mantle values. Such levels of enrichment can be achieved by low-degree partial melting or by interaction with a large volume of rock (melt fraction or HDF/rock ratio of ~0.2%). Lower levels of enrichment were recently found in melt inclusions in an eclogitic garnet, suggesting HDF/rock ratios of ~1%. Such levels are equivalent to typical kimberlite/peridotite ratios. Higher melt fractions are also known, for example in larger melt inclusions in eclogitic garnets reported by Kiseeva et al. (2017) and interpreted as the result of a few wt% melting of eclogites. However, while magmas derived by a similar degree of melting in the peridotitic system, e.g., alkali basalts, reach the surface, no such erupting magmas are known for the eclogitic system. This can be the result of biased sampling, if such magmas fail to reach the surface as efficiently as their peridotitic

counterparts, or due to the limited size of eclogitic bodies in the deep lithosphere that force melts formed by eclogite melting to pass through peridotitic zones, interact with them, and evolve into basalts that resemble peridotite-derived melts but still echo the contribution from a pyroxenitic or eclogitic source.

Nof R. N. (1), Baer G. (1), Rosensaft M. (1), Bernstein M. (1)
Sinkhole early warning system along the Dead Sea, Israel

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During the past three decades, the Dead Sea (DS) water level has dropped at an average rate of about 1 m/year, resulting in dissolution of a subsurface salt layer by under-saturated groundwater and formation of sinkholes along its coastline. Currently, about 6000 sinkholes are mapped along the Israeli shorelines of the DS, with more than 300 sinkholes formed annually. The sinkholes severely affect the daily life, economy, infrastructure, tourism and industry of the region. Sinkholes are associated with gradual land subsidence, before, during and after their collapse. Systematic high temporal and spatial resolution interferometric synthetic aperture radar (InSAR) observations, augmented by detailed Light Detection and Ranging (LiDAR) measurements enable utilization of interferometric pairs to detect minute precursory subsidence before the sinkholes collapse and generate sinkhole susceptibility maps. By now, InSAR measurements have become fundamental for sinkhole early warning and mitigation along the DS coast in Israel.
A semi-automatic processing system has been developed at the Geological Survey of Israel (GSI) using InSAR monitoring of sinkhole precursors for sinkhole early warning along the entire DS shores in Israel. The system allows us to produce an alert for a new sinkhole in less than 24 hours after data acquisition. We continuously monitor displacements along the shore and delineate small decorrelated areas covering all or parts of the subsiding areas as newly formed sinkholes. Final validations of new sinkhole collapses are carried out by field observations, drone photos, aerial photos and LiDAR digital elevation models (DEMs). The system results are continuously updated and available for stakeholders through the maps portal of the GSI.
We will present a few case studies that illustrate the timelines and effectiveness of our methodology, as well as its limitations and complementary methodologies used for sinkhole monitoring and hazard assessment.

Nof R.N. (1), Kurzon I. (1), and Lior I. (2)
TRUAA, Israel’s National Earthquake Early Warning System - Features and Expectations

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Following a governmental decision to build a national Earthquake Early Warning System (EEWS) named TRUAA, the Geological Survey of Israel (GSI) has upgraded the national Israeli Seismic Network (ISN) with more than 110 stations country-wide. The stations are spread mainly along the main hazardous fault systems of the Dead Sea and Carmel-Zfira which potentially may produce Mw 7.5 earthquakes. Currently the system is shifting from the deployment phase into a limited operational phase in which the Earthquake Point-source Integrated Code (EPIC) EEW algorithm is used.
Historical playbacks and Real-time performance match the expected design performance, with alert delays (span between origin-time and EEW alert time) reduced down to 3 s in some cases, leading to a potentially smaller than expected blind zones and show good agreement with the expected magnitude

and location misfits. We present an overview of TRUAA, the performance of EPIC in real time and playbacks, as well as the current official alert approach for Israel.

Oren O. (1,2), Nuriel P. (1), Kylander-Clark A. R.C. (3), and Haviv I. (2)
Reconstructing the Carmel-Gilboa triple junction with the Dead Sea transform: Geochronological insights from U-Pb fault dating

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The Carmel–Gilboa fault system (CGFS) is a NW-SE trending lineament that runs sub-parallel to the Azraq–Sirhan Garben and the Red Sea Rift. Although its initiation is often assumed to be associated with NE–SW crustal extensional regime during the Africa-Arabia break-up (late Oligocene to early Miocene), the exact initiation timing of the CGFS and its reactivation during the onset of the Dead Sea Transform plate boundary were never well constrained.
In this study, we present and evaluate 17 U-Pb ages of syn-tectonic calcite along the CGFS faults. The samples were collected from 3 sites located ~20 km apart. The new ages suggest that the earliest faulting phase took place between 25 Ma to 21 Ma - coinciding with the timing of initiation of the Red Sea Rift. Thus, the CGFS-Azraq-Sirhan rift system was active ~5-7 Ma prior to the initiation of the Dead Sea Transform. The second phase of activity along the CGFS was initiated at ~16 Ma during the Mid Miocene. This phase is in-line with 18 to 14 Ma northward propagation of the Dead Sea Transform from the Gulf of Elat to the southern tip of the Lebanese restraining bend. Our new U-Pb ages along the CGFS with previously published ages from Mt. Hermon and Elat area constrain the propagation rate of Dead Sea Fault to ~9 cm/year. We also discuss potential mechanical triggers for the evolution of two simultaneous rifts located ~ 500 km apart and the eventual failed rifting of the northern CGFS-Sirhan system.

Orion N. (1), and Ben Shalom R. (1)
Integration of geoethics within the highere education curricula through field trips

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Geoethics is an emerging field in geosciences. Following the emerging need for geoethics to raise awareness in higher education students, the main aim of the Geoethics Outcomes and Awareness Learning (GOAL) project is to elaborate a geoethics syllabus for academic Earth Sciences departments from Europe and beyond. Nevertheless, the GOAL project is only the first practical step of a long journey until the implementation of this syllabus, or even part of it, will take place in universities worldwide. It is important to note that the GOAL project is not just about producing a list of geoethics subjects and topics; it is also about how to teach it. Educationally, the project follows a contextualized approach supported by the case-based methodology and diverse strategies to develop the processes of teaching and learning. This educational aspect is quite a novel approach within the higher education, in general, and among academy geoscientists, in particular. This presentation aims to present fieldtrips as a strategy to enhance the learning of Geoethics in higher education as well as highlighting that its affective domain has the potential to achieve GOAL project aims and an awareness geoethics learning.

Oron S. (1,2), Sadekov A. (3), Katz T. (4), and Goodman-Tchernov B. N. (1)

Benthic foraminifer geochemistry as a monitoring tool for bioavailability of heavy metal and phosphorus pollution: The case of Eilat's fish farm removal

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Measuring environmental contaminants in coastal areas is critical for monitoring and managing their impact. Commonly used techniques involve repetitive field sampling which provides a single moment in time during each effort. In this study we examine the potential for using the geochemistry of foraminifers in monitoring and risk assessment as recorders of bioavailable pollutants. Geochemical shell analysis from growth chambers of a benthic foraminifer sampled annually at a previous fish farm location revealed the average elemental footprint during their growth period. The Foraminifera recorded high levels of cooper, zinc, and phosphorus during the three years following the fish cages removal, with a general reduction as years go by. Based on these finds, it is concluded that the geochemical analysis of growth chambers from recent benthic foraminifera shells can serve as a powerful monitoring tool of bioavailable contaminants in seawater over time. Additionally, the results highlight the need for heavy metal monitoring near marine aquaculture facilities and suggests that long-term impacts extend spatially and temporally far beyond the original point source.

Painuly A. (1), Katsman R. (1)
CH4 bubble growth topology and migration pattern in muddy aquatic sediments having anisotropic mechanical properties

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Gassy sediments of shallow water bodies are significant sources of atmospheric methane, an important greenhouse gas. Past accounts of gas bubbles developed in shallow aquatic sediments (and in their surrogates) have reported a controversial occurrence of vertical as well as horizontal bubbles topologies. Within the framework of tensile fracturing of muddy sediment produced by the growing bubbles, the vertical orientation of bubbles is well understood, however factors controlling horizontal bubble growth are largely unclear. Here we present temporal evolution of buoyancy driven CH4 bubble growth (prior to its rise) in muddy sediment exhibiting transverse anisotropy in mechanical strength, attributed to partial or full alignment of plate-like clay particles. A mechanical/reaction–transport numerical model is used, which couples diffusion-led expansion of bubble and elastic-fracture mechanical response of sediment to its growth. Our results demonstrate that bubbles growing in isotropic sediment develop a vertically oriented topology and start their ascent once reaching their mature sizes. Under an increasing measure of anisotropy, the bubbles grow horizontally at the initial stages, however at later stages they start evolving in vertical direction as well, under influence of gravity, and eventually initiate their vertical ascent. Our results suggest an explanation of apparent conundrum about preferred orientations of bubbles in muddy sediments. Laterally growing bubbles produced in anisotropic sediment are able to coalesce with neighboring ones and form interconnected permeable horizontal gas networks, as observed in some lab experiments. For the first time, our results suggest that anisotropy-led initial lateral bubble growth can also play a crucial role in accumulating gas reserve from long distances around large and small

scale seeps and outlets, at continental margins and inland water bodies sediment. Additionally, horizontal bubbles tend to be stationary (in contrast to vertical bubbles) thus being responsible for high gas storage (or retention) capability of aquatic sediments.

Palchan D. (1,2), Coodington J. (2), Ben David R. (2)
Rock mass classification using Q system in the upper Cretaceous bedrock Judea Mts.

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The Judea group deposited during the upper Cretaceous transgression of the Thetey's sea on a broad continental shelf of the Arbian Nubian shield. The various formations within the group comprise thick (almost 1km) of carbonates and siliciclastic deposits. Tectonics shaped the landscape first, under compressional stress forming a-symmetrical anticlines and synclines as part of the Syrian arch mostly during Senonian time. Later, the opening of the Dead Sea rift valley and accompanying tectonics had further affected the bedrock causing even more deformation. During the quaternary, accumulation of soil and development of biome on the surface facilitated formation of underground weathering creating karstic systems and driving below surface topsoil clays.
Underground infrastructure such as caverns, tunnels and deep foundations requires rock mass classification in order to provide engineers a measure with which support will be installed. A worldwide used method with which rock mass classification and is also popular in Israel is Barton's Q system. This empiric method evaluates six parameters that reflect block sizes, frictional strengths and surrounding effects caused by faulting and water stress.
In recent road tunnel excavation in the Judea Mts., specifically through the Judea group, we evaluated the rock mass quality using Barton's Q system. The different lithologies between the various formations within the Judea group are used to evaluate the Q system applicability in different local underground conditions. Rock conditions such as marl beds, voids and topsoil penetrations, that are not addressed in the formal method, prove to be challenging when tunnel support relies solely on Q system classification.

Pietraszek A.V. (1), Katz O. (2), Sharvit J. (3), and Goodman-Tchernov B. (1)
Geoarchaeology and Sea-Level Change: Records of Past Sea-Levels from Akko's Submerged Hellenistic Harbor, northern Israel
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With much of the world's population living within coastal zones and the continued threat of rising sea-levels, it is important to understand both the short-term and long-term factors affecting relative sea-level in a particular region. While geological and biological indicators of past sea-levels can provide information on long-term changes, it can be difficult to identify smaller-scale fluctuations from these data. However, such information can be obtained from archaeological indicators, which have well-constrained chronological and elevational limitations relative to sea-level at the time of their construction and use. This study aims to highlight the utility of archaeological indicators in sea-level research using a combined geoarchaeological approach to study the Hellenistic Period (3rd to 1st centuries BCE) harbor at Akko on Israel's northern Mediterranean coast. Here, harbor installations that would have been located sub-aerially during their functional periods were identified at depths averaging 1.1 to 1.2 meters below present sea-level (mbpsl), indicating a change in relative sea-level in the area since this time. By

incorporating marine sedimentological analyses with archaeological observations and previously recorded regional data, this study assesses three possible explanations for this apparent sea-level change: structural deterioration, sea-level rise, and vertical tectonic movements. Despite signs of structural deterioration in parts of the installations, this approach revealed that the harbor is largely in situ. Consequently, its current submarine position can be attributed to sea-level change and/or vertical tectonic displacements. These new data provide a reliable relative sea-level marker with high accuracy, suggesting a sea-level change of over 1 m near Akko since the Hellenistic Period, thereby renewing the overall consideration of the tectonic and sea-level processes that have been active along this stretch of coastline during the last 2,500 years.

Pinko D. (1), Abramovich S. (1), Titelboim D. (1,2)
Foraminiferal holobiont thermal tolerance under future warming – roommate problems or successful collaboration?

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The understanding of marine ecosystems response to expected future ocean warming is essential. The Eastern Mediterranean Sea is warming rapidly and can be considered as a natural laboratory for ocean warming influences. Large Benthic Foraminifera (LBF) are symbiont bearing protists with high importance as calcifiers and ecosystem engineers. Temperature is a significant factor in their distribution and well-being, therefore their fate under expected future warming is a major concern. In this study, we examined the thermal tolerance of two main types of LBF holobionts characterized by different algal symbionts and shell types (resulted from alternative biomineralization mechanisms): The hyaline diatom bearing, Amphistegina lobifera, and the porcelaneous dinoflagellate bearing, Sorites orbiculus. In order to assess the holobiont thermal tolerance we separately evaluated foraminiferal calcification rates and symbiotic net photosynthetic rates under present-day and future warming scenarios. This aims to better understand the relative contribution of host and symbiont algae in coping with future warming. Our results show that both holobionts record a graduate decline between 32ºC to 35 ºC. This sensitivity differs in the magnitude of their response: calcification of A. lobifera was almost inhibited while it was only reduced in S. orbiculus. Thus, future warming may significantly shift the relative contribution of the two species as carbonate producers. Moreover, A. lobifera exhibited a synchronous response of calcification and photosynthesis. While S. orbiculus symbionts decreased photosynthesis prior to calcification. This implies that the algal symbionts may limit the halobiont resilience.

Rabinovitch N. (1,2), Netzer L. (3), Livshitz Y. (3), Lazar B. (1), and Reznik I. J. (2)
The Hydrological Impact of the Eastern Drainage Line on the Coastal Plain Aquifer

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The coastal plain aquifer (CPA), geologically situated in the Kurkar group, is one of the primary sources for potable water in Israel, producing more than 210 MCM·y-1. Since the water production started, a slow salinization front originating from the eastern flanks of the CPA has been observed. The saline groundwater source was previously assumed to be fossil seawater trapped since the last marine transgression in low permeability formations, such as the onlapping Avdat group or the underlying Saqiye.

