# כנס החברה הגאולוגית הישראלית

Israel Geological Society Meeting

# תקצירים

# Abstracts

כינר 2015

Kinnert **2015** **כנרת**

# כנס החברה הגיאולוגית הישראלית 2015

## כנרת

# תקצירים


**עריכה: אורן פרידהיים**

**24-26.3.2015 ד'-ו' ניסן תשע"ה**

החברה הגיאולוגית הישראלית

Israel Geological Society

# Israel Geological Society Meeting

## Kinneret

# Abstarcts


**Editor: Oren Friedheim**

**24-26.3.2015**

# החברה הגיאולוגית הישראלית מודה למוסדות הבאים על תמיכתם ותרומתם לכנס השנתי בכינר:

המכון הגיאולוגי

המכון הגיאופיסי לישראל

המכון למדעי כדור הארץ, האוניברסיטה העברית

בית הספר למדעי הים, אוניברסיטת חיפה

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון

המחלקה לגאוגרפיה וסביבה, אוניברסיטת בר-אילן

המרכז הישראלי לחקר הים התיכון

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# Variability in sources and concentrations of Saharan dust phosphorus over the Atlantic Ocean

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Saharan dust that is transported over the Atlantic Ocean provides an important input of phosphorus (P) to the oligotrophic waters of ocean and the P-depleted rain forests of America. In order to establish more firmly the role of Saharan dust events as P suppliers, the dust-P sources needs to be identified. From analysis of phosphate oxygen isotopes of all the major Saharan dust events of 2011 over the Cape Verde islands in the North-Eastern Atlantic, supported by remote-sensing imagery, we infer that the dust-P originates from widespread sedimentary sources and magmatic P “hot-spots”, in which the latter enrich the dust in bioavailable-P. The fraction contributed from each source varied markedly between dust events. We also found that phosphate from the Bodélé depression is not evident in Cape-Verde. Our results provide new information for global biogeochemical studies and suggest that identification of Saharan dust-P sources is required to improve their accuracy.

# Inferences on the Cadomian tectonic setting recorded in the Tauride block

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The Tauride block in Turkey is a peri-Gondwana, Cadomian-type terrane that rifted from the Afro-Arabian margin of Gondwana in the Permo-Triassic and re-accreted to Arabia in the Neogene. In the Karacahisar dome in the southern-central Taurides, Neoproterozoic basement metasediments and intrusive volcanic bodies are overlain by Cambro-Ordovician, Carboniferous and Triassic sediments. We studied U-Pb-Hf in zircons from major rock units exposed in Karacahisar to constrain the Cadomian crustal evolution of the Taurides, to evaluate the provenance of the Neoproterozoic and overlying sediments, to constrain the paleogeography of the Taurides, and to assess their linkage to Gondwana.

The Neoproterozoic metasediments in Karacahisar are low-grade metamorphic wacke-type turbidites that evolved in a broad back-arc basin peripheral to Afro-Arabia. Their detrital zircon U-Pb signal comprises a preponderance (40-68%) of Neoproterozoic-aged zircons (peak ages defined at 635 and 830 Ma), indicating that the sedimentary pile was built mainly from the erosion of Neoproterozoic (Pan-African) terranes from Afro-Arabia. The εHf values of the younger population (635 Ma) are mostly positive, indicating derivation from a juvenile Ediacaran arc, whereas detrital zircons from the older Cryogenian-Tonian population spread vertically ($-25<\varepsilon Hf<15$), indicating a different provenance in which the mixing of juvenile and older crust was widespread.

An unusually high proportion of pre-Neoproterozoic zircons have been detected in all samples, including up to 31% from a Grenvillian-aged (ca. 1.0 Ga) zircon population and a significant proportion of 2.5 Ga zircons, which amounts up to 35%. This great proportion of pre-Neoproterozoic detrital zircons raises the possibility that, rather than being inherited, these zircons reflect the ages of rocks that resided in the provenance. Because only minor exposures of 1.0 and 2.5 Ga crustal vestiges are currently known in North Africa and Arabia, we infer that terranes that hosted pre-Neoproterozoic rocks were dispersed within the peripheral Cadomian realm itself.

The termination of Neoproterozoic sedimentation is marked by the intrusion of dyke swarms yielding a U-Pb zircon age of 544±4 Ma, coeval with magmatism in other Cadomian basement units in the Taurides (e.g., Sandıklı and Menderes), shortly after which the Tauride basement was overstepped by the vast Cambro-Ordovician platform.

# Methane transport and release to the atmosphere in permafrost areas via subterranean groundwater discharge

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Methane release to the atmosphere in permafrost regions of the Arctic is exacerbated by global warming. This may result in a positive feedback effect, as methane is a powerful greenhouse gas. Accordingly, it is important to gain a good understanding of the processes that contribute methane to the atmosphere, particularly in this region. Large quantities of methane are stored in the Arctic in natural gas deposits, permafrost, and as submarine clathrates. Releases from these sources arising from warming have been reported, however, there are still considerable gaps in our understanding of the methane cycle at present and particularly how predicted climate changes will impact the methane cycle.

Subterranean groundwater discharge (SGD) has been recognized as an important conduit for transport of nutrients, metals, methane and other pollutants from land to receiving water bodies throughout the world, and could be a potential important, yet not quantified, source of methane in the Arctic. SGD can be quantified using geochemical tracers such as Ra and Rn and when combined with methane measurements can elucidate the role SGD has in transporting methane form groundwater to surface water bodies such as Arctic lakes and the coastal ocean, from which this methane will be released to the atmosphere. We have used Ra and Rn along with analytical calculations and methane concentration and isotope analyses in order to determine the contribution of SGD to the methane budget in areas of different hydrological and permafrost conditions in Alaska. Our results indicate that SGD is a major conduit for methane release contributing significant amounts of methane to surface waters particularly in areas where permafrost is abundant and impacted by seasonal temperature changes.

# Oil and gas exploration in Israel (South Golan Heights)

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Afek Oil and Gas has received an exploration license in the southern Golan Heights looking for live oil in the Senonian rocks. As a first step, a detailed geological subsurface analysis was accomplished to direct exploration efforts and in particular to locate the Senonian rocks and to understand the geological structure in the license premises, as well as to assess maturation potential. The subsurface analysis was conducted using geophysical methods including reprocessed seismic lines, Controlled Source Electro Magnetic, and gravity.

The seismic interpretation focused on the stratigraphic units post Judea Group, a strong reflector that can be easily traced. The top of the Eocene and the Hordos formations were also marked using the outcrops intersection with the seismic lines and used as markers. Using this interpretation and correlation with the Ein Said well logs and detailed gravity mapping we established the stratigraphic framework for the Senonian interval and for other stratigraphic units as the volcanic phases of the Golan Heights.

In addition, a Controlled Source Electro Magnetic survey was conducted from Meizar Valley in the south of the Golan to Katzrin. The measurements provide a resistivity profile across the basin that was used to correlate between stratigraphic units. Zones with high resistivity values, which mark areas that may contain potentially oil or water, were mapped and analyzed in detail.

The data base that was created above was used for basin modeling to try and predict the potential for maturation levels at different locations in the basin.

The results along with new exploration drilling will provide the full basin oil and gas potential and refine the drilling program for the southern Golan Heights.

# The Tomb of Caiaphas: Petrochemistry of Ossuary Interiors, Two Nails and Some Implications

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The petrochemistry of degraded bones and sediment from the interiors of four ossuaries discovered in the 1st. century CE family tomb of the high priest Caiaphas was studied. During the 1990 excavation two iron nails approximately 8 cm long were discovered. One of the nails was inside an ossuary, the other on the floor of one of the nearby "kokhim". According to the Israel Antiquities Authority (IAA) everything in the burial cave can be accounted for except the iron nails, which have been misplaced. Investigative journalist Simcha Jacobovici believes that he has located the nails in the artifacts collection of the anthropology laboratory at Tel Aviv university. The IAA has stated that the nails found at TAU have nothing to do with the lost nails from the Caiaphas tomb. The presence of two nails in the Caiaphas family tomb is of profound interest because, according to the Gospels, the high priest Caiaphas was responsible for passing Jesus to the Romans who then crucified him. The possibility that the nails have been found, is to say the least, interesting and the implications, in view of their possible usage, potentially explosive.

Through the study of the mineralogy and the geochemical and sedimentary processes affecting the nails and interiors of the Caiaphas tomb ossuaries we have determined that the materials inside the ossuaries and the nails have followed and identical evolutionary path in what must have been a unique chemical milieu, that of a dark and moist microcave (ossuary) within a cave (tomb). Bone biodegradation is manifested by a range of mineral and organic components of fungi and bacteria which have retained most of their original morphologies. The are present in bone debris but also adhering to the nails. Oxidation of nails, assisted by iron bacteria, produced three phases - lepidocrocite, goethite and magnetite which reflect a moist chemical milieu of fluctuating pH and transitional aerobic to anaerobic conditions affecting the nails during some 2000 years of history. Slivers of well preserved although entirely petrified wood are welded onto the nails and chips of such wood and nails were found in the rubble of the Caiaphas ossuary. Based on the above observations, the unique morphology of the nails, the isotopic composition of flowstone from ossuary and nails we conclude that (1) the nails found in the TAU anthropology laboratory are the nails from the Caiaphas family tomb and (2) the nails studied are nails that were used in a crucifixion. In view of the high priest's reputation, it cannot be discounted that the crucifixion was that of Jesus of Nazareth.

# Assessment of Mine Suspected Areas (MSA) from Floods in the Arava Valley Using Hydrological and 2D Hydraulic modeling

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Along the Israeli borders, large areas of land have been designated as Mines Suspected Areas (MSA), as a result of potential mobilization of mines by major floods. In recent years, the Israeli National Mine Action Authority (INMAA) held a Mine Action project to clear the mines from the MSAs located adjacent to the Arava Stream at the Sapir and Tzukim sites.

In an attempt to save costs, minimize the damage to natural values and reduce the safety risks of implementing such actions, Ecolog Engineering Ltd. was requested by INMAA to developed a methodology to reduce the size of the MSAs at these sites by predicting the potential transport of the mines using hydrological and hydraulic modeling following large flood events. During the first phase of the project, a Digital Elevation Model's (DEM) were constructed using aerial photographs, satellite and LIDAR measurements while examining natural morphological and man made changes undergone at the Arava stream at the investigated area, in recent decades. The DEM's were used as the basis for the hydrological models for past major floods since the installation of the minefields in 1968 (data was used from 1970, 1975, 1993 and 2010 flood events). Hydrographs were calculated using rainfall data and a hydrological model for discharge rates for the various flood events at the main channel and sub watersheds located in Jordan and Israel which drain into the MSA from both locations (Israel and Jordan). Following the hydrological survey, a 2D numerical flow model was developed to calculate the two-dimensional velocity and water depth across the MSA to determine the feasibility for mine movement. Based on the results of the 2D hydraulic model, the MSA was divided into four levels of risk from Category 1-very low risk (areas where no water flow occurred during the past flood events), to Category 4 – high risk (areas where water flow occurred during the past flood events and was calculated to have high energy or flow depth that can mobilize the mines). At the Tsukim and Sapir MSA sites, 40% and 20% respectively of the areas were considered to be of low risk areas (Categories 1and 2). Model predictions were verified independently using data collected from the INMAA, from mines evacuated at the Sapir site. Ninety seven percent (97%) of the mines that were found were located in areas calculated to have a risk Category of 4. The other 3% of the mines found were found to be located in risk Category 3 (medium) areas. No mines were found in risk Category 1(very low) areas or risk Category 2 (low) areas. The use of the methods developed during the project can significantly reduce the work associated with mine removal operations, save valuable resources, improve safety, and significantly cut cost, ultimately optimizing the INMAA activities.

# Evidence for ancient life in anoxia: The Late Cretaceous benthic foraminiferal assemblages from the high productivity sequence in Israel

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It has generally been argued that fossil benthic foraminifera, the most common proxy for paleo bottom oceanic conditions, could not survive anoxia. Here we present evidence that fossil foraminifera were able to thrive at anoxic bottom waters, by using adaptations similar to those found in living species. Our study is based on a multi-proxy micropaleontological and geochemical investigation of the Upper Cretaceous sediments from the Levant upwelling regime. We mainly focused on the high productivity deposits from two basins in southern (Negev, Zin (Saraf borehole) and Rotem (PAMA section) valleys) and central (Shefela, Aderet borehole) Israel, which represent proximal and distal locations respectively, within the upwelling belt. These sections contain highly abundant and diverse benthic and planktic foraminiferal assemblages, and therefore provide an ideal test case to study the association of benthic foraminifera and anoxic depositional environments.

A turnover from buliminid to diverse trochospiral dominated assemblages was recorded in an interval with a distinct anoxic geochemical signature coinciding with a regional change in lithology. This change was triggered by a shift in the type of primary producers from diatoms to calcareous nannoplankton, enforcing a modification in the benthic foraminiferal life strategies and morphological adaptations. Our data show that massive blooms of serial (buliminids) benthic foraminifera with distinct apertural and test morphologies during the Campanian was possible due to their ability to sequester diatom chloroplasts and associate with bacteria, in a similar manner as their modern analogs. Diverse trochospiral forms existing during the Maastrichtian use apparently nitrogen instead of oxygen for their respiratory pathways in a denitrifying environment. Species belonging to the Stilostomellidae and Nodosariidae families might have been affected by the change in food type arriving to the seafloor after the phytoplankton turnover at the Campanian/Maastrichtian boundary, in a similar manner as their mid-Pleistocene descendants prior to their global extinction.

This study shows that the multi-proxy approach is essential in paleoceanographic reconstructions, particularly when studying abnormal environments such as thus of the high productivity regime. Moreover, this study promotes the need for a re-evaluation of the current models used for interpreting

paleoceanographic data and demonstrates that the identification of adaptations and mechanisms involved in promoting sustained life under anoxic conditions should become a standard in faunal paleoceanographic studies.

# Modern live and dead micro and macro faunal assemblages in estuaries of the southeastern Levantine coast: Implications for palaeo surge events

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Live and dead assemblages of foraminifera, ostracods and molluscs occurring in seven micro-tidal estuaries in the southeastern coast of the Levantine shelf (Israel) were analyzed and their ecological preferences and seasonal dynamics were determined. The reference baseline established was compared with two OSL dated cores extracted from the Tanninim stream estuary ~100 m inland from the coast, assuming that the micropaleontological and sedimentological records can serve as a new source of evidence for high-energy surge events.

The common living species in these estuaries were Ammonia tepida, Birsteiniolla macrostoma and Trichohyalus aguayoi (foraminifera), Cyprideis torosa and Heterocypris reptans (ostracods), Heleobia phaeniciaca and Pyrgophorus sp. (molluscs). Their distribution is influenced by the relation between the brackish river water vs. the salty sea water source, seasonal variations in environmental conditions and local anthropogenic stress. The time averaging death assemblage composed by the same species as in the living assemblage included also an outstanding event of high abundance of marine-derived foraminifera and to lesser extent ostracods and molluscs. The sharp increase in numerical abundance of the foraminifera, of several orders of magnitude, coincides with an extreme winter storm event. The allochthonous benthic and planktic faunal elements originating from ~40 m water depth and deposited few hundred of meters inland of the two estuaries, indicate an extreme hydrodynamic transportation event.

A similar event was identified in the fossil record of the Tanninim cores that otherwise is composed of the same brackish foraminifera species occurring in the living and death assemblages. Allochthonous marine-derived foraminifera deposition in the estuary ~100 years ago indicates for the first time the occurrence of high energy surge event in an area prone to extreme storm hazards.

# Silicified trees, corals colonies and massive de-dolmitization and recrystallization in the Zafit and Avnon formations in the Central Negev – are they all linked?

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Several large silicified trunks, up to 2.5 m long, were found in the middle and upper parts of the Zafit Formation in the central Negev. The hosting rock is consists of well bedded, fine crystalline, dolomite. Some trunks were found in sub-vertical position, integrated in the hosting rocks.

Up section, the lower unit of the Avnon Formation is made of marly and fossiliferous limestone developed upward to massive limestone beds forming cliffs. Scattered colonies of Isastrea corals in growth position were found in this part of the section. At the top of the massive limestone beds, some largely distributed silicified lenses are present.

In the same area, massive de-dolmitization and recrystallization to coarse crystalline calcite is observed in both formations, covering vast areas in the flanks of the Ramon monocline.

The research revealed that the first two phenomena indicate that shallow marine conditions were established during the Cenomanian in the central Negev. At first, the shallow marine basin accommodates deposition of dolomite in a relatively shallow and closed marine lagoon in which drifted woods from a near-by land mass were trapped and sunken. The returned of open marine conditions during the Avnon Formation deposition time enabled the colonization of corrals under clear water conditions, but in relatively shallow sea depth.

On the other hand, the widespread de-dolomitization and re-crystalization found in vast areas in the Central Negev are in close relations to the Regional Truncation Surface (RTS) developed during the Oligocene over the region. The deep truncation of the Ramon monocline by the RTS led to the exhumation of the Zafit and Avnon formations, subjecting them to weathering processes as freshwater penetrated the underling rocks.

# Oligocene tectonic deformation in the Central Negev – The Zeniffim structure as a case study

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Several anticlinal in the Central Negev are presenting clear evidence of tectonic deformation during Late Eocene – Oligocene times. These include (among others) the Ramon monocline, the Menuha ridge and the Zniffim structure. In all structures thick sections of the Eocene Avedat Group were removed from the crest of the structures by erosional process related to the formation of the Oligocene Regional Truncation Surface (RTS), indicating the formation of these structures in the time interval postdating the deposition of the Eocene strata and the final formation of the RTS in the Late Oligocene.
While the Ramon monocline presents widespread evidences of Senonian activity related to its development as part of the Syrian Arc structures, the Menuha and the Zeniffim structures are lacking any evidence of this kind. Among the two, the Zeniffim was recently observed aiming to clarify it evolution, as part of the final stages of a regional mapping projec. Its structure is demonstrating a central main monocline oriented N20-30E accompanied by two smaller monoclines on its both extensions. All monoclines are bounded by a fault, which was observed by Bartov (1994) as a reverse fault, cropping out along the eastern flank of Mt Zeniffim.

Based on the relations between its stratigraphy, structural pattern and morphotectonic configuration, several evolutionary stages presenting the development of the Zeniffim structure were reconstructed:

1. First indications of activity along the Zeniffim fault in recorded at the end of the Precambrian as the Zeniffim Formation is faulted, demonstrating development of two structural basins across the fault.
2. The present uplifted structure is truncated by the RTS, indicating that the main tectonic phase facilitating the present tectonic structure evolved during the Late Eocene to the Late Oligocene.
3. The Miocene Hazeva Formation was probably deposited on top of the RTS truncating the structure as it was preserved in the nearby depression of the Karkom basin.
4. The Arava Formation of Pliocene – Early Pleistocene age was deposited within wide valleys dissecting the monocline, draining the region toward the Paran-Neqarot drainage basin in the west.
5. A 1.5-1 Ma tectonic phase demonstrated by faulting and eastward tilting of the monocline toward the Arava depression caused the intensification of the inclination regime along the eastern flank of the monocline. This was associated with the reversal of the drainage system of the Arava Formation. At this stage the regional tectonic regime shifted toward extension, causing the development of graben and horst structures to the east of the monoclinal axes. In the northern segment of the Zeniffim monocline, the monocline itself became a graben while the lower terrain to the east was uplifted to form an elongated horst. At the early stages of this tectonic deformation, the Zihor Lake was formed. This may reflect re-organization of the whole regional tectonic regime bordering the Dead Sea Transform relatively to its Oligocene to Pliocene configuration.
6. During the Middle-Late Pleistocene, alternations of erosion and deposition episodes formed fluvial terrace on both sides of the Zeniffim structure, expressing the relaxation of the tectonic activity in the vicinity of the structure.

# Reassessment of the Hula Valley groundwater's conceptual hydrological model in light of new findings in the valley's margins

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Water wells, drilled in the last decade (2003-2011) throughout the Hula Valley, produce a large amount of high quality water from the Jurassic and Upper Cretaceous regional aquifers. The flow in these aquifers is into the Hula Valley fill. As a result of these new findings, reevaluation of the Hula Valley's previous water balances is required.

Groundwater produced from abandoned gas wells, drilled into the Hula Valley's sediments fill, reveals the geochemical and isotopic compositions of various hydraulic sub-aquifers. Similarities between the groundwater in the Hula's sediments fill and the regional aquifers indicate the groundwater flow directions. A significant difference in the $\delta 18O$ values distinguishes between two main vertical water bodies.

The natural outlet of the Hula Valley groundwater system is unclear. A spatial hydraulic head analysis offers three options, which do not contradict each other: westward beneath the Galilee Mountains, southward to the Sea of Galilee basin and upward to the Hula Valley's surface.

The reassessment of the Hula Valley's conceptual hydrological model will be used as an input to a numerical quantitative flow model. This model is expected to provide constraints and more insights into the complicated hydrological system of the Hula Basin.

# The Effects of Normal Stress on the Roughness Evolution of Experimental Faults: Results from Direct Shear Tests

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The topography of fault surfaces plays an integral role in the dynamics of earthquakes. The roughness profile of slip-surfaces relates strongly to the stress distribution across fault planes, their shear resistance and the critical slip distance. The evolution of fault surface roughness is studied here in direct shear laboratory experiments. Mating surfaces, produced by tensile fracture induced in prismatic limestone beams by means of the four point bending methodology, were sheared under imposed normal stresses of 5 to 15 MPa to a constant distance of 10 mm under a constant displacement rate of 0.01 mm/s using a hydraulic closed-loop servo controlled system. The roughness evolution was measured and analyzed using optical profilometer scans of the surface geometry before and after slip. The roughness results indicate that the surface roughness increases with normal stress through shear displacement when the normal stress level is greater than 5 MPa. Most of the damage sustained by the sheared surfaces was localized in well-defined damage zones. Through examination of the damage and wear it was concluded that the increase in roughness was due to penetrative damage to the host rock, which included fracturing and asperity plucking. The roughness evolution is correlated with the stress-drop experienced during shear displacement as both reflected the release of the stored elastic energy during the transition between peak shear stress and residual shear stress. An analytical model was further used to support the observed damage in the experiments. Model results suggested that the roughness of the sliding interface affects the near-interface stress field, which includes stress concentrations, amplifications of the principal stress difference and deviation of the near-field stress trajectories from the far-field stress orientation. It is also implied that the maximum resistance to shear is strongly dependent up on the near-fault stress field, as further reflected by the correlation between its value and wear volume accumulation.

# Initiation of the Dead Sea Basin in the early Middle Miocene inferred from geomorphologic analysis of its western fluvial outlet in the Arad – Be'er Sheva Valley

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The Dead-Sea pull-apart Basin (DSB) was formed consequent to the displacement along the Dead Sea Transform (DST) and their ages are intimately coupled. The 18-14 Ma age range of the DST is based on evidence from the Red Sea and eastern Sinai region, whereas the earliest direct evidence for a terminal base level in the DSB is the Late Miocene – Pliocene Sedom Fm. Here, we suggest an earlier time-constraint for the initiation of the DSB following a morphostratigrapic analysis of its western fluvial outlets to the Mediterranean coast through the corridor of the Arad – Be'er Sheva Valley (ABSV). For this purpose, we mapped remnants of terraces representing ancient stream valleys and marine abrasion surfaces in this synclinal valley. We identified four surfaces in the ABSV, determined their morphostrtigraphic position and verified regional correlation between eastern terrestrial and western abrasive surfaces. We found that these four surfaces truncate and postdate the Burdigalian Rotem Member and are correlated with abrasive surfaces capped by the shallow marine Ziqlag Formation (biozones – late N8 to N9), thus constraining their age to the early Middle Miocene. Paleogeographic reconstruction of these two surfaces in the east reveals four transversal valleys crosscutting the trace of the present regional water divide (RWD). The assemblage of the clasts covering the transversal valleys and the two upper surfaces resembles that of the Hufeira Member of the Hazeva Formation, which is the first sedimentary unit confined to the newformed DSB and contains clasts derived from its uplifted shoulders. Therefore, we postulate that these valleys served as the westward fluvial outlets of the evolving DSB, probably during the deposition of the lower part of Hufiera Member The two lower surfaces in the ABSV are the first to be confined to the western side of the RWD, manifesting its establishment contemporaneously with the transformation of the DSB to a terminal base level. Therefore, the initiation of the DSB and its conversion to an endoreic terminal erosion base level is constrained to a short period at the beginning of the Middle Miocene. The coupling of the DSB and the DST indicates that the DST was already active at the beginning of the Middle Miocene.

# Relating the concentration and isotopic composition of carbonate associated sulfate to parent solutions

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Carbonate associated sulfate (CAS) is structurally bound sulfate found in carbonate minerals of biological and chemical origin. Modern biogenic carbonates taken from sites around the world host CAS, which displays sulfur isotope ratios similar to modern seawater (d34S = 21‰ CDT) [1,2], suggesting that CAS may faithfully record the d34S of the seawater from which the carbonates precipitated. As such, CAS has proven valuable in providing near-continuous proxy records of seawater sulfate, d34S, especially during periods in which no sulfate evaporites have been preserved [e.g., 1,3,4]. However, despite this evidence, and the wide use of CAS as a proxy of seawater sulfate, the reliability of the pre-diagenentic isotopic record in CAS has not been verified experimentally. Whether chemical precipitation alone might fractionate the isotopes of sulfur, thereby complicating the interpretation of CAS records, is still unknown. We experimentally related the concentration and isotopic composition of sulfate within chemically precipitated calcium carbonate to those of aqueous sulfate in the carbonates' parent solution. We dissolved sulfate-free calcium carbonate in stirred solutions containing between 100 μM and 40 mM sulfate by raising the partial pressure of CO2 (pCO2) in a sealed glovebox, thereby decreasing the solutions' pH. We reprecipitated the calcium carbonate under near-equilibrium conditions by allowing the CO2 to diffusively exchange with the air outside the glovebox through a small opening. Aqueous sulfate and CAS concentrations were measured by ion chromatography, and sulfur isotope ratios were measured by high-resolution, multi-collector ICPMS [5].
The results of this study are central for the validation and calibration of CAS, a widely used method for reconstructing the history of sulfur isotope ratios in seawater sulfate.

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# Drowning a transform-fault controlled shelf: the Gulf of Aqaba

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We have sampled and analyzed twenty five geo-technical cores drilled from Eilat port area in 2012. The drill-holes campaign covers a 0.1 x 1 km2 shore-parallel band, with spacing varying between 50 and 500m. Twenty-one holes penetrated fossil corals which seem to have been a part of thriving reefs at the time. The reef-like intervals in the core' several meters long, overly a terrestrial column and a sub-meter transitional littoral unit. The corals are found 5-27 meter below sea level. U-Th and radiocarbon ages span 2.1-9.5 ka. The samples display stratigraphic order with the exception of a single core that might indicate minor faulting and erosion within the shore-parallel band.

The new evidence taken together with our previous studies constrain the Holocene sea level curve in the Gulf of Aqaba. Given the small width of the Gulf and its low-lattitude location, this curve is a useful proxy to the eustatic curve.

One of the surprising observation is the absence of an older fossil reef at least down to 80 meters deep. It seems that the environment prior to the Holocene reef was terrestrial (until 9.5 Ka); yet during the last interglacial highstand coral reefs thrived around the gulf including its north edge. Two explanations are plausible: The shore has transgressed during the last glacial cycle by at least 100 m, or the shelf has subsided sufficiently to bury the area under sediments.

# The involvement of different iron minerals in Anaerobic Oxidation of Methane in deep sediment of Lake Kinneret (Israel).

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Methane ($CH_4$) is an important greenhouse gas, whose natural production is mainly by the microbial process of methanogenesis. The primary control on methane emission to the atmosphere is methanotrophy (methane oxidation). Recently, we showed in situ geochemical evidence for anaerobic oxidation of methane (AOM) driven by iron reduction in Lake Kinneret (LK) (Israel) sediments. In this study we explored the mechanism of this process. Geochemical analyses of slurry experiments with labeled methane, different iron minerals (amorphous iron, goethite, hematite and magnetite) and inhibitors of sulfate reduction and methanogenesis show that the mechanism in LK is probably different than in the marine environment. The inhibition of sulfate reduction by molybdate did not stop the enrichmaent of the $\delta 13C_{DIC}$, which indicates that sulfate is not involved in this AOM process. Different iron minerals additions to the slurries show that AOM could utilize different iron minerals with different reactivity properties in the sediment.

# New glance on multiscale deformations in the Levant basin: formulation and verification of the new thermo-hydro-mechanical model

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The Levant has been repeatedly devastated by numerous earthquakes since prehistorical times, as recorded in historical documents, archaeological ruins, and sedimentary archives. In order to understand the role of the dynamics of the water bodies in triggering the deformations in the Levant basin, a new theoretical thermo-mechanical model is constructed using the finite elements method and extended by including a fluid flow component. The latter is modeled on a basis of two-way poroelastic coupling with momentum equation. This coupling is essential to capture the fluid flow evolution induced by dynamic water loading and to resolve porosity changes. All the components of the model, namely elasticity, creep, plasticity, fluid flow, etc., have been extensively verified and presented. The rich archives of pre-instrumental destructive earthquakes will set constraints for modeling under the present formulation.

# The origins of feldspars and clays in the Cambrian siliciclastic sequence of Israel; Insights from Pb and Nd isotopes

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Recent U-Pb dating of single-grain detrital zircons of the Cambro-Ordovician siliciclastic sequence of Northern Gondwana have indicated a dominant contribution of zircons of Mesoproterozoic to Early Paleoproterozoic Hf-model ages. These results challenge the previously-suggested dominant contribution of sediments from the juvenile Arabian Nubian Shield (ANS), which was formed through arc amalgamation and plutonism during the Neoproterozoic East African Orogeny (EAO). Nevertheless, the greater transportation distances, inferred from these results do not comply with the high abundance of K-feldspars throughout the Early Paleozoic siliciclastic sequence (5% to 25%).

K-feldspar is a dominant constituent of granitic rocks, abundant throughout the ANS and its neighboring terranes. While these lithologies of the ANS are considered to be of juvenile nature, similar lithologies outside the ANS were generally formed through the remobilization and melting of ancient crust, indicated by Nd and common Pb model ages.

Because of the low U/Pb and Th/Pb ratios in feldspars, their Pb isotopic ratios remain virtually constant upon crystallization, and are therefore expected to directly reflect the model ages of their provenance. Clays (<2μm), on the other hand, are products of surface weathering, and thus provide a complementary insight. εNd and Nd model ages of detrital clays reflect the weighted-average 'crustal residence' ages of their provenance.

In this study, feldspars from the Cambrian siliciclastic sequence were separated following standard procedures and analyzed for Pb isotopic ratios. Results were compared with equivalent values of feldspars of the ANS and previously published data. Nd isotopic ratios of clays (<2μm) were measured, and εNd values and Nd model-ages were calculated.