Over the years, the CPA has been over exploited, leading to deep (below sea level), wide and prolonged hydrological depressions. The formation of these depressions accelerated the brackish water inflow from the east, which led to a significant salinization of the CPA. This prompted the Israeli Water Authority to construct the Eastern Drainage Line (EDL), with the intent of creating a hydrological barrier (local drawdown) in order to capture the intruding saline water from the east (upstream), decrease the salt influx and prevent further salinization of the CPA. The EDL in a north to south production line consisting of 35 production wells, extending ~30 km, from Gan Yavne to Sderot. It began operating in 2015, gradually increasing its production up to 23 MCM·y 1 in 2019, which is ~65% of its planned capacity. In order to determine the hydrological impact of the EDL, 38 observation wells were drilled upstream and downstream of the EDL. Preliminary analysis indicates that a distinct hydrological barrier parallel to the EDL has not been form yet, despite the increase in production rates and the significant water table drop around the EDL (up to 1.8 m·y 1). Groundwater samples (<3,000 ppm TDS) were found to contain a mixture between fresh and saline end members both of which are affected to different degrees by water-rock interactions.

Ram R. (1,2) Burg A. (2), Yechieli Y. (1, 2), and Adar A. (1)
Identifying paleo and modern recharge processes to the regional aquifers of the Negev Desert using stable and radioactive isotopes

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Two deep regional aquifers with a similar flow pattern are found in the Negev desert - the deeper Kurnub and the shallower Judea groups. Groundwater in both aquifers flows from the central Sinai, through the southern Negev, toward the two main outlets - south of the Dead Sea and southern Arava Valley. The two aquifers differ from each other with respect to the potential recharge areas, which are much larger for the Judea Group. The present study combines stable (18O, 2H) and radioactive (3H, 39Ar, 14C, and 81Kr; half-lives of 12, 269, 5,730, and 229,000 yr, respectively) isotopes to illuminate paleo and recent recharge processes along the flow paths of the two aquifers.
Along the flow segment between the southern Negev (Shizafon) and the central Arava (Paran), ^{81}Kr age in the Kurnub Gr. aquifer increases by ~100,000 yr, and decreases by ~150,000 yr in the Judea Gr. aquifer. These opposite trends imply a contribution of local, however not recent, recharge to the shallower aquifer and none to the deeper. Such local recharge is evidenced in the deeper aquifer only further north (Ein Yahav area) and is attributed to recharge through the limited outcrops scattered to the west in Makthesh Ramon and Nahal Nekarot. The impact of very recent recharge is highlighted by elevated ^{14}C and ^{3}H activities only in proximity to the northern outlets and only for the shallower aquifer. The increasing contribution of local recharge along the flow trajectory is recorded in both aquifers by the simultaneous increase in the δ^{18}O values (although δ^{18}O values in the shallower aquifer are 0.5-1.0‰ higher along the entire flow-path). These findings demonstrate the relationship between geological structures, potential intake areas, and the isotopic compositions and their use for the study of paleo and current recharge to deep regional aquifers in arid environments.

Reiss A.G. (1), Bar-Nes G. (2), Emmanuel S. (1)
Chemical and physical mechanisms of cement degradation observed with atomic force microscopy
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Radioactive waste poses a serious challenge to modern societies. The accepted management strategy of radioactive waste disposal involves an initial stage of conditioning using stabilization and solidification matrices. Ordinary Portland cement (OPC) based matrices are the most common materials used in the disposal of low and intermediate-level radioactive waste. These matrices are designed to bind and retain radionuclides for long periods of time. However, interaction with fluids causes matrix degradation and potentially accelerates the release of radionuclides into the environment. Some aspects of fluid-matrix interactions, such as leaching, have been extensively studied. However, the dissolution rates of the different solid phases that comprise the matrix have yet to be studied.
We have recently developed an experimental scheme to image the surface of matrices during interaction with fluids. In our experimental design, atomic force microscopy (AFM) is used to image the surface of the solid, with nanometer resolution, as it reacts with the fluid. Preliminary results indicate that a large difference in dissolution rates exists along the solid-fluid boundary. Subsequently, sub-micron solid particles detach from the matrix and are transported as colloids.
To date, assessments of matrix stability do not consider grain detachment. Moreover, colloids are known vectors for the rapid transport of radionuclides. Yet, estimations of radionuclide mobility neglect to account for this colloid forming process. Therefore, predictions of matrix stability and its radionuclide retention ability may underestimate the matrix degradation and the release and transport of radionuclides. We are currently utilizing our new experimental scheme to quantify these processes under a variety of environmental conditions.

Reiss A.G. (1), Ganor J. (2), and Gavrieli I. (3)
Gypsum precipitation in Dead Sea – seawater mixtures: Implications for Dead Sea monitoring following the Red Sea – Dead Sea project

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The Red Sea - Dead Sea project (RSDSP), agreed upon in principle by the governments of Israel and the Hashemite Kingdom of Jordan, is to desalinate seawater from the Gulf of Eilat and convey the reject brine, with or without additional seawater, to the Dead Sea.
One of the environmental concerns with the project is the fate of the gypsum expected to precipitate in the lake. If this gypsum will remain suspended in the water column it could lead to increased turbidity and, under an extreme scenario, also to “whitening” of its surface water. The factors that control whether the gypsum precipitating in the lake would remain suspended or sink to the bottom are the crystal morphology and size distribution.
We have studied gypsum precipitation in mixtures of Dead Sea brine with seawater, concentrated seawater, and reject brine. Our results show that brine composition and oversaturation control crystal morphology which in turn determines the turbidity that develops in the brine. In addition, we found that scale inhibitors in the reject brine retain their inhibiting capabilities in Dead Sea - reject brine mixtures, and impact the rate of nucleation and consequently the size and number of the precipitating crystals. Our experiments show that under laboratory conditions, a spontaneous rise in turbidity requires higher oversaturation than that created in any mixture of Dead Sea and seawater or reject brine. However, the natural environment differs from the controlled conditions in the lab. Moreover, fundamental properties,

such as the ratio between fluid and the surface of the reaction cell or lake bottom greatly vary and can impact results. Thus, while our experiments cannot unequivocally determine whether the turbidity of the lake would increase or if the surface water will 'whiten', our study details the parameters that should be monitored if the RSDSP is constructed.

Reznik I. J. (1) and Bartov Y. (2)
Thermal history of the southern Golan Heights – geothermal gradients, source rock analysis and basin model

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While heat fluxes (HF) throughout Israel are low, a thermal anomaly exists around the Yarmuk. Data from Ness wells in the southern Golan Heights indicate that the distribution of the thermal anomaly is wider than previously thought. Additionally, a paleo-thermal analysis was performed using organic matter maturation profiles from the same boreholes. It turns that present day HF cannot explain the recorded levels of organic matter maturation and therefore a significant thermal event had to historically occur. Constraints given by geological considerations have associated the paleo-thermal event with Pliocene volcanic eruptions, allowing the reconstruction of the paleo-HF and spatial distribution of the anomaly. It is currently unclear whether the present anomaly, which has a smaller spatial distribution and lower HF, is a relic of the paleo-event and therefore sourced by the same magmatic chamber or whether the events are distinctly separate (the paleo-thermal event is related to a magmatic chamber associated with Pliocene eruptions while the present event relates to the younger localized Pleistocene eruptions of the Yarmuk). On one hand, thermal numerical modelling indicate that the time-scale required for heat to dissipate via conduction from the Yarmuk northward is in accordance with the young basalt age. On the other, hydrological cooling of water sourced from Mt. Hermon also provide the potential to gradually cool the paleo-thermal heat source from the north, leaving the south hotter.
The paleo-thermal event, which extended from the Yarmuk northward, was sharply bound by the Sheik Ali Fault (SAF). Several mechanisms are proposed for the sharp boundary: (a) the magmatic chamber diminished northward. (b) Tectonic displacement shifted the block north of the SAF from an area that was not influenced by the elevated HF (c) The SAF served as a hydraulic barrier which did not allow colder groundwater to flow southward.

Reznik I.J. (1), Purtschert R. (2), Sueltenfuss J. (3), Weinstein Y. (4), Shalev E. (1), and Yechieli Y. (1,5)
Fresh and saline groundwater ages and flow dynamics in a perturbed coastal aquifer

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Excessive freshwater pumping in coastal areas result in an inland intrusion of the saltwater wedge underlying the freshwater aquifer, leading to salinization of coastal aquifers. While multiple approaches and techniques in the form of analytical solutions, numerical simulations, mass balance calculations and laboratory experiments have been used to study the flow dynamics of the density-driven circulation of

saltwater, little is known regarding the groundwater ages in coastal aquifers and the process timescales. This is partially due to the fact that age tracers are commonly limited to either modern time scales (<70 years), such as 3H (t1/2=12.4 years) and 85Kr (t1/2=10.76 years), or significantly older time scales, such as 14C (t1/2=5,730 years) and 81Kr (t1/2=229,000 years). The current study makes use of the noble radioactive isotope of argon gas, 39Ar (t1/2=270 years), allowing to calculate sub-modern ages which are more relevant to the seawater circulation phenomena. In addition, the unique combination of both modern and sub-modern dating tools allow to individually calculate the ages of the saline and fresh water fractions within a given mixture.
The results indicate that seawater intrusion in the Nitzanim coastal reserve (prompted by excessive freshwater pumping upstream) has a different effect on the ages of the shallow groundwaters in comparison with the deeper groundwater. Close to the shoreline (<~200 m) at shallow depths (<40 mBSL), the intruding saline groundwater is younger than the freshwater system leading to young ages of ~50 years. Further away from the shoreline (~700 m), at greater depths (~60 mBSL), the deep intruding saline groundwater is dated to ~350 years, significantly older than fresh groundwater. The results are supported by a FeFlow numerical model which allows to better understand the density-driven circulation timescales and its contribution to the element budget transported into the oceans.

Robins L. (1,2), Greenbaum N. (1), Yu L. (4), & Roskin J. (2,3)
High-resolution portable-OSL analysis of Vegetated Linear Dune construction in the margins of the northwestern Negev dunefield (Israel) during the late Quaternary

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Vegetated Linear Dunes (VLDs) are common in arid environments. Their construction is controlled by vegetation and wind. VLDs vertically accumulate sand during elongation episodes and their internal stratigraphy thus serves as a proxy for major periods of strong winds. However, the framework of VLD buildup and elongation is constrained by low-resolution luminescence chronology, and limited understanding regarding their elongation and accumulation mechanisms. To overcome these gaps, this study applies high-resolution Portable Optically Stimulated Luminescence (POSL) profiling (0.25 m) coupled with OSL dating and sedimentology of an exposed VLD section (~6 m), combined with successive sections along a fluvially truncated downwind elongation trace of a stabilized VLD at the northwestern Negev dunefield, Israel.
POSL profiling of the VLD section revealed three statistically distinct stratigraphic units. Particle size distribution shows that the upper unit has a unimodal pattern (peak at 225µm) while two bottom units have a bimodal pattern (peaks at 65-70µm and 200-225µm). Selective winnowing at the upper unit can explain this textural difference, which results in a higher ratio between quartz and heavy minerals at the upper unit, as heavy minerals are abundant at finer fractions. This mineralogical difference decreased dose rates and, consequently, reduced bulk POSL luminescence signals and De values. The two upper units of the VLD section date to the Younger Dryas while the basal unit dates to the Heinrich-1 event. OSL ages at the lower unit and at the section bases along the downwind elongation trace of the dune indicate initial elongation during the Heinrich-1 event, and even prior.

The study shows that VLD construction includes non-coeval interchanges between active and stable periods. Furthermore, it demonstrates that beyond delineating accumulation stages and assigning stratigraphic units, POSL is a sensitive sensor of sedimentological and mineralogical differences within a dune profile, enabling correlation with OSL measurements.

Robins L. (1,2), Roskin J. (2,3), Yu L. (4), and Greenbaum N. (1)
Aeolian-fluvial sediments and landscapes along the northwestern Negev Dunefield (Israel) margins since the late Pleistocene

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Dunefield margins are prone to changing domination between aeolian and fluvial systems. Dominating aeolian systems divert or block fluvial systems or/and reduce their erosional forces often leading to amplified sedimentation by a wide range of unique aeolian-fluvial (A-F) sediments. The late Pleistocene encroachment of vegetated linear dunes into the northwestern Negev desert dunefield (Israel) comprised a distinct period of aeolian domination upon ephemeral drainage systems originating from the loess-clad Central Negev highlands. This study analyzes the sediments and landscape evolution caused by A-F processes along dunefield margins, in particular sediments deposited by dune-dammed water bodies slightly upstream of the dunefield edge and between VLDs. Research methods include high-resolution field mapping, relative (portable) and absolute OSL dating, stratigraphy and sedimentological analyses. Six main A-F sediment units were identified along incised dune-dammed sediments: (a) Aeolian sand, apparently, remnants of fluvially truncated VLDs. (b) Fluvial sand originating from nearby fluvial VLD erosion. (c) Massive loam to silty-clay loam indicating abrupt changes in hydraulic parameters (width/depth ratio and water losses through infiltration) which induce sudden deposition, of highly concentrated suspended loess. (d) Couplets, similar to the massive loam, containing mainly loess deposited in an ephemeral dune-dam waterbody. (e) Laminated silty-clay-loam units identified only between current VLDs. (f) High-energy fluvial deposits, which contain loam, sand and pebbles, with a clear erosional boundary that mark the upstream edge of A-F sedimentation.
The landscape of the Negev dunefield margins developed since the late-Pleistocene by short-term aeolian domination, which gradually changed into fluvial domination during the Holocene. Dune-damming depositions occurred during this transition, initially outside the dunefield, then propagated downstream into the dunefield. Fluvial aggradation of A-F sediments resulted in vast elevated flats covering over ~40 sq. km in the NW Negev dunefield margins, that following dune-dam breaching underwent incision, let alone in small (~<20 sq. km) basins.

Rosenberg O. Y. (1), Gvirtzman Z. (1), Abelson M. (1), Magal E. (2), and Yechieli Y. (1)
Geoscience Research in the Period of Energy Transition
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The increasing demand for safe and reliable energy sources in the shade of human-induced environmental and climatic harms has led us into an energy transition period. At the heart of this transition is the need

to reduce the use of fossil fuels. As countries declare their commitment to reducing fossil fuel consumption, geosciences must move away from petroleum-centered research and evolve into new fields of study, thereby playing a significant and active role in the energy transition.
Over the last year, the Geological Survey of Israel (GSI) and the Israeli Ministry of Energy have been examining the possibility of establishing a new division within the GSI that will focus on energy-related topics. We aim to define research fields that can facilitate the discovery and development of renewable and low-carbon energy sources, while considering the future of fossil fuel sources within the energy basket to maintain a reliable energy supply. Within this framework, we have defined four research fields: 1. Usage of the sub-surface for energy storage and energy-related byproducts (e.g., CO¬2, hydrogen, nuclear waste); 2. Environment – Energy nexus; 3. Fossil fuels; 4. Sources of carbon-lean energy. Within these fields, 12 potential research topics were defined and reviewed to map out academic and industrial status nationally and worldwide, and define possible knowledge gaps.
Altogether, these topics emphasize the vital role the sub-surface has as a disposal site (e.g., for CO2 sequestration) and as a storage site for energy and energy carriers (e.g., compressed air, H2). Geosciences and "traditional" experts in geology (e.g., geophysics, geochemistry, sedimentology), as well as petroleum geology expertise (e.g., reservoir engineering), are needed to solve many of the challenges related to the energy transition. This seminar will present an overview of the topics examined, discuss their rationale and the possible future directions.

Rosenzweig R. (1), Li Z.(1,2), Gelman F. (1), Crouvi O. (1), Arye G. (3), and Ronen Z. (2)
Remediation and hydrological implications of oil-induced soil hydrophobicity in the Evrona nature reserve

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Soil hydrophobicity was extensively investigated in the context of fire-induced, naturally-occurring and wastewater related hydrophobicity. However, Oil-induced soil hydrophobicity received less attention. In this study, we investigate the hydrological effects and the persistence of oil-induced soil hydrophobicity in the hyper arid Evrona nature reserve. The reserve has experienced two oil spills that occurred in 1975 and 2014. In this study, we 1) apply field monitoring to investigate how hydrophobicity affects water flow in the polluted soils, and 2) conduct laboratory incubation experiments to assess the natural attenuation of hydrophobicity and its relation with the content and composition of hydrocarbons.
We set up two monitoring stations in two adjacent streams, of which one is polluted and the other is clean. In each section, an array of water content sensors was installed. Analyses of three-year data reveal that during rain events infiltration in the oil-contaminated soil was much lower relative to the clean soil and showed highly preferential patterns. This may lead to negative consequences such as increased runoff and erosion, and reduction in the water available to native plants.
In the second part of the research, incubation experiments were conducted. Contaminated soils were treated with the addition of either water alone or combinations of water, nutrients and surfactants. Treated soils were sampled periodically to assess soil hydrophobicity and hydrocarbon content. The results show a concomitant decrease in the hydrophobicity and hydrocarbon content in the treated soils. Overall, the total petroleum hydrocarbon of the treated soils decreased by 40% in the 2014 soil and by up to 80% in the 1975 soil. However, the soils remained severely hydrophobic. This suggests that considering the concentration of hydrocarbons as the sole criterion for the endpoint of soil remediation is not sufficient and the degree of soil hydrophobicity should be evaluated as well.

Roskin J. (1,2), Asscher Y. (1)
Distinguishing between anthropogenic and natural deposition processes and sediments by pulsed-photon portable luminescence (PPSL) profiling

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Discriminating between natural to human-intervened deposition processes and sediments poses a challenge in many multi-layer archaeological sites and landscapes. Archaeological sediments are usually more heterogeneous in their composition than natural ones, but their signature is not easily apparent in the field.
Lateral and vertical pulsed-photon portable OSL (PPSL) profiling of bulk sediments that contain feldspar and/or quartz serve for understanding the relative chronology of sections, prioritizing samples for OSL dating and also for discriminating between natural and human-induced deposition processes and sediments. This study presents several geoarchaeological case studies in sites and landscapes with different Quaternary environments/sediments (loess, alluvium, Mediterranean soils, sand), exemplifying the utility of PPSL profiling for such discriminations. In some cases, the measured PPSL luminescence signals are coupled with gamma and FTIR spectroscopy, portable XRF geochemistry, carbonate content, particle-size distribution and colorimetry. These complementary methods characterize the relative mineralogical and chemical properties along the profiles, and help estimate possible in-sediment influences on the PPSL signals.

Rotem D. (1), Weinstein Y. (1), Harlavan Y. (2), Lyakhovsky V. (2), and Christiansen H.H. (3)
Water Chemistry of Permafrost Ground-Ice at Svalbard

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We studied the geochemistry of permafrost ground ice at Adventdalen valley, Svalbard. The geological profile consists of 3-5 m aeolian-fluviatile deposits, underlain by early Holocene deltaic-marine deposits, which covers early Cretaceous and Palaeogene sedimentary rocks, mainly sandstones and shales bedrock. Cryogenically, the aeolian/fluviatile permafrost is syngenetic, while the underlying deltaic sediments are epigenetic, i.e. sediments froze top-down post-exposure.
We sampled Permafrost at an up-valley site, 10 km from the sea, where the Holocene profile is 20 m thick. Using a drill-rig. two cores was retrieved down to 9-13 m. Cores were cut into segments of 0.5-1 m, crashed to chips and thawed by a microwave, followed by immediate separation of thawed water from sediments, using a centrifuge and filtering apparatus.
While the syngenetic permafrost ground ice is of fresh water, salinity gradually increases in the epigenetic ice between 5-13 m depth, up to >9,000 mg Cl l-1, demonstrating a frozen fresh-saline water mixing zone. This suggests a fresh groundwater flow down to this depth following exposure, prior to freezing, which could happen due to 10-20 cm rise above seawater, dependent on deeper layers salinity. Considering isostatic rebound rates, this could take ca. 10 years, which is much less than calculated top-down freezing to this depth.
Na/Cl ratios in the syngenetic permafrost are mostly lower than seawater (0.3-0.8), while higher (0.7-1.9) in the epigenetic permafrost. Ca/Cl and Mg/Cl show the opposite pattern, with much higher than seawater

ratios in the syngenetic and lower ratios in the epigenetic permafrost. SO4/Cl ratios are higher than seawater ratios throughout the profile, while Br/Cl ratios are mostly similar to that of seawater. It is suggested that the geochemistry of the epigenetic permafrost is controlled by saline water ionic exchange, while that of the syngenetic freshwater permafrost is controlled by dissolution and salt exsolution during freezing.

Rudnitsky N. (1), Antler G. (1,2), Gross A. (3)
The effects of ocean acidification on the bio-availability of dust-P in the Gulf of Aqaba,
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Atmospheric CO2 levels are rising since the industrial revolution, as result of fossil fuels burning. This rise is the main role in the process of ocean acidification, the ongoing decrease in the pH of the Earth's oceans. Ocean acidification has many consequences. One of the consequences is affecting biogeochemical cycling of major nutrients such as nitrogen (N), phosphorus (P) and iron (Fe). Most of the P that enters the oceans is in a solid phase and it is transported from the continent with desert dust storms. P is controlling primary production rates especially in ecological environments that are limited or co-limited by it. The poor solubility of P in seawater conditions, making most of the dust-P unavailable to planktonic organisms. In a series of lab experiments, we examined seawater samples with different pH conditions containing different dust types. We found that decreasing seawater pH, increases dust-P solubility and the releasing rate of P from the dust to the water. This released P is potentially bioavailable for primary production. We suggest that ocean acidification can increase the solubility of dust-P enters the ocean, therefore boosts ocean productivity. This process expected to act as a negative feedback mechanism for the increase in atmospheric CO2.

Sagi M. (1)
Software package development for shallow subsurface imaging and its implementation for mapping shallow potentially active fault

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One of the main difficulties of in-land seismic imaging is the presence of a complicated shallow subsurface. Complicated shallow subsurface may include low-velocity weathering zone, laterally velocity variations, dipping refractors, local anomalies of velocity or a combination of those.
By using a set of in house developed programs, that are built to provide careful analysis of the refraction waves. We are aimed to improve shallow-depth seismic imaging and provide synthetic solutions alongside real data interpretation from known fault zones and compare the data with previous works done at the same locations.

Sagy Y. (1), Gvirtzman Z. (1)
Levant basin depocenter evolution and migration

1. Geological Survey of Israel

The Levant basin is the last remnant of the Tethys marginal basin and has preserved an exceptionally thick (>15 km) sedimentary section that records more than 250 m.y. of tectonic and sedimentary history. Seismic reflection image the complete sedimentary column, but wells penetrates solely the uppermost < 6km section, hence constraining sediments age for the last 35 m.a.(Late Eocene). The interpretation of the deeper section is controversial. One possibility to resolve this ambiguity is to differentiate the syn-rift section from the post-rift. The conventional method of mapping faults and distinguishing the units that are displaced is challenged because these sedimentary sections are deeply buried at more than 10-12 km (>7 sec. twt) where seismic resolution decreases. In addition, the post-rift contractional deformation of the Alpine orogeny that affected the Eastern Mediterranean further challenge the identification of these faults.
We propose to distinguish the transition from syn-rift to post-rift section throughout the basin by focusing on abrupt versus gradual thickness variation of these units. In addition, by applying a low pass post-stack filtering on 2D seismic reflection surveys covering the Israeli economic water (> 27,000 km), we improved the imaging of the deeper reflectors and enabled the distinction of the deep units, which otherwise appeared blurred at conventional industry processed data. This improved data set enabled us to perform a basin wide interpretation of reflectors within the deeper part of the basin, more particularly to map the syn-rift section in the basin and delineate the sub basins that formed during the early stages of the basin formation. We present a series of 10 isopach maps for all the sedimentary sequences that demonstrate the basin evolution and its depocenter migration since the pre-rift and during its post-rift phases.

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Recommended Earthquake-Geotechnical Siting Process and Criteria for a Nuclear Power Plant in Israel
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The Geological Survey of Israel (GSI) recommends a systematic siting process to identify suitable locations for Nuclear Power Plant (NPP) in Israel with respect to the unique earthquake and geotechnical hazards that may impact its safety. The process was developed in accordance with the International Atomic Energy Agency (IAEA) guidelines and international standards of practice. The process includes four distinct phases of progressively more detailed study, and elaborates the values, characteristics and rationale of the screening criteria.
Furthermore, the GSI recommends to:
(i) Replace the siting criteria of the Israel Atonic Energy Commission - Licensing and Safety Division (IAEC-LSD, 1985) rather than to only revise them. The existing siting criteria of IAEC are, in practice, 'acceptance criteria' intended for final site licensing, while the purpose of the proposed approach is to provide an initial screening process to identify a suitable site, after which detailed site characterization studies would be performed to satisfy IAEC site licensing criteria;
(ii) Adopt the IAEA siting approach in order to be in line with international recommended practice;
(iii) Incorporate probabilistic rather than deterministic methodology, in order to capture the full range of deterministic worst cases with their individual rate of occurrence and relative weight among the whole spectrum of possibilities;
(iv) Maintain flexibility in the siting process to allow repeated iteration of each phase in case the initial results provide an insufficient number of potentially suitable sites;
(v) Leave the assigned screening criteria in a general form, to be calibrated at the time of siting according to the design characteristics of the proposed NPP and/or current licensing requirements.

The siting process allows to perform an orderly, transparent and well-documented assessment. Implementation of this siting process will increase regulatory assurance, and ensures interested organizations and the public, that a comprehensive and proper assessment has been completed.

Segall Z. (1), Vapnik Y. (1), Katzir Y. (1)
High-temperature metamorphism of phosphorites of the Mishash Formation in the Hatrurim Basin, Israel

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The Hatrurim metamorphic complex (or Mottled Zone), known in several sites in Israel and Jordan, is the metamorphic equivalent to the sedimentary Ghareb (Maastrichtian) and Taqiye (Paleocene) Fms (Burg et al., 1999; Hirsch et al., 2008). Metamorphism peaked at sanidinite facies conditions, characterized by high to ultra-high temperatures at low to ambient pressures. At the base of this complex, metamorphism also affects phosphorites of the Mishash Fm (Campanian).
Here we study metamorphosed phosphorites in comparison to adjacent non-metamorphosed phosphorites in the Hatrurim Basin. In the field, metamorphosed and low-temperature altered meta-phosphorites can be identified by their relatively dense and hard appearance, lack of bioclasts and reddish, grey and green colors. Our field observations shows that metamorphism of the upper layers of phosphorite of the Mishash Fm, up to 5 m below the contact with the Hatrurim complex, is a common feature in the Hatrurim Basin.
Petrographic and SEM-based study indicates that the metamorphosed phosphorites mostly comprise flourapatite, recrystalized from collophane (an amorphous form of francolite), and calcite. Less common metamorphic neoblasts include: magnesioferrite, oldhamite, lakargiite, hexaferrites of the barioferrite-hibonite series, perovskite, srebrodolskite-brownmillerite and vorlanite. These phases also occur in the high temperature pyrometamorphic rocks of the Hatrurim complex, indicating temperatures as high as 900ºC.
Whole rock chemical analysis shows enrichment in silica and alumina in the metamorphosed phosphorites compared to their protoliths. Metamorphic samples are REE enriched, while phosphate content (i.e., apatite) hardly changes during metamorphism. It is suggested that new metamorphic phases, such as perovskite and lakargiite, carry the excess REE. Thus, in terms of both major and trace element, metamorphism of phosphorite in the Hatrurim Basin was not isochemical. It follows that a thicker portion of the Mishash Fm. may have been subjected to the Hatrurim phenomena, resulting in redistribution of major and trace elements.

Segev E. (1)
Can multi-proxy arrays improve environmental reconstructions and reveal past microbial interactions?

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Coccolithophores are a diverse group of calcifying microalgae that have left a prominent fossil record on Earth. Various coccolithophore relics, both organic and inorganic, serve as proxies for reconstruction of past oceanic conditions. Commonly used coccolithophore-derived proxies for past sea surface temperature are alkenone unsaturation (UK'37), and the Sr/Ca ratio of the coccolith calcite. *Emiliania huxleyi* is the most widely distributed representative of the coccolithophores in modern oceans, and it is known to engage in dynamic interactions with bacteria. Algal-bacterial interactions influence various aspects of algal physiology and biochemistry.

I will present an experimental model system for the co-cultivation of algae and bacteria that allows detailed characterization of microbial interactions. According to data collected during multiple experiments in this model system, algal-bacterial interactions influence alkenone unsaturation, thereby influencing temperature reconstruction. In contrast, the Sr/Ca ratio of the coccolith calcite remains unaltered by bacteria, thus serving as a robust environmental paleo-proxy independent of microbial interactions.
I will discuss how the study of paleo-proxies in the context of microbial interactions has the potential to generate improved reconstructions of past environmental conditions. Moreover, multi-proxy combinations of both organic and inorganic indicators, emerge as a novel approach to detect past microbial interactions.