Preliminary results suggest that εNd values for clays range between -9.1 and -16.8, with model ages ranging from ca. 1.15 to 1.9 Ga. Pb model ages (Stacey and Kramers, 1975) of feldspars range from ca. 460 Ma to 820 Ma, with duplicates generally forming tight clusters. On 207Pb/204Pb and 208Pb/204Pb vs. 206Pb/204Pb diagrams, the data form four distinct zones, which range from nearly oceanic Pb (μ=9.8) to highly-radiogenic crustal Pb (μ=10.3). On a 207Pb/204Pb vs. 208Pb/204Pb diagram (Zartman and Doe, 1981), this study results are confined within previously published data for the ANS. A rough linear trend is observed, ranging from the lower, mantle-type Pb of ANS ages, towards higher enriched values of upper-crustal characteristics, pointing to a mixture of sources of different genetic histories with similar model ages.

These results further establish the ANS as a likely dominant contributor of sedimentary feldspars, while clays suggest a pronounced mixing of sediments from ancient terranes.

# Extensional exhumation, uplift and denudation along the Dead Sea transform: Recording continental breakup using low-temperature thermochronology

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The Dead Sea transform and Red Sea rift with their uplifted margins have long been the focus of efforts to better understand continental breakup processes. This study utilizes (U-Th)/He apatite low-temperature thermochronology, thermal modeling and topographic and structural analysis to constrain the timing and magnitude of uplift and extensional exhumation along the Dead Sea transform.

The apatite helium system has the lowest closure temperature among all known thermochronometric systems and constitutes a sensitive thermal recorder of exhumation processes at shallow (1-3 km) crustal levels. As the maximum exhumation depth since the Early Oligocene along most of the transform rarely exceeds ~2.5 km, the apatite He system is an ideal thermochronometer for this setting and can contribute significant low temperature T-t insights which cannot be obtained utilizing apatite fission track or other thermochronologic methods.

Our sampling strategy consisted of 8 transects along the eastern margin of the DST and 4 transects along its western margin (124 samples) covering a length of ~ 500 km along the transform, from the Dead Sea in the north, to the Sinai triple junction in the south. Vertical transects were collected utilizing a scheme which maximizes the range of structural levels and the apparent depth of exhumation along each transect.

Our current results include (U-Th)/He apatite age determination for 43 samples. Cooling ages along the eastern flank of the DST above the Gulf of Aqaba vary with elevation from 18 Ma to ~300 Ma. At the lowest elevations the ages are relatively uniform across a ~400 m range delineating rapid cooling commencing at ~24±6 Ma. This conclusion is reinforced by inverse modeling which utilizes our new ages in conjunction with published apatite fission track data. In addition, the Age-Elevation arrays clearly delineate a pronounced inflection point, representing an exhumed partial retention zone which constrains the pre-exhumation thermal gradient to < 25 oC km-1. Quantifying the magnitude of pre-transform and sin-transform exhumation is currently in progress. Our study is expected to help formulate geodynamic models dealing with lithospheric extension and continental breakup across rifts and transform plate boundaries and to improve our understanding of the asymmetric topography across the Dead Sea transform and the Red Sea.

# The Influence of Climate and Micro-climate (aspect) on Soil Creep Efficiency

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Although hillslope evolution has occupied geoscientists for over a century, the effect of climate on the morphology of soil-mantled, transport-limited hillslopes remained poorly-constrained. In this study we utilize numerical simulations of volcanic cinder cones in the Golan Heights to estimate soil creep efficiency across a strong north-to-south gradient in mean annual precipitation (1100-500 mm). Our model utilizes the cinder cone initial hillslope profile (constrained by the dip of the ash layers), the current hillslope profile (measured with cm scale accuracy) and the known eruption age (K-Ar and Ar-Ar constraints) to predict the best-fit final hillslope profile by changing the soil creep diffusion coefficient. Hillslope evolution is described using a diffusion equation which is similar in nature to the heat conduction equation.
Our initial results indicate that the best-fit soil creep diffusion coefficient varies from 10-2 to 10-3 m2/yr and decreases with precipitation. This climate dependency seems to reflect an increase in soil cohesion at higher precipitation rates due to vegetation coverage which co-varies with the rainfall. The only apparent outlier, where the soil creep diffusion coefficient increases with precipitation, is from a south-facing hillslope which is less vegetated relative to north-facing slopes. This suggests that aspect-related microclimate effects could be of the same order as precipitation. We are currently examining more data from different slope aspects to test these relationships. We also explore the possibility for long-term temporal variance in the soil creep efficiency using nearby cones with different eruption ages. Our study is expected to contribute to the understanding of hillslope form-process relation and the morphologic signature of climate and improve our ability to invert topographic-derived indices to estimated erosion rates.

# “Not all that glitters is gold”, but many times gold appears with no glitter – observations from an exploration project in Cote d’Ivoire

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The Toumodi-Sakassou area (central Cote d’Ivoire), situated along the Bandama Blanc River and lake, is well-known for gold mineralization. The geological section is composed of tectonized greenstone in association with metasediments, manganese, quartz and shale of the Birimian age. These overlie arkoses and arkosic-conglomerates (flychoïde Eburnean) of the Tarkwaïenne age. The Birimian and later the Tarkwaïenne exhibit NNE and SSW trending folds, generally sub-vertically dipping, forming greenstone belts. Detecting the gold occurrence in this context is rather challenging due to soil and tropical forest cover. We found significant mineralization zones by using the open pits of local miners which expose the rocks beneath the top soil. A rather vast soil sampling project was also performed.

The rock layers which were observed and mapped in ~2000 local miner pits were composed of tuffaceous red and grey shales, as well as fine and coarse grained chlorite schist with clear cleavage, all related with meta-volcanic rocks, altered to red and yellowish shale. The entire section is crossed by quartz veins which the gold mineralization are associated with. 33 rock samples from the artisanal pits and trenches, determined the gold potential of the permit using fire assay tests. The results showed 16 samples were below significant anomaly of 50 PPB. 17 samples returned moderate to very high gold concentrations, up to 25590 PPB.

By the method of soil sampling (in two phases of 1009, and ~6000 samples) which was performed in a 100*100 m grid, it was possible to find out the concentration of gold in the soil as an indicator of mineralization underneath. The results of the first 1009 samples: 879 samples returned below significant anomaly concentrations (<50 PPB); 130 samples were found to be moderate to highly rich in gold, (up to 41660 PPB). The high concentration soil samples appeared in a rather clear spatial field relation (6000 samples are at present in testing process). The satisfying results enable the planning of the next steps: trenching, geophysical study and drillings.

# The Timna Valley as a Geological Park

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Timna Park is a major tourist attraction site in the southern Arava. The goal of the presented initiative is to make the unique geology of the Timna Valley and its surrounding more accessible to the tourists, amateur geologists and students based on the up-to-date research and recent mapping. This project is carried out by the Geological Survey of Israel in cooperation with the Dead-Sea & Arava Science Center and the Timna Park Development Company. 62 stations, reachable by GPS, are presented, mainly along the Israel National Trail, where the detailed geological description is supported by drafts, maps and photos. The hard-copy report is available to download at the Geological Survey web-site. The final goal is to make it available to each visitor through a mobile multi-sensory cellular application (like “Maslulari” that was developed by the Dead-Sea & Arava Science Center and is available to iPhone and Android users).

# Aptian mass transport deposits in northern Israel and the paleo-configuration of the northern Arabian margin

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The Aptian sedimentary record of the northern sector of the African margin has been considered to indicate carbonate shoals and lagoons on a muddy, low-relief shelf or platform that formed during continuous subsidence far from the Eastern Mediterranean shelf edge. This succession differs notably from the coeval counterpart to the south, where siliciclastic marginal marine deposits are intercalated with terrestrial fluviatile successions. Nevertheless, initial results from high-resolution elemental, mineralogical, sedimentological and petrophysical analyses measured on a set of long cores from northern Israel indicate a much more complex scenario.

This investigation found the presence of mass-transport deposits (MTDs) of different types at the top of the Nabi Said and Ein el Assad formations. Calcirudite and calcarenitic carbonated MTDs as well as siliciclastic sand MTDs were emplaced into finely laminated marine shale. The transported masses were identified by a set of features including sheared bases, partial grading, and internal reorganization of sediments that resulted in increased density. The fine lamination, dark color and elevated sulfur and iron content of the background shale sediments, and notable absence of bioturbation features, imply extremely low water energy and anoxic conditions in the basin. The contacts between the marine shales and the MTDs show decrease in sulfur and iron indicative of more oxic conditions of the sediment-water interface in the original environment of deposition of the coarser units, compounded with coeval oxygenation of deeper waters due to mixing during episodes of mass transport. Increased magnetic susceptibility values measured within the MTDs are attributed to a detrital component of likely terrestrial origin that is not present in the marine shales. These observations indicate emplacement of coarse MTDs at the termination of a slope with a steep gradient sufficient to facilitate mass transport above a basal shear plane.

The lithological properties of these MTDs indicate the existence of a high energy downslope transport mechanisms providing calcareous and terrestrial material into a low energy deep basinal environment during the Aptian. Our observations challenge previous observations regarding the paleoenvironmental setting of the Northern Arabian margin. Moreover, our interpretation indicate that accommodation space in this proximal oceanic basin was sufficient so that continuous subsidence need not be invoked, hence pointing toward active tectonism.

# Lead-210 dating of continental shelf short cores – evidence for the anthropogenic effect on sediment transport

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The natural cycle of sediment transport along the Nile Littoral Cell (NLC) was profoundly altered during the early 20th century. The present sediment balance along the shallow continental shelf is a product of natural processes and anthropogenic intervention. The final closure of the Aswan Dam in 1964 terminated the transport suspended sediments and nutrient into the Mediterranean and the sediment balance at many localities along the NLC has been negative in the last decades. In addition, the growing industrial and demographic activities along the Israeli shore altered the sediment transport and deposition balance.

We present 210Pb activity and grain size distribution (GSD) on two short sediment cores from the distal part of the NLC off-shore Haifa. The cores were collected at water depth of 66 m (G1) and 36 m (B3) to the west and north of the bay, respectively.

The profile of core G1 exhibits an exponential trend, with highest values of 210Pb activity at the surface (240 mBq g-1), rapidly decreasing downcore to a background supported 210Pb activity of ~20 mBq g-1 at 7 cm depth and below. In the upper part of the profile, a conspicuous change of slope around 5 cm suggests the presence of a 5 cm thick surface mixed layer. Core B3 also exhibits an exponential profile with highest values of 210Pb activity at the surface (89 mBq g-1), rapidly decreasing downcore to background supported 210Pb activity of ~14 mBq g-1 at 7 cm depth and below. Different assumptions can be made to promote or reject results of the CF/CS and CRS models that were used to calculate ages and sedimentation rates. In core G1 calculated sedimentation rates range between 0.1 g cm-2 y-1 (0.13 cm y-1) and 0.16 g cm-2 y-1 (0.2 cm y-1). In core B3 sedimentation rates range between 0.08 g cm-2 y-1 (0.08 cm y-1) and 0.05 g cm-2 y-1 (0.05 cm y-1).

The GSD measured from the two cores present a significant change of coarsening of the sediment in the upper centimeters. In core G1 sand content increases from 5.5% at 5.5 cm depth to 30% at the core top. In the shallower core B3, sand content increase from 30% at 5 cm depth to 93% at the core top. The sedimentological change is smoothened when GSD is measured on the carbonate-free fraction suggesting that in the upper record the reduction of silisiclastic sediments leads to the dominance of the local biogenic and authigenic fraction. The sedimentological change was dated in both cores to the 20th century suggesting it is connected to decrease in Nile-driven sediments also in the distal parts of the NLC.

# Geochemical salinization mechanisms in the altered Hula Valley wetlands – the Ca-S-CaSO4×2H2O system

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Ongoing salinization of the Hula altered wetland soils has decreased the annual agricultural production by 10-15%. The effect of in-field geochemical processes of the Ca-S-CaSO4×2H2O system on salinization was studied in the field and by lab experiments. Calcium and SO4 were main ions in the soil extracts, and they were highly correlated with EC. Soil-paste solutions of the saline soils (EC > 3.5 dS/m) were in equilibrium with gypsum, while those of the other soils were under-saturated with respect to gypsum. In soils controlled by gypsum, EC was closely related to the Ca/SO4 concentrations ratio (r2 = 0.91), in accordance with a theoretical model that relates EC to Ca/SO4 in a gypsum-equilibrated system. The Ca/SO4 ratio was found to increase with decreasing extract water content. Extrapolating this trend to field capacity moisture has led to increased Ca/SO4 ratio and EC in comparison to their values in soil paste extracts. We conclude that in soil containing gypsum and having a high Ca/SO4 value the osmotic impact on plants will follow the proposed Ca/SO4–EC model and will be higher than commonly assumed for gypsic soils.
We also found that as soil solution dries, kinetic factors control the system and contribute to salinity above the Ca/SO4–EC model which assumes equilibrium. Dissolved organic matter (DOM) was found to decrease the gypsum precipitation rate and resulted in oversaturated gypsum solution for long periods of time. Thus, gypsum oversaturation due to DOM presence may even exacerbate the contribution of gypsum to soil salinization.

# Tsunami event identification using sediment cores offshore Caesarea Maritima, Israel- A uniquely comprehensive perspective

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Recent research argued for the presence of tsunami deposits offshore Caesarea Maritima, along the coast of Israel. We present here a comprehensive analysis and comparison of a total of 8 offshore sediment cores as well as sediment samples from onshore and offshore the ancient harbor of Caesarea and its environs. By using this methodology we've expanded the database of known historic and prehistoric tsunamis and significantly enhanced our understanding of the nuances of tsunami sedimentation patterns within the upper shelf. We also introduce here a new perspective on tsunami sediment distribution with depth. This site-specific study reasserts the idea that sedimentological tsunami fingerprints vary greatly from place to place, even within small distances. In learning to understand these variations we enhance our understanding of the intricacies of sedimentologicaly based paleo-tsunami studies as well as the various effects of tsunami waves on our surroundings.

# Study of the Moho boundary beneath the Dead Sea Transform using gravity modeling

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The width of continental transform plate boundaries at the lower crust and upper mantle can provide insight into the rheology of the continental lithosphere. The Dead Sea Transform (DST) separates the Arabian and African plates and is dominated by a left-lateral horizontal displacement of 105-110 km, The lateral offset likely juxtaposes continental crust of different thickness across the DST, yielding possibly a step within the Moho boundary. The shape and amplitude of this step are still in question. In this work an attempt is being made to model the Moho boundary beneath the DST using two long gravity profiles, centered at the DST. The profiles extend from the eastern Mediterranean in the west to the Al-Mafraq region in eastern Jordan to the east, crossing the Carmel region, southern galilee basins array, Bet-Shean basin and the northern Jordan highlands. Subsurface geophysical and geological data are being assembled, interpreted, and integrated to construct a density model along the profile. The free-air gravity profiles shows a low anomaly bounded within the DST that might be related to a low density body within the upper crust or the thinning of the lower crust beneath the DST. A shift that appears in the pattern between the free-air anomaly and the corresponding elevation from both sides of the DST might relate to isostatic changes and the transition from continental crust to a stretched crust.

# Geochronology, pedostratigraphy, and late Quaternary landscape evolution in the western Po Plain (northern Italy)

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Knowing the past landscape history is one of the key to understand the dynamics of the present territory, to reconstruct its recent evolution and hypothesize its future trend. With this assumption, in the recent years a number of tectonic and morphostratigraphic studies were performed in the Piedmont sector of the Western Po Plain, with the intention to reconstruct its landscape evolution since the Plio-Pleistocene. In particular, new seismotectonic models have been defined to characterize the state of activity of the fold and thrust belt along the Torino Hill – Monferrato Arc, and the related seismic potential. In fact, according to the available historical and instrumental information the local seismicity level should be considered very low. This notion was questioned after the 2012 Modena sequence, which raised the concern that earthquake hazards in the Po Plain have been largely overlooked until now. The detailed analysis of Quaternary landscapes is the key for attacking this issue. The evolutionary framework obtained so far, however, lacks a robust radiometric time reference, which would give a more precise definition of the Pleistocene fault slip-rates and their variability in time and space along the different segments of the Monferrato Arc. This opens a new research perspective, aimed to a detailed geochronological characterization of the western part of the Po river basin, through the use of innovative dating techniques, such as OSL dating. A preliminary survey allowed to identify a deposit on the lowest terrace at the Alessandria Plateau, for which the OSL dating is in progress. First results will be presented during the Geological Conference 24-26 March 2015 – Beach Kinar.

# Middle to Late Pleistocene drastic change in eolian silt grains additions into Mediterranean soils at the Levant's desert fringe

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Loess is one of the most important archives of long term dust deposition and Quaternary climate changes. Loess thickness and grain size decrease downwind from sources, trends that are powerful tools for reconstructing paleowind. Such trends are known across loess deposits but there is limited knowledge further downwind. Desert loess deposits are located at the desert fringes and their influences on soils downwind, usually in wetter areas, are not clear. The Negev desert loess (100–300 mm/yr) is an ideal study site for identifying loess impact downwind. It was accreted during ~95-11 ka and characterized by a bimodal (3-8 μm, 50-60 μm) particle size distribution (PSD) with a clear up-section coarsening. The main source of the coarse silt is the adjacent sand dunes. We hypothesize that soils located downwind to the loess in wetter Mediterranean regions accumulated finer silt grains concurrently to the Negev loess. To examine this hypothesis we studied 1-4 m thick late Pleistocene pedo-sedimentary sequences in Jerusalem, central Israel (550 mm/yr) only 50 km downwind to the loess edge. We used PSD and mineralogy analyses with optically stimulated luminescence ages and Palaeolithic artifacts to study temporal changes in the sediments properties.

The sequences are divided into two regionally recognized units separated by a clear unconformity. The lower unit (>150 ka) lacks coarse silt and is composed of unimodal clay (3-5 μm) with chert clasts and lower-middle Palaeolithic artifacts. The upper unit (27-5 ka) is clay-loam with a bimodal PSD (3-5 μm, 30-45 μm); the quartz content, the amplitude and the mode of the coarse fraction increase up section. We suggest that the coarse silt grains are a recent addition to the southern Levant Mediterranean region. In the middle Pleistocene the deposited dust was of mainly clay transported from afar. The coarse silts were deposited in this mountainous area downwind and coeval with of episodes of fast accretion of the loess, and generated by coeval eolian abrasion of sand grains in the upwind dunes. Similar to the Negev, the addition of coarse silts had resulted in the burial of drainage network, producing a net decrease in runoff and soil erosion rates. We stress here the importance of desert loess in determining soil composition and surficial hydrology in wetter areas located downwind.

# Conspicuous cone-shaped mound buildups and the linkage to a fluid flow system: Investigation from the outer continental shelf off-central Israel

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Analysis of commercially-acquired 3D and 2D seismic datasets, and a high resolution single-channel 2D seismic survey reveals some 31 discrete mounded structures, embedded at a Late Pleistocene single horizon (top Kurkar Group) in a confined zone on the outer continental shelf off-central Israel. The structures are conical or rounded with asymmetric flanks and a domed or ridge-like crest. They rise 10-30 msec above the fairly smooth unconformity and span 60-190 m across at its base. The mounded structures are characterized by anomalously high amplitudes at the apex and velocity pull-ups beneath. This may indicate the presence of denser materials; pipe-like wipeout zone and bright spots coupled by phase reversal in the underlying Kurkar Group unit immediately below the mounds – which are fluid flow markers. Accordingly, the main objectives of this study are to assess the features viability as biogenic or biomediated mounds and to scrutinize the possible association between past focused fluid flow seepage at the paleo-seafloor and the formation of these features, a documented phenomenon in carbonate mounds and isolated carbonate reefs worldwide.

Using a recently-developed seismically numerical score assessment of isolated carbonate-buildups (ICBs), the observed features obtained an overall score (9.5) within the probable case of an ICB (7.5-17), strengthening the evaluation their lithology as relatively more consolidated and/or cemented body. Three potential fluid flow sources may invoke fluid migration towards the mounds: 1) a contemporary shallow gas strip documented on the continental shelf about 5 km east of the mounds; 2) the Afiq sub-unit, locally deposited during the Lago-Mare phase (Late Miocene) and comprised mainly of porous and permeable sandstones and conglomerates; 3) the Delta Anticline, a Syrian Arc fold belt segment, located spatially beneath the mounds. The fluid flow conduit system to serve the latter two is presumed to consist of a series of listric normal faults, as part of a regional extensional fault system, which crosscut or deforms the Pliocene-Pleistocene succession across the continental slope and shelf edge.

# Time-lapse cameras in the service of geomorphologic research: examples from the Dead Sea coastal region

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Fast processes characterize the Dead Sea coastal and fluvial area, as a response to the decline of the Dead Sea level. Flash-floods, channel incision, bank erosion, landslides, subsidence, and sinkholes formation are common in this region and are all well known for their high rates and dynamic nature. There are several methods to document these phenomena at different stages of their formation, e.g. orthophotos, airborne and ground-based LiDAR, InSAR (Interferometric Synthetic Aperture Radar), and others. Most of these methods are based on output comparisons (before and after), that are generally of low-temporal resolution compared to the documented processes rate. "Eyewitness" evidence was generally absent, excluding sporadic observations of researchers and travelers. For this purpose we are using time-lapse cameras (TLC), which are set to capture and document processes at different intervals (seconds to hours), depending their characteristics and the desired installation period. As a compact (half-liter drinking bottle size) standalone sensor, the TLC can be installed in remote locations for periods of days to months. Time-lapse videos in different frame rates can reveal processes that are hidden at real-time speed. A process lasting hours to days can be compressed to a seconds to minutes video-clip. Combination of field measurements and image processing may also produce quantitative data. In this talk we will discuss the advantages and challenges using TLC as a geomorphologic and hydrologic research tool. We will present recent examples from the Dead Sea surrounding: channels evolution, triggering of sinkholes formation by flash-floods, and land subsidence.

# Channel incision of the Nahal HaArava and Jordan River in response to continuous base level lowering of the Dead Sea

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The Dead Sea (DS), as a terminal lake, experiences a level drop of >35 m in the past four decades and intensive tributary stream incisions in response. In the 1970s-1980s the southern shallow DS basin was drying quickly to a total desiccation and exposure of its bed in the mid-1980s. As a result, Nahal HaArava channel length increased by 30 km in a few years, following the northward retreating DS shores. Since then, this new section of Nahal HaArava is incising fast in the exhumed lacustrine sediments as a response to the continuous level lowering (at ~1 m /year) of its base level, the northern DS basin. At the new section, Nahal HaArava acts as a perennial stream as brines are discharged to its channel from the nearby evaporation ponds (~250*10^6 m^3 /year). On top of this discharge the channel is affected by occasional desert flashfloods. At the mouth of Nahal HaArava, a unique salt delta is being constructed. Geomorphologically, this channel provides a rare opportunity to document and analyze field-scale, decades-long evolution of a newly incising stream, which is fast responding to a noticeable base-level drop. On the basis of high resolution LiDAR-based DEMs, ortho-rectified aerial photographs, Landsat imagery, and field observations we documented annual to decadal detailed channel morphological changes including past longitudinal profiles and incision rates, knickpoint retreat and modulation, sinuosity, width and delta evolution; furthermore, the high spatiotemporal and topographic resolutions allowed determining the causes of such changes.
Rapid incision was detected mainly in the downstream (northern) 12 km of the channel. Near its mouth, the channel bed is approximately 18 m lower than pre-incision, ~30 years ago. Upstream the mean incision is ~6 m. The salt delta progradation rate varied temporally and spatially, where high brines discharges and shallower DS floor generated fast progradation while deeper DS floor, flash floods and unsaturated DS epilimnion inhibited it. In general, the delta progradation moderated the channel mouth slope by preventing its exposure to the steep bathymetry of the DS (~85‰). Since early 1990s a remarkable knickpoint migration was documented associated with rapid incision, narrowing and increased sinuosity of the downstream channel. Upstream the knickpoints, the channel experienced relatively minor modifications. The knickpoint retreat accelerated dramatically in the beginning of the 2000s from tens of meters per year before 2001 to more than 3000 m/year after 2003. In this talk, we will demonstrate the major role of delta development rates on the evolution of channel responses to base level drop. Examples will be given from Nahal Harava and the Jordan River.

# Hazard Map for Ground Failure Associated with Active Faulting

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The SI413 active/potentially active fault map (Sagy et al., 2013) is not a comprehensive surface rupture hazard map in the sense that it only documents discrete evidence for the intersection with the surface of the earth of fault surfaces that slipped during the last 13,000 years (for "active" faults; and up to 35,000 years for "potentially active" faults; in other countries definitions range from 5,000 to 1.8 million years). This is because SI413 is being used for the seismic design of specific structures, therefore, building restrictions associated with active faulting can only relate to explicit evidence for surface faulting. However, the along-strike continuation of explicit 'active fault' also imposes, potentially, some level of hazard. In addition, the mapping of 'active faults' in Israel is partial and limited, especially in covered/disturbed areas.

Geological mapping of surface ruptures show broad shear zones with numerous previously un-mapped faults, with some faulted alluvial surfaces having no expression in post-earthquake mapped trenches (e.g. Landers 1992, Mw=7.3). Paleoseismic mapping of the San-Andreas fault in Central California shows ~10 fault branches that ruptured the surface in six earthquakes over a 21 m wide fault zone (Grant and Sieh, 1994). These evidence imply that the location of future surface displacement within a fault zone cannot be predicted with certainty even with detailed mapping, a problem that is not resolved by the 'zone of active faulting' in the SI413 map. In addition, the evidence for surface displacement can deteriorate in timescales well below the criteria for active faulting (e.g., Begin, 1992; Gardosh et al., 1990). Of 28 earthquakes that ruptured the surface in California during 1974 to 2007, 3 occurred on previously un-mapped faults. Many of these earthquakes were associated with tens of subsidiary surface faults, which in some cases ruptured areas outside the official active faulting buffer.

Broad mapping gaps, the aleatoric uncertainty associated with future location of ground displacement within a fault zone, and the poor resistance of fault scarps are therefore the main reasons that surface rupture hazard prevail in areas much larger than those delineated in the SI413 map. We therefore propose that surface faulting hazard zones for planning (vs. design) purposes should include shear zones and faults that are neotectonically active, e.g. have geomorphic expression, or distinct correlation with seismological and geodetic observations, and are, in general, participating in active shaping of the landform. A map with such hazard zones will facilitate safer development prioritization during urban planning, and will allow reliable estimation of the cost and duration of specific site surveys and construction. Examples for such non-standardized hazard zones include the Carmel fault southeast of Yokneam, some sections of the Arava fault, and broad marine active shear zones at the continental slope.

# Wavelength-Dispersive X-Ray Spectroscopy (WDS)

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When an electron beam interacts with a sample target it generates X-rays, as well as derivative electrons (e.g. secondary, back-scattered). A wavelength-dispersive spectrometer uses the characteristic X-rays generated by individual elements to enable quantitative analyses (down to trace element levels) to be measured at spot sizes as small as a few micrometers. WDS can also be used to create element X-ray compositional maps over a broader area by means of rastering the beam. Together, these capabilities provide fundamental quantitative compositional information for a wide variety of solid materials. This technique is complementary to energy-dispersive spectroscopy (EDS) in that WDS spectrometers have significantly higher spectral resolution and enhanced quantitative potential. Many SEM and EPMA instruments have EDS systems mounted to the column, and an EPMA typically has an array of several WDS spectrometers for simultaneous measurement of multiple elements. In typical EPMA applications, EDS is used for quick elemental scans to find out what a material contains, and WDS is then used to acquire precise chemical analyses of selected phases.

A wavelength-dispersive (WD) spectrometer is used to isolate the X-rays of interest for quantitative analysis. There may be a single WD spectrometer horizontally mounted on an electron column (more typical in SEM instruments) or 4-5 spectrometers may be mounted vertically in sequence around the sample chamber (more typical of EPMA).

WDS can result in high resolution wavelength spectra and high quality element x-ray compositional maps, but the most common application of WDS is for quantitative spot analysis. Typically, individual WDS spot analyses include information on the ratio of the WDS detector counts of the sample relative to the counts on a standard for each element (k-Ratio), a measure of the minimum detection limits of an element (MDL), the weight % of each element (El-Wt%), the weight % of each element expressed as an oxide (Ox-Wt%) that results after the matrix correction is made and the atomic proportions (At-Prop) based on a fixed oxygen normalization basis. The El-Wt% or Ox-Wt% are typically used as input for a subsequent calculation of the stoichiometry of a mineral or material that is most appropriate to the nature of the material. This stoichiometric calculation is generally based on a fixed number of oxygens or cations or metals depending on the sample being analyzed.

# Dead Sea Sediments as a Recorder of the Geomagnetic Field

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Earth magnetic field varies on wide range of time scales. Recovering the past geomagnetic variations is one of the ultimate aims of the paleomagnetic research. The ICDP is an ideal environment for studying this effect. The core offers a unique opportunity for investigating temporal variations in the field in a continuous high-resolution fashion from the rapidly accumulating and continuous sedimentary sequence of the Dead Sea. To achieve this goal we should first have a comprehensive rock-magnetic assessment of the ferromagnetic minerals and the magnetization residing in them. This data is essential for constraining the lock-in time of the magnetization, and determining whether the magnetization is a depositional remanent magnetization (DRM) or chemical remanent magnetization (CRM) in origin.

In this presentation we will show data from two sections of the Lisan Formation: the ICDP core and the Massada outcrop. The sections were taken from a time interval covering the Laschamp geomagnetic excursion, an extreme event in which the field deviated substantially from northerly oriented field. Surprisingly, the paleomagnetic data from both sections did not reveal any paleomagnetic excursion. Instead, we obtained declinations and inclinations expected from Geocentric Axial Dipole (GAD). A preliminary investigation of the paleo- and rock- magnetic properties combined with electron microscopy analysis indicates a complex magnetic recording mechanism. We identified ferromagnetic Iron-sulfur mineralization (CRM) masking an original Detrital Remanant Magnetization (DRM). The Iron-sulfur magnetization is not apparent in the Masada outcrop probably due to oxidation.

# Sedimentological characterization and chronology of recent submarine landslides on the continental slope of Israel

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Submarine slides are considered a direct geohazard to marine infrastructure and coastal facilities, and can be the cause of destructive tsunami events. Exposed and fresh sliding scars on the continental slope off Israel, as well as historical record of recent local tsunami events, suggest that there is an active landslides system in our region. A practical assessment of the risks associated with this system requires a definition of the chances of sliding to occur in the future and the understanding of their mechanism. In this study, we focus on constraining these parameters through dating and characterizing the scars and deposits of seemingly most recent submarine slides on the Israeli continental slope. In the course of this research, sets of cores (piston and box) were extracted from three sites along a presumably most recent scar offshore Ashkelon: 1) the undisturbed slope, just above the head scar, as a reference; 2) the exposed face of the head scar; 3) the tail region. To the naked eye, the cores seem to be composed of homogenous brown clay, top to bottom. However, initial examination of the cores through computed tomography (CT) scans, reveals different units of sediments with varied density, zones of increased presence of biogenic elements and units with stochastic bedding compared to stratified units. In the reference core we observe a continuous sequence of sub-horizontal layers, whereas a distinct sedimentary transition is present in all three cores extracted from the head scar, 30-50 cm from their top (seafloor). This transition is marked by a major change in the density of the sediments, accompanied by up to 10 cm long biogenic burrows. We suggest that this transition represents the contact between the pre-slide material to sediments that deposited after sliding, along the slides detachment surface. The observed intense burrows are in agreement with our suggestion. It was suggested in literature to represent enhanced biogenic activity as a response to post sliding methane emission, and suggests that the transition surface was exposed to the seafloor for a relatively extended time. The sediments overlying the transition represent the time elapsed since sliding, and considering the estimated sedimentation rate of ~1m/kyr at the continental slope, approximates sliding to have occurred ~500 ya. This age estimate correlates to a historical tsunami event, driven by a Dead Sea Transform earthquake, which took place in the 16th century. Additional constraints will be provided soon, as the first group of samples had been sent for radiocarbon dating, and initial grain size analysis was applied and needs to be continued and interpreted.