Shaanan U. (1), Mushkin A. (1), Amit R., Malik U. (1), and Eppes M. C. (2)
Continuous temperature-moisture measurements in late Quaternary Reg soils from the hyperarid Negev desert, and their implications for gravel shattering

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Gravel shattering is one of the primary processes driving the pedogenesis of Reg soils. Mature Reg soils also present gypsic and salic–petrosalic soil horizons (By/Byz and Cz) at respective (i.e. increasing) depths. They typically present salt-shattered gravels at depth of 20 - 60 cm at the By and Cyz horizons. Below this depth, although salt concentration increase, the shattered gravel are lesser. Although the shattering gravel commonly associated with the presence of salts, the specific stress-loading mechanisms and the rate-limiting conditions that govern the process of gravel shattering remain poorly constrained. To address this knowledge gap we study the pedo-hydroclimate regime in two Reg soil profiles developed on late Pleistocene (~70 ka) and early Holocene (~12 ka) alluvial terraces of the Shehoret fan in the Arava valley, Israel. Quantitative mapping of shattered clasts and continuous moist and temperature measurements were conducted on both the Pleistocene and Holocene soil profiles. Temperature oscillates daily and seasonally, regardless of textures and soil horizons. Unlike the temperature, the moisture content at the lower part of the soil profile (~>1 m) is quite constant year-round. At the lower part of the mature soil, halite accumulates and forms a petrosalic horizon with almost no gravel shattering. However, shattering developed pervasively down to depths where the diurnal temperature variation is above ~5ºC and/or the annual variation is >20ºC (i.e., <40 cm), and the water content change dramatically in response to rain events. These continuous yearly measurements provide a unique opportunity for examination of physicochemical mechanisms that control the maturation of hyperarid soils and weathering processes of alluvial surfaces with time.

Shaked Y. (1,2), Basu S. (1,2), Kessler N. (2,3), Feinstein R. (1,2), Wang S. (1,2), Gledhill M. (4)
Dust as a nutrient source to the globally important marine cyanobacterium *Trichodesmium*

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Air-borne dust is a significant source of the nutrients iron and phosphorus to remote ocean regions, but its utilization by phytoplankton is constrained by rapid sinking and slow dissolution. Desertification

induced by global climate change is expected to increase dust fluxes and nutrient input to the ocean surface. Research in our group, exploring mechanisms employed by phytoplankton to extract nutrients from dust, center on the globally important N2-fixing cynaobacterium, Trichodesmium, with implications for ocean productivity and carbon drawdown.
Studying natural Trichodesmium colonies from the Gulf of Aqaba, we discovered unique adaptive mechanisms for capturing and storing dust particles within the colony core, enabling efficient utilization of nutrients from dust. We documented a variety of biochemical pathways and physical mechanisms that assist Trichodesmium to obtain iron from mineral sources. We found that dust packaging in the colony core is beneficial for uptake, since cell-particle proximity minimize iron loss by diffusion, and that natural colonies enhance dissolution rates of dust-bound iron. We discovered that Trichodesmium and its associated bacteria act together to increase availability of dust-bound iron, where bacteria secrete iron-binding molecules that promote dust dissolution and Trichodesmium provides dust and optimal physical settings for dissolution and uptake. In addition, we revealed that Trichodesmium can sense iron and selectively choose iron-rich dust particles, thus optimizing iron supply.
Our multidisciplinary research, which involves the phosphorus, iron, nitrogen and carbon cycles, will assist in modelling the ocean's biogeochemical response to dust inputs and predicting the ocean's function as a life-supporting system in the global change era.

Sharon M. (1,2) Kurzon I. (1,2), Wetzler N. (1), Sagy A. (1), Marco S. (1), and Ben-Avraham Z. (2)
Spatio-temporal variations of the frequency-magnitude relation along the southern Dead Sea Transform

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The relationship between the frequency of earthquakes and their magnitude has been the source for thorough seismological investigations, derived from the significant impact for hazard evaluations and tectonic implications. This relationship is considered to be based on the Gutenberg-Richter empirical law, and can be deduced from either instrumental or pre-instrumental data or their combination. Here, we examine dataset of more than 20,000 instrumental earthquakes that were recorded in the past 37 years, within a regional rectangle of the latitudes 27.5°-35.5°N and longitudes 32°-38°E, with a focus on the seismicity in Israel and its vicinity. Our analysis includes preliminary stages that are important for estimating the frequency-magnitude parameters: after a hypocentre relocation process, we examine the relationship between the duration magnitude (Md) and the moment magnitude (Mw) due to the necessity of a homogenised catalogue in terms of the magnitude type, since most earthquakes have received only Md, which is considered to have larger uncertainties than the physics-based Mw. We obtain a conversion formula and achieve a homogenised catalogue with Mw that is mostly converted. Then, we calculate the frequency-magnitude relation in several spatio-temporal frames. A b-value of 0.96 is obtained for the seismic network coverage area (approximately overlaps the state of Israel) and 0.93 for the southern Dead Sea Transform (DST; excluding the Gulf of Elat), considering a completeness magnitude of Mw=2.1. Other spatial frames include seismogenic zones, some of which were delineated to separate between the main fault segments of the DST and its internal structures. We further examine relationships between the b-value and other seismic parameters such as the hypocentre depth distribution. In addition, the results of the frequency-magnitude relation, deduced from instrumental record of a few decades, are compared with pre-instrumental earthquake data of a much longer time window, based on previous paleoseismic and historical investigations.

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Sorption and retention of Strontium and Cesium in high- and low-pH cementitious pastes

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Ordinary Portland Cement (OPC) matrices are used to stabilize and solidify low- and intermediate-level radioactive wastes, containing 90Sr and 137Cs. In order to improve their retention properties and the long-term durability of the matrices, many formulations have been developed over the past decades. The natural pH of cement pastes is pH>12. Such high pH may cause environmental perturbations; thus, milder pH conditions are of interest. In order to lower the matrix pH reactive SiO2 can be added to the OPC formulations. Such addition may also affect matrix porosity, physical strength and chemical durability.

In this work, the effect of the SiO2 addition on retention capability is studied. Moreover, in order to gain mechanistic understanding on the retention process, a model system, based on Alite (tri-calcium silicate), is used, to be compared with the complex OPC system. The systems were characterized for their chemical and mineralogical composition and subjected to leaching experiment to study Sr retention, and to sorption experiments for Sr and Cs.
The low-pH pastes were found to have a significant effect on Sr retention. Sr leaching was lower by one order of magnitude relative to their corresponding high-pH systems. Additionally, OPC pastes show lower Sr leachability compared to their corresponding model systems, probably due to Sr2+-Ca2+ substitution in aluminate and sulfate phases.
In the sorption experiments, the low-pH systems exhibited higher partition coefficients (Kd), for both Sr and Cs with respect to the high-pH systems, over a wide concentrations range (0.1 ppm-1000ppm). The differences between the Kd of the low- and high-pH systems were by one order of magnitude for Sr and by two orders of magnitude for Cs. Furthermore, low-pH OPC paste prepared with colloidal silica fume, showed higher Kd values relative to similar pastes that contain densified silica fume, due to their high surface area and reactivity.

Shmilovitz Y. (1), Mushkin A. (2), Wieler N. (2), Zhang H. (3), and Shelef E. (4)
Morphologic dating of gully incision on abandoned alluvial surfaces using a landscape evolution model

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Alluvial deposits are important recorders of Quaternary climate, tectonic activity, and landscape evolution. However, in-situ dating (e.g., 14C, Luminescence, cosmogenic isotopes) of alluvial landforms is often limited by the resources required, accessibility issues, and the availability of suitable dating material. Here we describe a new complementary method for obtaining calibrated surface ages for alluvial

landforms using high-resolution topographic data and a landscape evolution model. We first reconstruct the topography of the alluvial surface before incision began, and then, morphologically date the surface age by running the landscape evolution model incrementally until a sufficient match between the simulated and observed gully topography is achieved. Local calibration of the erosion model parameters (using stream-power formulation) requires in-situ surface ages. Then, the calibrated model can be used to infer the incision time of different gully sections (upstream of a fault for example) and to evaluate the surface age for nearby alluvial remnants.
We apply the method at two arid study sites in southern Israel and NW China. In both sites, the calibrated model parameters were within the typical range reported in the literature. At the Israel site, we obtained calibrated geomorphic ages of 80±8 ka and 33±10 ka for alluvial surfaces that were independently dated with a luminescence method to 70±6 ka and 34±3 ka, respectively. At the China site, we successfully obtained late Quaternary across-fault incision ages that reconciled the differential offsets recorded by three adjacent gullies that cross the Altyn Tagh Fault.
Our results demonstrate the applicability of using landscape evolution models to date gully incision and to obtain calibrated surface age estimates for abandoned alluvial landforms across regional scales. Future work will test the applicability of the approach introduced here to investigate the climatic and tectonic factors that drive the dissection of alluvial fans.

Shtober-Zisu N. (1), Vaks A. (2), Korngreen D. (2), and Frumkin A. (3)
Slope retreat rates estimated from chronology of tufa deposits sheltered by inland notches on Mt. Carmel

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Inland notches are elongated half tube indentations that develop on the carbonate rocky cliffs of mountainous zones. Occasionally tufa accumulates within notches as stalactites, drapes and crusts, covering the cavity backwall or floors. In attempt to determine the age of the latest stage of notch formation and calculate the relative rate of slope retreat, U/Th dating was used on 16 tufa samples from2 notches, providing 28 ages. Tufa grow during the time interval between the backwall erosion and visor collapse, and therefore tufa age is an approximation of the timing of the formation of the surface it developed on, i.e. the age of the notch.
The oldest known tufa sample is 39.0±10.4 ky (2σ), and the ages of other tufa samples range from2.1 to 23.3 ky. At the Nahal Oren notch, the present-day backwall formed by the end of the last glacial period (14 to18 ky), whereas the visor in its present form is from the early Holocene (7 to10 ky). The oldest sample was found ~1 m from the backwall, suggesting that backwall retreat rate ranges from 20 to 35 mm/ky. Other samples were deposited 50 to 200 cm from the visor edge, suggesting that slope retreat order of magnitude ranges from101 to 102 mm/ky. The backwall of the Nesher notch formed between 10 and 14 ky. Our results correspond with the rates of tens of meters per million years, similar to the magnitude of denudation found by previous studies in the Mediterranean zone of Israel. Dating tufa deposits is a good proxy to estimate the rate of erosion in carbonate slope retreat; however, a precautionary approach should be taken, as rock particles from the eroded bedrock might embed within the tufa, affecting the age results. Questionable samples can be identified using Cathodoluminescence (CL) microscopy.

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The life cycle of cyclones, dry intrusions and cold fronts and their role for ocean evaporation and precipitation

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Ocean evaporation and precipitation, key components of the large-scale hydrological cycle, are modulated by the passage of extratropical cyclones in the midlatitudes. We aim to understand the present variability of evaporation and precipitation and their extremes driven by the cyclone- associated airstreams and fronts based on detailed analysis of reanalysis data.
Particularly strong ocean evaporation is observed in the post-cold frontal region, where airmasses within the dry intrusion (DI) airstream descend slantwise from the upper troposphere towards the cold trailing front. This yields a non-local cyclone influence on the ocean surface, and suggests the importance of DI for intense and transient evaporation events. While the key role of cyclone-associated fronts on precipitation has been studied extensively, the cyclone influence on ocean evaporation is still unknown. We consider the life-cycle of extratropical cyclones to link both precipitation and evaporation extremes, focusing on the relationship between extratropical cyclone characteristics, DIs and cold fronts. As the cyclone case-to-case variability is high, understanding the co-occurrence of DIs, cold trailing fronts and cyclones is important for understanding the variability of surface freshwater fluxes.
We show that 65-80% of the extratropical cyclones in the storm track region are accompanied with DIs, mainly during the early stages of the intensification period. Furthermore, cyclones associated with DIs induce up to 50% stronger precipitation in the frontal regions, and up to 60% stronger evaporation, especially in the DI region of influence, compared to non-DI cyclones. These DI-induced evaporation events account for up to 40% of the observed climatology, demonstrating the significant role transient weather systems play in the air-sea interaction, at times through a fairly remote influence of the cyclones. This climatological analysis can further be used as a metric to compare climate models, and to understand past and future projections of mean climate trends and the associated precipitation and evaporation.

Siman-Tov S. (1), Marra F. (2)
Antecedent rainfall could be a critical prerequisite for debris flow triggering in the hyperarid Judean Desert, Israel
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Debris flows are fluidized, unconsolidated sediments that gravitationally flow downslope along channels, and constitute one of the most impactful natural hazards in mountainous regions, with casualties and damage to infrastructures. They are typically triggered by heavy rain or sudden ice melt in mountainous and volcanic areas. In Israel, debris flows are relatively rare and are mainly observed along the hyperarid slopes of the Dead Sea basin escarpment (north eastern Judean Desert), where the mean annual precipitation does not exceed 100 mm yr-1. Currently, debris flows are not considered an important hazard; however, previous studies reported a significant increase in their occurrence during a late Holocene dry period. It is thus crucial to assess whether climate change could affect their frequency and intensity. Here, we combine high resolution digital terrain models with weather radar data to better understand the conditions leading to debris flows in this hyperarid area. We identified over 40 debris flows by comparing digital elevation models available for the period 2013-2019. The deposits are relatively small (a few tens of meters) and usually observed along the steepest slopes of the escarpment, at the outlet of small ephemeral streams. We divide the debris flows into four groups based on their spatial and temporal distribution. Using radar data and witness information, we identify three storms, as the most

likely triggering events for these groups. In all cases, debris flows were triggered by an intense convective cell (lasting 30 min to 1 hour) which was preceded by significant rainfall amounts (8-12 mm) delivered over relatively long times. We discuss the possibility that antecedent conditions could represent a critical factor for the triggering of debris-flows in hyperarid environments.

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Sedimentology and stratigraphy of a modern halite sequence formed under Dead Sea level fall

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Halite sequences in the geological record accumulated in deep hypersaline basins. However, such halite sequences are interpreted based on modern analogues of halite deposition in shallow hypersaline environments. Recently, halite deposition in the deep, hypersaline Dead Sea has been studied together with its coeval environmental and limnogeological forcing. This is the closest modern analogue for deep environments. Therefore, stratigraphy, sedimentology and petrography of a well-dated, high-resolution modern Dead Sea halite sequence are explored. The sequence was deposited during a ca 30 m lake-level decline since the onset of modern halite deposition in 1980, and was compared with sub-annual lake levels, precipitation and flood records. The sedimentology of the sequence documents the trend of shallowing water depth, including individual floods. The sequence base is composed of alternating bottom growth-cumulate halite annual couplets, typical of deep hypolimnetic water deposition. Up-sequence, the annual couplets disappear and towards its top are composed of cumulate layers with dissolution features, typical of shallow epilimnetic water deposition. Halite deposition rate is reduced by 60% at the shallow lakefloor compared with the deep lakefloor, mainly due to the summer undersaturation that leads to depocentre 'halite focusing'. The top of the sequence contains shoreline deposits, halolites (halite ooids) and polygonal surface cracks, indicating subaerial exposure. This study shows petrographic indicators for summer thermal dissolution (partially dissolved crystals), which are distinct from dissolution features by winter floods that generate a regional truncation surface. Spatial variations in halite thickness and facies, indicating much thinner and spatially limited halite units compared to modelled halite units based on mass balance considerations were also observed. These observations provide criteria for: (i) recognizing water depths and shallowing lake-level trends from halite sequences throughout the geological record; and (ii) interpreting palaeolimnology, water column structure and the relations between stratigraphic horizons and corresponding shorelines.