# Fluids and melts in equilibrium with carbonated hydrous eclogite system at 4-6 GPa and 900-1200°C

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The carbonated hydrous eclogite system is studied between 4-6 GPa and 900-1200°C in order to define the position of its solidus and determine the composition of fluids and near-solidus melts in equilibrium with eclogites. These compositions will be compared with natural fluid inclusions found in diamonds in order to examine the genesis of silicic to low-Mg carbonatitic high-density fluids (HDFs) at depth. Experiments were conducted using a rocking multi-anvil press. Equilibrated fluids and melts were analyzed using LA-ICP-MS equipped with a freezing stage for their total solute content. H2O and CO2 concentrations were determined by mass balance calculations. Solid phases were chemically characterized using EPMA.

Eclogites in this study are composed of garnet, clinopyroxene and carbonate as major phases with coesite, rutile and kyanite as accessory minerals.

At 4 GPa, the Clionopyroxene composition is omphcitic and garnet composition changes systematically as the Mg/Fe ratio increases with temperature. Carbonate compositions shift from a two component system comprised of a Fe-bearing calcite-dolomite solid-solution and a magnesite solid solution at 900-1000°C, to a one component magnesite solid-solution at 1100-1200°C.

The solidus at 4 GPa was located between 1000 and 1100°C. Subsolidus fluids contain 30-40 wt% H2O and 25-30 wt% CO2 changing to silicate hydrous melts with only 15 wt% H2O and 12 wt% CO2 above the solidus. When compared with the HDFs trapped in diamonds the fluids and melts fall within the compositional field spanned by silicic to low-Mg carbonatitic HDFs.

# Mt. Olympus dome, Troodos ophiolite, Cyprus - a forearc serpentine diapir?

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The anticlinal structure of the Troodos ophiolite, north of the Arakapas transform, was considered as associated with the early Pleistocene (~2.0 Ma) regional uplift of Cyprus, centered near Mt. Olympus (Robertson, 1977). A superimposed local uplift of the area adjacent to the summit of Mt. Olympus itself was attributed to an uprise of a serpentine diapir formed above a Pleistocene subduction zone (Allen, 1975). The circular serpentinized mantle outcrop, considered as the head of the diapir, has been shown to comprise two generations of serpentine (Nuriel et al., 2009). Early oceanic lizardite, with low $\delta^{18}O$ values of +4 to +6‰ that is heavily overprinted by late chrysotile veins of unknown source with high $\delta^{18}O$ values of +10 to +14‰. Boron content and isotope ratio are used here to better constrain the hydration agents of the Troodos serpentine.

Boron is a powerful tool in the study of the serpentinization process since it is a highly mobile element that incorporates into the serpentine lattice during hydration of fresh mantle rocks. Peridotites and dunites contain minor amount of boron (0.1 ppm) with very low $\delta^{11}B$ values (-5‰), while serpentine may contain up to a few tens ppm of B and much higher $\delta^{11}B$ values. Since the incorporation of B to serpentine is T and pH dependent, B content and its isotopic ratio may track the type of water involved in the serpentinization and the ambiemt conditions of the hydration reaction. $\delta^{11}B$ values of Troodos serpentine gradually decrease from +26 to -6‰ northwards and away from the Cyprus Arc subduction trench, resembling similar across arc trends recorded in basalts. The decrease in $\delta^{11}B$ can be accounted by selective mobilization of boron from subducting materials due to progressive slab dehydration. Since the heavy boron isotope (11B) is preferentially partitioned into aqueous fluids, the $\delta^{11}B$ of the extracted fluids and magmas should gradually decrease away from the arc front. This implies that the thick chrysotile veins formed by fluids released from a subducting slab beneath Cyprus at depths of 70 to 120 km, migrated upward through the already emplaced ophiolite and overprinted the partially serpentinized mantle. The resulting buoyancy gradient lead to serpentine diapirism.

# Intra- to Post-Messinian deep-water gas piping in the Levant Basin, offshore central Israel

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This study presents evidences for fluid flow manifested as pipe structures identified from a high-resolution deep-water (1100 - 1500 m) three dimensional seismic dataset offshore central Israel. Interestingly these pipes are genetically and spatially contextualized east and west of the study area, all emanating from the Messinian evaporite substratum. Pipes in the western group accounts for 83% of the pipe population, are crudely cylindrical, oval to elliptical in planform, with diameter and height ranging ~350 - 2000 m and 320 - 420 m, respectively. Internal configuration within this group varies from chaotic to concave upward reflections diagnostic of fluid induced collapse. Pipes in the eastern group are paleo seepage pipes appearing conical in shape, with height of ~350 - 510 m and diameter of 320 - 420 m. The eastern group pipes are characterized by lack of internal reflectivity and/ or disrupted stratal reflections. The western group indicates an episode of fluid flow till the mid-Pliocene, compared to late Pliocene in the eastern group. A conceptual model for the pipes in the western group is proposed to have occurred from subjacent dissolution of the Messinian evaporite under deep-water marine conditions during the Pliocene by vertically focused fluid flow from intra-Messinian realm dissolving the top evaporites and inducing systematic collapse in the overburden. The onset of which may have been triggered by seismicity. Conversely, pipes in the eastern group are proposed to develop from breaching the top evaporite by pressurized fluids that developed from lateral pressure transfer due to differential loading of the overburden and salt tectonics. The pipes identified in the study area extends the current understanding of fluid flow during and subsequent to the Messinian salinity crisis (~5.96 - 5.33 Ma) and may likewise have geohazards implications for deep-water hydrocarbon exploration targeting the sub-salt in the Levant Basin. Our result has wider implications for the hydrodynamics of many basins where thick salt layers are widely developed may serve as an analogue to understand the nature of fluid flow.

# The geological map of the Feiran Metamorphic Belt, Sinai, Egypt, scale 1:75,000

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The Feiran Metamorphic Belt (FMB), the fourth published detailed geological map of the Sinai Precambrian massive, is located in the northwestern part of the massive along the Feiran and Solaf wadies. The oldest rocks in the FMB are metasediments comprising of the Feiran schist, Feiran Calcsilicates and Tarbush quartzite with a provenance age of ~1000 Ma (Abu El-Enen and Whitehouse, 2013, Precambrian Research). The metasediments were intruded, during the island arc stage, by the ~800 Ma (Eyal et al., 2014, Gondwana Research) El-Sheikh diorite gneiss, ~785 Ma (Eyal et al., 2014, Gondwana Research) Feiran diorite gneiss, and Solaf granitic gneiss plutons that acquired their gneissosity after the metasediments were transformed to schists. The Feiran migmatite that most probably was migmatized during the accretion stage of the island arc to Gondwana at ~640 Ma forms the hearth of the FMB.To the north and northeast the FMB is bordered by the calcalkaline plutons of the ~595 Ma (Be'eri-Shlevin et al., 2009, J. Geological Society of London) Nisrey'in gabbro and diorite, Hallal granodiorite, Uktoon quartz diorite, Tibeina granite, ~600 Ma (Be'eri-Shlevin et al., 2009, J. Geological Society of London) Solaf granitoid complex, and Banat quartz syenite Ring Dike of the alkaline magmatic phase. To the east it is intruded by the Katherina Ring Dike Complex that includes the Jurjunia Formation, Katherina Outer Ring dike and Katherina Pluton. To the south the FMB is intruded by the ~620 Ma (Be'eri-Shlevin et al., 2009, J. Geological Society of London) calcalkaline Mir Hebran granitoid complex and Kabrin diorite Pluton. The center of the FMB is intruded by the Umm Takha lineated white granite Pluton of the accretion magmatism stage, the ~600 Ma (Abu El-Enen and Whitehouse, 2013, Precambrian Research) Rimm gabbro intrusion, and the Geba' granodiorite Pluton of the calcalkaline magmatic phase, and the ~600 Ma (Be'eri-Shlevin et al., 2009, Lithos) Serbal alkali granite ring dike of the alkaline magmatic phase.

# Geological map of the Elat Metamorphic Belt, NE Sinai, Egypt, scale 1:50,000

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The Elat Metamorphic Belt, the fifth published detailed geological map of the Sinai Precambrian massive, extends along the western side of the Gulf of Elat (Aqaba) from the town of Elat southward. It represents an island arc located at the most northern part of the Arabian Nubian Shield. The Elat schist, the oldest rock unit in the belt, is 10-15 km thick and represents the metamorphic products of sediments eroded from the volcanic arc with provenance age of 870-800 Ma. Four deformation phases were defined in the schists on the basis of foliation, growth of minerals and the mutual relationships between them. During the first two phases, under low to medium pressure metamorphism of amphibolite-greenschist facies, its cleavage was formed. The schists were intruded, during the island arc stage, by the 780 Ma Taba quartz-diorite, 767 Ma Fiord tonalite, the Um Maghragranodiorite (with the synplutonic basic dikes) and Abu Samra granodiorite. During the later deformation phases the cleavage was deformed and the plutonic rocks acquire their gneissosity.

The accretion stage of the island arc with the Gondwana continent began after an extension phase at ~700 Ma in which basic dike swarms intruded the older rocks. It was followed by the intrusion of Tueiba and Mahash gabbro, Magrish and Mahash granodiorite and Morakh and Umm Zeriq granites. During the accretion the above intrusions were transformed to schist dikes, amphibolite and gneisses respectively. At this stage was formed, most probably, the Magrish migmatites due to metamorphic differentiation of the Elat schists.

The only presentation of the calcalkaline magmatic phase is the Haneikiya granitic Pluton. The Katherina Group is represented in the northern part of the area by the ~ 600 Ma Neshef Formation composed of alkali rhyolite lava and tuff and quartz trachitic lavas. In the central part of the area, the acid volcanics and sediments of the Mhash Formation are surrounded by the Mhash granophyre ring dike.

The Precambrian basement is truncated by a regional peneplain and overlain by platform siliciclastic sediments of the Cambrian Yam-Suf Groups and Lower Cretaceous Kurnub Group. The sandstones are overlain by carbonate rocks of Upper Cretaceous Judea and Mount Scopus groups and Eocene Avedat Group.

Clastic rocks of Pleistocene-Holocene age form the upper part of the sedimentary section. The area is crossed by many faults commonly sub-parallel to the Dead Sea Transform, resulting in graben, horst and tilted block structures.

# Archaeoseismology and paleoseismology in the area of Tiberias city, Sea of Galilee – preliminary results

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The city of Tiberias is sited on the shores of the Sea of Galilee, a pull-apart basin located along the Dead Sea Transform. Here we present the first results of a cross-disciplinary investigation focused on the evaluation of earthquake hazard for the city: aerial photo interpretation and field surveys were combined with shallow seismic surveys and paleoseismic analyses. An archaeoseismic survey has been performed on archaeological structures on the top and at the foothill of Berniki hill.

Geomorphological mapping enabled us to draw a morphotectonic map of the area; several landslide deposits, lineaments and anomalies in the river network were identified. At Berniki Roman theatre tilting and open fractures of the walls were recorded; most of the features are aligned along a N140° direction and might be earthquake-related.

Further work has to be done for a complete seismic hazard characterization; planned activities include the opening of new trenches, analysis of slope instability and landslides related to fault lines and a more detailed investigation on the archaeological structures. The completion of activities should shed light on some open issues and should give more conclusive results.

# The importance of accounting for dynamic directivity effects in seismic hazard analysis

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Numerical simulations of earthquakes enable a careful inspection of dynamic processes and transient effects which are overlooked in any static representation of seismic source processes. While earthquakes nucleate at a singular point, the rupture that tears through the crust propagates and generates seismic waves from all along the trace of the ruptured fault. Simple point source representations of earthquakes are therefore inadequate for earthquakes with long rupture traces (i.e. M>6). Comparing source point (static) calculations of shaking patterns (e.g. PGA maps) with calculations assuming a static line source and with calculations based on dynamic rupture simulations reveals great discrepancies in the shaking intensity and distribution. These differences have profound implications on the evaluated seismic hazard, leading in recent years to massive investments in the more-reliable dynamic simulations in country-scale hazard assessments, e.g. California's TeraShake initiative.

The present work aims to derive a simple but accurate correction function that could be applied to improve PGA maps calculated using a static line source model, so that these account for the dynamic directivity effect. For this we characterize the shaking amplification patterns in a range of dynamic models and compare them with PGA maps derived using common seismic hazard software. In this presentation we discuss a few scenarios that demonstrate an important dynamic directivity effect, we present our method for deriving a correction factor and show results from its application in forming PGA maps. In addition, we present the effect of dynamic PGA amplification on probabilistic seismic hazard analysis. We find that the area in which any certain PGA level is expected is greatly underestimated if calculations are based on static point/line source models. We therefore introduce a method to re-evaluate the probability of exceeding a certain PGA level in a way that accounts for the dynamic directivity effect.

# Lake Kinneret as a natural laboratory to study the carbonate system using 88Sr/86Sr fractionation in authigenic inorganic calcite

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The precipitation rate of inorganic calcite (Rcal) is a function of the calcite degree of saturation (Wcal), which in turn is a function of the ionic composition and the ambient water temperature. It was found experimentally that the fractionation factor of the stable Sr isotopes between dissolved Sr and authigenic calcite (defined as Δ88/86Srcalcite-water=δ88/86Srcalcite-δ88/86Srwater) is a function of Rcal (Böhm et al., 2012), this however was never demonstrated in the nature. In this study we use carbonate system parameters, CaCO3 vertical flux and the Sr isotopic composition δ88/86Srwater and δ88/86Srcalcite in Lake Kinneret (Sea of Galilee) to evaluate the relationship between Δ88/86Srcalcite-water and Rcal. Lake Kinneret serves as a "natural laboratory" for this purpose, since its Wcal increases seasonally as a result of massive phytoplankton blooms, which causes calcite precipitation.
Our preliminary results of authigenic calcite that were collected in sediment traps deployed in the lake show a wide range of Rcal. The Sr isotopic composition of the dissolved Sr (δ88/86Srwater) and the authigenic calcite (δ88/86Srcalcite) show that Δ88/86Srcalcite-water depends on Rcal. It is concluded that after proper calibration it will be possible to use down core δ88/86Srcalcite data that was measured on lacustrine (and marine) authigenic inorganic calcite for reconstructing variations in calcite deposition rates.

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# Pliocene cave deposits in Israel: Implications for uplift and relief development

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Age dating of cave deposits can constrain landscape evolution, particularly under erosional regimes, where no sediments are found on the surface. We present three independent lines of evidence indicating that caves across central and southern Israel were already above the water table during the Pliocene. Radiometric (U-Pb) age-dating of the earliest speleothem deposits in Ktora and Ashalim caves at the Negev Desert show that an early stage of vadose speleothem deposition occurred around ~3.1 Ma (Vaks et al., 2013).
Burial age-dating of fluvial deposits using Be-Al cosmogenic isotopes in the Judean Desert caves show that these deposits accumulated already during the Pliocene (Matmon et al., 2014). In the Cave of the Letters fluvial deposition of early Nahal Hever occurred until ~3.1-2/8 Ma. At the upper eastern side of Masada cliff, 'Cave 2008' shoreline/fluvial deposits are dated to ~3.6 ± 0.4 Ma.
At the water divide of Israel, a collapsed cave (Bethlehem fossil-bearing site) contained mammal and reptile remains whose paleontological evidence indicates Pliocene age according to recent reevaluation (Rabinovich and Lister, 2014).
The morphology of the discussed caves indicates that they had formed under the water table. At a later stage, the dated deposition occurred above the water table, indicating a Pliocene (or earlier) uplift stage associated with the dewatering of the caves. The main water divide of central Israel was already established during this stage, indicated by the fluvial deposits of streams, such as Nahal Hever, flowing eastward towards the Dead Sea basin.

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# The spatio-temporal patterns of radon along the western fault of the Dead Sea Transform, NW Dead Sea

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An extensive radon anomaly is developed along the western boundary fault of the Dead Sea Transform in the NW sector of the Dead Sea, extending 15-20 km north-south. The highest radon values occur in proximity to the fault scarp. Radon is measured, in gravel (depth 1.5 -3 m) at sites located at a) on-fault positions, 1-30 meters east of the fault scarp, and b) off-fault positions located 600-800 m to the east. Prominent signals occur in the annual and daily periodicity bands, as well as non-periodic multi-day variations (2-20 days). Modulations occur among the annual variation and the multi-day and the daily signals, and between the multi-day and the daily signal. Dissimilar variation patterns occur at on-fault versus off-fault sites in the time domain, and in the relative amplitude of the daily periodicities. Variation patterns and their modulations are similar to those encountered in experimental simulations. It is concluded that: 1) above surface atmospheric influences can be excluded; 2) a remote above surface influence probably drives the periodic components in the annual and diurnal bands; 3) diurnal as well as the multi-day signals are modified and inter-modulated by near field geological (static) and geophysical (dynamic) influences. Systematically different influences are operating at on-fault versus off-fault positions, So far the natures of these near field influences are unidentified.

# Observations of the relationship between directionality and decay rate of radon in a confined experiment

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Radon (222Rn) is a radioactive inert gas with an accepted half life of 3.8235 days. Its unique, systematic and complex variation in the geological environment and in simulation experiments combined with lack of understanding of the underlying drivers lead us to conduct tests of its apparent half life. A primary test took into account experimental observations indicating anisotropy of the gamma radiation from radon in air, which is related to global orientation. Using a goniometric configuration radon diffuses into two identical cylinders oriented along Earth axis of rotation and in a vertical and perpendicular direction to the latter. Detectors placed on cylinder ends along these directions measure gamma radiation from a 8.5% solid angle sector of the 4π sphere. At steady state and confined conditions different patterns of daily signals are observed in the two directions. Isolating the cylinders from the source leads to an exponential decrease on which similar daily signals are superimposed, having amplitudes proportional to the level of the remaining radon. The indicated apparent half-lives are in significant difference from the accepted value: 0.861±0.003 days in the pole direction and 2.308±0.008 days in the vertical direction. The outcome is in conformity with observations on radon signals in confined conditions and their different manifestation at different directions.

# Submarine slides: the shaping of the continental slope offshore Israel

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Mass Transport Complexes (MTC) play an important role in the evolution of continental margins and the sedimentary fill of basins. We analyzed the tracks of MCTs along the continental slope offshore southern to central Israel based on a newly integrated digital elevation model (DEM), combining the IOLR-GSI multibeam bathymetric data-sets (25,50 m resolution) with 3D commercial seismic cubes seafloor picking (12.5 m resolution). This DEM reveals that the slope is etched by MTC escarpments, varying in their spatial distribution and morphologic appearances. In order to investigate the dynamics of events that shaped these escarpments we applied morphometric analysis, utilizing a spectral decomposition of the DEM. The bathymetry was divided to its main spectral components, representing different degrees of surface perturbations, then cross-referenced with seismic sections in order to explore their sub-seafloor origin.

Regional bathymetric variations divide the slope from Gaza to Dor to three regions. From south to north the regions vary in slope width (17 to 21 to 13 km), slope strike azimuth (027° to 017° to 029°) and slope average dip (3.5° to 4.2°). ~15 km long bathymetric undulations correlate with buried slump scars and up to 80 m thick, 15 km long and 25 km wide debris lobes frontally confined to the lower slope. These slides headwalls are preferentially aligned with deeper faults.

~1 km bathymetric changes are composed of two feature types:1)Slope-parallel bathymetric steps up to 50 m high representing deeper faulting, rooted in the Messinian evaporates. 2)Slope-perpendicular, kilometers wide bathymetric escarpments located in the upper and lower slope incise the sedimentary cover and debris lobes of the larger scale slides described above. We mapped 102 escarpments, which show south to north increase in population and decrease in size. The Nonlinear volume-area relationship and well fitted lognormal cumulative distribution agree with the distribution of submarine slide scars in various subaqueous environments worldwide. ~50 m bathymetric roughness variations represent marks of debris lobes, extending <18 km west of the slope and into to the basin to water depths of ~1300 m. Also,~50 m wide and~10 m deep smooth lineaments mark a network of channels overprinting the MTC escarpments.

We suggest that a series of~25 km wide frontally confined slumps formed the general morphology of the slope offshore central Israel. Sediments accumulated within the scars of these slumps and their debris lobes nucleated smaller scale disintegrative slides, which transported ~10 km3 of sediments into the basin along ~100 km section of the continental margin. This accounts for a ~3 m thick sediment cover, considering the maximum runout distance observed. Bottom currents farther incise the slide escarpments, creating narrow channels, which initiate northward intensifying canyon headword erosion. In addition, northward intensifying deeper faulting have been persistent throughout the described evolution of the slope, forming tens of meters high bathymetric steps.

# Anchoring and mooring facilities in the Sea of Galilee and offshore anchor-holds

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Scarcity of natural shelters, and on-shore winds, prevailing on the Sea of Galilee, endangered water craft operating on the lake. Several droughts during the 1990s resulted in exceptionally low lake-levels. Consequently wide areas of the former lake-bottom were exposed, revealing ancient structures of various forms and sizes, including several mounds of undressed stones. Recently such underwater mound was reported and interpreted as an Early Bronze Age megalithic structure. Using archaeological finds, the ancient navigation and anchoring facilities on the Sea of Galilee were investigated and discussed in light of the prevailing physical conditions on the lake. A typology of the anchoring facilities is proposed. The study suggests that ever-occurring and unpredictable mega changes in the water level of the lake (up to several meters yearly) made the construction of long lasting harbors problematic and unjustified economically. To facilitate anchoring and safe mooring for water craft, when needed, small temporary "ad-hock harbors" were constructed and adopted to the changing lake levels when needed. Natural small bays (Amnun and Hale) and river estuaries (Jorden and Zaki) were also used to provide sheltered anchoring or mooring. Column drams inserted in the “Nemala Rock” located tens m offshore, and perforated stones inserted in a shore structure near Migdal were used for Mooring. Additionally, off shore stone mounds, including the newly reported one, were constructed by dumping stones from boats, thus providing anchor holds, avoiding grounding of boats by on-shore winds. They functioned at different lake levels and were also used as fish nurseries.

# The Effect of Groundwater Velocity and Dispersion on Dissolution Rate of Carbon Dioxide in Saline Aquifers

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Geological Carbon Sequestration (GCS) is a promising tool for reducing atmospheric CO2 emissions. In GCS, CO2 is injected into saline aquifers at a depth larger than 800 m where a top sealing layer is used to retain the CO2 in the aquifer. Since the density of the injected supercritical CO2 is lower than that of the ambient groundwater, the CO2 rises to the top of the aquifer and accumulates below the sealing layer. With time, other trapping mechanisms begin to act and contribute to the security of CO2 storage. Such an important mechanism is the dissolution of CO2 within the aquifer water. Once the CO2 is dissolved, it is no longer buoyant and doesn't tend to flow upwards. In fact, water saturated with dissolved CO2 is denser than the CO2-free water and thereby tends to sink. The formation of a dense layer of CO2-rich water on top of a layer of CO2-free water induces a convective instability, where fingers of dense, CO2-rich water are generated and propagate downwards. The convection of CO2-rich water away from the interface greatly enhances dissolution rates and therefore storage security .

In previous studies groundwater velocity and hydrodynamic dispersion were assumed to be negligible and weren't considered in the analyses of convective instability. However, aquifers with zero flow are rare even in deep formations. In the current research, we examine the effect of groundwater velocity and hydrodynamic dispersion on the convective instability and the dissolution rate. We perform laboratory experiments in a Hele-Show cell packed with glass beads using a methanol and ethylene-glycol solution (MEG) as an analog fluid of the CO2. MEG, as CO2, is lighter than water in pure form, but when dissolved in water it becomes denser than water and therefore able to reproduce the dissolution pattern and convective instability of CO2 in water. In the experiments, dyed MEG was injected to the top of the Hele-Show cell while keeping a constant lateral water flow. The spreading and dissolution of MEG within the water were recorded by using a time-lapse camera and analyzed by means of image processing for a variety of flow rates.

It was found that water velocity affects the formation of fingers, their characteristics and the MEG dissolution rates. We show that water velocity suppresses the formation of instability. This is manifested in either earlier disappearance of the fingers or a preventing of their formation. A better assessment of CO2 dissolution rate is of high importance as it affects the prediction of CO2 migration and trapping in the aquifer and hence the evaluation of CO2 storage potential and security.

# 3D reservoir model construction for estimation of remaining hydrocarbon potential at the Kokhav-Heletz-Brur oil field.

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The overall aims of the study were mapping and characterisation of the Kokhav Dolomite reservoir, construction of 3D reservoir model and estimation of hydrocarbon potential at the Kokhav-Heletz-Brur oil field. The methodology for construction of 3D reservoir model and reservoir reserves estimation was based on combined geological, lithological and geophysical data (well logs data, core and small cuttings description and analysis, well testing, seismic surveys and available geological information). The following technological sequence was formulated and applied for construction of 3D reservoir model and reserves estimation:

- Collection of existing data and digitization of well logs.
- Construction of lithological logs on the basis of interpretation of well logs data.
- Definition of reservoir petrophysical properties (lithology, porosity and formation fluid properties).
- Construction of Expanded Composite Logs for oil wells, Lithostratigraphic Correlations and Geological Cross-Sections.
- Construction of Reservoir Structure, Isopach and Porosity Maps.
- Development of the Reservoir Geological Model.
- Estimation of original and remaining hydrocarbon potential at the Kokhav-Heletz-Brur oil field.

In the framework of the work, reservoir analysis of the geological and geophysical data from 88 wells (Heletz field – 42 wells; Kokhav field – 32 wells and Brur field – 14 wells) of the Kokhav-Heletz-Brur structure has been performed.

Detailed geological, lithostratigraphic and petrophysical interpretation was carried out. The result is a 3D geological model of the Kokhav Dolomite reservoir, represented by a set of tables and images (Expanded Composite Logs, Lithostratigraphic Correlations, Geological Cross-Sections and Structure, Isopach and Petrophysical Maps), including:

- Geometry, internal reservoir architecture and lithofacies of the reservoir layers and cap rocks.
- Tectonic blocks, lithological heterogeneity and pinch-out zones within the reservoir.
- Type and spatial extent of reservoir trap.
- Gross and net pay thickness of reservoir layers.
- Spatial distribution of petrophysical parameters (porosity, permeability, pressure, temperature and oil saturation) within the reservoir.

This geological model provides the foundation for establishing principal trapping mechanisms and delineating local distribution of the reservoir and cap rocks.

3D geological model for carbonate reservoir allows construct a comprehensive picture of subsurface geology and estimate reservoir reserves. Reserves estimation for Kokhav Dolomite reservoir was carried out separately for each defined block of the Kokhav- Heletz-Brur oil fields.

Estimation of hydrocarbon potential of Kokhav Dolomite Reservoir at the Kokhav-Heletz-Brur oil fields showed that the remaining reservoir oil reserves are significant (7,459,515 bbl). The use of modern secondary and tertiary oil recovery techniques (steam, water, carbon dioxide and polymer flooding, gas injection and gas lift and other physical, chemical and hydrodynamic methods) can significantly enhance oil recovery at the Kokhav-Heletz-Brur oil fields.

# The Kuchinarai Erosional Cirque – a genuine “Makhtesh” in the Phu Phan Range of Northeast Thailand.

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The Makhteshim in Southern Israel and Northern Sinai, in particular the well-enclosed ones in the Hathira and Hatzera anticlines, are often cited as unique geomorphologic landforms that are not found anywhere else on the globe. In this note I allude to the presence of a virtually identical Makhtesh in the Kuchinarai Anticline, situated in the Phu Phan anticlinorial range in Northeast Thailand.

A “Makhtesh” (Hebrew for “mortar” and “crater”), termed “Breached Anticline” in the geological literature, is a crater or cirque-like landform in which a circumferentially-enclosed depression is situated in the center of an anticline which is ideally drained by a single stream. Genetically, a well-developed Makhtesh is, literally, a Hollowed Out Anticline (“HOA”). It is a rare landscape feature because its genesis requires the co-existence of a rather exceptional combination of a particular set of suitable stratigraphic, lithologic, structural, land-denudation events and paleogeographic circumstances.

The Kuchinarai structure is an asymmetric anticline whose entire core was eroded away to form a large flat-lying oval depression with maximal axes of 31 and 15 kms. The depression is surrounded by steep scarps. Its eastern enclosing walls, build by the Phu Kradung and Phra Wihan formations, are the steepest, reaching heights of 100 to 300 m. The depression is drained by a single ephemeral stream that cuts through its steeper western limb.

The geological attributed and setup in the Phu Phan Range do indeed furnish the concordant existence of all the required circumstances for the formation of a ‘perfect’ HOA: (1) The Kuchinarai structure is a markedly asymmetric anticline. (2) A regional fluvial erosion event at the end of the Cretaceous striped away from the crests of the anticline a circa 2,000 meter thick sequence of the hard sandstone formations of the upper part of the Cretaceous Khorat Group, thereby exposing the underlying less resistance clastics of the Late Jurassic Phu Kradung Formation to intensive erosion. The latter, covered on the rims by the Phra Wihan Formation, forms the lower part of the walls and floor of the cirque. The eroded products were deposited as the Cenomanian to Paleocene clastic Phu Thok Formation that covers the Albian Maha Sarakam evaporites over the entire Khorat and Sakhon Nakhon basins. (3) The paleogeographic (as well as present) location of the regional drainage base level in the southwest induced the formation of a dendridic drainage system inside the depression which coalesced into a single outlet stream that incised its path through the steepest section of the west limb where the strata have their highest inclination (19 degrees) and where the thickness of the rim to be traversed is the thinnest.

# Providing knowledge of sites and phenomena to the public – cellular tour guide, mini-posters and fossils website

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In Israel, hundreds of interesting earth science and historical sites are exposed to the public. During the last few years we developed three different ways to share our knowledge with the public. Most people have cellular phones and therefore we developed an application and a website with relevant knowledge available for each site. We have built a Guide of the Most Frequent Macro-Fossils in Israel. And we also developed simple and colorful mini-posters that can serve as guides for guides and teachers. "Masslulari" - The "Cell-Tour" app and website is designed to be used in the field by providing information (as many other web sites do), but in addition, also provides guiding material and specific suggestions to the traveler's current location. The app provides informative text, illustrations, and images, audio and video explanations. Part of the information about the sites was written by school students from 18 schools from different parts of Israel. The application and website have been running successfully in the past three years in Israel, and more than eighty thousand smartphone users have downloaded the app. The website address: http://www.tourisrael.org.il

"Miniposters" - To disseminate scientific knowledge about the landforms and geologic processes that form the scenery and phenomena observed in the field, we designed and distributed a large set of explanatory mini-posters. These colourful A3 and A4 sheets contain graphic descriptions of natural phenomena complemented by concise explanations that are tailored for a wide audience (from independent hiker to tour guide and even for geology students). To achieve a wide distribution of the mini-posters, they were posted online in the Dead Sea and Arava website - http://www.adssc.org (freely available for download). The miniposters are sold to tour-guides, field-schools and outdoor education centers.

Guide to Macro-Fossils in Israel - The main objective of this project is to provide accessible information on macro-fossils to the general public by a website. The guide refers to the macro-fossils over one centimeter in size, conspicuous on the ground or out of the bedrock. The guide focuses on the fossils most frequently found in Israel. Thus, it exposes the scientific value of fossils, their beauty and their fascinating life environments to a wide audience. The website contains photos and geological background of more than 50 fossils.

# Middle Pleistocene water-bodies in Hiyyon stream dated by luminescence

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Fluvio-lacustrine sediments are exposed around the confluence area of Nahal Hiyyon in the central Negev, in an area located eight km north of the water divide, which separates the streams flowing northwards to the Dead Sea from those flowing southward. The Nahal Hiyyon fluvio-lacustrine sediments gently slope to the north with an average gradient of 1%. Sediments crop out in an area 1.5 by 1.0 km, with maximum thickness of 10 m. The sediments overlie the distal parts of a large abandoned alluvial fan deposited by a stream which drained the Edom Mountains in the east. They are characterized by frequent lithological changes - grey limestone with remains of gastropods, travertine, and grey silt with poorly preserved gastropods and ostracods, conglomerate and coarse sand. On the east there is one meter of green marl that contains quartz grains, flay and fauna remnants. Each sediment unit represents a different environment in a fluvio-lacustrine system. The fossil-rich limestone was deposited in a shallow fresh, low salinity waterbody that drained towards the central Arava valley. The sediments were probably deposited under more humid climate conditions in comparison to the recent extreme aridity.

The two uppermost limestone layers were dated by Kronfeld and Livnat (1987) using U-Th to 178 Ka and 93 ka. New samples were collected from the section and quartz was extracted for luminescence dating. The OSL signal was close to saturation and gave minimum ages of 180-210 ka, however TT-OSL measurements gave much older ages in the range 270-450 ka, indicating a long and probably punctuated period of higher water availability.

# Rotational deformation near major faults: a new mechanical approach for connecting paleomagnetic and geodetic observations

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Vertical axis rotations are a significant component of crustal deformation and provide important constraints on the tectonic history of plate boundaries. Geodetic measurements can be used to calculate interseismic rotations whereas paleomagnetic measurements can be used for calculating long-term (i.e., permanent) rotations accumulated over geological timescales. Here we present a new approach that links these timescales through mechanical modeling. Our methodology involves mechanical modeling of faults at their locked state to simulate the elastic interseismic deformation rate constrained by GPS measurements. We then apply a slip to the faults above the locking depth to simulate the long-term deformation of the crust from which we derive the rotations. We test this approach in northern Israel along the Dead Sea Fault and Carmel-Gilboa Fault System. We use 12 years of interseismic GPS measurements to constrain a 3D slip model of this region. Next, modeled rotations are compared against long-term rotations determined based on new primary magnetic remanence directions from 30 Neogenic basaltic sites with known age. The heterogeneous paleomagnetic results stand in general agreement with the vertical axis rotations predicted by the mechanical model, both showing spatial variations of vertical axis rotations along faults and significant rotations near their tips and bending points. The comparison between modeled and paleomagnetic rotations suggests that the tectonic setting of the Carmel-Gilboa Fault system was fairly stable during the last 6.5-8 Myr. Finally, the new suggested method for connecting interseismic deformation with long-term deformation unravels important insights on the timing, magnitude and style of deformation along major faults.

# Boron Alkalinity in Brines or Why is the Dead Sea acidic?

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Total alkalinity (TA), or acid-neutralizing capacity, is defined operationally as the buffer capacity of water as determined by potentiometric titration with strong acid. The major buffer species in seawater are the bicarbonate, carbonate and borate species that make up 77 %, 19 % and 4% of the TA, respectively. At early stages of seawater evaporation (e.g. lagoons) the dissolved inorganic carbon (DIC) and carbonate alkalinity (CA) of the residual brine decrease considerably due to precipitation of CaCO3 (mainly aragonite), while total boron increases conservatively, becoming the dominant alkalinity species of marine derived brines. Indeed, borate is the dominant TA species in the Dead Sea brine, which evolved from seawater that evaporated in the Sedom Lagoon during the Pliocene. Despite the rather high TA of the Dead Sea (3.826 mmol/kg) the pH of the Dead Sea brine is known to be slightly acidic with a value of ~6.3. In comparison, seawater with the same alkalinity would have a pH value well above 8.3, meaning that H+ activity is 100 fold lower than that of Dead Sea brine. In the present work we assess the apparent dissociation constant value of boric acid (K`B) for the Dead Sea brine and use it to explain the brine's low pH value.

Two independent methods were applied to derive the pK`B in the Dead Sea brine as well as in more diluted brine. One method uses measurements of boron, TA, DIC, pH and the dissociation constants of the carbonate system as extrapolated from earlier work by Sass & Ben-Yaakov (1977). The other method uses boron, DIC and pH measurements and a thermodynamic code and database of Pitzer ion interaction parameters. Both methods yielded nearly identical results showing that pK`B decreases with ionic strength and that K`B in the Dead Sea it is two orders of magnitude higher than in seawater. Similar decrease of pK` as a function of ionic strength was observed previously for the apparent dissociation constants of the carbonate system in the Dead Sea (K`1 and K`2). Furthermore, the values of pK`B and pK`2 in Dead Sea brine are very similar, making the separation between titration inflection points of these two buffer systems, impossible. This implies that for a given pH, the relative abundance of deprotonated species is higher in the Dead Sea brine relative to their abundance at lower ionic strength solutions. Based on the thermodynamic Pitzer model equations, it is suggested that the brine composition is a major factor determining the K`B value, the higher the proportion of divalent cations the higher the K`B values due to formation of complexes with borate. Our data analysis indicates that the pH of the Dead Sea brine is low (despite its high TA) because its salinity is extremely high (TDS = 348 g/L) and divalent Mg is the dominant cation.

# Annual dynamics of dissolved inorganic carbon in the Dead Sea 2013-2014

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Aragonite precipitation in the Dead Sea and in it's precursor, the last Glacial Lake Lisan, are a result of common ion effect induced by mixing of high bicarbonate freshwater runoff with the extremely Ca-rich Dead Sea brine. Due to decrease of inflows to the basin, the recent Dead Sea is precipitating mostly halite. Still, the freshwater inflows that do enter the lake are likely to precipitate small amounts of aragonite. The present work compiles recent and historical field data to yield 20-year mass balance of the carbonate system in the Dead Sea.

During the years 2013-2014, bi-monthly depth profiles of total alkalinity, dissolved inorganic carbon (DIC) and its isotopic composition (δ13C) were conducted in the Dead Sea, from sea surface down to the bottom of the lake (290 m).

The data show high and stable alkalinity throughout the water column during winter, with minor enrichment in the epilimnion during summer. However, when normalized to the quasi-salinity of the brine (σ25=1000*(ρ25-1)), the depth profile becomes uniform with an average alkalinity of 3.824±0.006 mmol•kg-1, indicating that during these years the alkalinity was conservative (no measurable precipitation or dissolution of CaCO3). DIC measurements show no significant variations, yielding normalized average value of 0.860±0.008 mmol•kg-1. However, the δ13C profile shows summer epilimnion enrichment, indicating slight CO2 degassing. This degassing is plausible due to the high PCO2 of the brine. Sample taken on July 2014 had a PCO2 value of 1770±70 µatm.

The data collected in this study was compared to older data sets. DIC and PCO2 measured in this study are similar to those recorded in the deep water of the lake during 1993 (Barkan et al. 2001) while today's total alkalinity is higher and δ13C is enriched. The long-term δ13C change is following the general pattern of enrichment observed in the 1980's (Luz et al. 1997).

A simple mass balance shows that DIC reservoir is shrinking while total alkalinity remains conservative. Together with the observation that during last two decades δ13C increased, the carbonate system data indicate that the main process governing carbon dynamics in the Dead Sea is CO2 loss by degassing and possibly some aragonite precipitation. Other processes such as mixing, respiration and CO2 intrusion from the atmosphere play probably just a minor role in the carbonate system of the Dead Sea.

# The timing of rifting-related magmatism in the Levant margins: U-Pb dating of zircons from the Asher volcanics

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The Levant basin, at the easternmost Mediterranean, preserves a unique record of the continental rifting process leading to the opening of the NeoTethys. The earliest rift-related sequences are deeply buried within the basin, but are accessible by drilling at its margins along the Israeli coastal plain. Three rifting phases, from Early Permian to Middle Jurassic times, were deduced based on subsidence patterns and timing of magmatism (Garfunkel, 1998; Gardosh et al., 2010). A 2.5 km thick mostly basaltic sequence of alkaline affinity, named 'Asher volcanics', was penetrated by the Atlit-1A borehole, and shown to accumulate within a deeply buried fault-bounded basin along the Carmel coast (Garfunkel, 1989). It thus provides convincing evidence for the activation of a Tethyan rift in the Levant. Previous K-Ar and Ar-Ar Jurassic ages of the Asher volcanics were suspected as partially or fully reset by hydrothermal activity (Lang & Steinitz, 1989; Kohn et al., 1993). Zircon, known to attain and retain magmatic crystallization ages, is used here to precisely date the Asher volcanics in Atlit-1A and Elijah-3 boreholes. Rock cuttings of the topmost ~500 m of Asher volcanics were recently recovered from the Elijah-3 borehole, 2 km SE of Atlit-1A, and are first studied and dated here. The volcanostratigraphy of Asher Volcanics in Elijah-3 borehole includes from bottom to top: (1) seriate plagioclase basalt, (2) olivine basalt and (3) dolerite. SHRIMP U-Pb dating of zircon from base keratophyres (Atlit-1A; n=2) and top basalts (Elijah-3; n= 30) indicates that the Asher volcanics erupted in relatively short time interval in the latest Triassic (206 to 204 Ma). Future U-Pb dating of rift-related volcanic sequences in SW Cyprus and S Turkey will test possible age correlation with the Levant and allow palaeogeographic reconstruction of the precursor rift of the Eastern Mediterranean basin.

# Geochemical reactivity of naturally polished carbonate rocks in fault zones

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Fault mirrors are made up of a thin layer (typically thinner than 1 μm) that forms during slip and coats the surface of the fault. This layer gives the fault surface its polished, glossy appearance. Calculations based on the reaction rates for carbonate minerals indicate that such a thin layer should weather away within 1 year of formation. However, the faults are clearly much older than this, suggesting that the polished surfaces are resistant to weathering. However, at present little is known about the reactivity of fault mirrors and their behavior in the environment. In this study, we determine and compare the dissolution rate, dissolution pattern and composition of carbonate bearing faults mirrors. Atomic force microscopy (AFM) dissolution experiments indicate that fault mirrors display significantly lower dissolution rates than the bulk rock. Moreover, dissolution patterns are notably different, exhibiting horizontal peeling of the layer rather than dissolution perpendicular to the surface. Rutherford backscattering spectrometry (RBS) revealed that the layer is 150-600 nm thick and comprises a mix of carbonate minerals and silica, possibly clays and Fe-oxides. The duration of time in which the layer is peeled can be indicative to the rocks environment and climate. We are planning to determine this relation between dissolution experiments and field observations along with the impact of nano structures on weathering.

# Evidence for post-last-glacial maximum punctuated sea level rise found on the eastern Mediterranean coast of Israel

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The eustatic sea level curve for the eastern Mediterranean presents a general trend characterized by rapid post-last-glacial maximum rise (20,000 years ago), slowing approximately 6000 years ago and stabilizing at current sea-level 4000 years ago. Sea level evidence from portions of the Israeli coastline, suggest minimal to no hydro-glacio-isostatic influence on the local relative sea level curve, and no tectonic offsets for at least the past two thousand years. Recently, a submerged series of relict wave cut notches and erosional pits were identified along a sequence of coastal sites located approximately 20km from one another (Olga, Michmoret, Caesarea, Dor) at shallow water depths. The features were carved into an upper-Pleistocene to Holocene eolianite sandstone, the age of which was previously constrained by OSL measurements to MIS 1-3. Elsewhere in the Mediterranean, similar features are widely used as sea-level markers. In this study, at some of the sites, we found a coinciding submerged cliff with overhanging upper part, morphology that is comparable to the morphology of the modern coastal cliff. These submerged features should either suggest a tectonic offset, which is not favorable for the study area, or they might suggest that sea level rise has not been gradual, but rather punctuated, exhibiting pulses of sea level rise followed by periods of sea level stagnation. For the study site, the last stagnation took place at a few meters below current sea-level and enabled the development of the observed wave induced morphology within the eolianite. At present sea level, similar features exist and are being actively formed within the same host rock. At some of the sites, artificially-cut archaeological features from about the last 2000 years present with notches or erosional pits thereby providing insight into the period of time required for their creation due to their archaeological associations.

Sea level rise impacts the coastline significantly, with ramifications ranging from erosion, undermining littoral infrastructure, infiltrating aquifers, and a wide set of issues associated to reshaping the landscape. In the area studied, for example, this manifests itself in the carving of the current coastal cliff into the long-shore eolianite sand dunes. If sea-level rise occurs following a punctuated pattern, preparations for its occurrence are dramatically different on a geographical and temporal scale than preparations for an anticipated gradual sea level rise. For monitoring and conservation efforts, awareness of the nature and timing of sea-level rise will assist in modeling and estimating coastal changes as well as better understanding the morphology of submerged habitats. In addition, these findings contribute greatly to the discussion of whether the eastern Mediterranean experienced tectonic activity during the recent Holocene.

# Modes of Horizontal Deformation from Rotated Rivers: A Case Study from Mount Lebanon

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The Dead Sea Fault System, which is the plate boundary between the Sinai micro plate and the Arabia plate, changes its orientation across Lebanon and forms a restraining bend. A relatively complex suite of tectonic structures accommodates the relative plate motion across the Lebanese restraining bend. Out of which, the Yammouneh Fault, that runs along the strike of Mount Lebanon, is believed to be the main strand that relays deformation from the southern section to the northern section of the Dead Sea Fault System. However, uncertainties regarding slip rates along the Yammouneh Fault and strain partitioning in Lebanon still prevail. Here, we use morphometric analysis together with analytical and numerical models to constrain rates and modes of distributed and localized horizontal deformation along the Lebanese restraining bend.

The rivers that drain the western flank of Mount Lebanon show a consistent counterclockwise rotation with respect to an expected orogen perpendicular orientation. We apply the χ mapping technique to these rivers, which aims at estimating the degree of geometrical and topological disequilibrium in river networks. The mapping reveals a periodic pattern of χ differences across the divides that separate the rotated rivers. We interpret this pattern as indicating that the western Lebanon rivers are in a state of a disequilibrium, where the drainage area distribution and the topology of the network are transient. We further develop an analytical model that relates the river orientation to a set of kinematic parameters that represents a diffused velocity field along the western flank of Mount Lebanon. We find that the velocity field that best explain the present day orientation of the western Lebanon rivers imposes a condition of a combined pure and simple shear. Application of the inferred velocity field in a landscape evolution model results in rotated rivers with a similar χ pattern to that of the natural rivers. Our results indicate that diffused deformation to the west of the Yammouneh Fault takes as much as 30% of the relative Arabia-Sinai plate velocity since the late Miocene, and that the average slip rate along the YF during the same time interval has been 3.8-4.4 mm/yr. Finally, we use the analytical model to explain paleomagnetic rotation in the same region.

# Free energy and temperature dependence of Albite dissolution kinetics

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Quantification and understanding of silicate mineral weathering have important implications for many environmental problems. Yet, except the recent study of Gruber et al., (2014), rate laws for silicate minerals dissolution, which are based on experiments conducted under ambient conditions (close-to-equilibrium, low temperature and acidic-neutral pH), are lacking. The dissolution rates of silicate minerals are very slow under ambient conditions and the change of the ion concentration is lower than the uncertainty associated with measurement. As a result, the uncertainties attributed to the derived dissolution rates are very large causing the rates to be insignificant. In order to overcome these analytical difficulties, dissolution experiments are usually conducted under far-from-equilibrium, elevated temperature and very high or low pH conditions.

Here we present new experimental results of single point batch experiments (SPBE) of albite dissolution in a spiked solution. The novel method that use Si isotopes(Gruber et al., 2013) enables to detect rates that otherwise can't be detected using conventional methods at ambient conditions. Albite dissolution rates were determined under neutral-acidic pH and three temperatures (3.6, 25 and 50 °C) under a wide range of under saturation conditions (ΔGr). The activation energy (Ea) of albite dissolution was found to be identical within uncertainty to the Ea derived from the elevated temperature experiments from previous studies. The dependency of the dissolution rate on deviation from equilibrium (f(ΔGr)) was in agreement with the prediction of the proposed rate law of Gruber et al., (2014) which is based on the stepwave model. However, the value of ΔGcrit was found to be significantly different, suggesting an effect of intrinsic properties of the dissolved mineral sample.

Gruber, C., Harpaz, L., Zhu, C., Bullen, T. D., and Ganor, J., 2013. A new approach for measuring dissolution rates of silicate minerals by using silicon isotopes. Geochimica et Cosmochimica Acta 104, 261-280.
Gruber, C., Zhu, C., Georg, B. R., Zakon, Y., and Ganor, J., 2014. Resolving the gap between laboratory and field rates of dissolution. Geochimica et Cosmochimica Acta 147, 90-106.

# Bottom currents regime along Israeli continental shelf and the upper slope during last interglacial, as inferred from the sedimentological pattern.

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The Israeli continental margins are part of the Nile littoral cell, along which sediments are being transported mainly by cyclonic currents. During the last glacial maxima (LGM), sea level drop exposed the margins to atmospheric erosion. This in turn, left behind an erosional unconformity recognizable on seismic data as the top of a fossilized eolianite (Kurkar) ridge. It is widely accepted that since then, longshore currents which prevail up to 30m of depth, have played a major role in net north sediment transport along the Israeli continental shelf for thousands of years. This transport in turn, is responsible for the gradual buildup of the continental margins by continuous deposition, in accordance with available accommodation space and sediment supply. However, high-resolution bathymetric and recently obtained seismic reflection data, reveal the presence of erosional and depositional processes across the study area, as well as the existence and contribution of bottom (contour) currents, which prevail deeper in the basin. These currents are considered as stable and may last for millions of years, although they may also be driven and affected by short time scale processes and seasonal dynamic instabilities. The present research is focused on the continental shelf and upper slope, where active bottom currents have left behind depositional and erosional features (contourites), which are well preserved in the geological record. Seismic data confirms the presence of four elongated, shore parallel sedimentation zones, between the shoreline up to a water depth of 350m. It seems that bottom currents were acting simultaneously in space and affecting one another, while transporting masses of sediment along and across the entire shelf. During last interglacial, lanes of bottom currents migrated spatially as a result of eustatic, isostatic and tectonic variations, causing lateral migration of the sedimentation zones. Analysis of surficial and subsurface contourites within the zones will be used for reconstruction of sedimentation patterns dictated by bottom current regimes.

# Bathymetry of the Levant basin: interaction of salt-tectonics and surficial mass movements

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A new high resolution bathymetric map of the Levant Basin between Israel and the Eratosthenes Seamount reveals previously undetected folds, faults and channels. The map facilitates a regional map-view analysis of structures that were previously examined only in cross section. The systematic mapping of morpho-structural elements in the entire basin is followed by a kinematic interpretation that distinguished between two main processes sculpting the seabed from bottom and top: salt tectonics and sediment transport. We show that the contractional domain related to salt tectonics is far more complex than previously thought. Ridges, previously interpreted as contractional folds are, in fact, surficial undulations of the seabed reminiscent of sediment waves. Moreover, other folds previously interpreted as downdip contraction of the westward gliding Plio-Quaternary section are, in some parts of the basin, caused by updip climbing of this section eastwards as a result of the regional pattern of salt flow away from the Nile Cone. In the context of sediment transport, we show that the northern Sinai continental slope is covered by a dense net of turbidite channels, whereas the Levant slope has no channels at all. Particularly interesting is the Levant Turbidite Channel, described and named here for the first time. This feature begins at the southeastern corner of the Mediterranean at water depths of ~1100 m, continues along the valley between the Sinai and Levant slopes, and reaches the deepest part of the basin, in water depths of ~2500 m, northeast of the Eratosthenes seamount. However, this prominent feature cannot be explained by the current drainage, consisting of two minor rivers that enter the basin at that point, and thus most likely reflects periods of wetter climate and/or lower sea-level, when these rivers were more active and possibly connected to the submarine channel system.

# A New Bathymetric Grid for the Israeli EEZ: Preliminary Results

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A regional bathymetric map of the Eastern Mediterranean area was previously published in 1994. This map was compiled from all the depth measurements that were available at the time. In recent years a large amount of new gridded bathymetric data was collected offshore Israel within the framework of research and hydrocarbon exploration activities.

The extensive activities in the Israeli EEZ (Exclusive Economic Zone) by oil and gas exploration and production companies, by academia and governmental monitoring agencies requires an up-to-date high resolution bathymetric grid of the EEZ. In this work we present a detailed bathymetric grid of the Israeli EEZ that was compiled from all available data sets, i.e. multibeam bathymetry acquired by IOLR (Israel Oceanographic & Limnological Research) between 2001-2010 as part of the Israel National Bathymetric Survey, 2D and 3D seismic surveys, and by other available single beam bathymetric surveys. In the shallow area (10 to 1600 m below MSL) mapping is primarily based on multibeam sonar. In the deeper part of the EEZ (deeper then 1600 m) mapping is based on 2D and 3D seismic grids and well survey data. The 3D seismic sets used in this work consist of seven adjacent and overlapping seismic cubes. In areas without multibeam or 3D seismic cube coverage, data from 2D seismic profiles was used. The depth to the sea-floor was based on the 'peak' of the first seismic reflection across the 3D cube or 2D profile. When the seismic data was available only in two-way travel time it was converted to depth using the profile of the speed of sound in the water column.

The new grid will be used by governmental ministries, academia and a low resolution version will be available for free downloading. In the following years we plan to update the present grid by new multibeam surveys that will be conducted by the new R/V Bat Galim.

# High temporal resolution of magnetic secular variations: the use of archaeological destruction layers

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Archaeological destruction layers can store the direction and intensity of the geo-magnetic field prevalent on the destruction date. Archaeological materials such as pottery artifacts and clay bricks heated above the Curie temperature by fires, triggered by an earthquake or set by a conquering army, gain a magnetic vector parallel to the ambient at that time. If the destruction layer was sealed by debris or covering layers, artifacts can be found in situ and sampled as oriented, preserving the direction of the magnetic vector.

Knowing the changes in the direction and intensity of the archeo-magnetic field in adequate resolutions may enable the creation of SVC (secular variation curves). These curves, calibrated for the southern Levant and with minimum age uncertainty will, in turn, serve future archeological and environmental studies to constrain conventional dating by an independent and accurate measurement.

We present 28 new directional archeo-magnetic results from well dated archaeological context in Israel that span over the past 3200 years, with a concentration of data from the Iron Age II. The data fit well with the expected from global models with some differences. At two different time points, results from different sites, different researchers and dating methods fit almost perfectly. These examples corroborate the validity and show the potential of the method.

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# Volcanism and Tectonics in northern Israel and adjacent areas

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The breakup of the Arabian-African continent in the late Cenozoic was accompanied by extensive eruptions of basalts on both sides of the opening Red Sea as well as on its floor. While in the southern Red Sea volcanism commenced more than 30 Ma ago (e.g. the Yemen Traps), in our region (at the NW edge of the large A-Shama field) the ages are younger (e.g. < 25 Ma) accompanying in time the tectonic activity along the Dead Sea Transform (which was initiated 18 m.y. ago). Yet, the relation between the basaltic volcanism and the DST are not clear. Only limited volcanism occurred within the rift (e.g. Korazim plateau, Kinnarot valley, El Gahb graben (northern Syria), Karasu valley (Turkey)).

Nevertheless, the dating of the volcanic rocks provides a major tool in establishing the chronology of the Neogene-Quaternary tectonic activity in northern Israel and adjacent areas. A major dating effort was performed at the K-Ar (and later Ar/Ar) laboratory of the Geological Survey headed by Dr. Gidi Steinitz. This comprehensive data set enabled us to date, among others, the tectonics evolution of the Hula Valley (at around 4 Ma), the Kinnarot Basin (at around 12 Ma), the Kinneret (< 1 Ma), the tectonic activity in the Yizre'el Valley, understanding the block rotation at the Korazim plateu, the tectonic activity at the Metulla high, the formation of the continuation of the DST in SE Turkey, as well as other tectonic structures in the area.

We could also observe North-Eastward migration of the volcanic activity.

Thus, the situation of having a tool for direct dating, which is not always common, enabled the much better understanding of the tectonic setting of the central and northern Dead Sea Transform.

# Focal mechanisms in the southern Dead Sea basin and related structural elements based on seismological data

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A dense temporary local seismological network was operated from 10/2006 to 3/2008 in the southern Dead Sea basin also outside the basin within the framework of the DESIRE (DEad Sea Integrated REsearch) project, providing many recordings of local earthquakes. We used the recordings of DESIRE and also the recordings of the permanent networks of Israel Seismic Network, Israel, and Jordan Seismic Observatory, Jordan. We determined high quality focal plane solutions of 490 events, using at least 6 stations (normally >10 stations) with a good station distribution around the epicenters. In the southern Dead Sea basin and adjacent regions there are several clusters of earthquakes. Most of the activity occurred along the eastern bordering fault of the basin, in the Lisan Peninsula and just south and north of it. Along the eastern and western bordering faults we observe mainly strike slip mechanism, probably supporting the left lateral motion along the Dead Sea fault. The nodal planes of many of focal mechanisms inside the basin are parallel to the transverse faults crossing the basin, i.e., Bokek and Ein-Gedi faults, and also parallel to faults that border the Lisan Peninsula on the north-western and south-western sides.

# 1,256 meters inside the earth - observations of seismic activity in the Dead Sea basin using borehole seismometer

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Seismological measurements, conducted at great depths of several hundred of meters or even a few km, can provide useful information that one cannot get while conducting the measurements on the surface. We take advantage of Masada Deep borehole, an abandoned oil well, for the installation of a seismometer at a large depth of 1,256 m. Seismological observations since 1983, using permanent and portable stations, revealed earthquake activity along the Dead Sea fault and its proximity, which is in good agreement with geological observations of young faulting age >)KY 30). The operation of such station will enrich the seismological database with high quality data. The study has a few goals: 1) improving the detection capabilities of small earthquakes in the Dead Sea basin; 2) improving characterization of seismic activity in the Dead Sea basin; 3) better identification of seismic activity on the Dead Sea fault and observe earthquake nucleation and rupture processes in the near field; 4) extending the Gutenberg-Richter of frequency-magnitude relationship of earthquakes into smaller magnitudes below the threshold of the Israel Seismic Network catalog. The borehole seismometer was installed in Dec. 2012. We present seismic observations of small events conducted at a depth of 1516 m, many of them were not recorded by the Israel Seismic Network.

# Chronology for geomorphic processes in the Golan volcanic terrain: Runoff and sediment discharge, River incision and Erosion rates

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The shaping of the Golan Heights landscapes by erosional processes is related to the volcanic lithology, high relief, high seasonal climatic contrasts and long-term high magnitude events.They exemplifymorphological processes in volcanic terrains, which are unique and different from the processes that affect sedimentary terrains.The high topographic gradient- from 1200 m in the Northern Golan to 210 m below sea level in the Kinneret Lake, and the tectonic framework- mainly the Dead Sea transform and related faults determine steep channel slopes and sharp climatic gradient. The volcanic lithology enables radiometric dating for channel incision rates, while the morphometric analysis of the cinder cones determines relative ages and erosion rates for longer periods in dated pyroclastic cones.

Hydrological runoff and sedimentological processes were studied since the establishment of hydrometric stations in the main rivers since 1968. Annual runoff is usually on the order of about 20% of total rain against only 2-5% in a similar climate in carbonate terrains. Peak flows reach values of 300 m3/sec in relatively small drainage areas, such as theMeshushim river (160 km2), asagainst 220 m3/sec in the Jordan river with a drainage area of 1500 km2.

Channel incision: Basaltic river channels are characterized by deep entrenched canyons and 40-50m high waterfalls. Incision rates in the Yarmouk and Orvim channels were studied by Mor (2014) and by the authors in the Hemdal and Saar channels. Values obtained for the channel incision processes were 10-50 cm/ky.

Catastrophic floods are the main geomorphic factor in shaping the landscape. A major flood in January 1969, with a recurrence interval of 1:200 years developed a boulder alluvial fan in the Meshushimriver and a new Jordan delta in lake Kinneret. The annual sediment discharge is about 20 ton/km2, as compared with an average of about 100 ton/km2 for the northern catchments of Israel.

The morphometric index of the cinder cones (the Height/Basal diameter of the cone) and the cone's slope valuedecreases with time due to erosion processes. The obtained index values specifies two main groups of cones whose radiometric age is about 0.6 My for the old group and about 0.1 My for the young one.

# The role of high-density microinclusion fluids in the growth of monocrystalline diamonds

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It is accepted that fibrous diamonds grew from the high-density fluids (HDFs) they trapped as microinclusions. Such fluids are not found in monocrystalline (MC) diamonds, leaving their source of carbon a mystery. Fibrous diamonds carry nitrogen in A centers and are young (106 years), while most MC diamonds carry aggregated nitrogen in both A and B centers and are older (109 years). Weiss et al. (2014) found saline HDFs in the core of a coated diamond from Guinea and carbonatitic and saline fluids in a South African diamond, both with low concentrations of B centers (A/(A+B) of 5-27%). Here we report finding microinclusions with high-Mg carbonatitic, low-Mg carbonatitic, silicic and saline HDFs in MC diamonds. The infrared spectrum of these diamonds confirms their highly aggregated nature (35-85%).

I studied a suite of twinned diamonds, macles, from the Venetia and Voorspoed mines in South Africa. The diamonds were polished perpendicular to their twinning plane and cleaned in HF and HNO3. Twinning planes were identified using cathodoluminescence images in a JEOL JXA-8230 EPMA. Back-scattered electrons and secondary electron images were compared in order to identify shallow, sub-surface inclusions along and next to the twinning planes. When found, the inclusions were analyzed using the EDS detector.

Twenty-eight diamonds were examined in this study. Twenty-four inclusions were found in eight of these diamonds. The inclusions are a few hundred nanometers in size and constitute a small part of the volume analyzed by the EPMA (total oxide content of 0.4 to 3.4 wt %). Compared with the total area and volume examined, the 24 inclusions correspond to a concentration of ~20 ppb of HDF in the diamond. In four Venetian diamonds (ON-VNT 605, 608, 614, 619) the HDFs are rich in MgO, CaO and K2O with lesser FeO and SiO2. This composition is similar to that of high-Mg HDFs from fibrous diamonds. The HDFs from Voorspoed (ON-VRS-630) are rich in Cl, K2O and CaO, similar to saline HDFs. Voorspoed diamond (ON-VRS-627) carries three low-Mg carbonatitic inclusions and a silicic one.