Soibelman Y. (1), Storz-Peretz Y. (2,3), Ish-Shalom C. (2), and Weisbrod N. (1)
Spatial and temporal changes in the contamination extent in an ephemeral stream following a single contamination event

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On June 30, 2017, 200–300 thousand cubic meters of acidic water flooded into the Ashalim Stream as a result of a failure in the Rotem Amfert gypsum precipitation pond, causing considerable environmental

damage to the ecosystem in the area. This is unusual because it was a single large-scale event. Moreover, the Ashalim Stream is located in a hyper-arid region, subjected to short and intense low frequency flow events that often change the stream's surface. The objective of this study is to understand the contamination extent and governing processes along the Ashalim Stream following this large-scale event. In this study, we explored the change in contamination level at three sites along the stream. The water quality was monitored by upstream and downstream hydrometric stations. Water and suspended fine alluvium samples, as well as soil samples from cross-sections along the streambed, were taken during flood events. Changes related to the morphological dynamics were examined, using photogrammetry and scour chains, in addition to the geochemistry.
Six flow events were measured during this research. All were monitored downstream, while only two events were monitored upstream. Side tributaries were observed as the main contributors to the generation of the floods downstream, rather than the polluted upstream. The results indicate a decrease in the water's contaminant concentrations during each flood event, with levels continuing to decrease further during each subsequent flood. In addition, as the rainy season progressed and following flow events, the ratio between the adsorbed and dissolved flux increased, i.e., the contaminants transitioned from the dissolved to the adsorbed phase. Photogrammetry and scour chains indicate that flood events can cause considerable morphological changes in the streambed, which are not always obvious after the flood ceases. This is an important aspect to consider when analyzing the geochemical processes in a polluted streambed.

Starr M. (1,2) Klein T. (2) and Gross A. (1)
Phosphorus-rich dust acts as a foliar fertilizer for forest trees

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Phosphorus (P) is a vital element for plant nutrition. Sources of phosphorus input to terrestrial eco-systems include P released by weathering of rock and inputs from the atmosphere, such as P rich dust. Although the soil may receive an abundance of P-rich dust, P availability to plants via the roots is often limited by various environmental soil conditions and currently, the effects of desert dust on the P nutrition and uptake mechanisms by trees is unknown. Although the soil may receive an abundance of P-rich dust, P availability to plants via the roots is often limited by various environmental soil conditions. Such conditions include unsuitable soil pH keeping P fixated, and a strict dependency on microorganisms' cooperation, thus, restricting the ability of P inputs being optimally utilized by tree roots.
Here we hypothesize that trees can absorb P from dust that settles on their leaves directly via the foliage, bypassing the soil. Our hypothesis is based on the ability of tree foliage to capture atmospheric dust better than the ground due to their large surface area. Additionally, the acidic pH on the leaf surface is suitable for dissolving P from apatite, the major P bearing mineral in desert dust. Foliar P uptake is a well-known mechanism in agriculture. However, the contribution of foliar P uptake from desert dust by forest trees has not yet been studied.
In this study, we have grown 4 tree species: Oak (Quercus calliprinos), Carob (Ceratonia siliqua), Brazilian Peppertree (Schinus terebinthifolius), and Brazilian rosewood (Dalbergia nigra) in a greenhouse with and without P addition. The trees were then applied with desert dust either on the ground or directly on the above-ground tree surfaces, acting as their only P source. We monitored the trees growth and biomass accumulation, P levels, leaf surface pH and exudation, and the rate of their photosynthesis. Results from this experiment are expected in the next couple of months.

Stauber O. (1) Granot R. (2) Finzi Y. (3)

The heat source to the quartzite “Carpentry" hill, Central Ramon, from detailed magnetic mapping

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The presence of quartzite in Makhtesh Ramon has been associated with local metamorphic events that occurred at shallow depth under high temperature. Prior research showed that the heat source for similar events was associated with the magmatic activity that intruded the Jurassic sandstones. One of the localities in which the quartzite is most extensive is the quartzite “Carpentry” hill found in central Makhtesh Ramon. However, this site lacks conclusive evidence for a magmatic body that could have provided the needed heat for the relatively wide-spread quartzite. We carried out a detailed ground total-field magnetic survey to locate and characterize the magmatic body that supplied the heat that eventually caused the quartzite formation. Overall, we took 1362 measurements over an area of 60,000 m2. Processing included subtracting the geomagnetic field magnitude for each measurement and de-spiking. The resulting anomaly map shows two prominent features. A strong linear positive anomaly indicates the presence of a newly detected buried dike found south-east of the hill. More importantly, a prominent negative circular anomaly feature is observed at the center of the hill, indicating a wide magmatic body with a diameter of ~180 m, which is best explained by a shallowly buried body found beneath the center of the hill. The topographic shape of the hill follows the geometry of this anomaly, and hence we suggest that this magmatic body served as the heat source that led to the metamorphism. A negative anomaly indicates that the magnetic source layer is reversely magnetized. Thus we associate its formation with the early Cretaceous magmatic event (125-123 Ma) that predated the Cretaceous Normal Superchron. Finally, the exposed dikes surrounding the hill and our newly discovered buried dike have different magnetic signatures compared with the main negative anomaly, suggesting that they are probably unrelated to the main intrusive body.

Stein S. (1), Sivan O. (1), Yechieli Y. (2), and Kasher R. (3)
Redox condition of saline groundwater from coastal aquifers influences reverse osmosis desalination process
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Reverse osmosis (RO) seawater desalination is a widely applied technological process to supply potable water worldwide. Recently, saline groundwater (SGW) pumped from beach wells in coastal aquifers that penetrate beneath the freshwater-seawater interface is considered as a better alternative water source to RO seawater desalination as it is naturally filtered within the sediments which reduces membrane fouling and pre-treatment costs. The SGW of many coastal aquifers is anoxic –and thus, in a low redox stage –has elevated concentrations of dissolved manganese, iron and sulfides. We studied the influence of the SGW redox stage and chemistry on the performance - permeate flux and fouling properties - of RO desalination process. SGWs from three different coastal aquifers were sampled and characterized chemically, and RO desalination experiments were performed under inert and oxidized conditions. Our results show that all three aquifers have anoxic saline groundwater and two of them have intensive anaerobic oxidation of organic matter. Two aquifers were found to be in the denitrification stage or

slightly lower and the third one in the sulfate reduction stage. Our results indicate that the natural redox stage of SGWs from coastal aquifers affects the performance of RO desalination. All SGW types showed better RO performance over seawater desalination. Furthermore, air oxidation of the SGW was accompanied with pH elevation, which increased the membrane fouling. Hence, keeping the feed water unexposed to atmospheric conditions for maintaining the natural reducing stage of the SGW is crucial for low fouling potential. The observed benefits of using naturally reduced SGW in RO desalination have significant implications for reduction in overall process costs.

Tal A. (1)
The effect of the Geological Structures on the Groundwater Flow in Kabri Basin

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The Kabri groundwater basin serves as an important water source for supply and its discharge points along the Ga'aton and Kziv Rivers are fascinating nature reserves. The groundwater flow in the basin is in the Judea Group and is dictated by the geological structures mainly fault systems. As a result the basin is divided to several sub-basins, each with its natural outlets.
To the west, the aquifer is hydraulically connected to the coastal aquifer, while interpretation of seismic data, along with the results of two-dimensional flow and transport model, show that there is insignificant hydrological connection between the Judea aquifer and the open sea. The Judea Group is cut off from the sea by the young strata of the clayey Saqiya Group. Small exposure of the Judea Group to the sea exists in the Achziv Canyon, at a depth of approximately 850 m. According to the numerical model, the flux through this geological window is small. However it is essential to prevent seawater from entering inland by maintaining a relatively high groundwater levels (by production restrictions).
The hydrological responses of the Kabri springs, located on a geological fault, have been under discussion for years. The stability of the springs flow is in contrast to the trends seen in the Judea Group host aquifer. The unique karst system of the Kabri springs has been uncovered following unplanned man-made activities; Emergence of a new spring during limestone quarrying, and a large pollution event followed by a tracer test, helped to further understand that the karst system that feeds the springs extends far up the basin and builds a separate and developed pipe-like karstic system.

Tal Y. (1)
Modelling the effects of fault geometry and off-fault rheology on the earthquake cycle
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Earthquakes occur by slippage along pre-existing faults. It is increasingly apparent that faults are zones with a complex internal structure, which typically exhibits localized deformation on slip surfaces within a fault core that is surrounded by a damage zone of distributed fractures. High-resolution map traces of large continental earthquakes and field measurements from exhumed faults show that the slip surfaces are typically non-planar, exhibiting fractal geometry at all scales. This deviation from planarity results in geometric asperities and a locally heterogeneous stress field, which affect rupture process during earthquakes or aseismic deformation. The exact extent of their effects, however, is not yet clear. Here we use numerical simulations to examine how fault non-planarity and off-fault rheology affect the earthquake source process, in terms of magnitude, reoccurrence time, slip distribution, and rupture nucleation and propagation. We perform earthquake cycle simulations on non-planar faults governed rate and state friction, using Drucker-Prager viscoplasticity to account for inelastic deformation of the off-fault material. Our results show that fault non-planarity introduces considerable complexity into the rupture

process and that the magnitude of the events decreases as the level of roughness increases. We suggest that small degree of fault roughness can explain the variability in recurrence time and magnitude observed for sequences of small repeating earthquakes, such as those near Parkfield, California.

Tau G. (1,2), Crouvi O. (2), Enzel Y. (1), Teutsch N. (2)
Shutting down dust emission during the middle Holocene drought in central Arizona

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Long-term relationships between climate and dust emission remain unclear, with two prevailing, but opposite hypotheses for impacts of climate shifts. A) Increased dust emission with increased aridity and reduced vegetation coverage. B) Emissions decrease under drier, less stormy climate as fewer sediments replenish dust sources. Here we test these hypotheses by analyzing an ~11-m long core, archiving Holocene dust, trapped in the Montezuma Well (MW), Arizona, together with current dust sources and transport pathways. Major elements indicate that MW sediments originated from two end-members: local carbonate bedrock and external silicate-rich dust. Core sediments are similar to the adjacent silicate-rich soils accumulated over the carbonates, pointing to their eolian origin. Particle-size distributions reveal that the accumulating dust in the core is fine and coarse, respectively transported during winters and summers from western Arizona, the Mojave Desert, and southern Arizona, similar to current climate systems and dust pathways. Surveys of potential dust sources indicate that current summer and winter dust sources are in a supply-limited fluvial system. Dust fluxes were high during wetter phases of the Holocene when winter sources dominated. During the middle Holocene drought, dust fluxes were minimal, dominated by summer sources up until dust input ceased as drought conditions did not produce enough floods to refill sources with sediments. We propose that in arid central Arizona, dust activity is strongly connected with climate, occurring primarily during humid intervals, and enhanced by dust supplied by replenishing of sediments at dust sources.

Teutsch N. (1)
Environmental assessment of coal fly ash usage in Israel
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Coal ash production as a by-product of electricity generation in Israel started in 1982, peaked in 2012, and since then has significantly decreased with the utilization of natural gas for electricity production. Coal fly ash (FA) use spans various fields including infrastructure, construction, industry and agriculture. During use, FA comes in contact or is blended with other substances which could influence its characteristics. Trace element leaching from FA depends on the pH, water contact, and physical-chemical properties of the resultant product. Israeli fly ash research is testing FA “as is” and in mixtures in order to estimate the actual release capability of constituents of potential concern (COPCs), subject to varied environmental conditions.
“Leaching Environmental Assessment Framework” (LEAF) is a result of over 20 years of collaboration between USA and Europe research teams which resulted in a collection of four US-EPA leaching tests, guidance, and software for database management and modelling. Leaching characteristics of a material acquired by LEAF are used to estimate COPCs leaching under field scenarios.
Environmental assessment has been carried out for FA uses such as in cementitious materials, agriculture and infrastructure. These studies have focused on leaching and uptake of COPCs, taking into consideration the Israeli environment using worst case scenario FA types and use conditions. The cementitious materials, controlled low-strength material (CLSM) and grout, contained up to 40% FA; the agricultural

experiment checked lettuce growth with as much as five times the recommended FA amendment level. The infrastructure research is underway applying FA as is for use in construction base and embankments. Data gathered over the last decade indicate that even with greater than planned usage rates of fly ash containing relatively high levels of COPCs in the studied materials, no environmental safety concerns exist from leaching or crop uptake of COPCs in the Israeli environment.

Tibor G. (1), and Rinkevich B. (1)
Call for multidisciplinary research in the Northern Gulf of Aqaba/Eilat utilizing R/V Bat Galim, Spring 2023 (March-April)
1. Israel Oceanographic & Limnological Research Ltd., Tel-Shikmona,Haifa, Israel

R/V Bat-Galim is the most heavily equipped and advanced research vessel operated in Israel. It is capable of performing high resolution sea-bottom bathymetric and sub-bottom mapping, water column sampling and high-accuracy targeted 9m sediment coring, box coring, as well as serve as a platform for deep water ROV and AUV equipment. To maximize its efficacy, the ship is scheduled to sail to the Northern Gulf of Aqaba/Eilat during Spring of 2023 and is inviting interested universities, organizations, and individual scientists to make use of the ship and maximize its activities during its time there. The scheduled cruise is part of a proposed research study (USAID-MERC; under review) on the subject of “Geo-hazards and biodiversity offshore the new anthropogenic impacted Jordanian Red Sea coastline”. This will be the first time that this set of capabilities will be available to researchers in the Northern Gulf of Aqaba/Eilat from a single vessel. Bringing the ship to the Gulf via the Suez Canal and operating it during its stay is a costly endeavor, but with a group effort to combine several multidisciplinary research projects it is expected to be made possible. At present, efforts are being made to create additional funding through specialized proposal calls from organizations such as : MERCI, IUI, IOLR, GSI, Universities and the scientific offices of relevant government ministries. During this talk, we will present a brief overview of our MERC research proposal, highlight the R/V Bat Galim’s unique capabilities, and provide information regarding the estimated costs for carrying research with the ship.