Five microinclusions in ON-VNT-608 and one in 605 carry high concentrations of SiO2, MgO and FeO, with little else. Their compositions fall close to that of orthopyroxene, suggesting that both diamonds belong to the peridotitic paragenesis.

I suggest: 1. The presence of HDFs suggests that the macles formed from HDFs. 2. The macles are clear; some carry mineral inclusions and carry aggregated Nitrogen. They are similar to the rest of the MC diamonds. 3.This suggests that most diamonds grew from HDFs. 4. Most diamonds grew perfectly and trapped no or very few inclusions. 5. Fluids were still trapped in imperfections such as the twinning planes or between the growing fibers in fibrous diamonds. 6. The finding of inclusions in diamonds that reside in the mantle for a long time, as well their presence in fibrous diamonds that erupted in Canada at 2.7 suggest that the composition of diamond-forming fluids has changed little over time.

# Impact of vegetation on biogeochemistry of intertidal and salt marsh sediments of the German Wadden Sea

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Coastal regions are highly productive parts of the Earth biosphere. Tidal flats are unique coastal systems whichharbor different types of sediments, such as permeable sandy sediments with low organic carbon content and cohesive muddy sediments with high organic carbon content. The organic matter is mineralized by a cascade of redox processes depending on energy yields and availability of electron acceptors, mainly oxygen and sulfate. Bacterial sulfate reduction is responsible for 25-50% of organic matter mineralization in coastal marine sediments and results in production of hydrogen sulfide. In this research we investigate the impact of vegetation on the biogeochemistry of permeable and cohesive intertidal sediments. Vegetation may have significant impacts on oxygen and organic matter content and availability in the sediment.

The study site is part of the northwest German Wadden Sea (North Sea). The area harbors permeable and cohesive sediments as well as vegetated and non-vegetated areas. The pioneer zone of the Wadden Sea as well as the salt marsh harbor habitats inter alia of cordgrass (Spartina anglica), sea arrowgrass (Triglochin maritima) and other halophytic plants, including upright glasswort (Salicornia stricta). Sampling was performed at six locations with different sediment and vegetation types: permeable and cohesive sediment non-vegetated (intertidal zone), permeable and cohesive sediment vegetated with Spartina (intertidal pioneer zone), cohesive sediment vegetated with Triglochin (supratidal zone/ salt-marsh) and cohesive sediment vegetated with Salicornia (intertidal pioneer zone). Physical and biological parameters such as grain size distribution and root content were combined with pore-water chemical analyses including hydrogen sulfide (H2S), dissolved iron (Fe2+) and manganese (Mn2+). The results show a correlation between root content and H2S concentrations in the cohesive sediments. H2S concentrations are high at depth where no roots are present. The Fe2+ and Mn2+ profiles correlate negatively with the H2S profiles. In permeable sediment no H2S was found except for a high peak in both locations (vegetated and non-vegetated) around the 10-20 cm bsf depth. The grain size analysis shows relatively high silt content, indicating more cohesive sediment at this depth. No Fe2+ was detected in the non-vegetated permeable sediment samples, except for a high peak at 3 cm bsf. In the permeable sediments covered with Spartina, Fe2+ was found at depth 3 and 35 cm bsf, although in much lower concentrations compared to the non-vegetated sediment. Our results show that vegetation increases the oxygen transport to deep cohesive sediments.

# Reconstructing the shoreline and climate of the ancient maya port vista alegre using marine geoarchaeological methods

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The environmental and morphological history of the ancient Maya port site of Vista Alegre, located along the north coast of Mexico's Yucatan Peninsula, is being investigated within a larger multidisciplinary effort called the Costa Escondida Project. The project's main goals are to learn how the ancient inhabitants adapted to their environment and the changes it underwent through time, as well understand how this coastal site was integrated into broader maritime trade routes. The portion of the research presented here concentrates on the site's geomorphology and climate changes during the past 2-3000 years through a multiproxy analysis of cores and surface samples. This study aids our understanding of the environmental challenges the local inhabits contended with, the site's possible functions and possible ancient harboring locations. Results from the research may make it possible to recognize hurricane proxies in the sediment, locate underwater manmade seafaring artifacts and facilities, determine the range of economic opportunities for past inhabitants and quantify the availability of potable water sources.

# The newly discovered Zalmon Cave can shed light on paleoclimate and paleoseismicity

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In October 2013, while expanding route 65 in the Eastern Galilee, a small opening in the roadcut was found. This opening turned out to be the entrance to a newly discovered speleothem-rich cave, exhibiting considerable amounts of seismites in the form of broken and re-welded stalagmites, fallen stalactites embedded in flowstones, portions of collapsed cave ceiling and cracks in the cave walls. These findings suggest that the cave has endured numerous seismic activities throughout its geological history, most likely due to its relatively close proximity to the Dead Sea Fault, merely 5 km from Lake Kinneret. Speleothems have long been used to gain better understanding of paleoclimate and paleoseismicity in our region. Using U-Th dating methods, various speleothem laminae can be dated quite accurately. Alongside the dating, stable isotope values (and) can be measured. The combination of these methods can provide information about both "what" and "when" in attempts to reconstruct paleoclimate and paleoseismicity. The proximity to Tiberias enables comparison and calibration with historical documents from the last two millennia. From a paleoclimate point of view this cave is located in the Dead Sea catchment which will enable comparison with Dead Sea lacustrine records and other speleothem records. Alongside the ability to correlate the stable isotope profile with previous results, both locally and globally, our study offers an unprecedented opportunity to date the frequency of earthquakes through the mid- to late-Quaternary and try to assess their magnitude.

# Multiple sulfur isotopes fractionations associated with abiotic sulfur transformations in Yellowstone National Park hydrothermal springs

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We present a quantification of main (hydrogen sulfide and sulfate) and intermediate, (zero-valent sulfur (ZVS), thiosulfate, sulfite, thiocyanate) sulfur species in hydrothermal springs and pools of the Yellowstone National Park (YNP). We combined these measurements with the measurements of multiple sulfur isotope composition of sulfate, hydrogen sulfide and zero-valent sulfur. The main goal of this research was to reveal multiple sulfur isotope fractionation in the system, which is dominated by complex, mostly abiotic, sulfur cycling. Water samples from six springs and pools were sampled. Spring and pools were characterized by pH, chloride to sulfate ratios, sulfide and intermediate sulfur concentrations. Concentrations of sulfate in pools indicate either oxidation of sulfide by mixing of deep parent water with shallow oxic water, or surface oxidation of sulfide with atmospheric oxygen. The $\delta^{34}S$ values of sulfate in four systems were found to be close to those calculated using a mixing line of the model based on dilution and boiling of a deep hot parent water body. In two pools, $\delta^{34}S$ values of sulfate differ significantly from the values calculated by using this model. Sulfur isotope fractionation between ZVS and hydrogen sulfide was close to zero at pH<4. At higher pH, zero-valent sulfur is slightly heavier than hydrogen sulfide due to equilibration in the rhombic sulfur – polysulfide – hydrogen sulfide system.
A limited number of studies were performed on multiple sulfur isotope fractionation during sulfate reduction, sulfur disproportionation and sulfide oxidation. Multiple sulfur isotope fractionation during abiotic sulfur cycling in natural aquatic systems was not studied, and thus its importance was neglected in previous studies. Triple sulfur isotope ($^{32}S$, $^{33}S$, $^{34}S$) fractionation patterns in waters of hydrothermal pools are more consistent with redox processes involving intermediate sulfur species than with bacterial sulfate reduction. The difference between $\Delta^{33}S$ values of sulfide and sulfate are positive for microbial sulfate reduction and are slightly negative or slightly positive for microbial sulfur disproportionation. In our work, the isotopic composition of sulfur species of only one system fits the predicted range of values for microbial sulfate reduction. None of the isotopic compositions fit experimental data for microbial sulfur disproportionation. Thus, we suggest that a combination of (a) difference in $\delta^{34}S$ values of sulfide and sulfate that is too low to be interpreted as microbial sulfur disproportionation (≤10‰), and (b) difference in $\Delta^{33}S$ values of sulfide and sulfate that is too low to be interpreted as microbial sulfate reduction (≤ 0.00‰), may serve as an indicator for complex abiotic transformations of sulfur species. Implications of mass-dependent multiple sulfur isotope fractionation by abiotic sulfur cycling for the understanding of biogeochemical processes in the sulfide-rich Proterozoic ocean will be discussed.

# Reconstructing a holocene earthquake record in the northern gulf of aqaba-elat from submarine cores

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We aim to augment the Holocene tectonic record of the Northern Gulf of Aqaba-Elat (NGAE) by identifying and dating evidence for seismically induced submarine mass transport in offshore cores from across the NGAE.

Marine sediment piston cores retrieved from the NGAE were profiled for grain size, demonstrating discrete anomalies suggested as representing sediment reworking events. 14C age constraints of these anomalies in the offshore core P27 (530 mbsl) coincide with paleoseismic trenching observations of surface rupture on the on-land Avrona Fault nearby. These observations coincide in time with the historically documented earthquake which destructed the township of Aqaba in 1068 AD, and the 1458 AD historic earthquake.

Following the grain size anomaly pattern of P27, we further suggest that other grain size anomalies dated in this core, as well as in other cores from across the NGAE, create a set of dated anomalies coinciding in ages, yielding an age correlation between anomalies in different cores. Identifying and radiocarbon dating the anomalous events in cores P27, P12, P17, P22 and P29, which demonstrate independent validation for the tectonic/seismic origin of sediment reworking events which they represent (versus local sediment disturbances e.g. sporadic slumping), we suggest a reconstruction of Holocene (and even late Pleistocene) earthquake record for the Northern Gulf of Aqaba-Elat, dating back to ~14 ka.

# Correlation of Shape and Size of Buoyant Methane Bubble with Mechanical Properties of Fine-Grained Muddy Aquatic Sediment: Numerical and Analytical Modeling

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Shallow gassy sediments contribute to destabilization of aquatic infrastructure, air pollution, and global warming. In the current study a precise shape and size of the buoyant mature methane bubble in fine-grained muddy aquatic sediment is defined by numerical and analytical modeling, their results are in a good agreement. A closed-form analytical solution defining the bubble parameters is developed. It is found that the buoyant mature bubble is elliptical in its front view and resembles an inverted tear drop in its cross-section. The size and shape of the mature bubble strongly correlate with sediment fracture toughness. Bubbles formed in the weaker sediments are smaller and characterized by a larger surface-to volume ratio that induces their faster growth and may lead to their faster dissolution below the sediment-water interface. This may prevent their release to the water column and to the atmosphere. Shapes of the bubbles in the weaker sediments deviate further from the spherical configuration, than those in the stronger sediments. Modeled bubble characteristics, important for the acoustic applications, are in a good agreement with field observations and lab experiments.

# Submarine landslides and fault scarps along the eastern Mediterranean Israeli continental-slope

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The present work maps and studies the continental slope off the southeastern Mediterranean Israeli coast. A 15 – 50 m/pixel bathymetric grids were used to map over four hundred submarine landslides and numerous fault scarps exposed on the sea floor.

Landslides are found at water depth ranging between 130 m to 1100 m, where slopes exceed a critical gradient of about 4°. Their surface areas range from 0.0024 to 91 square km. Landslides show a hierarchical pattern, resulting from sequential slope-failure events. landslides are also observed to interact with a group of faults oriented sub-parallel to the coast. These Faults are a result of salt tectonic related extension, their scarps forming elongated step-like morphological features rupturing the surface of the continental slope and as well as the deeper sea floor. Scarp heights are up to 70 meters and the slopes within the scarps are up to 20°.

The morphology of the landslides as well as their cross cutting relation with the faults scarps, suggest that these landslide are recent, apparently younger than 50,000 years. The triggering mechanism is not clear yet, though several conditions which are known to promote slope instability prevail in the studied area: submarine slope gradients are close to the critical slope angle; continuous sedimentation increases the load on the slope; active salt tectonic results in an overall extension and surface rupturing by normal faults; the studied area is at a range of about 50 km from seismogenic zones; and finally apparent existence of gas close to the surface. Hence, it is suggested that submarine slope failure events in the studied area are also possible in the future.

# Garnet pyroxenites as markers of recurring extension and magmatism at the rifted margins of the Levant basin

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The Cretaceous within-plate magmatism of the Levant ended with underwater eruptions of alkaline basaltic tuff (97-82 Ma) at the edge of the Arabian continental shelf in Mt. Carmel, northern coastal Israel. The pyroclastic horizons contain a suite of garnet clinopyroxenite xenoliths, otherwise rare across the Arabian plate. Clinopyroxenites of magmatic and metamorphic textures include pyrope-rich garnet, augite and spinel. Kelyphitic rims of micron-sized orthopyroxene, anorthite and spinel, are chemically identical to the parent garnet. The coexistence of garnet and spinel indicates crystallization at T = 1100-1200°C, P = 13-15 Kb. Modeling of REE contents shows that the pyroxenites could not have formed as residues after melting of subducted mafic rocks, but rather as cumulates by 1% fractional crystallization of OIB- like melts. Oxygen isotope ratios are within the mantle range [$\delta^{18}O$ Grt = 5.31 ±0.22‰; $\delta^{18}O$ Cpx = 5.18±0.34‰] and also indicate pure mantle origin with no crustal contribution to the source. Nd and Hf isotope ratios plot on the evolution line of the Arabian sub-continental lithospheric mantle considered to form by a late Neoproterozoic asthenosphere plume head. Nonetheless Sm-Nd and Lu-Hf whole rock isochron ages are 306±8 and 197±13 Ma, respectively, and may represent heating and/or metamorphism. The Carmel garnet pyroxenites crystallized from OIB-type melts in the uppermost mantle prior or during early Mesozoic rifting. Some recrystallized due to later metamorphism. Prior to entrapment by ascending magma the pyroxenites decompressed to lower crustal conditions and were partially granulitized. Garnet pyroxenites record recurring episodes of extension and magmatism along the Arabian rifted margins.

# The potential of radionuclide pollution resulting from interaction between spent fuel products and various rocks of Mt. Scopus Group; experimental study

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Constructing an electrical nuclear power plant requires the regulator to attain a safe long term disposal scheme of its associated spent fuel waste. Although geological disposal is considered as the least hazardous path way for spent fuel disposal, potential leakage of radio-nuclides from buried spent fuel, still pose risk for the long term run. This study aims to explore the interactions between carbonate bearing rocks from Mt. Scopus group with artificial rain water containing radionuclide (or simulated spikes) that are relevant to spent fuel from electric power plants, by means of experimental study. The experiments were conducted using the "single point batch experiments" (SPBE) methodology. Synthetic rainwater spiked with 9-16 ppm U, Cs or Ce (as a surrogate for actinide with variable redox states), were used as the interacting medium with five rock types. Chalk and marl from the Mt. Scopus Group were sampled via boreholes at a depth relevant to a geological disposal site. Three of the rocks display elevated TOC of 3-10 wt%. In order to study the role of surface area, each rock type was tested at three size fractions: 200-400 micron, 0.5-1 mm and 2-3 mm.

For each experiment, rock fragments were brought to equilibrium with synthetic rainwater solution and only then one of the spike contaminants (U, Cs or Ce) was added. The experiments took place in a rocking bath held at a constant temperature of 25 ºC. The testing tubes were sampled immediately after doping and then consequently 1, 2, 4, 8, 16 and 32 days after doping. For each tube, the solutions were separated and the pH was measured. The general chemistry and specifically, the spike concentrations were analyzed.

Initially, the addition of the dopant caused a pH change of up to one pH unit from the initial pH (8-8.4). However, in most cases the initial pH was regained by the end of the 32 experimental days. For all rock types, Ce concentrations dropped down from an initial value of 9 mg/L to below 50 µg/L immediately after the Ce addition and to an even lower value (1 µg/L) at day 8. The initial Cs concentration was 16 mg/L and after 32 days only 10-20% of the initial Cs was adsorbed to the rock fragments. Similarly, the initial U concentration was 10 mg/L and only 10-20% of the initial contaminant was adsorbed to the rock fragments. A slight difference in the adsorption of U was observed between rock types. Organic matter rich rocks adsorbed more than the organic free rocks.

This research provides a tool that will allow predicting the type and extent of reactions in the event of radionuclide migration from the geological disposal into the surrounding rock formations.

# 3D Seismic Geomorphology and Evolution of Deep-Water Channels from the Levant Basin-Floor, Offshore Israel

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New 3D pre-stack depth-migrated seismic reflection data from the deep Levant basin reveal two end-member morphological styles of submarine channels: (1) low-sinuous, narrow channels, and (2) deeply incised systems with moderate- to high-sinuosity channel axes. Interpretation of the channels focuses on their incision depth, long-profile gradient, channel-axis sinuosity and crosscutting relationships. In particular, on their involvement from initially straight to highly sinuous, wider and deeper incised channels. Evolution of submarine channels is dictated by external factors such as tectonics and climatic fluctuations as well as autogenic factors (sediment supply and bottom currents). Initial results suggest that this deep-water complex extends in south-north direction from Wadi El-Arish and has existed since a transition from basin-floor to slope deposition (since the Late Pliocene?). Modifications in the sediment supply from the Nile River and Wadi El-Arish during this period as well as bottom currents may explain the patterns observed in the data.

# Local Fault Structures from Directivity Analysis of Small Earthquakes at the San Jacinto Fault Zone

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We implement a time-domain tool for analyzing rupture directivity of small earthquakes to reconstruct local fault structures and dominant source mechanisms at the Trifurcation area of the San Jacinto Fault Zone (SJFZ). Three local aftershock sequences of the Mw 5.2 June 2005, Mw 5.4 July 2010 and Mw 4.7 March 2013 events, with an overall magnitude range of M 1 - 5.4 are used, allowing a high resolution multi-scale study. In this time-domain directivity tool, peak amplitudes of S body waves are corrected for hypocentral distances, and analyzed statistically to find the Azimuth of maximum amplitudes. The tool requires local hypocentral distances of up to 80km, and a relatively dense and even coverage of seismic stations. In order to make this tool more robust we added several requirements, including analysis of the three components: vertical, radial and transversal, searching for those events in which we get a good agreement between the radial and transversal components, in determining the rupture directivity. This analysis shows clearly several groups of events, each group with a dominant directivity. In order to quantify these groups, we applied cluster analysis according to two main parameters: a) the azimuth of the rupture directivity, and b) the distance between the events; the resulting clusters are approximated as 3D patches, with dominant directivities. Analysis of peak amplitudes, together with directivity-oriented cluster analysis, provides a fast and reliable tool for revealing fault structures, for small events in which focal mechanism techniques fail. In addition, we reconstructed possible fault structures from the recent tomography of the Trifurcation area of Allam et al. (2014). Using the velocity and velocity gradients of the 3D tomography, we examine and show fault structures in which the directivity reflects the velocity contrast across the bimaterial interfaces of local fault structures.

# 3D Seismic stratigraphy of the post Messinian Levant margin- Preliminary results from seismic interpretation

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Post Messinian stratigraphic development of the Levant continental margin is dictated by the interplay between vertical tectonic motion, eustatic sea level variations and the rate of sedimentation. Studies have shown that during the Plio-Pleistocene all three components experienced considerable modifications – accentuated land topography developed alongside enhanced sediment supply from the Nile River. Expression of these modifications across the sedimentary sequences was previously examined based on 2D seismic reflection data. Here we re-examine these sequences through interpretation of a 3D pre-stack depth migrated seismic reflection volume located across the Levant margin. Data show two main sedimentary patterns – aggradation across the Pliocene succession which fills Messinian erosional topography and turns into basinward progradation throughout the Pleistocene. Our results indicate that dynamic equilibrium between subsidence and sediment accumulation during the Pliocene was breached during the Pleistocene, when sedimentation intensified in comparison to vertical subsidence.

# Archaeoseismology: Tracing historical earthquake date by pollen seasonality in tel Yavneh

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The identification of historical events with physical evidence (archaeological and geological) is often ambiguous and non consensual, undermining the enormous potential for sub-annual precision and accuracy in dating. The ruin of a ceramic factory in Yavneh, considered one of the largest of its kind in the Middle East at Byzantine times (4-7th century CE), exemplifies this: aligned fallen walls and columns and a kiln that collapsed while still in operation, with dozens of ceramic storage jars in articulation. The archaeological dating, which constrains the time of the collapse to the 7th century CE, cannot distinguish between two earthquakes that happened during this interval. Here we analyze for the first time pollen, trapped by collapse, to rule between the two candidate earthquakes: the pollen, indicating spring blooming, rules for the June 659 CE earthquake over the September 634 CE one. The source location of this earthquake is unknown. Paleoseismic records from the Dead Sea Fault, some 70 km east of Yavneh, show that it is the most likely source. However, a few minor epicenters located to the Judean Foothills by modern seismometers indicate that other sources should not be precluded. Moreover, these results carry significant implications related to the broader issue of the decline in the Palestinian wine trade after the Byzantine domination, given the fact that much of this wine was transported in commercial storage jars of the types produces at Yavneh.

# Landscape Evolution of the Judean Desert; the Ze'elim Basin case study

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The drainage system of the Ze'elim Basin was chosen as a case study aiming to analyze the evolution of the southern sector of the Judean Desert. This 260 km2 basin is the second largest (after the Hemar basin) in the Judean Desert.

Three generation of terraces were found along the present Ze'elim channel, indicating gradual incision of the Ze'elim valley. Mapped in the region between the Ze'elim headwater and the downstream Ze'elim canyon, these terraces are elevated as much as 0-10, 25-35 and 95-105 m above the current channel. Age estimations for these terraces are in the range 70- 20 ka for the lowest to more than 1 Ma for the upper surface.

An alluvial terrace of 50 m width and 4-6 m thick was found at an elevation of 560 m a.s.l at the water divide between the Ze'elim basin and the upper Be'er Sheva basin in the eastern Arad Valley. The alluvial section contains several beds with a bi-modal grain size distribution in the range 0.5 - 60 cm. The clasts consist of a polimictic lithological assemblage of limestone, chert, quartz sand and allochtonous chert derived from the Hazeva outcrops, which are widespread in the Arad nearby hills. To the northwest of the first outcrop additional fluvial deposits were mapped at elevations of 520-565 m a.s.l. These outcrops are located along the main water divide between the Mediterranean and the Dead Sea.

Based on this evidence it is apparent that during the Quaternary there was a significant change in the drainage pattern located near the present main water divide between the Arad Valley and the streams draining toward the Dead Sea. Hereafter we aim to reconstruct the evolution of the Ze'elim basin in order to uncover its morphotectonic history as an indicator of the evolution of the southern Judean Desert.

# Quantifying micron-scale grain detachment during simulated carbonate weathering experiments

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Weathering in carbonate rocks is often assumed to be governed by chemical dissolution. However, mechanical processes can also contribute to carbonate weathering by fracturing the rock into smaller fragments. Furthermore, at the micron scale, small grains can undergo partial dissolution followed by detachment from the rock surface, accelerating overall weathering rates. Although this process could be crucial for the understanding of carbonate weathering at the global scale, the role played by grain detachment is poorly understood. To quantify the contribution of grain detachment to surface retreat rates, and to determine the impact of the flow regime, we carried out a series of simulated weathering experiments on micritic limestone. Using atomic force microscopy, we obtained high resolution in situ data of surface topography for reacting rock surfaces. In all the experiments, both grain detachment and chemical dissolution were observed. However, in the laminar conditions we explored we found no clear correlation between the flow rate and detached grain size, or between the flow rate and the frequency of grain detachment events. Importantly, our results establish that grain detachment contributes significantly to the overall surface retreat, on average accelerating mass loss by 38 ±16% (1σ). In addition to speeding up weathering, the mechanism could also influence the evolution of porosity in aquifers and hydrocarbon reservoirs, and provide a natural flux of colloids that could transport heavy metals or radionuclides.

# Dissolution and precipitation of salts in the late Quaternary Dead Sea from porewater brines in the Dead Sea deep core

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Porebrines extracted from a 456m core, drilled at the deepest floor of the Dead Sea at a water depth of 300m comprise the lower Dead Sea brine mass, showing its evolution over the past 220kyr (several interglacial-glacial cycles). The records of the conservative dissolved ions: $Br^{-}$, $K^{+}$ and $Mg^{2+}$, provide a unique archive illustrating lake volumetric changes as a result of variations in the Levant hydroclimate. Conservative ions became diluted and concentrated as a result of positive or negative net freshwater influxes into the Dead Sea; corresponding to glacial and interglacial periods respectively. There is a continuous independent evolution of the conservative ions in comparison with salinity, Na+, and Cl- records, and a strong correlation ($R^2$=0.91) between the conservative ions and the Na/Cl ratio, suggesting that the salinity was buffered as a result of precipitation and dissolution of halite (NaCl). During periods of lake brine dilution (e.g. glacial periods) the salinity of the lake had seemingly been buffered by dissolution of halite, while during interglacial periods the lake salinity was buffered by the precipitation of halite. Only during the last glacial period had the lake diluted to an extent which caused a decline in salinity; becoming undersaturated with respect to halite in spite of an apparent continued accumulation of dissolved NaCl. An estimate for the rate of dissolved NaCl accumulation in the lake between 45 to 15kyr, based on porebrine concentrations, was found to be $7.2 \bullet 10^{12}$ ($\pm 0.2 \bullet 10^{12}$) mol/kyr; quantitatively adding ~35% of Na+ and ~15% of Cl- relative to initial concentrations at 45kyr. Independent estimates for the rate of dissolution of the Sedom diapir cap, based on of an exposure rate of 3-4mm/yr, were $2 \bullet 10^{12}$ – $3 \bullet 10^{12}$ mol/ky respectively. Based on these calculations the dissolution of the Sedom diapir cap over 45 to 10kyr would have provided around ~30-40% of the total quantity of NaCl added into the lake.

# The impact of climate change compared to land use changes on runoff regime in upper Meshushim basin, Golan Heights.

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The Golan is a volcanic plateau area of about 1000 km2. It is characterized by basalt surfaces of different thicknesses that are dissected by creeks and valleys creating landscape with a variety of natural habitats. Like other regions the Golan is subjected to climatic changes, and intensive land use changes. The rate of grasslands conversion in the Golan Heights is approximately 2000 Dunam/year, and the forecast for the upcoming years an additional conversion of about 40,000 Dunam of natural areas to agricultural croplands. During the past three years ,since the 2011-2012 winter, we conducted a study to examine the effects of environmental changes, namely climatic and land use changes on the biotic (vegetation, mammals), and abiotic factors (rain-runoff ratio) in the central Golan.

The study focuses on two drainage basins in the central Golan, the Upper Meshushim and the Adi catchments. The two catchments have similar characteristics in terms of lithology but are different with respect to land use. Upper Meshushim catchment starts at the western slopes of Mount Avital until the point of Fachora near Kidmat Tzvi settlement. The area of this catchment is approximately 15 $km^2$ and it is characterized by natural open space of which approximately 6% are agricultural lands. The Adi catchment begins approximately 1 kilometer southwest of Naphach camp, and converges with the upper Meshushim stream near the north junction of Katzrin ( area ~ 5.5 $km^2$) of which approximately 30% are agricultural lands. The objective of the study is to compare the changes in rain runoff ratio, in the two drainage basins since the 1960s to today. The hypothesis of the study is that, if there are changes in rain runoff ratios, the environmental changes will be expressed by the rainfall-runoff ratio: If the ratios change in a similar manner in both catchments, then climatic changes are argued to be significant. If the ratios changes over time differentially between the catchments then land use changes are argued to be significant. If there are no apparent changes from 1960s compered to today in both basins, it is suggested that environmental changes are not reflected in the flow regime.

Analysis of the flow regimes indicates that there are differences in rainfall-runoff ratios between the two catchments: In the Upper Meshushim catchment the runoff ratio remains similar between the late 1960's once compared to the 2012-2014 period. In contrast, the Adi catchment shows a decrease in the runoff ratio during the same time frame. Therefore we conclude that land use is the dominant factor affecting system dynamics, and specifically in this case the conversion of grasslands to agricultural areas.

# Petrophysical core-log characterization of the Northern Dead Sea Basin: lithological reconstruction at the ICDP site 5017-1A

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Downhole logging profiles were examined in well 5017-1-A of the ICDP deep borehole in the Dead Sea. The study includes the total and spectral gamma-ray, acoustic impedance, sonic velocity and magnetic susceptibility measurements carried out along the 450 (m) deep borehole. Integration of a qualitative method has been applied in order to generate a generic lithofacies classification from a combined set of logs. When calibrated with the core lithological descriptions, the outcome provides a continuous vertical lithofacies distribution and offers a continuous subsurface record over potentially missing interval gaps. Additional information from core analyses will be examined to help understand the response of petrophysical data in a mixed carbonate-silisiclastic environment and their accuracy as lithofacies predictors.

Results show a high variability of spectral gamma ray radiations (3 to 40 API) and correlative radioactive elements associated with lithological and geochemical differences. Detailed petrophysical properties of selected high (SGR) values and potassium (K), uranium (U) and thorium (Th) content are respectively correlated with greatest clay fractions concentrations. Measurements of acoustic impedance (R) and sonic velocity (Vp) logs obtained in evaporitic rich sections such as those found during MIS 2/1 (Lisan-Zeelim transition), mainly support precipitation/deposition of halite rocks. Sonic and acoustic impedance peaks are suggested to indicate carbonate-dominated intervals or a gradual increase in the energy of the depositional environment. Facies analysis allowed the characterization of four main logfacies: (1) Lacustrine mudstones; (2) Mass flow deposits; (3) Evaporites and (4) Heterolithic/carbonate-rich. The analyzed facies in 5017-1-A borehole show a siliciclastic/evaporitic distribution in the section obviously correlated to the core description and confirm the integration of petrophysical record as proxy for lithological reconstruction. These results can be useful as a basis for identifying Transgressive-Regressive facies cycles in the sequence stratigraphic framework of the Dead Sea Basin.

# Characterizing and timing the latest submarine slides offshore Israel

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Evidences of recent local tsunami events, hitting the Mediterranean coast of Israel in correlation with inland Dead Sea Transform earthquakes, imply recent triggering of submarine slides on the continental slope. However, the actual mechanisms involved are not specifically constrained by observations. This study focuses on interdisciplinary examination of slide tracks on this slope, and identification and timing of recent most ones. We delineated the evolutionary trends of slide tracks based on spectral decomposition of a combined multibeam and 3D seismic seafloor picking, and their correlation with existing seismic profiles. A particularly prominent ~7 km wide and ~60 m high slide scar at ~450 m water depth opposite Ashqelon, associated with a generally >10 m thick depositional lobe stretching ~35x10 km, is suggested to represent a recent sliding event based on its rough bathymetry and cross cutting relations. We acquired a set of multichannel high resolution (0.5 to 2.5 kHz) sparker seismic profiles, totaling ~500 km, across this slide and the neighboring region. The slide surfaces are characterized by diffractions, implying sharp contacts occur <0.5 m below the seafloor. In contrast, neighboring diffractive slide deposits are covered by up to several meters of layered sediments. Also, a specific sedimentary layer consistently coalesces with, and appears to constitute, the basal detachment surface of this slide. Comparative sets of a box core and two to three approximately co-positioned ~5 m long piston core samples were extracted onboard R/V Shiqmona, with USBL precise positioning, from each of three sites: 1) undisturbed slope (PSL), as a reference; 2) presumably exposed head scar (PHS); 3) tail of the depositional lobe (PTL). Our working hypothesis is that sliding offsets and resets short-term structural geochemical and sedimentary time-dependent indicators in the vicinity of the newly exposed head scars, which can serve as timing markers of the last sliding event. A set of box and piston core from each site was sliced onboard under anaerobic conditions and pore water was extracted, and then passed for sedimentological and mineralogical studies. A separate set of cores was preserved for not-invasive petrophysical and CT scans, and then passed for laboratory measurements of physical parameters. Preliminary scanning results reveal low densities (~1 g/cc) and a regularly layered sedimentary structure throughout the PSL cores. In contrast, ~50 cm below the top of PHS there is a pronounced (~20%) increase in the density, accompanied by a clear change of the sedimentary character and intense borrowing. The measured geochemical profile values at PSL, and

the reduction profiles gradients at PHS differ significantly from the other cores. Based on the published sedimentation rates for the slope of ~1 m/ka and preliminary modeling of the geochemical profiles we suggest that the slide's age is <1 ka, and more probably ~500 years.