Tiwari S. (1, 2), Erel R. (2), Shtein I. (3), Gross A. (1)
Direct foliar uptake of insoluble phosphorus from desert Dust
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3. Eastern Region Research and Development Center, Ariel, Israel.

Phosphorus (P) scarcity is a global challenge for plant growth in many ecosystems. In P-poor ecosystems, plant productivity are directly linked with the deposited P-rich dust originating from desert storms. However, dust P usually has low bio-availability and is considered exclusively via root system. Here we describe an adaptive unrecognized foliar P acquisition pathway in plants that have origin to dusty region can directly utilize P from atmospherically deposited desert dust. In a greenhouse experiment we found that the growth of P starved chickpea and wheat plants supplemented with desert dust on their leaves stimulated plant growth and doubled the biomass and P uptake in comparison to undusted plants. The P starvation induced morphological and chemical modifications that promoted solubilization of P from dust deposited on their leaves. No effect was observed in maize plants that evolved far from desert ecosystem. Further we found that P starvation induced modifications, involved increased leaf dust retention capacity and accelerated solubilization of P mineral forms that are theoretically considered unavailable to plants via lowering the leaf surface pH and exudation of organic acids. Our results suggest that 'foliar dust uptake

traits' enable plants in dusty regions to acclimate to nutrient poor conditions via utilizing alternative foliar acquisition pathway. As it is projected that global environmental changes and P limitation will increase in near future, the plants adopting dust traits will gain competitive advantage over other species. Thus we propose that exploiting such traits in future for sustainable agriculture.

Topaz A. (1), Boneh Y. (1), and Golan T. (1)
Texture Evolution of Amphiboles - a Case Study from the Mamonia Complex, Cyprus
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Amphibole's ubiquitous occurrence makes its texture key for assessing tectonic regimes in the lower crust and subduction zones. The manner of analyzing a crystal's texture is by investigating its crystallographic preferred orientation (CPO). Amphibole often display a typical CPO where the crystals [001] axes align with lineation and the [100] axes align with the normal to the foliation plane. However, this common CPO was attributed to numerous different deformation mechanisms, such as rigid body rotation, dislocation creep, or dissolution precipitation, and there yet to be found a distinct relation between amphibole CPO and the prevailing deformation mechanism. Here, we present a microstructural analysis using electron backscatter diffraction sensor installed on a scanning electron microscope that allows us to detect diffracted patterns of electrons, and map the crystals orientations at µm resolution. Two samples of highly deformed amphibolite, comprised mainly of hornblende and plagioclase, from the metamorphic sole of Mamonia Complex in Cyprus were analyzed: 'Agia Varvara' (AV), and 'Bath of Aphrodite' (BOA). Despite similar compositions and conditions (~600 °C and 6 kbar), there are differences in their texture. Hornblende from AV show curvy boundaries and a strongly clustered amphibole CPO, with the [001] axis is aligned parallel to X-axis and the [100] axis aligned at Z-axis. Hornblende grains from BOA are tabular-shaped and show two CPO types: axial [001], where the [001] is aligned parallel to X-axis while [100] and [010] oriented along the Y-Z plane, and orthorhombic, where the [001] and [100] are aligned with the X and Z axes, respectively. In addition, difference of intragrain misorientations between the two samples suggest plastic deformation characteristics in AV. We interpret the textural and microstructural analysis of the amphibolites to reflect different deformation mechanisms. For AV, the strong CPO and curved boundaries suggest deformation through dislocation creep. In BOA, the observations of tabular-shaped grains, along with a varying texture, suggest deformation by rigid body rotation.

Torfstein A. (1,2), Kienast S. S. (3), Chernihovsky N. (1,2), Yarden B. (2), and Almogi-Labin A. (4)
Export production and biogenic fluxes in the Gulf of Aqaba: a glimpse into warming oceans of the future

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The oceanic biological carbon pump modulates atmospheric CO2 concentrations by transporting carbon from the sunlit surface to greater depths. The efficiency of the biological pump, and its response to warming temperatures are of importance to future projections of global change. We present a new time series of organic carbon and inorganic CaCO3 fluxes from a monthly resolved sediment trap time series in the warm oligotrophic Gulf of Aqaba, which is part of the Red Sea Dust, Marine Particles and Seawater Time Series (REDMAST) campaign. With the goal of better quantifying carbon cycling in the warm parts of the global ocean, we evaluate the attenuation of sinking carbon across the seasonal cycle, and discuss findings in the context of globally compiled attenuation curves.

The results show that attenuation of organic carbon is less intense and occurs deeper in Gulf of Aqaba than expected based on a global correlation with temperature. This challenges the globally uniform role of temperature in controlling carbon attenuation in the ocean. It also suggests that a positive feedback between rising ocean temperatures, increasing carbon attenuation and increasing atmospheric CO2 in not globally consistent. By contrast, inorganic carbon fluxes in the Gulf of Aqaba are dominated by a terrigenous end member, it self composed of a mixture between far travelled atmospheric dust and local fluvial contributions, as well as a quantitatively minor fraction of biogenic-inorganic carbon (e.g., foraminifera shells). Nevertheless, the organic and inorganic carbon fluxes are tightly coupled, reflecting the strong role of mineral ballasting on the biological carbon pump, implying that future changes in terrigenous fluxes (e.g., dust) will impact carbon sequestration rates in the oceans.

Torfstein A. (1,2), and Steinberg J. (3)
The Oligo–Miocene closure of the Tethys Ocean and evolution of the proto-Mediterranean Sea

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The tectonically driven Cenozoic closure of the Tethys Ocean invoked a significant reorganization of oceanic circulation and climate patterns on a global scale. this process culminated between the Mid Oligocene and Late Miocene, although its exact timing has remained so far elusive, as does the subsequent evolution of the proto-Mediterranean, primarily due to a lack of reliable, continuous deep-sea records. Here, we present a new framework of the Oligo–Miocene evolution of the deep Levant Basin, based on the chrono-, chemo- and bio- stratigraphy of two deep boreholes from the eastern Mediterranean. The results reveal a major pulse in terrigeneous mass accumulation rates (MARs) during 24–21 Ma, reflecting the erosional products of the Red Sea rifting and subsequent uplift that drove the collision between the Arabian and Eurasian plates and the effective closure of the Indian Ocean-Mediterranean Seaway. Subsequently, the proto-Mediterranean experienced an increase in primary productivity that peaked during the Mid-Miocene climate optimum. A region-wide hiatus across the Serravallian (13.8–11.6 Ma) and a crash in carbonate MARs during the lower Tortonian reflect a dissolution episode that potentially marks the earliest onset of the global middle to late Miocene carbonate crash.

Tsesarsky M. (1), and Glechman Y. (1)
3D simulations based ground motions as a complementary tool for seismic hazard assessment in Israel
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The seismicity of Israel is dominated by the Dead Sea Transform (DST), an active plate boundary with a proven pre-instrumental seismic record of significant earthquakes. Pre-instrumental catalog suggests at least 14 large (M>7) seismic events associated with the DST in the past two millennia. The last major event was the Mw 6.2, Jericho earthquake in 1927. The instrumental catalog of Israel is based on a spatially sparse network which does not cover the major urban and industrial centres of the state. Moreover, due to slow slip rate of the DST and long recurrence intervals of strong earthquakes, the catalog lacks records of strong ground motions. This situation results in a critical data gap in estimation of seismic hazard in Israel. To bridge this gap, we employ 3-D numerical computational approach to compute synthetic records of ground motions in Israel from earthquakes generated by active segments of the DST. Our model includes the major fault zones, i.e. The DST and the Carmel Fault Zone (CFZ), and the accompanying sedimentary basins and structures, including the Zevulun and Jezreel basins along the CFZ and the Hula,

Kinnarot and Bet Shean Basin along the DST. The model also includes the sedimentary wedge underlying the coastal plain, where most of the population resides. We present the first set of results of large scale modeling (159 km x 124 km x 28 km) for central and northern Israel with surface resolution of 76 m. Based on synthetic seismograms from a network of 129 stations, we present attenuation relations for Peak Ground Velocities (PGV) and intensities (EMS scale), resulting from plausible scenarios of Mw 6.85 and Mw 6.2 earthquakes. We further plan to perform more simulations to complement and update imported GMPE'S in order to mitigate the seismic hazard in our region.

Tsumi N. (1), Kiro Y. (1), and Reznik I. (2)
Seawater flow patterns in coastal aquifers: Nitzanim (Israel) case study

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The interaction between the ocean and coastal aquifers is complicated as it involves multiple geochemical reactions due to water-rock interaction. Moreover, the seawater's intrusion pathways into the coastal aquifer and the mixing with fresh groundwater are not fully understood. Extensive pumping and sea-level rise expose the coastal aquifers to seawater intrusion (salinization) and may impair groundwater utilization for drinking and irrigation. Most of the studies that deal with seawater flow and circulation in the aquifer are modeled-based and, therefore, bound to hydrological assumptions that do not necessarily reflect this system's real behavior. This study adds an alternative perspective based on the geochemical reactions along flow paths in coastal aquifers. Our research aims to describe seawater flow and mixing with fresh groundwater in coastal aquifers using detailed chemical analyses of major and trace elements and radiogenic isotopes of 234U/238U and 87Sr/86Sr.
The study area is in Nitzanim nature reserve, and samples were taken from the shoreline and from three monitoring wells that belong to Israel Water Authority.
Our preliminary results show:
• Same elements (major and trace) can display conservative and non-conservative behavior depend on the geochemical processes.
• Enrichment of U in all sites and Sr enrichment far from shore.
• Sr and U respond at a different rate to water-rock interaction.
We hypothesize that these results reflect the period of the interaction between the circulated seawater and the aquifer sediments. i.e., groundwater samples that correlate linearly on the mixing line reflect a short-time scale of water-rock interaction, while samples that lie below or above reflect longer time scales. We assume that U and Sr enrichment results from carbonate dissolution and that the difference in the response rates can be used to track the flow paths and mixing of seawater with fresh water in the aquifer. Given this rationale, our results suggest that groundwater flows from the shore inland up to 200 meters from the shore and then mix with fresh groundwater.

Vigderovich H. (1), Eckert W. (2), Elul M. (1), Lotem N. (1), Rubin Blum M. (3), Elvert M. (2), Sivan O. (1)
Potential electron acceptors for reverse methanogenesis during long-term incubations of lake sediments

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4. MARUM - Center for Marine Environmental Sciences and Department of Geosciences, University of Bremen, Leobener Strasse 8, Bremen, Germany

Methane is a potent greenhouse gas that is produced naturally via microbial processes in anoxic environments (i.e. marine and lake sediments). Anaerobic oxidation of methane (AOM) is one of the major processes that limit the release of greenhouse gas methane from natural environments. AOM is driven by a variety of electron acceptors, including sulfate, iron, manganese, nitrate, nitrite, and organic electron shuttles such as humic substances. Iron-coupled AOM (Fe-AOM) was suggested to play a role in the oxidation of methane in Lake Kinneret methanic fresh sediments by anaerobic methane-oxidizers (ANME) or methanogens, combined with aerobic methanotrophy. Nevertheless, the mechanism and the way they collaborate, if at all, is still unknown. Here we performed long-term incubations of Lake Kinneret methanic sediments with 13C-labeled methane and various electron acceptors and inhibitors, to investigate how methane oxidation is performed. Geochemical measurements indicate, considerable methane oxidation (up to 0.2 µM d-1) in a net methanogenesis environment, and a shift in electron acceptor utilization: from anaerobic and aerobic methane oxidation in fresh incubated sediments to strictly anaerobic methane oxidation in pre-incubated sediment experiments. Iron oxides and humic substances might support this AOM, while sulfate, nitrate, and nitrite do not. Additional organic geochemical and metagenomic analyses suggest that the AOM in the long-term incubations is performed by methanogens through reverse methanogenesis either metabolically or by back flux reactions.

Waldmann N.D., Daniels W.C., Castañeda I.S., Wooller M.J.
Reconstructing climate and environments in the heart of the Bering Strait: insights from an 18,000 year-long multi-proxy record from St. Paul Island.

St. Paul Island is located in the south central Bering Sea and was home to a local population of woolly mammoths until approximately 5.5 ka. The sediment record from the island's Lake Hill offers a valuable opportunity to characterize the paleoclimate of the Bering Strait region and to assess the role of climate in the local extinction of woolly mammoths. Here we use a suite of biomarkers from Lake Hill to document changes in temperature, precipitation, and vegetation from 18 ka to present. We find that deglacial warming was stronger in the island record compared to surrounding sea surface temperatures, and temperatures gradually increased over the Holocene, a stark contrast with records from the Alaska mainland. Changes in ecological indicators, such as leaf wax distributions and diatom assemblages, appear more strongly controlled by precipitation than temperature. We suggest that an increase in winter precipitation at 5.5 ka contributed to the mammoth decline, and that following extinction, significant vegetation changes occurred as a result of decreased herbivore pressure.

Weber N. (1,2), Gavrieli I. (1,2), Stein M. (1,2), Yechieli Y. (2,3), and Lazar B. (1)
The buffer system of the Ein Qedem hydrothermal springs, Dead Sea

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The Ein Qedem (EQ) hydrothermal spring system includes ~40 springs over a coastal strip of ~2 km, along the west coast of the Dead Sea (DS). The EQ groundwater originated from the Last Glacial Lake Lisan epilimnion which infiltrated into the marginal aquifer. It is a Ca-Chloride brine with similar ionic composition to that of the DS and about half of DS's salinity. The chemical compositions of these two

brines indicate that since their separation the groundwater and the lake's brine underwent different paths. The lake continued evaporating and precipitating evaporite minerals, while the EQ groundwater interacted with the aquifer's rocks.
In most natural waters the buffer system (total alkalinity-TA) is controlled mainly by the carbonate alkalinity; in the DS, however, the carbonate plays a rather small role and the major buffer is the borate. The buffer system in EQ springs system is even more complex as it has up to four potential components: carbonate, borate, sulfide and ammonia. This is a rather unusual case for groundwater flowing mainly within a carbonate aquifer. Calculations based on measured TA and of the bulk components of the buffer system (e.g., total sulfide), show that at the geochemical conditions (i.e., composition, temperature, pH) prevailing in EQ, the TA consists mainly of three components: 88% carbonate, 11% sulfide and 1% borate, and its PCO2 is extremely high ~250,000 matm. This composition suggests that the EQ brine evolved by several water-rock interaction processes: Oxidation of organic matter at high temperatures which is responsible for the high PCO2, adsorption of borate on aquifer's rocks which decreased the original boron content, and bacterial sulfate reduction which converted part of the sulfate to sulfide and mineralized ammonium. The Ein Qedem springs contribute DIC to the DS, however, their low pH prevents aragonite deposition in their mixing zone by the shoreline.

Weber N. (1,2), Antler G. (3,4), Lazar B. (1), Stein M. (1,2), Yechieli Y. (2), Gavrieli I. (2)
Gypsum deposition by outsalting – mixing of groundwater with Dead Sea brine during the late Holocene and paloeclimatic insights

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The rapid retreat of the Dead Sea during the past decades led the exposure of unique structures of massive gypsum with aragonite laminae. Many of these structures are associated with activity of Ein Qedem-type saline springs that currently discharge hot-saline Ca-chloride brine to the modern Dead Sea. Here, we report on the radiocarbon aragonite ages, chemical and sulfur isotope compositions of the gypsum structures and present a geochemical model to their formation. The model describes mixing of the Dead Sea and Ein Qedem Ca-chloride brines with different salinities and sulfur concentrations. This mixing results in gypsum "outsalting" – attainment of oversaturation and mineral precipitation, which occurs at the off-shore shallow water environment, such as the Ein Qedem shore, where we focus our research. The gypsum stable isotopic composition from various locations along the Dead Sea western shores show uniform values. This uniformity indicates a similar and unique source of brine from which the different gypsum structures precipitated. The low radiocarbon content in the aragonite crusts suggest contribution of bicarbonate ions that were provided by Ein Qedem-type brine. Currently, gypsum does not precipitate at the mixing zone between the Dead Sea and Ein-Qedem brine. However thermodynamic calculations show that gypsum outsalting occurred when both brines where more enriched with sulfate, i.e. at times when Ein-Qedem reservoir in the subsurface had less intensive bacterial sulfate reduction, and before the Dead Sea brine has precipitated and lost much of its gypsum and sulfate, respectively. Condition for enhanced saline springs discharge and gypsum outsalting occurred in the mid to late Holocene (~ 6.6 to 0.6 ka) and were mainly intensive at the latest stages of regional aridity cycles when springs activity resumed and the saline springs and later freshwater springs discharged to the Dead Sea.

Weiss Y. (1)
Fingerprinting the involvement of carbonate-rich melts in oceanic island basalt sources

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Mantle melting, which leads to oceanic and continental crust formation, and crust recycling into the mantle through plate tectonics are the two primary processes driving the chemical differentiation of the Silicate Earth. Present-day mantle, as sampled by mid-ocean ridge basalts (MORB) and ocean island basalts (OIB), shows large chemical and isotopic variability bounded by a few end-member compositions: The 'depleted MORB mantle' or 'DMM', sampled by most MORB, and three distinct trace-element 'enriched mantle flavors' in OIBs called EM1, EM2 and HIMU. Among these, HIMU basalts stand out with the highest Pb isotope ratios, high Os isotope ratios, low Sr isotope ratios slightly higher than depleted MORB, and Nd-Sr isotope ratios plotting 'below' the so-called 'Nd-Sr mantle array'. Its mantle source has been generally considered to represent recycled basaltic oceanic crust. However, recent analyses of olivine phenocrysts in HIMU lavas indicate derivation from partial melting of peridotite, rather than from the pyroxenitic remnants of recycled oceanic basalt. In addition, exceptionally high Ca/Al in these olivines indicate an old metasomatic enrichment process involving carbonatitic fluids. A key piece to the HIMU puzzle is the similarities in trace element patterns between carbonatitic melt inclusions in diamonds, kimberlites and HIMU lavas. These patterns, which are now shown in many alkaline basalts from different provinces, reflect similar processes of trace-element depletion and enrichment experienced by their mantle sources integrated over geologic time. Thus, carbonatite-rich fluids-melts are an important agent of mass transport and metasomatic enrichment in the Earth interior which shape the chemical heterogeneity of the sources of oceanic island basalts.

Weissman G. (1), Dahan O. (1), and Bel G (2,3).
Flux probability distribution in heterogeneous unsaturated soil based on Measurements and modeling

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Estimation of contaminant fluxes through unsaturated soil is limited, among other factors, by the uncertainty regarding the heterogeneity of soil properties and by the lack of studies focusing on heterogeneous vadose zone transport based on continuous non-destructive measurements. Here, we present an approach that intends to provide reliable estimates of fluxes of solutes in the vadose zone, considering the measured variability of flow and transport. Our measurements are taken as part of a field experiment focusing the accumulation in soil and leaching of agricultural nitrate. The flow and transport below the root zone are monitored by a Vadose zone Monitoring System (VMS) that was installed in the unsaturated zone under the field. The VMS provides long term continuous measurements by 24 moisture sensors and 32 pore water sampling ports that are distributed across the unsaturated soil profile at depths of 1 to 4.5 m. Measurements show that the solute accumulation and transport in the soil vary greatly in time and space. Using a new modeling approach, multiple 1D simulated profiles (using HYDRUS) were compared separately to each sensor across the unsaturated zone. This comparison enabled a weighted characterization of the heterogeneity using the characteristics of the measured water contents and solute concentrations directly, instead of pre-estimating the heterogeneity or deriving it from the particle size

distribution alone. The simulated water contents and solute concentrations are weighted using different weighting schemes including the error in simulated profile and the error in the arrival time of identified wetting fronts or solute breakthrough. This approach allows the estimation of the entire probability distribution of the fluxes.

Weiss-Sarusi K. (1), Bookman R. (2), Silverman J. (3), Teutsch N. (1)
Tracing sources, dispersal and burial of heavy metals in Haifa bay using lead and zinc isotopes in recent sediments - Perliminary results

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The abundance of anthropogenic heavy metals (HMs) in the marine environment has risen significantly since the beginning of the Industrial Revolution. Most HMs are defined as pollutants in the marine environment because they are toxic to living organisms. In marine sediments, anthropogenic HMs are linked to direct input of effluent discharge from waste treatment plants, heavy industries and mining operations. During rain events, polluted industrial and urban surfaces, and coastal stream sediments can also be an important source of anthropogenic HMs to coastal waters following surface runoff through drainage systems and stream flooding that causes resuspension and transport of polluted sediments. Atmospheric deposition (wet\dry) to the sea surface is also considered an important source of anthropogenic HMs such as those emitted by coal burning power plants. Finally, submarine groundwater discharge to coastal waters have also been shown to be an important source of anthropogenic HM pollution. Haifa Bay, as a case study of an industrial bay in Israel, is investigated for modern dispersal and redistribution of anthropogenic HMs from land based sources and sedimentary hotspots of pollution. In this work, isotopic systems of lead (Pb) and zinc (Zn), two HMs with distinct anthropogenic signatures are applied in the aquatic system to reveal pollution sources, dispersal and burial patterns. In order to determine the transport and dispersal of HMs from Haifa Bay, sediment traps were deployed at ~15-30 m water depth inside the bay and along its western open water boundary during October 2020 for an overall 2 year period. The sediments from these traps will be collected for the first time and analyzed in February 2021 and preliminary work on HM concentrations and Pb isotope ratios will be presented. The annual time-series of these measurements will reveal pollution transport and sources in relation to meteorological and oceanographic conditions.

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Unearthing the "Bio-Mounds" of the Northern Red Sea

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Environmental-engineering organisms structure their habitat in a way that can extensively impact the complexity and functionality of the surrounding ecosystem. Volcano-shaped, sediments mounds have been observed in many shallow areas in the northern Gulf of Aqaba-Eilat. These structures are most likely biologically created and are clearly affecting the biogeochemistry, ecology, and sedimentary processes of

their surroundings. Despite their wide-spread presence in the gulf, information regarding mounds abundance, size distribution, dynamics, and other basic properties is scarce. Nor a definitive capture or observation of the organisms creates them. This dearth in research may be a result of a lack of "charisma" for the subject, however, given their ubiquity and probable role in constructing the physical framework, primary research is long overdue. In this pioneering research, preliminary baseline data is being collected in several locations in order to map the mounds distribution along the NE coast of the Gulf of Aqaba. In addition, a 144m2 study polygon established; mound size (height, diameter, angle), and grain size (along gradient of slope) are monitored over time. Also, time-lapse and regular photography is taken, and repeated micro-topographical time-series mapping is produced using 3D agisoft photomosaicing. These data along with Luminophores tracers' experiments will be used to calculate the rate and volume of sediment displacement and mixing depth over time. Efforts to identify the mound-building organism(s), are underway and include excavation of the mounds using an airlift fitted with a fine-mesh sieve and high speed in situ time-lapse photography. The results of this study will provide a much-needed first glance at these significant features, their makers, formation, and environmental significance.

Wetzler N. (1), Segev A. (1), and Lyakhovsky V. (1)
Motion and strain at periphery of the Lebanese Restraining Bend, the Dead Sea Fault

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The strain field associated with complex faulting structures along strike-slip systems attracts geological and geophysical studies and numerical modeling. We study the impact of crustal structure on the peripheral strain field associated with the ongoing strike-slip motion along the Dead Sea fault system by combining seismological focal mechanism data and numerical modeling. The regional seismicity and focal mechanism solutions demonstrate strike-slip activity along the main transform fault, normal faulting along the Galilee (northern Israel), and normal faulting along the Irbid-Azraq rift zone, (east of the DSF, Jordan). We study the distributed deformation and crustal motion utilizing a 3-D lithospheric model with a brittle seismogenic crust governed by a damage rheology overlayed a visco-elastic mantle. Based on the GPS data and the focal mechanism solutions we include opening of the Irbid-Azraq rift to the model conditions. Comparing results of numerical modeling with different settings emphasizes the role of each tectonic feature, restraining bend and rifting, separately and their interaction. The model predicts the compression west of the bend and tension on the south-west of the transform. The overall deformational pattern and vertical crustal motions are consistent with the uplifted Lebanon Mountains and the N-S extension and faulting observed in the Galilee region. This study emphasizes the importance of using a realistic 3-D lithospheric structure with major geological units.

Wieler N. (1), Hamiel Y. (1), Nuriel P. (1), Katz O. (1)
Marginal faults activity along the central Jordan Valley section of the Dead Sea Fault

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The Dead Sea Fault (DSF) forms the tectonic boundary between the Arabian plate and the Sinai sub-plate. Here, we examine the deformation accommodated by the N-S striking marginal faults located at the western border of the central Jordan Valley section of the DSF, near the town of Beit Shean. Morphological steps, composed of Tufa sediments and bounded by three sub-parallel normal faults, were studied in order to resolve the spatial and temporal distribution of active faulting. The marginal faults were mapped using high-resolution airborne LiDAR data combined with field observations, and the sub-surface structure was demonstrated using high-resolution seismic line. U-Th dating of Tufa samples enabled us to constrain

the faulting age that formed the morphological steps. Samples ages ranges between 80-12 Kyr, corresponding to sedimentation rate of 0.6±0.1 mm/yr. Across the westernmost fault a significant deviation from this sedimentation trend is observed. We found 16±1 meters of vertical offset across this fault occurring post Tufa deposition at 12.4±0.89 Kyr ago. These values lead to an average vertical slip rate of 1.3±0.1 mm/yr on the westernmost marginal fault, higher rate than previously reported. The central and eastern faults do not show any significant vertical offset in the last 80 Kyr. Our results suggest that (i) The westernmost marginal fault is active and accommodates substantial portion of the deformation along the DSF by vertical displacement; and (ii) The observed high vertical deformation suggests that the central Jordan Valley near Beit Shean is a unique area, which experiences high rate of vertical deformation during the last 80 kyr. These results have important implications to seismic activity in central Israel and therefore should be considered in any future hazard analysis.

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New constraints on Quaternary slip partitioning near the eastern termination of the Altyn Tagh Fault

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Slip partitioning along the northern boundary of the Tibetan Plateau is essential for understanding regional deformation and the seismic potential of the different faults that accommodate it. Within this framework the Altyn Tagh Fault (ATF) is commonly viewed as the primary structure that separates the Tibetan Plateau from the stable Gobi-Alashan block to the north. Late Quaternary sinistral slip rates of 8-12 mm/yr across the central ATF between 86° and 93°E decrease eastwards to zero as the fault approaches its mid-continental termination at ~97°E. To better understand how late Quaternary slip is partitioned along the ATF's eastern termination we obtained new slip-rate measurements for the ~200-km-long left-lateral ENE striking Sanweishan Fault (SSF) located ~60 km north of the ATF between 94°-96°E near the town of Dunhuang.
Multiple sinistral offsets ranging up to 600 m were identified by linking the clast assemblage of offset alluvial fan remnants with their provenance upstream of the fault. Luminescence dating revealed depositional ages ranging from 100 - 200 ka for the offset features and time-invariant minimum sinistral slip of 2.5±1 mm/yr during the last ~200 ka, which is approximately an order of magnitude higher than previously reported slip-rates for the SSF. Our results indicate that the SSF and the eastern segment of the ATF accommodate comparable magnitudes of late Quaternary slip. Considering this substantial transfer of lateral slip as far as 60 km north of the eastern ATF we propose that the SSF may represent juvenile northeastward expansion of the Tibetan Plateau into previously stable parts of the Gobi-Alashan block.

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Waste to resource– development of sustainable one-part geopolymers from industrial waste

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The concrete industry has an enormous environmental footprint. Cement production alone is responsible for 8% of man-made CO2 emissions. There is a growing need to develop sustainable, environmentally friendly building materials. Geopolymers, typically produced by alkali activation of aluminosilicate binders, are an attractive alternative to conventional cements. This research focuses on reutilization of industrial wastes, to develop sustainable building materials. The research facilitates the “one-part geopolymer” (OPG) approach, where liquid alkali solutions are replaced by solid activators, pre-mixed into raw binder. This enables the application of common "just add water" cement assembly, broadening current geopolymer scope to in-situ applications. Additionally, while common geopolymers use alkali hydroxides as an activator, this work examines the use of alkaline earth elements. In order to verify the viability of OPG synthesis in the presence of solid CaO and MgO, a model system based on metakaolin was created. Indeed, geopolymerization occurred, producing the expected C-A-S-H and M-A-S-H binding phases (determined by XRD).
Next, Dolomite quarry dust (QD) was evaluated as a possible solid activator. QD was analyzed by XRD, TGA, SEM-EDS for chemical and morphological characterization. To induce its reactivity QD was calcinated at 950℃ and 1000℃. Both treatments yielded complete transformation of the dolomite mineralogy to metal oxides. However, while the QD treated at 950℃ exhibited sponge-like morphology, due to CO2 extraction, the QD treated at 1000℃ exhibited intensive cracking, due to rapid CO2 release and thermal shock. Even though the thermal treatment did not change the overall particle size (1-300µm), it doubled the effective surface area (5.5 to 10.2 m2/g, by BET). Calcinated QD was added to metakaolin, yielding, upon water addition, a hydroxide concentration of 6 N. The resulting geopolymer showed fair compressive strength of 14.6 MPa at 47 days.