# Morphotectonic Changes in the Lower Jordan Valley during the Late Holocene

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The Jordan River (JR) exists since the Late Holocene and runs through the Jordan Valley Fault (JVF) from Lake Kinneret (LK) to the Dead Sea (DS). The river changes its course constantly as a result of climatic, anthropogenic, hydrological and geological factors. For most part, the river runs through the official Jordan-Israel border and prevents extensive fieldwork and close-up inspection of the river geomorphological features. Since the beginning of the 20th century, many maps and data along the JR have been accumulated and provided a good platform for high resolution analysis of the river basin. In this research we report first efforts in characterizing and studying spatial and temporal changes of the JVF basin during the last 30 years using aerial photographs, GPS data, historical maps, sub-terrestrial gravity data, and geological and structural maps. By GIS processing, we show first results of differentiating the influence of tectonics from hydrological and anthropogenic factors towards quantifying morphotectonic features that are seen in the JR basin.

# Ocean-ocean subduction and the initiation of oceanic core complexes: a conceptual model

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Analog structural experiments and numeric models emphasize repeatedly the significance of two parameters that are critical to the initiation of subduction – the density contrast between two juxtaposed lithological slabs located across a lithosphere-transecting fault, and the friction between them. Other parameters, such as viscosity or temperature, would probably affect the rate of the tectonic process as well. The experiments demonstrated that contrasting lithospheric densities would rotate the entire contact plane until the denser slab would be driven under the lighter one. The rate of penetration would be determined primarily by the friction between the slabs, but the style of deformation of both slabs, once their motion started, would be constrained by metamorphic processes affecting the down-going plate, changing its mineralogy, petrology and density.

While many subduction zones develop between oceanic and continental lithospheres, where the contrast in physical properties between the facing slabs is obvious, subduction processes also occur where transform faults juxtapose oceanic lithospheres of different densities, temperatures and ages. A slow spreading ridge would be a favorable site for such initiation of subduction because the slow rate could juxtapose lithospheric slabs of considerably different physical properties across transform faults. As the denser slab is driven under the lighter one, it would enter domains of increasingly higher temperatures and pressures, which could cause two types of mineralogical metamorphism that would depend on the availability of water. The basalt and gabbro of the oceanic crust undergoing subduction would produce either peridotites and eclogites under dry conditions, or serpentinites in wet domains. While the dense eclogites would drive into the asthenosphere, the light serpentinites would flow up through available zones of weakness. The diapiric flow of the serpentinites could carry along blocks of peridotites, enabling the intimate ophiolitic co-occurrence of these two diverse lithologies in core complexes on land and at sea. Consequently it seems that ocean-ocean subduction could take place across transform faults, even along mid-ocean ridges, provided that the density contrast between the juxtaposed slabs is large enough to generate thrusting, and serpentinites would develop early in the process to reduce friction. Such processes would account for the occurrence of various serpentinites and peridotites in oceanic transform valleys.

# Deposition, removal, and burial of flash flood deposits in the Gulf of Eilat- Aqaba

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The Gulf of Eilat-Aqaba is surrounded by a hyperarid desert that is subject to ephemeral flash floods, which can damage infrastructure and endanger lives. The historical frequency of flash floods in the region has been poorly documented, so anticipation of future risks posed by floods is largely speculative. Because of scarcity of vegetation in the catchment areas, flash floods entering the Gulf of Aqaba carry enormous quantities of fine suspended sediment, so incoming flood water is denser than the receiving waters in the Gulf. These marine hyperpycnal flows leave distinctive sedimentary deposits on the shallow seafloor at the head of the Gulf. The objectives of this study are to quantify the time evolution of flow properties and sediment deposition during flash floods, to explicate the post flood mechanisms and dynamics for the removal of deposited flood sediments from the shelf, and to determine how frequency and intensity of flooding affects the preservation potential of flood deposits on the shallow seafloor. These research objectives will be addressed with a multi-component sampling strategy. One set of measurements, which will be triggered by forecast of flood events, will gather short time series of the vertical structure of the water column density, velocity, and total suspended solids (TSS) before, during, and after a flood. A second set of measurements will include a 16-month bi-monthly survey of flood deposit properties, nearbed flow velocity, and TSS. Additionally, seasonal surveys (tri-monthly) of water column density structure and TSS will be carried out. Samples will be analyzed for grain size, calcium carbonate, foraminifera assemblages, and element composition. Finally, continuous time series of temperature, tides, and salinity will be constructed from the national monitoring program data and a measurement station established at the site. Another component to the study will be analyzing the presence of microscopic particles of plastic (diameter < 5 mm) in flood samples compared to non-flood samples. This research will help determine if proxies can be identified and used to indicate modern flash floods on the shallow seafloor, and if these proxies can be applied to reconstruct a historical record of the frequency and magnitude of flash floods from deep sediments in the Gulf of Aqaba.

# Biological shifts and their influence on the amount and type of deposited organic matter as evident in the Upper Cretaceous high productivity sequence in the Shefela basin, central Israel

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The complexity of organic matter (OM) formation, its source to sink propagation and preservational process through geological time, has been the focus of extensive and interdisciplinary studies. In this study we address this topic by examining the Upper Cretaceous organic-rich succession in the Levant. A multi-proxy approach, integrating elemental, isotopic, Rock-Eval and faunal analysis, is amalgamated into a holistic model through which the properties of presently prospected OM could be elucidated. A turnover in primary producer assemblages, and consequent reorganization of the bottom-water bacterial consortium, enforced sedimentologic and faunal changes in the depositional environment. This major oceanographic event has occurred around the Campanian/Maastrichtian boundary, as evident by lithological variations and biomarker analysis. The siliceous and phosphatic lithologies of the Campanian gave way to the Maastrichtian uniform organic-rich deposits; a six-fold increase in sedimentation rates has facilitated both an increase in the amount of OM and its excellent preservation; and, the balance between the elemental compounds in the OM has shifted in favor of carbon. The proposed shift in the type of bacterial consortium could have impacted the abnormally high C/S ratio (averaging at 5.5) owing to the central role of bacterial activity on natural sulfurization of OM. Our analysis also raises a possibility that the primary producer turnover, most probably caused by a change in the upper-water nutrient pool stoichiometry, is directly related to the extremely high C/N ratio measured along the core (averaging at 24.5).

While the entire Upper Cretaceous organic-rich sequence is considered as an excellent source rock, the oceanographic modifications which have occurred around the Campanian/Maastrichtian boundary resulted in a marked interval, with the highest OM content and generation potential levels, which stands out as the potentially preferred target layer for shale oil production. In past studies we have demonstrated that in addition to O2 availability and food flux, the type of available food has a substantial influence on benthic foraminiferal communities. In this study we focus on the influence of food type variations, i.e., the turnover in primary producer assemblages, on the OM preserved in the sediment. We propose that these biological shifts promote a change both in the amount and type of preserved OM.

# "....Two times the sea rose and flooded the world"

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The Talmud (Yerushalmi, Shekalim ) and the Midrash (Bereshit Raba) describe two events in which the sea flooded the earth.
Two models are presented to explain these flooding events: The "Mediterranean sea-flooding model" and the "Tsunami wave model".
It seems that the "Tsunami wave model" is the more pertinent one to the description in the Talmud. We know of two "Mega-Tsunami" events in the Mediterranean Sea , one that occurred ca. 7600 years ago, due to a slide in the Etna, and the second ca. 3600 years ago, due to the Santorini eruption.

# On the impact of entrapped air in infiltration under ponding conditions:
# Part a: Preferential air flow path effects on infiltration

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Entrapped air effects on infiltration under ponding conditions could be important for massive infiltration of managed aquifer recharge (MAR) or soil aquifer treatment (SAT) of treated wastewater. Earlier studies found that under ponding conditions, air is being entrapped and compressed until it reaches a pressure which will enable the air to escape (unstable air flow). They also found that entrapped air could reduce infiltration by 70-90%. Most studies have dealt with entrapped air effects when soil surface topography is flat. The objective of this study is to investigate, under ponding conditions, the effects of: (1) irregular surface topography on preferential air flow path development (stable air flow); (2) preferential air flow path on infiltration; and (3) hydraulic head on infiltration when air is trapped.

Column experiments were used to investigate these particular effects. A 140 cm deep and 30 cm wide column packed with silica sand was used under two boundary conditions: in the first, air can only escape vertically upward through the soil surface; in the second, air is free to escape through 20 ports installed along the column perimeter. The surface was flooded with 13 liters of water, with ponding depth decreasing with time. Two soil surface conditions were tested: flat surface and irregular surface (high and low surface zones). Additionally, Helle-show experiments were conducted in order to obtain a visual observation of preferential air flow path development. The measurements were carried out using a tensionmeter, air pressure tranducers, TDR and video cameras.

It was found that in irregular surfaces, stable air flow through preferential paths was developed in the high altitude zones. Flat surface topography caused unstable air flow through random paths. Comparison between irregular and flat surface topography showed that the entrapped air pressure was lower and the infiltration rate was about 40% higher in the irregular surface topography than in the flat surface topography. No difference of infiltration rate between flat and irregular surface topography was observed when air was free to escape along the infiltration path.

It was also found that at the first stage of infiltration, higher hydraulic heads caused higher entrapped air pressures and lower infiltration rates. In contrast, higher hydraulic head results in higher infiltration rate, when air was free to escape.

Our results suggest that during ponding conditions: (1) preferential air flow paths develop at high surface zones of irregular topography and increase infiltration rate; and (2) higher ponding depths increase entrapped air pressure and decrease infiltration rate if air cannot escape.

# The dynamics of the coastal cliff collapse: preliminary results from the Sharon region

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Erosion and inland retreat of coastal cliffs present one of the mostdynamic landscape evolution processes presently challenging coastalcommunities and infrastructure. Thus, the study of coastal cliff retreat at different timescales is crucial. The cliffs of the Sharon Escarpment consists of alternating latePleistocene–Holocene quartz-dominated, carbonate-cementedeolianites and clay-bearing paleosols. Over the years, the escarpment moves evenly eastward by discontinuous collapse and slumping on the seaward side, at annual rates of few to tens centimeters.

However, the dynamics of the full cycle of cliff collapse that include the removal of the collapsed sediments (talus) by wave swash is poorly constrained. In this study we quantify the dynamics of cliff collapses along 4 km beach stretch in the Sharon region using vertical and horizontal air photos that's taken between the years 1992-1999. Our results show that the studied taluses can be divided into 2main categories according to their life span: Short lived taluses are mostly small (<50 $m^3$) and are mostly removed by wave swash up to 1.5 years after their appearance; some last up to 3 years. Long livedtaluses, mostly composed of made of 6-8 m long eolianite boulders that protect the cliff from further erosion; these taluses were identified for at least 7 years and probably last for tens of years.

# Granulitic xenoliths and the formation of the lower crust below southern Syria and northern Israel and Jordan

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Xenoliths are an important source of information about the lithospheric mantle and crust. Xenoliths found in alkali basalts in Syria Jordan and Israel provide a wealth of information on the northern Arabian lithosphere that is otherwise hidden under a thick sedimentary cover. Peridotites and pyroxenites yield information on the lithospheric mantle, granulites sample the lower crust and felsic xenoliths provide information on the upper crustal basement rocks of the region.

Mafic granulites from the Qarnei Hittin Area in Israel, Thell Thannoun in SW Syria and the Remah and Aritain volcanic centers in north Jordan show similar mineralogy of plagioclase+clinopyroxene±orthopyroxene with some of the Israeli samples also carrying garnet (Gazit, 2005; Stern et al., 2014; Nasir, 1992). This mineralogy suggests that the garnet-free granulites originate from depth of 15-25 km (pressures of 0.5-0.7 GPa) and even deeper in the crust in the case of the garnet-bearing ones. Thermometry yielded temperatures of ~8500C for all assemblages. Such temperatures at ~25 km are high above the present geothermal gradient calculated from surface heat flow. It was suggested that this may reflect a recent heating of the base of the crust associated with the A-Sham volcanism. Alternatively it may reflect the high temperatures during the formation of the lower crust. The high Al2O3 content, the presence of positive Eu anomalies and the systematics of Ni and Cr suggests that the mafic granulites are cumulates from basalts. Incompatible elements are enriched, suggesting affinity to alkali basalts. However, groups of similar xenoliths form straight lines on 143Nd/144Nd vs. 147Sm/144Nd diagrams with slopes that correspond to 550-750 Ma, suggesting formation during the Pan-African. The granulites from Tel Thannoun yield Pan-African Nd model ages of 550-630 Ma, but Zr ages of 355-359 Ma on three samples (a granulite, a pyroxenite and a charnokite) suggest a younger age (Stern et al., 2014). Post Pan-African modification of the lower crust is also suggested by the granulite facies metamorphism of the xenoliths and their fabric and by young mineral isochrons.

# The origin of dunites in the Troodos ophiolite: a Rare Earth Element perspective

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Dunites, rocks composed of nearly pure olivine, mark the location where gabbroic melts first emerge into the oceanic crust and begin to crystallize. They are traditionally considered as cumulates and most abundantly occur at the oceanic mantle-crust transition. An alternative mechanism to form dunite is dissolution of orthopyroxene by interaction of basaltic melts with the uppermost mantle harzburgites. In the Oman ophiolite dunite bodies within peridotites and layered dunites below a thick ultramafic cumulate section were interpreted to be of 'replacive' and 'cumulative-replacive' origin, respectively. In the Troodos ophiolite, Cyprus, hundreds of meters thick dunite 'provinces' occur above mantle peridotites and are topped by layered ultramafic and mafic cumulates. This study focuses on hitherto unreported interstitial clinopyroxene in Troodos dunites, as a key feature to understand their origin in the Troodos ophiolite and elsewhere. The variable textural occurrence of clinopyroxene in Troodos dunites, from isolated crystals through vein-like trails of crystals to poikiloblasts, all characterized by cuspate contacts with matrix olivine, suggests that it crystallized from melt flowing through reaction-induced porosity. The REE composition of interstitial clinopyroxene together with the major element compositions of olivine and spinel are used here to constrain the nature of melts that equilibrated with dunites while ascending to the crust. The high-Mg and low–Ti contents and spoon-shaped REE pattern of interstitial clinopyroxene in dunites are indicative of equilibration with boninite rather than with tholeiite melts. This is in line with the occurrence of a boninite suite at the top of the volcanic section and of boninitic dykes and boninite-derived plagiogranite in the middle crust of the Troodos ophiolite. Nonetheless olivine Mg# in Troodos dunites (0.88-0.91) is either equal or lower than that of associated harzburgites (0.91-0.92) suggesting that some of them formed by crystal accumulation. It is here suggested that the main dunite bodies in Troodos are relicts of channels of melt that flowed along the rheological boundary between the asthenosphere and the lithosphere, and at the base of the crust at the proximity of the spreading axis. During this migration the melt dissolved orthopyroxene in the host harzburgite and formed a dunite melt channel. The interstitial clinopyroxene bears the geochemical signature of boninites, the most depleted melts characteristic of the latest evolutionary stage of the Troodos supra-subduction zone spreading center.

# The ICDP Dead Sea Cores and the Dead Sea Heat Flow

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The amount of heat the earth emits at the surface can be measured and be used to estimate the heat flux of the Earth's interior. The heat flux can help determine the depth of the seismogenic zone, the thickness of the lithosphere, the type of deformation and thus infer on the thermal structure and geological evolution of an area. Being such an important tool in geophysical studies, numerous measurements of heat flow have been made across Israel. During the late 70s measurements of the heat flow around the Dead Sea were conducted by several groups. One group used temperature logging in abandoned oil and water wells while another used a special probe designed for heat flow measurements in lakes. Even though the groups measured the same low heat flow some questions were raised. One problem was that measurements conducted by the lake-floor probe were relatively shallow. In addition, it is impossible to use this method these days as the Dead Sea is no longer thermically stable and because a thick layer of hard salt is now covering most of the lake bottom which makes it almost impossible to penetrate. On the other hand, some argue that measurements carried out in abandoned wells display high variation of heat flow values over short distances, which might indicate a problematic methodology. Therefore another way of measuring heat flow is required in order to validate results of past studies. The ICDP deep Dead Sea borehole offers an ideal opportunity to conduct a comprehensive heat flow study of the Dead Sea basin. The cores stored in Bremen hold a unique opportunity to measure the thermal conductivity of Dead Sea sediments up to a depth of few hundred meters unlike the shallower studies that were carried out in the late 70s. Together with the logged downhole temperature gradient it is possible to calculate the surface heat flow of the Dead Sea to a very good precision. The calculated heat flow would help settle the dispute regarding the value of the heat flow around the Dead Sea, thus shedding light on the tectonics of the Dead Sea area and helping to estimating the geological evolution of the area.

# Sinkhole formation along the shores of the Dead Sea: results of laboratory experiments

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The Dead Sea level has dropped by more than 30 meters since 1970 as a result of anthropogenic intervention in its water balance. This level drop has a major influence on hydrogeological processes adjacent to it. The formation of sinkholes is an example for a dynamic process related to the drop of the lake level. Because of the recession of the Dead Sea level and the decline in the freshwater-saltwater interface (FSI), brines that use to occupy salt layers below this interface are flushed out by freshwater. The freshwater dissolve the salt layers and create cavities, which in time collapse and form the sinkholes. This conceptual mechanism for the formation of sinkholes is based on hydrogeological observation and geophysical and geochemical data. The objectives of this study are to use controlled laboratory experiments in order to validate and visualize this mechanism under different geological, hydrological and limnological setups.

The laboratory experiment was conducted in a rectangular flow tank which represents the aquifer, in order to test the effect of different hydrogeological cross sections, and the effect of different characteristics of the salt layer (porous salt grains versus massive salt blocks), on the process of salt dissolution and sinkholes formation. The initial conditions of all the experiments are when the salt layer is located below the FSI and exposed only to water saturated to halite. The experiments start when the level of the saltwater boundary is dropped. As a result the interface withdraws back towards the saltwater boundary and direct contact between the salt layer and the fresh groundwater become possible. Preliminary results show that under all of the examined experimental setups, the dissolution of the salt layer by fresh groundwater leads to formation of sinkholes above it. Thus, the experimental results support the conceptual mechanism presented above. The results also show that when the salt layer is composed of salt grains, cavities are created only in the unsaturated zone due to larger mechanical strength of the porous medium there. In addition, the response of the porous medium is continuous and sinkholes forms by slow subsidence of the surface. However, when the salt layer is composed of massive salt blocks, the processes of cavities and sinkholes formation are different. Cavities are created first within the salt layer and kept under its top part, due to the high mechanical strength of the salt. Only after instantaneous mechanical failure of the salt layer, cavities climb up into the unsaturated zone, and collapse sinkholes, instead of surface subsidence, are created. It should be noted that the layers in the experiment were different from those in the field (sand versus gravel and clay) and thus comparison of the mechanical behavior should be done with cautious.

# North Atlantic control over cyclic deposition of halite and clastic laminae during the Last interglacial Dead Sea

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The last interglacial Dead Sea (i.e. Lake Samra) experienced strong droughts in its watershed recorded by its low lake levels and by deposition of thick sequences of halite. Analyses of these halite sequences present intercalations of halite laminae with fine-grained clastics brought to the lake primarily by floods. Geochemical characterization of these sediments complemented by statistical analyses indicates an annual depositional cycle of 7.5 yr, as it is also identified by other recent regional archives. Thus, we propose a common climatic mechanism behind the modern and last interglacial periodicities. We suggest that the 7.5 yr cycle had possibly been affecting the Eastern Mediterranean region during past interglacial intervals for a long time, possibly also during glacial intervals. This cycle has been proposed to be synchronized with the North Atlantic Oscillation and is induced by the 7-8 yr oscillation in the position of the Gulf Stream front. We anticipate that this expression of North Atlantic control will result in a similar periodicity in other annual sequences in the region.

# Near East Synoptics of the Last Interglacial

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The last interglacial period accommodated the early phase of dispersal of Anatomically Modern Humans (AMH) “Out of Africa” via the currently hyperarid Red Sea–Dead Sea Rift (RS-DSR). Scarce archeological evidence indicate AMH existence along the Red Sea at the peak of Marine Isotope Stage 5e (MIS 5e) between ~130-120 ka BP. The environmental conditions that supported the early AMH migration remained largely obscure and represent episodic events. Nd-Sr isotopes and chemical compositions of fine dust particles, recovered from several sediment cores drilled along a transect extending from the Gulf of Aden via the Red Sea to the Dead Sea basin, provide continues evidence for the synoptic patterns that controlled environmental conditions along the route of AMH dispersal. Between ~130-124 ka BP intense, precession-forced, African monsoon rains that caused the sapropel (S5) conditions in the eastern Mediterranean, introduced wetness to the RS-DSR that could facilitate the AMH migration through the desert climatic barrier. Environmental conditions supporting hominids in the deteriorated at ~119-116 ka BP, when the entire Levant–Red Sea-Gulf of Aden area went through an extreme drought, reflected by dry eastern winds that caused a catastrophic decline of Dead Sea water levels. This hyperarid period brought the early phase of AMH dispersal along the RS-DSR to its end coincide with a global melt water pulse.

# Customization and adaptation of ShakeMap software for near real time evaluation of seismic intensities and peak ground motions in Israel (I stage)

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The ShakeMap system, developed by the U.S. Geological Survey (USGS) to rapidly display and disseminate information about the geographical distribution of ground shaking following a large earthquake, has proven to be a vital tool for post earthquake emergency response efforts, and is being adopted and emulated in various seismically active regions worldwide Shake Map provide near-real-time maps of ground motion and shaking intensity following earthquakes.Shake Map systems serve in the USA, Italy, Switzerland, Romania, Turkey and other countries.

In the 2013 year new GII project was initiated for implementing the ShakeMap system in Israel. The overall goal of this project is to develop new algorithm and software for customization and adaptation of the USGS's ShakeMap software in Israel.

On the first project stage a set of new programs was developed:

1) computation of Peak Ground Motion (PGM) parameters;
2) writing the PGM data into the MySQL database;
3) computation of site amplification factors for PGM parameters, based on the SEEH method and subsurface 1-D multi-layer soil column models.

The database of strong earthquakes, recorded by stations of the Israel Seismic and Accelerograph Networks, was created. Using the new programs, the acceleration and velocity records were processed and all reliable PGM parameters were included into the GII seismological MySQL database that is necessary for implementation, testing and adaptation of the ShakeMap.

We conducted estimation and analysis of site-effect at some network stations that is necessary to take into account for in the ShakeMap calculations. Resonance frequencies and their associated amplifications were estimated at accelerograph stations using the horizontal-to-vertical spectral ratio for strong motion records from the collected database.

The VS30 site classification for Israel and neighbor areas based on the topography basis was elaborated and this first site-effect approximation was used for implementation of ShakeMap software for Israel earthquakes.

To be implemented in Israel local conditions, the ShakeMap software was adapted to the GII computer platforms (Linux). Two trials were conducted using input data for two local felt events occurred in 2004 with M=4.7 (the Jordan Valley) and 5.2 (the Dead Sea) and all required maps of PGA, PGV, Intensity and PSA (Pseudo Spectral Acceleration) were successfully elaborated.

# Improved Processing Seismic-Acoustic Data originating in Israel and adjacent Area

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We explore a joined analysis of seismic and infrasonic signals for improvement in automatic monitoring of small local/regional events, such as construction and quarry blasts, military chemical explosions, sonic booms, etc. using collocated seismic and infrasonic networks recently build in Israel (ISIN) in the frame of the project sponsored by the Bi-national USA-Israel Science Foundation (BSF). The general target is to create an automatic system, which will provide detection, location and identification of explosions in real-time or close-to-real time manner. At the moment the network comprises 15 stations hosting a microphone and seismometer (or accelerometer), operated by the Geophysical Institute of Israel (GII), plus two infrasonic arrays, operated by the National Data Center, Soreq: IOB in the South (Negev desert) and IMA in the North of Israel (Upper Galilee),collocated with the IMS seismic array MMAI. The study utilizes a ground-truth data-base of numerous Rotem phosphate quarry blasts, a number of controlled explosions for demolition of outdated ammunitions and experimental surface explosions for a structure protection research, at the Sayarim Military Range. Special events, comprising military explosions in a neighboring country, that provided both strong seismic (up to 400 km) and infrasound waves (up to 300 km), were also analyzed. For all of these events the ground-truth coordinates and/or the results of seismic location by the Israel Seismic Network (ISN) have been provided. For automatic event detection and phase picking we tested the new recursive picker, based on Statistically optimal detector and a new robust location techniques for infrasonic source location. The results were compared to the manual picks and the ground-truth locations respectively. the new Bayesian Infrasonic Source Localization (BISL) method, incorporating semi-empirical model-based prior information, was modified for array+network configuration and applied to the ground-truth events.

# Newly discovered miocene proboscideans in the southern levant

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The evolutionary history of proboscideans is characterized by three successive events known as the Eocene radiation, the Miocene radiation and the Mio–Pliocene radiation. The highest taxonomic diversity in proboscideans occurred during the Miocene. Through study of the modes of dispersal of proboscidean species, we can theoretically reconstruct the routes along known geological land bridges by which dispersal took place. That in turn allows us to interpret the evidence of different proboscidean species from remote geographical regions in reconstructing paleogeography. The southern Levant is located on the route of dispersal in and out of Africa. New finds from Miocene localities reveal a rich faunal distribution, including various proboscideans. Proboscidean remains have been reported from several find-spots in the Golan Heights, the Negev, and the Arava Valley. In the Negev, fossilized mammals have been exposed in the Rotem and Yeroham Basins at three localities. At least two proboscideans have been indentified including Prodeinotherium sp. Gomphotherium or Ambelodintidae, together with other vertebrates. The taxa are mainly of African origin but there are also a few Eurasian as well as endemic elements in the record. These rich faunal remains suggest they existed within a wide variety of habitats of an early Miocene Age (Burdigalian). Recently, a mandible of a new proboscidean, Gomphotherium, has been discovered in sandy sediments of the Rotem Formation of the Hazeva Group near Ein Yahav in the Arava Valley. In spite of the spatio-temporal position of the Negev sites as crucial for interpreting initiation of biotic exchange between the Afro-Arabian and Eurasian realms. Intensive tectonic activity and erosion post-dating the Miocene Hazeva Group has removed most of the sediments of that group, leaving only thick sections sheltered in Grabens, therefore localities with fauna are quite rare. Synchronic and diachronic changes in the fossil proboscidean record of the southern Levant, species morphological characteristics, diet preferences, and species turnover is analyzed within their geological and geomorphological contexts in order to reconstruct past environments.

# Searching for the Edge of Destruction: Umayyad Palaces and the mid-8th and 11th century CE Earthquakes

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Palaces constructed during the Umayyad regime (r. 661-750 CE) in the southern Levant provide a unique opportunity to examine the distribution of seismic damage from a well defined fault system, namely the Central Jordan Valley (CJV) fault. The construction of circa twenty monuments with a similar size, plan, and design, preceded the earthquake cluster in the mid-8th century CE and the ultimate strong activity during the 11th century CE. One seldom finds a well dated, homogeneous group of buildings, distributed in a broad region that straddles a plate boundary.

While historical sources, describing the above events have been thoroughly studied, archeoseismological research is limited to a few sites. We address the following questions: What is the relation between damage and distance from the CJV? Is damage symmetric across the plate boundary? What are the roles of local conditions such as topography, geological infrastructure, and building materials.

Rather than using existing intensity scales that are based on percentage of damaged structures, a new intensity scale is designed for comparisons within a well-defined group. The scale is determined first by grading the relative damage, and then by grouping sites with comparable damage. The decay of damage with distance seems compatible with published attenuation relations.

Despite data scarcity from the western block, we propose that damage distribution across the CJV is asymmetric. The destruction zone is considerably wider on the eastern side reaching 80 km from the fault in contrast to 50-60 km on the west.

# Environmentally-Friendly, EDTA Enhanced Sediment Rehabilitation Using Controlled Deficit Irrigation (CDI)

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Application of organic ligands enhances heavy metal transfer into the canopy of vegetative trees however at the cost of polluting soils and groundwater. We tested the hypothesis that CDI of fast growing, salinity resistant trees coupled with timely EDTA application/avoidance, enhances sediment remediation while minimizing leaching of metal complexes by allowing for their biodegradation prior to uncontrolled winter leaching.

Two experimental setups were examined: (i) 24 lysimeters (220-L) packed with a mixture of metal polluted sludge and quartz sand, and (ii) two 60 m3, drainage-controlled basins filled with dredged, polluted, saline estuary sediment. Both were planted with Eucalyptuses. The CDI with either tap or RO water (lysimeters) or secondary wastewater effluent (basins) started in the following year. Chelants were fertigated during May-August, either continually (lysimeters; at 2 mM) or intermittently (dredged sediment basins; at 10 mM). While TPAs had no effect, EDTA solubilized and translocated metals (including Cd, Pb, Zn, Cu, Ni) into the canopies. As under the CDI most all leaching was prescribed (for soil solution monitoring), the overall leaching fraction was <2% of water applied.

The average weight of the 3.5 years old E. camaldulensis and E. occidentalis trees was 55 and 45 kg/tree, respectively. The growth was largely unaffected by the CDI-induced salination of the soil solution (to up to 20 and 35 dS m-1 in the sediment basins and lysimeters, respectively) nor by the EDTA concentration build-up to up to 100 mM in the lysimeters' soil solution (starting at 2 mM in the irrigation water). This did not occur in the sediment basins. Hence, while EDTA degrading microflora established rather slowly in the EDTA-treated lysimeters (EDTA half-life ≥27-d at 10 mM; incubation; soils after 2.5 years of treatment), such microflora was probably already present in the dredged sediment (or in the wastewater effluent irrigation water). The EDTA concentration in the winter leachates from the basins was >0.01-0.1 mM. Thus, the uncontrolled winter leaching was free of metal complexes which profusely formed in the preceding summer. In the above incubation study EDDS degraded rather quickly (half-life = 5-11 d) which explains its ineffectiveness in solubilizing and translocating the metals.

In the lysimeters, the soil solution and Eucalyptus leaves peak average metal concentrations under EDTA vs. control treatments were as follows (all respective values): Cd: 200 mg L-1 vs. 1.0, and 67 vs. 21 mg kg-1; Cu: 90 vs. 1.5 mg L-1, and 17 vs. 3.0 mg kg-1; Cr: 4.0 vs. 1.4 mg L-1, and 3.0 vs. 1.0 mg kg-1; Ni: 60 mg L-1 vs. 14, and 20 vs. 6.0 mg kg-1; Pb: >44 vs. 0.1 mg L-1, and 9.0 vs. 1.0 mg kg-1; and Zn: 650 vs. 4.0 mg L-1 and 200 vs. 70 mg kg-1. Seven years after onset, the concentrations of Cd, Zn, and Pb in upper soil 15 cm layer of the EDTA treated soil decreased by 60-67% and in the control it decreased by 6-28% ($p<0.05$). Cadmium concentration in the leaves of the Eucalypts that grew in the sediment basins were considerably lower than the above, usually >15 mg kg-1.

To conclude, the study suggests that sustainable phytostabilization and phytoextraction of heavy metals is achievable under CDI with EDTA fertigation at low dose. The TPAs tested were completely ineffective. RO water Irrigation widened the scope of this CDI based remediation technique.

# Petrophysical qualities of shallow marine sediments offshore Haifa bay, Northern Israel: implication on hydrocarbon flow inhibition

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High-resolution geophysical data acquired over the continental shelf offshore Haifa Bay identified a shallow free gas accumulates bearing layer stretching over ~72 km2. Postulating that fluid flow plays an import role in localizing the free gas, this study investigates the petrophysical properties that control such flow through the sediments confining this shallow gas layer. We study sediment core samples (4.8 – 5.3 m long) that were collected from three locations (NRD, SG1 and PC3) along a NE – SW transect, each site ~ 1500 m apart, and analyzed for the presence of methane. The cores were subjected to high resolution CT-Scan and a suite of petrophysical (gamma density, magnetic susceptibility, p wave velocity), sedimentological analysis (grain size distribution, XRD) and geochemical analysis. On board investigation showed inclusions of bubbles presumably methane in SG1 core sample tearing up the structure of the core while coming to the surface positively correlated to a set of geochemistry analyses with methane consecration reaching up to 35 mM to suggest fluid plumbing. Preliminary result shows density values of almost the same trend ranging from 1.5-1.75 g/cc in all three cores. However magnetic susceptibility results show possible evidence of a different sedimentological regime north to the embayment of Haifa bay , almost two orders of magnitude difference may affected by the spatio-temporal texture and sedimentary fabric of the shallow unit and ultimately the porosity and permeability within this zone. Supporting this argument is the p-wave velocity change to a lower velocity of ~1100m/s evident between PC3 and NRD as we go north. Future analysis will focus on high resolution porosity permeability and lithological measurements from the cores along the three sites a to support modeling fluid flow in the overburden. Determining the porosity and permeability will be the challenging aspect of this study due to the nature of the near seafloor sediments, yet is crucial for modeling fluid flow within this region. It is anticipated that the results from this study may serve as analogue to understand fluid plumbing dynamics in relation to shallow gas reservoirs on continental shelves worldwide.

# Rock-Burst simulations with 2D-DDA

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Rock-bursts can be defined as a sudden displacement of rock in deep excavations that can come in different intensities and may cause severe damage in life and equipment. Two source mechanisms are typically considered for rock-bursts: 1) Strain relaxation leading to displacement of excavation surfaces, 2) Energy redistribution induced by explosions and drilling activity at the working face. In this study we investigate further into those mechanisms using the numerical Discontinuous Deformation Analysis (DDA) method.

DDA is a numerical, discrete element method, which solves a more general type of a finite element mesh. By using a new viscous boundary and excavation sequence modeling capabilities we now have the ability to model dynamic deformation during deep tunneling excavations at higher accuracy. The rock-burst type considered here is slip-fault based, because the DDA version we are using only solves for large block displacements along preexisting discontinuities; fracture mechanics and excavation induced fracture are not considered.

To verify the accuracy of the DDA wave propagation in a discontinuous medium, a simulation of P-wave in one-dimension elastic bar was performed. The results show that DDA presents high accuracy provided that the time step is sufficiently small and the ratio between block and wave lengths is between 1/8 and 1/12. Additionally, a radial P-wave propagation simulation was formed to emulate an underground blast. Finally, a simulation of a blast functioning as a micro seismic event in a discontinuous medium with an open tunnel was compared to in-situ measurements made in the Jinping II Hydropower project in Sichuan province, China.

After performing the validations successfully we began modeling the strain relaxation mechanism by removing circular tunnel sections in a medium subjected to increasing levels of hydrostatic stresses from 0 to 50 MPa and monitored the behavior of keyblocks around the tunnel. We obtained a very strong relation between the initial stress and the velocity and acceleration of the ejected key block following the removal of the tunnel section, which gives an indication regarding the intensity of the predicted event as a function of the level of initial in-situ stress and the geometrical and mechanical characteristics of the jointed domain.

We are now exploring the energy redistribution mechanism due to a faraway blast.

# An overall method to measure gypsum crystal size distribution in batch experiments.

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Gypsum precipitation is of interest for various geological and industrial processes. The crystal size distribution (CSD) of forming gypsum crystals is one aspect of gypsum precipitation that is of major importance in these processes. An example to this is the question of whitening of the Dead Sea due to massive gypsum precipitation following inflow of seawater (in case the Red Sea – Dead Sea project goes ahead). CSD will determine how many minute crystals will stay afloat which will determine if a whitening event will take place. However, theoretical calculations and thermodynamic or kinetic considerations do not provide a forecast for CSD.

In order to experimentally characterize CSD a new method was developed: A set of experiments were first conducted in order to find: 1- The type of bottle that will allow maximum filtration of formed crystals and 2- Solvent type that allows washing excess solution from the crystals without causing additional gypsum precipitation. These experiments have shown that glass bottles allow maximum filtration and that washing the formed crystals with ethanol will not cause any additional precipitation.

Once the experimental setup was established photos of the formed crystals were then taken using a binocular and the photos processed in imageJ software. This software allows measuring various properties of the formed crystals (crystal sizes, aspect ratios etc.). Filtering different bottles containing the same initial brine mixture, allows observing the change of these properties with time.

The results of preliminary experiments conducted to verify the method show that: 1- The method yields consistent results, 2- most of the growth throughout the experiment is done within relative proximity to the induction time, and 3- That the aspect ratio of the growing crystals is constant with time which means that the gypsum formed from the mixture of Dead Sea with Red Sea brines grow invariantly.

# Intra-basin hydrological processes during stream flow events under various hydrometeorological conditions

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Rainfall-runoff interaction is extremely complex and involves numerous heterogeneous and non-linear processes. The study of this interaction often includes considerable simplifications and requires the use of hydrological models. Runoff discharge measurements are usually available at the basin outlet, which covers dozens or hundreds of square kilometers. Most models simulate the discharge at the outlet and use the discharge measurements for calibration and validation. The gained information from these simulations and measurements is at the resolution of an entire basin or its sub-basins. As a consequence, intra-basin processes are overlooked. This study aims to move beyond this simplified representation of rainfall-runoff generation and gain a better understanding of the intra-basin hydrological processes under various hydrometeorological conditions.

To achieve this a fully distributed hydrological model is being developed. Field measurements and observations during rain events provide data and insights that are used to build, improve, calibrate, and validate this hydrological model. The field measurements include: Landuse mapping, soil depth and texture estimations, rain and discharge rates evaluation, and frequent moisture measurements. Measured rain data acquired from the rain gauges, rain radar, or generated artificially using a weather generator will be used as input to the model. The use of a distributed model will provide a tool to simulate infiltration, water height, and flow rates at a high resolution (10X10 square meters). Thus, identification of hydrological features such as hydrological connectivity, hydrological active areas, and areas that contribute to the overall stream discharge will be feasible. Moreover, the role of soil type and depth, landuse, and vegetation will be identified. The use of the data obtained by the weather generator will allow the study of the hydrological response under specific hydrological settings and rainfall scenarios. In particular, it will allow the identification of conditions in terms of basin characteristics and storm dynamic under which extreme floods are generated.

As part of the ongoing development of the model it is already applied to the upper Dalia basin and rainfall-runoff simulations are already feasible. Preliminary results using the weather generator synthetic storms and rain radar data will be presented.

# Improved prediction of nitrogen mineralization and nitrification rates in soils

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During the mineralization process, organic nitrogen (N) is biodegraded to mineral N. There are significant levels of soil organic N, and particularly in organic amended soils. On one hand, the supplied, biodegraded organic N may increase soil N inputs for crop demand, while on the other hand it may induce water contamination and air pollution.

Gross or "real" mineralization rate is accounting for the total mineralized N, including mineral N consumed by other processes (e.g. , denitrification, immobilization). Gross rates determination of mineralization and nitrification, may improve quantification, understanding and control of N losses. Traditionally, the “net” rates of these two processes are used in common practice. They indicate the “net” change of given species (e.g. ammonium) with no account for the indirect processes of loss. Recent publications provide evidence that gross mineralization rates can be better estimator for N availability to plants plants than net N mineralization (Habteselassie et al. 2006)

Ion Exchange resins (IER) became common for studying soil nutrient dynamics, and N fluxes in agro-ecosystems (e.g., Qian and Schoenau, 2008). Soil mineral N is adsorbed rapidly by IER, and thus they can serve as “super sinks” for mineralized N that are stronger than microbial or plant uptake sinks (Griffin 2008). Accordingly, it can be assumed that IERs can index gross N mineralization rather than measuring net changes in mineral N pool size.

The main research hypothesis in our work is that sensible utilization of IER may provide an effective, rapid, easy-to-get solution for estimating gross mineralization and nitrification rates in soils. This may provide improved, deeper understanding of processes that control soil N availability. Results obtained so far focused on better understanding of the factors affecting the efficiency of IERs for better assessment of the nitrification and mineralization "real" rates. It was found that nitrate adsorption to anion exchange resin beads, uniformly distributed in soil, significantly protect it from denitrification losses, even under anaerobic conditions. In addition, Soil samples were incubated with or without (control) anionic exchange resin (AER) beads under aerobic, optimal conditions for nitrification and amended with $NH_4Cl$. . Nitrification rate was significantly higher in the IER treatment, assumable due to protection of the nitrate from losses via denitrification. However, N mineralization rate, in some soils, was reduced with the AER beads, probably due to N adsorption and thus, practically, increasing soil C:N ratio. Additional experiments were conducted under aerobic conditions, without fertilizer addition to soil samples prior incubation. These experiments showed positive accumulation of mineral N which was higher in the AER treatments. This may indicate the possibility of improved mineralization prediction under "natural" conditions by anionic exchange resins. However, those results should be compared to gross mineralization and nitrification rates measured by standard measurements, such as the isotopic dilution method.

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# AVA Inversion Using Converted Wave OBC Data: A Case Study from the Gulf of Mexico

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We present a case study that demonstrates the use of both P-to-P elastic impedance (EI) and P-to-S elastic impedance (PSEI) inversion. The seismic data recorded using an ocean bottom cable (OBC) from the West Cameron area in the Gulf of Mexico (GOM), have a good converted wave response and PS data have a higher signal-to-noise ratio when compared to the PP reflection.

As only a small amount of gas in a reservoir is needed in order to produce a significant reduction of compressional wave velocity (Vp), it is difficult to discriminate quantitatively "fizz-water" from commercial gas using PP reflection data only. PSEI is not dependent on Vp and its monotonic relationship with density makes attributes that are closely related to density useful proxies for estimating gas saturation (González, 2006).

In this study we show the advantages of using the PS data and describe a workflow for separate and joint PP and PS inversion to extract elastic properties from seismic amplitude variations with offset (AVO). A comparison between separate PP and PS data and joint PP-PS data in PP time shows that in this case PS data critically improve subsurface characterization.

# Simulations of migration and trapping of injected CO2 into various structural settings of the Jurassic deep saline aquifer of the Negev

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Carbon dioxide (CO2) capture and storage (CCS) is considered as a leading technology for the reduction of atmospheric emissions of greenhouse gas in the short run. In CCS, CO2 is separated from the gas stream of large stationary sources (e.g., power plants), transported to the storage site and injected into suitable deep geological formations. A previous study of the capacity of CO2 geological storage in Israel identified the Jurassic middle aquifer as the most suitable for CO2 storage. The middle aquifer consists of a porous and permeable sandstone layer (Inmar, Daya, and Sherif formations) overlaid by carbonate-rock dominant layers (Zohar formation). An aquitard made of a thick impermeable shale layers (Kidod Formation) seals the aquifer from above.

In this work we present numerical simulations of CO2 migration and trapping for various scenarios of CO2 injection into the aquifer. The aquifer is modeled either as a three-dimensional homogeneous medium having averaged properties or as an axisymmetric multilayer aquifer where each formation is characterized by a different set of properties.

Simulations were performed for three structural settings typical of the Jurassic aquifer of the Negev; an anticline, a horizontal domain and a sloping aquifer. The results describe the migration and distribution of the CO2 plume, the pressure behavior and CO2 trapping. The influence of the natural groundwater flow, the stratigraphic setting and the structural layering on the CO2 migration and trapping is examined. Consequences and perspective for future storage projects are discussed.

# The Holocene evolution of the beach and inland aeolian sand of the north-central Mediterranean coast of Israel

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This study focuses on the Holocene appearance, chronology and drivers of beach sand deposition and inland aeolian sand transport along the Caesarea-Hadera dunefield. The dunefield, situated in the north-central coastal plain of Israel extends 5-6 km inland from the current shoreline and is under a Mediterranean climate. The sands and dunes are stabilized by Mediterranean plant associations that participate in a psammosere - a plant succession on sand.

A detailed field survey and sampling campaign was carried out along two transects loyal to the past advancement orientations of the dunes that was derived from the dune morphologies. Beach sand, sand sheets, a linear dune, and parabolic and transverse interdunes were sampled down to their substrate by hand drilling and from exposed sections. Forty-nine samples were analyzed for particle size distribution and eighteen samples were analyzed for calcium carbonate content. Twenty-four samples were dated by optically stimulated luminescence (OSL).

The results indicate that beach sand started to substantially accumulate at 6-5 ka and until ~4 ka, sand sheets encroached 2-3 km inland. This sand accumulation is associated with the final stages of global sea level rise. Sand ages clustering in the range of 1.2-1.1 ka are coevally found throughout the dunefield. The 1.2-1.1 ka ages do they coincide with any local or regional climate changes with regard to windiness, or transitions in coastal sand supply and availability. We suggest that the age cluster represents sand stabilization due to vegetation reestablishment, possibly due to the decline in human activity in the Caesarea region during the Early Islam period. The particle-size distributions of the fine to medium-sized aeolian sand showed minor variation linked to inland transport distance and age and did not significantly differ from the values of beach sand.

The study illustrates the initial role of natural processes, in this case mainly Holocene sea level rise and stabilization, and the primary role of fluctuating past human environments upon Holocene coastal sand mobilizations and stabilizations.

# Particle-size fractionation of aeolian sand along a climatic and geomorphic gradient of the Sinai-Negev erg

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This study examines changes in the aeolian sand fractions along the west-east aeolian transport path of the northern Sinai Peninsula – northwestern (NW) Negev erg of Egypt and Israel. This erg originates from the Nile Delta and is comprised of currently active linear (seif) dunes in northern Sinai (its western part), and currently stabilized vegetated linear dunes (VLDs) in the NW Negev dunefield (its eastern part). Sand samples from the Nile Delta, northern Sinai and NW Negev were analyzed for particle-size distribution and sand grain morphology in accordance to their luminescence and radiocarbon chronologies. Linear seif dunes differ from VLDs in their vegetation cover, linearity, and dynamics. Although both are continuous landforms with similar orientations and sand-grain roundness values, the linear dunes of northern Sinai are coarser-grained than the Negev VLDs. The VLDs have a significantly higher proportion of very fine sand (125-50 μm) content and a varying but lower sand fining ratio defined as the ratio of fine sand percentage to very fine sand percentage. Very fine sands are suggested to have been winnowed by saltation and low suspension from source deposits and sand sheets. Semi-quantitative examinations of sand grains by a SEM collected along a Negev VLD shows that most grains do not exhibit implicit features that can be attributed to aeolian abrasion by sand grain-grain collisions. From these observations we infer that fractionation of sand was an important process leading to downwind fining along the studied aeolian transport path.

We suggest that the very fine sand fraction of Nile Delta and Sinai sands has been transported downwind since the late Middle Pleistocene. In the Late Pleistocene, sand reached the NW Negev in the form of VLDs due to last-glacial period windiness of intensities unprecedented today and probably larger sediment supply. Generally current and inferred past decreasing wind velocities and increasing precipitation along the dune transport path enhanced vegetative and biogenic soil crust cover in the NE Sinai and NW Negev and enabled deposition of the very fine sand component within VLDs that was probably partly transported by low suspension.

Our results suggest that particle-size distribution can elucidate much about erg and dunefield history especially where a climatic gradient exists, over timescales of a glacial-interglacial cycle.

# Kinetic isotope effects in carbonate mineral formation

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Equilibrium carbon and oxygen isotopic compositions of carbonate minerals are commonly used to study paleo-climate and paleo-hydrology. Natural carbonates, which precipitated out of equilibrium, such as some corals and speleothems, are often excluded as proxies from the available geologic record. Although non-equilibrium isotopic compositions are widely observed in nature and in the laboratory, they are not well understood. Such deviations from equilibrium are qualitatively attributed to mineralogy, temperature, pH, precipitation rate, and degassing of CO2.

Non-equilibrium isotopic compositions arise from kinetic isotope effects (KIEs), which occur when reaction rates of the heavy and light isotopes differ. Such KIEs complicate interpretation of the carbonates' isotopic composition, and often render the carbonates altogether unusable. In abiotic carbonate systems, KIEs may be associated with precipitation, speciation reactions, and CO2 degassing during carbonate mineral formation. In biotic systems, vital KIEs are also involved. A complete understanding of non-equilibrium isotopic compositions requires constraining the KIEs of all reactions involved in mineral formation. However, to date, the magnitudes of these KIEs are either highly uncertain or simply unknown.

The present study reports experimental data for carbon and oxygen non-equilibrium isotope compositions of witherite (BaCO3). The witherite was precipitated at its kinetic limit from solutions at 15, 25 and 40ºC and pH ~8, ~10 and ~12. A dynamical analysis of the results yielded temperature-dependent KIEs associated with precipitation of BaCO3 from aqueous CO32- and HCO3-, as well as insight into the KIEs associated with CO2 (de)hydration and (de)hydroxylation reactions. This study helps to better understand non-equilibrium compositions of carbonate minerals, and may be a step towards unlocking paleo-climatic and paleo-hydrological information in speleothems and cryogenic calcite, among other carbonate repositories.

# Long lasting continued activity of buried mass transport deposits in the southeast Levant margins

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Mass transport deposits (MTDs) are commonly considered to be motionless evidences of past mass transport that occurred at the seafloor, or active salt tectonics features. This study reveals evidences of continued long lasting and even current deformation of ~2Ma old MTDs, now buried hundreds of meters beneath and still impacting the seafloor. Our study is based on detailed interpretations, aided by coherence and structural attributes, of the Top-Messinian to Quaternary sedimentary section as imaged by the Gabriela and Isramco-NC 3D seismic surveys, offshore central Israel. The Messinian Erosional Surface (MES), at the base of the studied interval, is a permanent undulated surface affected by several local deformations: a 20 km long fault at the southern part of the study area; a 3 km wide northwest-southeast truncating canyon at the center; and northeast-southwest parallel faults to the north. A continuous ~200 m thick stratified sediment package accommodates the MES structural relief and completely detaches it in our study area from pervasive faulting of the overlaying layers. Next, on the stratified layer are the headscarp regions of two ~300 m thick MTDs, constituting a part of the large scale (4800 Km2) Israel Slump Complex. The northern MTD covers an area of 135 km2 within the survey area and is composed of two sub-circular terminals of 50% chaotic material and 50% detached and rotated ~1 km scale blocks, separated by a 1.5 by 6 km remnant block at the middle. To the south, a second MTD extends over an area of 113 km2 and is composed of 75% chaotic material and 25% detached blocks, and a series of rotated blocks bounding the eastern side of the headwall scarp. A 'crown' of faults emanates upwards from these MTDs headwalls carps, truncating and deforming the overlaying layers and vertically offsetting significantly younger units by tens of meters up to ~100 m below the seafloor. Three critical observations should be stressed: the faults do not breach the layered interval bellow the MTDs and are not connected to the MES; the sagged and faulted units appearing above the MTDs retain the structural signatures of the MTDs headwall scarps and are affected by the presence of blocks within the MTDs matrix; the displacement accommodated by the emanating faults decreases upwards above the MTD's. Additionally, we have investigated several smaller and younger MTDs identified farther up the sediments package, portraying similar structural-deformational kinematics. Consequently, we suggest that the MTDs undergo long term post-slumping vertical differential compaction, possibly combined with lateral mobilization. These deformations actively generate the upward propagation of faults in an upslope direction. These observations call for a re-evaluation of the deformation potential of shelf regions.

# Evolution of gravel-bed channels in response to non-steady flow regime

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Longitudinal profiles of alluvial channels may be altered rapidly in response to base- level lowering or changes in flow regime.
Previous models simulating the response to such changes assume steady and uniform discharge, or use a calibrated diffusion coefficient as a proxy for stream discharge. Such models do not account for intra and inter annual variation of flood frequency, volume and peak discharge which characterise arid channels. Our new gravel-bed longitudinal profile response model combines kinematic wave flood routing with sediment transport based on the Meyer-Peter-Muller equation . The model predicts changes in channel longitudinal profile in response to changing flow regimes and base- level lowering rates. We adopt a stochastic approach by formulating a "flood generator" which produces flood data series based on the known probability distribution of floods in a specific basin.
The model was applied to the lower part of Nahal Darga gravel-bed channel which drains into the Dead Sea. In the last 40 years, the profile of this reach has changed from a uniform-gradient to a convex profile as a result of drastic lowering of the Dead Sea level at rates of 1 m/y. Measured time-series of channel profiles were used for the model validation. The effect of different scenarios of lake level drop and of flood regime on the channel profile has been examined.

# Updated $^{40}Ar$-$^{39}Ar$ Chronology for Top Lower Basalt, Base Cover Basalt, and Related Units, Northern Valleys, Israel

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An inland basin extended during the Neogene in north-east Israel and south-west Golan Heights where continental sedimentation was accompanied by massive basalt issuing and by repeating marine ingressions. New 40Ar/39Ar ages, including 41 plateau and 24 total fusion ages of volcanic rocks, enable to establish a detailed chronostratigraphic framework for the Neogene sequence in the Yizre'el, Kinnerot and Lower Galilee valleys. This sequence was deposited during a period of ~5 m.y., between the top of the latest Middle Miocene Lower Basalt (LB) and the earliest Pliocene base of the Cover Basalt (CB). The issuing of the LB terminated at 10.1 Ma in the east and at 9.1 Ma in the west. Between ~12 and 10.1 Ma erosional products from uplifted blocks, along with pyroclastic sediments, were deposited in structural lows (Umm Sabune Fm.). A gradual lithological transition to well-bedded lagoonar/lacustrine carbonate and evaporitic rocks of the Bira Fm. occurred in this time interval. The top of the LB in structural highs could be as old as 14.2 Ma, and it is overlain there by a thin sedimentary sequence, or directly by the CB. Basalt flows within the sedimentary sequence are scarcer than conceived earlier. Dating the two flows in the Bira Fm. in Kokhav HaYarden section enabled to calculate sedimentation rate and estimate the time of the transition to the overlying freshwater Gesher Fm. at ~7 Ma. Accordingly, the Bira and Gesher Fms., which has similar thicknesses, have also similar duration. Hence, the gypsum beds at the upper part of the Bira Formation predated the Messinian salinity crisis (MSC). A newly-discovered unit of conglomerates and paleosols underlying the CB is considered as the continental equivalent of the MSC evaporites deposition.

The ages of the CB base are in the range of 5.6 – 4.6 Ma. The younger ages occur in the east, at the contact with the underlying Fejjas Tuff, which was deposited throughout ~0.5 m.y., contemporaneously with the early phase of the CB and the upper part of the Gesher Fm.

# Cretaceous volcanism in Israel with focus on the Carmel Volcanics

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During the Early Cretaceous, a swell several hundred kilometers wide, was formed between Lebanon, Syria and Sinai. Five Cretaceous tectonomagmatic events have been identified in Israel during a ~55 Myr period: (1) Berriasian-Hauterivian (141-133 Ma; Tayasir Volcanics); (2) Early Aptian (125-123 Ma; Elije Volcanics, or Shen Ramon Gavnunim igneous rocks); (3) Late Aptian-Albian (116.5-108 Ma; Ramon Volcanics); (4) Cenomanian (99-95.4 Ma; Carmel Volcanics); and (5) Campanian (82 Ma). Events 1-4 are attributed to Cretaceous mantle plume (Levant–Nubian) activity that affected the Levant region. Igneous rocks of these events are distributed mainly over an area of c. 800×200 km in outcrops and in the subsurface of Israel, Syria, Lebanon, Jordan, Sinai and the Eastern Desert of Egypt, comprising various volcanic sequences and small hypabyssal intrusions.

The majority of volcanic eruptions in Mt Carmel were explosive, and in Umm El Fahm effusive. They took place in four separate phases, from the Latest Albian to the Late Cenomanian, and a single Campanian event. Three of the volcanic phases were active at the beginning of sedimentary cycles/formations: V1 (Maharal) - Isfiye Fm, V2 (Tavasim) - Arqan/ Zikhron Fms, and V4 (Shefeya) - Bina/Sakhnin FMs, respectively, and one (V3-Raqefet) in the middle of the Zikhron Formation. The four Cenomanian volcanic phases were 40Ar/39Ar dated to: 99.0±1.0 Ma; 98.2±1.1Ma; 96.7±0.6Ma and 95.4±0.5Ma. The uppermost volcanic phase (V5) occurs within the Senonian En Zetim Fm and is K-Ar dated to 82.0±1.3Ma. The volcanic rocks in Ein HaShofet borehole in Ramot Menashe have a cumulative thickness of ~240 m, indicating that the volcanic intercalations of Mt Carmel and Umm El Fahm on both sides of this borehole are well correlated. This thick volcanic section clearly points to this region as the center of the Carmel Volcanics. The pyroclastic volcanoes formed relatively small cones, which protruded from the sea during their activity. Upon cessation of volcanism, their subaerial and shallow submarine parts were rapidly removed by erosion and abrasion, and atolls developed on top of the abrasion surfaces. The estimated water depth at the beginning of the volcanic activity was ~65 m. The first and fifth volcanic phases in Mt. Carmel consist of altered gray tuff containing mainly xenoliths of garnet clinopyroxenites, amphibole and garnet xenocrysts. The interpretation of Kaminchic et al. (2014) suggests that these xenoliths were crystallized as cumulates from OIB basaltic melts within the lithospheric mantle (40-45 km depth, or ~90 km according to Mittlefehldt, 1986). It appeared during upwelling of mantle plume at the end of the Pan-African orogenesis or during the Early Mesozoic breakup of Gondwanaland. Some of these xenoliths were recrystallized during a younger reheating event, before their capture by the Late Cretaceous magma that brought them to the surface.

# Geochemical evidence for biogenic methane production and consumption in shallow sediments of the SE Mediterranean shelf (Israel)

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This study presents geochemical evidence for biogenic methane formation (methanogenesis) in the shallow sediments of the oligotrophic SE Mediterranean continental shelf at water depths of between 46 and 88 m. Depth-profiles of methane concentrations and related chemical parameters such as dissolved sulfate, dissolved inorganic carbon (DIC), and the stable carbon isotope composition of DIC and methane (δ13CDIC, δ13CCH4, respectively) were measured in six sediment cores (4.2-5.4 m long) to quantify the processes involving methane production and anaerobic oxidation (AOM). Sulfate reduction carried out to completion in all sediment cores and in-situ microbial methane production (methanogenesis) was detected in all sediment cores in different depths. Methane concentrations reached saturation levels in one of the cores, and might have in the others at greater depths, within the zone of maximum methanogenesis. δ13C of methane exhibited depleted values of -80 to -100‰ in all cores a strong indication for biogenic production from H2/ CO2 pathway. Anaerobic oxidation of methane (AOM) was also evident in the sulfate-methane transition zone, showing a distinct isotope signature, and diffusion limited conditions.

# Holocene geomagnetic field is changing faster and stronger: knowns, unknowns, and possible impacts

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The behavior of the geomagnetic field, the geodynamo driving it, and its impact on the atmosphere and possibly climate, make it one of the great puzzles in Earth sciences. Over the past few decades our knowledge on the behavior of the geomagnetic field has increased dramatically. Yet, while a significant focus has been given to global events on long-term geological timescales, such as, for example, reversals, less attention has been given to the past several millennia. Thus, until very recently, the Holocene has been considered as a relatively "quiet" epoch with only minimal spatial and temporal geomagnetic variations. However, new data from archaeological and sedimentary sources shift this paradigm toward a more realistic and complicated picture.

In this presentation I will review the current status of our knowledge and the open questions in the field. I will present the most up to date status of "Levantine Archaeomagnetic Compilation" (LAC), a community effort to compile together paleomagnetic intensity data from Israel and nearby countries. The "LAC" data indicate that the field is changing much faster and much stronger than previously assumed. A comparison with the global data reveals some intriguing extreme spatial variations. The question of whether these variations can be linked to variations in the atmosphere and possibly climate is a highly debated issue.

# Characterization of saline groundwater across the coastal aquifer of Israel as resource for desalination

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In arid countries with access to marine water seawater desalination is becoming an important water source in order to deal with the water scarcity and population growth. Seawater reverse osmosis (RO) facilities use open seawater intake, which requires pretreatment processes to remove particles in order to avoid fouling of the RO membrane. In small and medium size desalination facilities an alternative water source can be saline groundwater in coastal aquifers. Using saline groundwater from boreholes near the shore as feed water may have the advantage of natural filtration and low organic content. It will also reduce operation costs of pretreatment. Another advantage of using groundwater is its availability in highly populated areas, where planning of large RO desalination plants is difficult and expensive due to real-estate prices. Pumping saline groundwater underneath the freshwater-seawater interface (FSI) might shift the interface towards the sea, thus rehabilitating the fresh water reservoirs in the aquifer. In this research, we tested the potential use of saline groundwater in the coastal aquifer of Israel as feed water for desalination using field work and desalination experiments. Specifically, we sampled the groundwater from a pumping well 100 m from the shore of Tel-Aviv and sea water from the desalination plant in Ashqelon. We used an RO cross flow system in a pilot plant in order to compare between the two water types in terms of permeate flux, permeate flux decline, salt rejection of the membrane and the fouling on the membrane. The feed, brine and fresh desalinated water from the outlet of the desalination system were chemically analyzed and compared. Field measurements of dissolved oxygen, temperature, pH and salinity were also conducted in situ. Additionally, SDI (silt density index), which is an important index for desalination, and total organic carbon that has a key role in organic fouling and development of biofouling, were measured and compared. The results have shown that using saline groundwater underneath the FSI as a resource for RO desalination process is beneficial in terms of fluxes: the flux reduction in the seawater desalination was 16% of the initial flux, while the flux reduction with the saline groundwater was only 9%. The SDI and total organic carbon were lower in saline groundwater than in seawater, which support the flux results. Therefore, using saline groundwater as feed water for desalination may be advantageous because of lower operational costs and reduced applied pressure needed and energy usage.