Wittenberg L. (1), Shtober-Zisu N. (2)
Long-term effects of wildfire on rock weathering and soil stoniness in the Mediterranean landscapes

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The severe wildfire at Mt. Carmel, Israel, in 2010, caused massive destruction of carbonate rocks. The thermal shock caused extreme exfoliation, producing large and flat clasts, affecting rocks to a depth of up to 20 cm. A decade after the fire, most flakes and spalls disappeared from the rock outcrops and adjacent soils. From these observations, this study pursued two objectives: (a) to monitor and analyze the spatio-temporal distribution of the disintegrated flakes 10 years after the fire and (b) to test the hypothesis that fires contribute to increased soil stoniness via physical and chemical flake erosion.
The studied area included five lithostratigraphic units composed of chalk, limestone, and dolomite. The Schmidt Hammer test showed that after a decade, most of the spalled surface on the burned outcrops was lost, exposing new rock surfaces to atmospheric and weathering processes. The spalls and flakes were broken down and pulverized.
The most prominent effects were changes in surface stoniness on the rendzina soils over the chalks, while there was less impact on the dolomite and limestone samples. The stoniness of the non-burned chalk was 23–39% and increased significantly to 69–86% in the burned area. Chalk erosion produced large (>16 mm, median 8–16 mm) and abundant gravel, suggesting fragmentation of large spalls, and particles that lost their bladed shapes becoming oblate and equant.
While earlier works suggested that increasing rock fragment cover is often associated with the removal of fine particles, our results showed a substantial increase in rock fragments due to fire-induced exfoliation of rock surfaces, leading to long-term changes in soil properties. We therefore propose that the size, shape, and spatial distribution of rock fragments should be considered when examining the effects of rock fragments on hydrological and geomorphological processes or on post-fire soil rehabilitation.

Yagel O. (1), Greener A. (1), Erel Y. (2), and Ben-Yosef E. (1)
Metalliferous pollution of ancient metal exploitation activities: Timna Valley as a case study

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The magnitude of ancient (pre-Industrial Revolution) metalliferous pollution and its possible effects on the health of societies and metalworkers' communities are debated topics. Interpretations vary between severe, widespread and hazardous to mild, discrete and benign - sometimes even for the same case study. Our research on metalliferous pollution of soil and human remains in the ancient copper production district of Timna Valley aims at shedding more light on this issue. As part of the ongoing Central Timna Valley Project (https://www.tau.ac.il/~ebenyose/CTV/) we mapped the elemental composition of the soil in two sites that represent copper smelting activities in two distinct periods - the Iron Age Site 34 ("Slaves' Hill"), ca. 3000 years BP, and the Early Bronze Age Site 201, ca. 4500 BP. The high resolution mapping was based on pXRF analysis of hundreds of samples from each site and data extrapolation using GIS (ESRI's ArcView). While the results demonstrate a dramatic increase in the scale of contamination (represented by Cu and Pb) between the two periods, it seems that even in the more "industrial" Iron Age soil pollution was rather contained, and its hazardous effects were rather limited, and possibly negligible for those who were not directly involved in the smelting activities. It is our intention to further corroborate these results with ICP measurements of selected soil samples from the investigated sites and add control samples from other locations in the valley that were not directly related to smelting. Furthermore, recently excavated human remains, dated to both periods under discussion here, provide the opportunity to examine the possible impact of metalliferous pollution on individuals that lived in the region, including possibly the metal smelters themselves. This will be based on elemental and isotopic investigation of teeth, using experimental protocols that proved successful in recent studies.

Yanuka-Golub K. (1), Kiro Y. (1), Belkin N. (2), Mayyani M. (1), Sisma-Ventura G. (2), Rubin Blum M. (2), Rahav E. (2)
The groundwater microbiome outcompetes primary producers upon discharge in the coastal ultra-oligotrophic eastern Mediterranean Sea

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Submarine groundwater discharge (SGD) is a globally important process supplying nutrients, trace elements, and microorganisms to the oceans, thereby affecting different biogeochemical cycles in the marine environment. Subterranean estuary, where terrestrial groundwater and seawater mix is an important hotspot for biogeochemical reactions, yet the knowledge of microbial diversity and function in this zone is scarce. This is especially true for ultra-oligotrophic coastal regions such as the eastern Mediterranean Sea, where the effects of the discharge are potentially most prominent. We thus evaluated the response of bacterial and phytoplankton community interaction to groundwater additions using incubation experiments.
We aimed to understand the role of subsurface microbiota in biogeochemical cycles in the subterranean estuary at the northern part of a coastal aquifer (Achziv, Israel). At this site, we recently showed that SGD contributes to high concentrations of dissolved nitrate and orthophosphate in comparison to the coastal seawater, resulting in elevated in situ phytoplankton biomass and primary productivity. A complimentary

microcosm experiment, in which Achziv brackish water was mixed with SGD-unaffected seawater at different ratios (0-20% volumetric), showed that the low mixing ratio of freshwater to seawater (5%) enhanced the phytoplankton biomass and primary productivity more than high-ratio mixing scenarios (10% and 20%). Bacterial production increased with larger groundwater additions, indicating a dose-dependent response. To evaluate the role of groundwater microbes, we filtered groundwater (0.2 µm) and mixed it with SGD-unaffected seawater. Remarkably, this treatment showed the highest assimilation number and bacterial production rates, suggesting that phytoplankton was outcompeted or inhibited directly by the groundwater bacteria in the non-filtered treatment groups, highlighting the intricate interactions between autotrophic and heterotrophic microbes in oligotrophic realms such as the Mediterranean coast.

Yeshno E. (1), Jupiter R. (1), Arnon S. (2), and Dahan O. (1)
Optimization of fertigation and irrigation practices based on real nitrate monitoring in agricultural soils.

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Preserving the quality of consumable natural sources such as surface water and groundwater is one of the greatest environmental challenges over the last century. Incorrect management of N fertilizers and water interface in conventional agriculture, result in Nitrate (NO3-) leaching from the roots zone area to runoff water, deep vadose zone, and aquifers. As a result, nitrate concentrations increase in freshwater reservoirs, which leads to vast ecological catastrophes such as algae bloom, as well as drinking water resources disqualification. This worldwide environmental issue is caused mainly by inadequate information regard nutrients availability in agricultural soil and nonregulatory guidelines for fertilizing applications during the crop growing cycle. In this lecture, we present the incorporation of a newly developed technology for monitoring nitrate concentration in large-scale wheat growing column experiment. The system was set to monitor nitrate concentrations in three depths in the column: (1) the shallow root zone, (2) mid-depth root zone, and (3) below the root zone. Real-time data from depths (1,2) was used to monitor nutrient availability to the wheat crop, while data from depth (3) was used to assess nitrate leachate out of the root zone. Throughout the experiment decision-making in terms of fertigation and irrigation was made on the basis of real-time data as obtained by the nitrate sensor. We have demonstrated that such field practices, based on on-line data have reduced significantly nitrate leachate out of the root zone while preserving a healthy wheat crop. We hope the incorporation of such precision farming monitoring equipment in the future will lead to the optimization of fertilizers application while reducing the agricultural activities' environmental impact.

Yizhaq H. (1), Dubinin V. (2), Ashkenazy Y. (1)
Climate impact on the mobility of Nizzana sand dunes

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The Nizzana dunes are located in the western Negev along the border between Israel and Egypt and along the rainfall gradient from the arid zone in the north-west (annual mean of 140 mm) to the extremely arid zone in the south-east (80 mm). These dunes are part of the larger northern Sinai dune field. The dunes on the Egyptian side are bare and active while those of the Israeli side are (partly) covered by biogenic

crust and shrubs and are (semi) stable. Nizzana dunes are classified as vegetated linear dunes (VLD) where only their crests remain active in the southern edge of the dunes. Such dunes are one of the most common dunes in the world and cover vast areas in the Australian and Kalahari deserts. We develop a mathematical model for dune mobility. The model shows that the dune reactivation process is almost irreversible, as a fixed dune will become active only under the action of very strong winds and can then return to the fixed state only when wind power decreases far below the levels under which the initial dune maintained its stability. Similar hysteretic behavior of dune mobility is predicted by the model with respect to changing precipitation and human pressure parameters According to our model, prolonged droughts and increasing windiness due to climatic change, combined with grazing or clear cutting, may turn currently stable, vegetated dunes into mobile, bare dunes. We use remotely sensed data to study the effect of anthropogenic activity and climate conditions on the mobility of sand dunes. We also study the response of the Mediterranean dune fields to future climate change scenarios using Global Circulation Models (GCMs) and predict that Nizzana dunes will remain (partially) fixed by the end of 21st century since both wind power and precipitation will not change drastically.

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A Seismic Time Reversal Mirror Field Experiment

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Time Reversal Mirror (TRM) is a physical process which refocuses recorded waves into their initial source location. We demonstrate how seismic P-wave is successfully focused back to its original location in a 3D field experiment. The method does not require a-priori knowledge of seismic velocities in the medium for re-focusing to occur. We further examine the observed focusing resolution of the back propagated wavefield by quantitative comparison to acoustic numerical modeling. As in any TRM process, the experiment includes two stages: in the first stage the seismic wave is generated by a sub-surface point source and recorded by a 3D surface array (the mirror). In the second stage, we activate a new seismic vibrator, based on a linear synchronous motor (LSM) to re-emit the time-reversed signals from the original receiver positions. As opposed to standard hydraulic-based seismic vibrators, the LSM-based vibrator enables generation of arbitrary seismic signals, efficiently acting as a reversal mirror. We record the re-emitted wavefield at sub-surface locations, near and at the original source location. Both real and modeled data focus within the theoretical range of half the dominant wavelength, validating the TRM experimental results.

Zaarur S. (1)
Age constraints for the Golan Heights Soils

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The Golan Heights plateau, northern Israel, located at the western edge of the Harrat Ash-Shaam volcanic field, is underlain by volcanic rocks that range in age between ~5.5 and 0.1 Ma. Throughout the Golan Heights, these rocks are covered by shallow soils that rarely exceed 0.5 m in thickness. The accepted assumption is that the ages of the Golan Heights soils correspond with the ages of the basalts they cover. Such age correspondence would imply that the soils have been slowly accumulating over hundreds of thousands to a few million years, and thus suggest a generally stable system. The ages of these soils, however, and their temporal correlation to the basalts have never been determined nor tested. Here we present age constraints for the soils of the Golan Heights. Soils were surveyed and sampled with

their respective basalt bedrock, for mineralogical and chemical analysis. Basalt age of the sampling sites spans between ~4.5 to 0.1 Ma. Accounting for dust contribution, mass balance calculations based on conservative immobile elements, coupled with basalt denudation rates based on ^{36}Cl measurements, suggest that the soil ages are decoupled from the ages of the underlying basalt, and represent up to a few thousand years of soil productions. This time frame is orders of magnitude shorter than the basalt age (~4.5-0.1 Ma) and challenges the prevalent assumption that these soils form a chronosequence, where the soils mature in correlation with the basalt age, and represent a slow and steady soil production process. Furthermore, these results suggest that despite the generally flat morphology of the plateau, this region is subject to erosion, loses soil at high rates, and hence is likely sensitive to changes in environmental conditions. This is particularly important in light of the known sensitivity of the Eastern Mediterranean climate to global climate change.

Zhou X. (1), Painuly A. (1), Katsman R. (1)
Numerical Simulation of Solute Transport during Methane Bubble Growth and Ascent in Muddy Aquatic Sediments with Different Fracture Toughness

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Methane (CH4) bubbles in cohesive aquatic sediments are found at many sites all over the world. The aquatic sediments present a significant source of CH4 release when bubble migration is its most successful mechanism from sediment to the water column and potentially to the atmosphere. This process is accompanied by sediment fracturing, which contributes to the mechanical destabilization of the aquatic sediments and even might result in slope failure. Bubble growth and migration are fuelled by CH4 bubble solute exchange with surrounding muddy sediment, which was scarcely explored by the previous studies. We explore the CH4 bubble solute exchange process during bubble growth and ascent within cohesive aquatic sediments with different fracture toughness, using a coupled single-bubble mechanical/reaction-transport numerical model. Modeling results indicate that lower fracture toughness of muddy sediment increases the integrated solute flux to the growing bubble due to the larger bubble surface area produced by its larger shape deviation from the spherical configuration. It is also enhanced by the lower inner bubble pressure affecting solute concentration at the bubble surface, compared to that in bubbles in sediments with higher fracture toughness. The local solute flux through the bubble surface decreases from the bubble surface to the bubble center. The bubble in sediments with lower fracture toughness grows faster, affected by the bubble solute exchange.

Zweig I. (1), Kamyshny A. (1), Schneider-Mor A. (2), Teutsch N. (2)
Iron speciation in pristine and reworked phosphorites as a key step for improving iron removal protocol

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Phosphate rocks are the primary raw material for phosphoric acid production, which is essential for agriculture. Iron is one of many impurities that affect the manufacturing process of phosphoric acid. Phosphorite deposits in the Negev synclines occur in two facies: low phosphorous pristine phosphorite and high phosphorous reworked (economical) phosphorite. Pristine phosphorite is attributed to high productivity and sedimentation rates in suboxic to anoxic conditions, whereas deposition of reworked

phosphorites has been attributed to oxidizing conditions at low sedimentation rates during high-energy episodes accompanied by bioturbation.

The current Israeli exploited phosphate fields have relatively low iron content, but future potential fields comprise high iron phosphate rocks. Previous studies demonstrated that various purification processes led to insignificant decrease of iron in the produced phosphoric acid. In this study, speciation of iron and phosphorous in primary and reworked phosphates was characterized to understand the role of iron in phosphate rocks for both industrial and paleoenvironmental purposes. Phosphates studied include low iron sections from the Negev Zin and Rotem synclines and iron-rich phosphates from the Arava Ein-Ofarim deposit.

Iron speciation was used as a redox proxy to distinguish oxic, ferruginous and euxinic precipitation conditions. Results show that pristine phosphate layers contain higher total iron than reworked phosphate layers but lower highly reactive iron to total iron ratios. There is a significant difference in iron speciation between the deposits of the Negev and Arava. Dominant iron species of the Zin syncline and primary layers of Rotem syncline are sulfur-bound iron. Reworked layers of Rotem syncline show the decreasing of sulfur-bound iron and increasing of magnetite fraction. Phosphate paleosol in Ein Ofarim contains very high iron concentration with the dominant iron minerals being goethite and hematite. In addition, experiment shows that iron-bound phosphorous fraction is less than 5% of total phosphorous for all iron speciation.