# Medical use of stable isotopes

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Atoms of the same element can have different numbers of neutrons; the different possible versions of each element are called isotopes. For example, the most common isotope of hydrogen has no neutrons at all; there's also a hydrogen isotope called deuterium, with one neutron, and another, tritium, with two neutrons.

# $\delta^{88/86}Sr$ and $^{87}Sr/^{86}Sr$ as combined tracers of the evolution of continental strontium, examples of soils and carbonates from Israel

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Fluxes of Sr in continental environments, from weathering of rocks, through soils and dust formation, to accumulation and precipitation in rivers and lakes, have traditionally been evaluated using the radiogenic ratio of 87Sr/86Sr. This ratio is a sensitive proxy for material provenance and mixing between Sr sources. The developments in mass spectrometry enabled determining minute variations in the stable Sr isotopes ratio, 88Sr/86Sr (expressed as δ88/86Sr), opening the opportunity to study geochemical processes involving fractionation of Sr isotopes. The previous attempts of using stable and radiogenic Sr ratios (δ88/86Sr and 87Sr/86Sr) simultaneously, demonstrated their potential for quantifying the marine Sr cycle and help in understanding the global carbon cycle (e.g. Krabbenhöft et al., 2010). This study describes an attempt of applying the dual Sr isotopes system to continental environments. The Sr isotopic compositions (δ88/86Sr and 87Sr/86Sr) of sedimentary continental materials were measured in several settings including: soils, their carbonate bedrocks and the parent desert dust, speleothems, tufas, lacustrine aragonite precipitates and various water types. The isotopic measurements were conducted by double-spike MC-ICP-MS (Shalev et al., 2013). The results showed that Sr isotopes fractionate during Ca-carbonate precipitation in continental environments, producing 88Sr-depleted carbonates ($\Delta^{88/86}Sr_{carb\text{-}water}$ = -0.20±0.08‰, 2SD, n=5), whereas the 87Sr/86Sr ratio remains almost unchanged. The soils did not show significant fractionation in stable Sr isotopes and their δ88/86Sr values remained similar to those of the parent materials. On the other hand, 87Sr/86Sr ratio varied dramatically probably due to preferential leaching of the less radiogenic minerals. The results suggest that the dual isotope systems of Sr may be used to identify processes in the evolution of continental materials such as soils, freshwater and dust, as it enables differentiation between mixing and precipitation processes.

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# Manganese-Bearing Black Painted Bands in Decoration of Late Bronze Age Canaanite Pottery, Tel Esur, Israel

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The black painted bands and the ceramic body of Canaanite pottery excavated at Tel Esur, on the western entrance of Nhhal Iron, were chemically analyzed by using pXRF (Portable X-ray Fluorescence Spectroscopy). The pXRF method enables analysis of the thin painted bands directly on the surface of the vessels. According to the results, the black painted bands consist of manganese-bearing pigment rich in iron oxide; indicating the utilization of black ferromanganese pigment ore for raw material. In contrast, the ceramic body of the vessels is rich in silica and alumina and contains lesser concentrations of iron oxide and only trace of manganese; which is in accordance with the use of local clays for production of the vessels themselves.

Practically, a source for black ferromanganese pigment ore is not found in vicinity to Tel Esur or anywhere else along the coastal plain of Israel. Thus, for painting in the Canaanite workshops the black pigment was brought from external ore source. As a comparison, in Cyprus the use of ferromanganese pigment ore (Cyprus umber ore) for black painting of Late Bronze Age Cypriot pottery is well known. These black painted Cypriot ceramic include the milk bowls group that were imported to Canaan and found together with the black decorated Canaanite pottery at Tel Esur. The black decorations on the Canaanite pottery and on the Cypriot milk bowls imports at Tel Esur has similar composition. This may indicate that for black painting the Canaanite workshops utilize an imported ferromanganese pigment from Cyprus.

# Simulation of Seismic-Wave Propagation during the 1927 M 6.2 Jericho Earthquake

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The Dead Sea Transform (DST) is the major seismic source in Israel and neighboring countries capable of producing up to M 7.5 earthquakes known from geological, archeological and historical records. However, due to low seismicity rate, strong earthquakes and their ground motions were not recorded in Israel. The last major earthquake on the terrestrial part of the DST was the 1927 M 6.2 Jericho event, resulting in numerous casualties and extensive structural damage.

In absence of recorded ground motions we concentrate our efforts on forward numerical modeling to estimate the ground motions during strong earthquakes. A reliable ground motion prediction must account for site, path, and source effects. Assessment of site effect, which mainly depends on near-surface material, and assessment of path effect, which depends on the deeper geological structure, is constantly improved by geotechnical, geological and geophysical investigations. Contrarily to these two effects, which remain constant for a given area of interest, the earthquake rupture process and geometry varies from one earthquake to the other. To this end we have developed the Distributed Slip Model (DSM), a generic, physical finite fault source with a smooth “pseudo-Gaussian” slip distribution on an elliptical rupture patch.

In this study we compare the numerical ground motion predictions, using the DSM, with the intensity observations from the Jericho event. We calculate the Modified Mercalli Intensity (Imm) using the Wald et al., (1999) relations and compare our results with the intensity data published by Avni et al., (2002) and Zohar and Marco (2012).

This task is a necessary step toward a reliable ground motion prediction in the state of Israel and in other earthquake-prone areas with low seismicity rate and limited instrumental coverage.

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# Oligocene to late Miocene erosional and depositional processes in the southeastern part of the Levant basin, Offshore Israel

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Tectonic and eustatic changes that were initiated during the Early Oligocene resulted with the development of three major submarine canyons (Afiq, El-Arish and Ashdod) in the southeastern margin of the Levant basin. This study focuses on the evolution of the Afiq submarine canyon in pre-Messinian time. Integration of 2D and 3D seismic data with borehole data allows interpreting five erosional surfaces that are associated with canyon incision in the study area.

Mapping of the erosional surfaces indicates that during the Early Oligocene the Afiq canyon was less developed then the El-Arish and Ashdod canyons. The incision in Afiq intensified in the Early Miocene and in the early Late Miocene, when the erosion had cut deeper, partly removing older incisions surfaces. The youngest surface mapped in the study area is the base Messinian “N” horizon, which shows similar erosional pattern as the older surfaces. Despite the fact that during the Messinian the amount of see-level drop was higher than in earlier periods, the base Messinian surface displays relatively minor incision of the Levant slope.

Seismic facies and seismic attribute analysis of the intervals between the interpreted incision surfaces had allowed identifying several depositional patterns, such as channel-levee systems in the canyon-fill. Integration of our results with previously published models helps to set constrains on the erosional and depositional processes that shaped the southeastern Levant slope. The results further contribute to the understanding of the Levant deep-water system in the Early Oligocene to late Miocene, and support hydrocarbon exploration activity in the southeastern Levant basin.

# A Geochemical Map of the Eastern Higher Galilee Area

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A geochemical map of the Eastern Higher Galilee area is presented, based on stream sediment sampling at a density of ~ 1 sample/1sq.km, including the eastern shores of Lake Kinneret. The samples (sieved to minus 100 mesh) were analyzed for some 30 major and trace metals using ICP-AES and ICP-MS following digestion with Na2O2. The spatial distribution of the metals usually depicts the geochemistry of the outcropping rock units. Unusual concentrations of Cd, Zn, Ni were found in the northern part of the survey area (near the Lebanese border) and those are attributed either to past aerial application of fire retardants or to phosphate-rich Dietary Supplements which are common in cattle corrals throughout the area.

Since the study area comprises a major part of the Kinneret drainage basin, the collected database can serve as a means to asses metals input into the lake.

# Poroelastic Modeling of Organic-Rich Chalks from the Shefela Syncline

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We report the effects of porosity and total organic carbon (TOC) content on the mechanical behavior of organic-rich chalks from the Senonian Ghareb and Mishash formations. This deposit is an immature oil-prone source rock, about 300 meters thick, situated at shallow depths (several hundreds of meters) in the Shefela basin in central Israel. The study is based on core data collected from the Zoharim borehole and tests performed at the Rock Mechanics Laboratory of Ben-Gurion University.

Three main phases comprise the bulk volume of the studied rocks: 1) carbonate mineralogical phase (predominantly calcite), 2) fluid-filled pores (mostly saturated with brine), and 3) solid organic phase (type IIS kerogen). Using porosity and TOC measurements, volumetric fractions of mineralogical and organic phases were obtained. Dynamic elastic moduli of brine-saturated core plugs were measured using ultrasonic velocity measurements on 1 inch diameter cylindrical plugs, oriented orthogonal to the bedding plane. Comparison between the bulk modulus of brine-saturated rock and volumetric fractions of the three phases highlighted the mechanical effects of porosity (23-45%) and TOC (4-19%). The brine-saturated rock bulk moduli correlated best with the volume-sum of kerogen and pores, rather than each of them separately. Poroelastic modeling of the organic-rich chalk was made using the Hashin-Shtrikman upper and lower bounds of the bulk moduli ignoring anisotropic effects for now. Based on Marion's Bounding Average Method (BAM), the normalized stiffness factor of the chalk was $w \sim 0.2$, indicating a soft pore geometry. Using the normalized stiffness factor, BAM predictions showed good correlation with the measured saturated rock bulk modulus. Fair correlations were obtained using the fluid substitution Biot-Gassman model as well, yielding a relatively high Biot coefficient ($\beta \sim 0.9$).

Based on our findings, the overburden pressure is mainly supported by the mineralogical phase and the thermally immature kerogen contributes weakly to the compressibility of the chalk. We also propose here a method for calculating the Hashin-Shtrikman bounds based on porosity and TOC measurements. The mechanical effects of porosity and TOC shown here are very important for understanding the influence of immature kerogen in highly porous chalks, as in the Ghareb and Mishash formations. We believe that the effects of porosity and TOC content on the mechanical behavior of the rocks observed here are pertinent to many other low-maturity organic-rich chalks elsewhere. The poroelastic coefficients obtained here make possible the determination of fluid saturations from acoustic well logs and seismic data.

# Tales of a submerged landscape: the last Glacial-Interglacial cycle sequence using high resolution seismic data from the central coast of Israel

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Sea-level changes are a dominant mechanism that controls coastal environmental changes through time. Regressions and transgressions over the last glacial-interglacial cycle shaped the deposition, preservation and erosion patterns of unconsolidated sediments currently submerged on continental shelves. The current study focuses on creating an integrated geophysical and stratigraphic framework off Hadera, in the north-central continental shelf of Israel. This research aims to serve as a test case for addressing the true complexities of the response of coastlines to sea-level changes, and provide guidance for future national strategic infrastructure construction, archeological research, and natural landscape preservation.

A multi-disciplinary approach was applied by compiling existing elevation raster grids, single beam bathymetric charts, sixty lithological bore-hole data-sets, and a 110 km long subsurface geophysical survey. Based on seismic stratigraphy analysis, stratigraphic superposition, observed geometries, and reflective appearances, six bounding surfaces and five seismic facies were identified and characterized. The seismic facies were then correlated to litho-facies based on the corresponding boreholes. The first two units consist of brown to red clayey sand, which are overlaid by two dark silty clay deposits and topped by a quartz sand facies. This entire sequence superimposes a calcareous aeolianite sandstone unit, which is interpreted as the top of the middle to late Pleistocene Kurkar sequence. These litho-facies were then correlated with a time constrained chrono-stratigraphy in addition to observed reflection geometries, the elevation of the unit bases and corresponding terrestrial units identified by previous works. These together allowed us to constrain the litho-facies relation to sea-level changes and enabled the reconstruction of Hadera coastal evolution through time.

We suggest that the lower clayey sand units were deposited in a terrestrial environment on the exposed shelf during regression and very early stages of the transgression. This sequence was accompanied by pedogenesis and creation of paleosols. The subsequent two units were deposited in a low energy fresh to brackish shallow water body during a transgressive interval. At that time, the western part of the research area was occupied by a wetland, probably fed mostly by an elevated groundwater aquifer, while the eastern part was a fluvial plain fed by the ancient course of the Hadera River. Reconstructed paleo-channels are suggested to represent the flow pathways of the latter to the western wetland area. The topmost sand was deposited following flooding of the shallow shelf at the end of the transgression and its burial by longshore driven sand supply proceeding from the Nile Delta.

# Accelerated weathering of carbonate rocks following the 2010 forest wildfire on Mt. Carmel, Israel

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Massive destruction of carbonate rocks occurred on the slopes of Mt. Carmel, during the severe forest fire in 2010. The bedrock surfaces exhibited extensive exfoliation into flakes and spalls covering up to 80%–100% of the exposed rocks; detached boulders were totally fractured or disintegrated. The fire affected six carbonate units composed of various types of chalk, limestone, and dolomite. The burned flakes show a consistent tendency towards flatness, in all lithologies, as 85%–95% of the flakes were detached in the form of blades, plates, and slabs.

The extent of the physical disruption depends on rock composition: the most severe response was found in the chalk formations which are covered by calcrete (Nari crusts). These rocks reacted by extreme exfoliation, at an average depth of 7.7 to 9.6 cm and a maximum depth of 20 cm. Scorched and blackened faces under the upper layer of spalls provide strong evidence that chalk breakdown took place at an early stage of the fire.

The extreme response of the chalks can be explained by the laminar structure of the Nari, which served as planes of weakness for the rock destruction. Three years after the fire, the rocks continue to exfoliate and break down internally. As the harder surface of the Nari was removed, the more brittle underlying chalk is exposed to erosion.

# The influence of flash-floods on subsidence rates and volumes in sinkholes sites along the Dead Sea: Insights from high resolution InSAR

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Sinkholes and sinkhole-related subsidence constitute major geo-hazards along the Dead Sea shores challenging both existing infrastructure and future development plans. Sinkholes generation is attributed to the dissolution of a subsurface salt layer by under-saturated groundwater. We use high resolution radar interferometry (COSMO SkyMed - 3x3 m per pixel, $\lambda$=3.1 cm) integrated with stream gauge and rain data to quantify the effect of flood water on subsidence in the vicinity of sinkholes and examine its spatial and temporal variability.

During the past 3 years we measured subsidence rates and volumes in several active sinkhole sites. The sites include the outlets and alluvial fans of Darga-Hazazon, Arugot, Hever, Zeelim and Rahaf channels. For each site, a time series of interferogram-derived subsidence was constructed, bracketing major flood events and intra-flood periods. Subsidence rates in sinkhole sites increase dramatically by a factor of 2-5, from rates of ~0.3-1 mm/day in the dry season to above ~2 mm/day following flood events, and decay subsequently in the following weeks to months. Subsidence volumes vary in a similar manner. In Zeelim, Hever and Hazazon fans, subsidence sites that were inactive during the dry season, became active following the flood events. In addition, a significant increase in the subsidence area (by a factor of ~2-7) was observed following floods. This seasonal increase is super-positioned on a multi-year trend of gradual increase in the subsidence area.

As expected, the observed influence of flood water is greater on sites located at, or near active channels. The major mechanism for flood-dependent subsidence acceleration is a dramatic increase in the dissolution rate of the subsurface salt layer immediately after flood events. In many locations flood water drain rapidly and efficiently through existing and newly formed in-channel sinkholes. In addition, regardless of the infiltration mechanism, floods contribute to raising the regional groundwater level causing a subsequent increase in subsidence rates during the following months also in off-channel sites, which in some cases continue into the summer periods. When the groundwater level drops the subsidence rate gradually decelerates. We also suspect that the groundwater flow pattern is dictated by the course of buried paleo-channels and can thus have a focused effect on salt dissolution.

# Oxygen isotope composition of Sparidae (sea bream) tooth enamel from well-dated archaeological sites as an environmental proxy in the East Mediterranean: A case study from Tel Dor, Israel

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This study examines the potential of oxygen stable isotope composition of Sparidae (sea-bream) tooth enamel phosphate ($\delta^{18}O_P$) as an indicator of the habitat in which the fish were captured. The isotopic compositions of Sparidae pharyngeal teeth recovered from the coastal site of Tel Dor (northern coast of Israel), from a sequence dated to the 12th–7th centuries BCE were compared with modern specimens from two different habitats: the Southeast Mediterranean littoral and the Bardawil lagoon of north Sinai, Egypt. The $\delta^{18}O_P$ values of the archaeological specimens exhibited a wide range of values, varying between 21.3 and 25.2±0.2‰. The older specimens, dated to the 12th–9th centuries BCE, indicate tooth enamel deposition in typical East Mediterranean coastal water, while some of the later teeth, dated to the 9th–7th centuries BCE, indicated tooth enamel deposition in a hyper-saline environment. This study discusses two possible sources for the Sparidae carrying heavy isotopic signature: local, short-lived lagoons or indication to trade with Egypt/northern Sinai through the long-lived Bardawil Lagoon.

# Alkali basalts from the Golan and Galilee - signal from the early differentiation of the earth mantle

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Alkali basalts that erupted over the Golan and Galilee (GG) during the Neogene-Quaternary times are characterized by geochemical and radiogenic isotope compositions (e.g. Nd-Sr-Pb) that resemble many "OIB basalts" and are distinctly different from "MORB-type" basalts that erupted on the Red Sea floor. The GG alkali - basalts were interpreted as melting products of the Arabian lithospheric-mantle (Weinstein et al. 2006). This lithosphere, in turn was regarded as a "fossilized mantle wedge" whose chemical composition was shaped during the late Proterozoic subduction – related magmatic and metasomatic processes at the Arabian-Nubian Shield (Stein et al., 1997). The Nd-Sr isotope compositions of the GG basalts resemble many other Cenozoic alkali-basalts from various continental volcanic fields over the old Gondwanaland. Thus, it appears that the late Proterozoic uppermost mantle comprised an enriched Nd-Sr isotope reservoir. While this enrichment was related to "plume magmatism" (Stein and Hofmann, 1994) the mechanism of its production in the mantle remained largely unclear. Recent discoveries in isotope geochemistry such as 142Nd anomalies and the compositions of Hf isotopes in zircons shed new light on the origin of this common enriched basalt source. In the talk I will review these data that indicate a link between the Golan-Galilee basalts and early differentiation of the earth mantle.

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# Basin scale estimates of pelagic and coral reef calcification in the Red Sea and Western Indian Ocean

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Basin scale calcification rates are highly important in assessments of the global oceanic carbon cycle. Traditionally such estimates were made based on rates of sedimentation measured with sediment traps or in deep sea cores. Here we estimated CaCO3 precipitation rates in the surface water of the Red Sea from total alkalinity depletion along their axial flow using the water flux in the straits of Bab el Mandeb. The relative contribution of coral reefs and open sea plankton were calculated by fitting a Rayleigh distillation model to the increase in the strontium to calcium ratio. We estimate the net amount of CaCO3 precipitated in the Red Sea to be 7.3±0.4·10^10 Kg•y-1 of which 80±5% by pelagic calcareous plankton and 20±5% by the flourishing coastal coral reefs. This estimate for pelagic calcification rate is up to 40% higher than published sedimentary CaCO3 accumulation rates for the region. The calcification rate of the Gulf of Aden was estimated by the Rayleigh model to be ~1/2 of the Red Sea and in the northwestern Indian Ocean it was smaller than our detection limit. The results of this study suggest that variations of major ions on a basin scale may potentially help in assessing long-term effects of ocean acidification on carbonate deposition by marine organisms.

# The interaction between a multi-layer coastal aquifer and the sea and the impact of surface reservoirs (fish ponds) on this system

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We studied the aquifer-sea relations at Maagan Michael (southern Carmel coast) and the impact of surface reservoirs (fish ponds) on this system. The Quaternary aquifer in this area is sub-divided into three units – one phreatic (unit A) and two confined (units B and C). We used marine seismic survey (CHIRP) to study the geological structure under the sea. On the terrestrial side, water level and water chemistry was studied and monitored in all three sub-aquifers in both existing and new boreholes. Seawater intrusion was mapped by TDEM survey and monitored manually (EC profiling) and continuously by CTD-divers. Water chemistry and isotopic composition was used to evaluate the effect of the fish ponds on the various aquifer units. A numerical model with the FEFLOW code, used for the quantitative assessment of the various sub-aquifers of the Pleistocene aquifer and the sea. In addition, the model was used to examine the relation between the Upper Cretaceous and the Pleistocene aquifers.

Water chemistry suggests that the component of the pond water in the Kurkar aquifer (units B and C) is not more than 15-20%, whereas in the upper phreatic sand aquifer it is almost 100%. This is due to a clay layer that efficiently separates the sand unit from the Kurkar aquifer. The level in the phreatic unit is 0.5 – 3 m higher than in the confined Kurkar aquifer. The Judea (Yarqon-Taninim) aquifer was found to be the main source of water for the Pleistocene aquifer in the Maagan Michael area. Preliminary numerical simulations indicate the good connection between the Kurkar and the Judea aquifers, whereby an increase in pumping from the Kurkar aquifer results in a decreased groundwater flow to the sea and an increased flow from the Judea aquifer.

The submarine CHIRP mapping indicates that while at the southern site the upper clay is truncated next to shore [100 m], at the northern site the clay is continuous to at least 1000 m from shore. In the numerical model, this resulted in different extent of seawater intrusion in the [shallow] confined layer. While at the southern site, the interface reached the observation well 70 m from shore just few years after pumps as began; at the northern site the water is completely fresh at this distance from shore (interface only arrived few years later). These results are consistent with those of the TDEM that show relatively fresh groundwater in unit B of the northern site while saline water in the southern site. In both sites, a slow penetration of seawater in unit C was observed in the simulations, which did not reach the shoreline. This, too, is in agreement with the TDEM and chemical data that show relatively fresh water in unit C.

# Master Plan for Utilization of Floodwater in Central Arava and Kikar Sedom

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During the period 1975-1998 six floodwater reservoirs were constructed in central and northern Arava, in most cases at the initiative of the Jewish National Fund and under its management. The first reservoir, constructed in 1975, was Nekarot, followed by Eshet (1986), Tzukim (1994), Idan (1997/98), Neot Tmarim (1997/98) and Hatzeva (1998). The total potential storage capacity of the reservoirs is about 10 million cubic meters. Construction of the reservoirs was prompted by the understanding that floods reaching the Sedom salt pan were lost from the utilizable volume and that it would be worth attempting to retain flood flows in the Arava Stream in order to intensify artificial recharge in the upstream sections, in the vicinity of the consumers and existing production facilities (wells). Over time doubts began to be expressed regarding the efficiency of the reservoirs. Pumping systems were installed in some of them to enable direct use of the water in agriculture.

Floodwater utilization schemes are mostly complex in nature, are difficult to operate and manage, and necessitate considerable investments in ongoing maintenance. Some of the familiar problems associated with the operation of such schemes are even intensified by the conditions prevailing in the Arava Region of Israel.

The Israel Water Authority requested that an analysis be conducted of the performance of the reservoirs over time and that ways be identified to improve floodwater utilization in the region.

The master plan focused in the first stage on updating data on the hydrological and operational conditions of the floodwater reservoirs in the Arava. Within this framework the design volumes of surface runoff were calculated for each reservoir, including the relative contribution from both sides of the Rift Valley – the western watershed (Israel) and the eastern watershed (Jordan). For each reservoir an in-depth examination was conducted of the relationship between reservoir water, floodwater and groundwater, as well as the hydrological benefit obtained from each of the reservoirs. Work in the second stage focused on a techno-economic analysis of various alternatives for improving the floodwater utilization systems. To this end five principal alternatives were defined for investigation:

Alternative I – maintaining the status quo
Alternative II – demolishing the reservoir and restoring "natural" conditions
Alternative III – suspending ongoing maintenance of the reservoir
Alternative IV – improving controlled release of the water and artificial recharge downstream
Alternative V – utilizing reservoir water directly

Relevant alternatives for investigation were defined for each of the six reservoirs. An analysis was conducted of the incremental water expected vs. the investments required, and recommendations were made regarding the preferred alternative.

# The potential of Natural Methane Hydrates occurrence in the southeastern Levant

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This study investigates the possible occurrence of Natural Methane Hydrates (NMH) in the Southeastern Mediterranean Sea (SEMS), incorporating modeling techniques and seismic interpretations from five 3D-seismic surveys. The search for a NMH in the SEMS was sparked by our observation of a regionally discontinuous band of high, and in many cases negative phase, seismic reflectivity (HSR) in the shallow deep sea sediments in all of the 3D-seismic blocks investigated. Such reflectivity is commonly associated with the occurrence of free gas within the sediment. Moreover, this band of reflectivity underlies several sites of active methane seepage that were investigated during the 2011 E/V Nautilus cruise offshore Israel, and actually served as a basis for their discovery. Several pockmark structures identified in the seismic data are added to the sprouting picture of an extensive shallow gas system in the SEMS. Furthermore, several observations of NMH were recently reported from other localities in the EMS. A Methane Hydrate Stability Zone (MHSZ) was modelled as a function of pressure-temperature-salinity using the CSMHYD modeling routine of Sloan (1998). Our MHSZ prediction model for the SEMS is based on three approximations: sediment pore pressure is hydrostatic; water temperatures and salinity at depths >1 km are 13.8°C and 38.8‰ respectively; the sediment temperature increases linearly with the geothermal gradient. Our model predicts that the top MHSZ is located at a water depth of 1240 m. This falls in agreement with the existing evidence of NMH in the EMS such as nodular NMH cored in mud volcanos around the Anaximander seamount, with the shallowest sample located at a water depth of 1264 m. Moreover, hydrates were recently observed forming on the surface of hydrocarbon bubbles collected from gas seeps in the Nile deep sea fan, and dissociate as they were brought up to a water depth of 1350 m, in agreement with the prediction of the top MHSZ boundary of our model for the same published gas composition and local P-T conditions.

In order to evaluate the quantitative correlation between the modeled MHSZ and the HSR we have picked 294,848 points representing the HSR using Paradigm software. An average of 93% of the picks at water depths >1240 m were found to reside within an average of 45 m below the base of the MHSZ, confirming a positive relation between the modeled MHSZ and the observed HSR. We suggest that methane gas appearance and migration processes in the shallow deep sediments of the SEMS are possibly controlled by an extensive NMH system that was previously overlooked. This, in congruence with other reported Mediterranean NMH occurrences, implies a probable and substantial NMH reservoir with a direct impact on carbon budget estimations, climatic modeling and economic resources.

# Corundum, Moissanite and Super-Reducing Conditions in the Upper Mantle Beneath the Lower (southern) Galilee (Israel)

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B"H

Over the past 14 years, Shefa Yamim's exploration for gem and heavy minerals in the Kishon and Zippori River catchments, on Mt Carmel and in the Menashe Hills of northern Israel, has led to the discovery, in volcanic rocks and secondary alluvial deposits, of an unusual association of xenocryst minerals. This includes, inter alia, diamond, zircon, rutile, ilmenite, garnet, corundum (sapphire, ruby and non-gem corundum (NGC)) and the largest known crystals (4.1 mm) of the rare gem mineral, moissanite (SiC). The relationships among these xenocrysts are not yet clear; we report here initial findings on the corundum species and their possible link to the moissanite in the primary occurrences. Crystals of ruby and sapphire show weak cathodoluminescence (CL) with some local oscillatory zoning; each grain appears to be a single crystal. Analyses of minor and trace elements (EMP, LA-ICPMS) show that ruby is characterized by high Cr2O3 (1.6% average), but low Fe, Ti and V (16, 16 and 4 ppm, respectively). Sapphire, in contrast, contains on average 1% FeO, 280 ppm Ti and 61 ppm V, but only 260 ppm Cr. Darker-blue sapphires generally are richer in Ti and Mn than lighter-blue varieties. In these characteristics, the ruby and sapphire are similar to corundum megacrysts found in alkali basalts in e.g. E. Australia, Thailand and E. China.

The colourless to pale brown NGC "megacrysts" are granular aggregates with irregular melt pockets along grain boundaries. The melt pockets contain a unique mineral assemblage indicative of very low oxygen fugacity (fO2), including inter alia native Fe, Ti and Si and Fe3Si. The NGC contains essentially no Cr or Fe, but high levels of Ti (up to 2.8 wt% expressed as TiO2). It also shows striking, highly irregular CL patterns; very bright CL correlates with low Ti, whereas the highest Ti contents completely extinguish the CL. Ti contents increase toward the melt pockets, and stoichiometry suggests the substitution of Ti3+ in the corundum.

It is not yet clear whether the melt pockets represent residual melts after the precipitation of corundum, or the introduction of a foreign melt phase into pre-existing corundum. However, the presence of native Ti in the melt pockets and other inclusions in the NGC indicate extremely low fO2, >8 log units below the Iron-Wustite buffer commonly accepted as the defining the minimum fO2 in the upper mantle. These fO2 levels are low enough to stabilize moissanite (SiC), and suggest a genetic link between the SiC and the reduced melts trapped within the NGC. The processes that have generated these super-reducing conditions, and the role of corundum crystallization in these processes, remain unclear; the Mt Carmel mineral associations thus hold the keys to some important petrological problems.

# High Pressure Indicator Minerals from the Rakefet Magmatic Complex (RMC), Mt. Carmel, Israel.

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The RMC is one of a cluster of volcanic diatremes proximal to the Dead Sea Transform. Following the discovery of diamond by SY, surface sampling as used in diamond/kimberlite exploration produced abundant upper-mantle indicator minerals or "KIM"s (garnet, clinopyroxene, ilmenite, chromite, mainly in the 0.3 to 1.0 mm size range but with a maximum size of 20mm+ recovered).

A rock sample (260kg) also produced these KIMs and a micro-diamond. The volcanic host rock is petrographically described as 'kimberlite', 'alkali-tuffite', or 'something in-between'.

The tectonic setting is unusual for primary diamond deposits, and the indicator mineral chemistry has been used to ascertain host petrology and nature of the upper mantle. SEMQ analyses are presented in several diagrams commonly used in kimberlite-related diamond exploration.

**Garnets** show two populations: eclogitic (predominant) and peridotitic-lherzolite (lhz). No sub-calcic (G10) garnets occur. Lhz varieties (G9) have low $Cr_2O_3$ (<<2wt%) and consistent Mg# (~0.84); the $Cr_2O_3$ vs Ca0 plot suggests pressures above 20.2 kb (~60km); a calcium projection of 4-5 wt% CaO suggests a shallow peridotitic mantle. However, the $TiO_2$ vs Na2O pressure proxy for eclogitic garnets (G3/4) shows $Na_2O$ >0.07wt%, indicating potential pressures in the diamond stability field.

**Chromite** $Cr_2O_3$ vs MgO by $TiO_2$ implies a shallow upper-mantle peridotite source. The absence of 'diagnostically kimberlitic' high-TiO2 populations suggests little interaction between source magma and peridotite.

Lherzolitic **clinopyroxene** (cpx) compositions as Na vs Ca + Al (6 oxygens) and variations of $TiO_2$ and Mg# indicate upper-mantle spinel/garnet lhz. Thermobarometry gives ~75 to 110 km at ~900 °C on a ~45mW/m$^2$ model geotherm. By comparison, the marginal/off-craton weakly diamondiferous Gibeon kimberlite cluster (Namibia) is from a slightly deeper but hotter lherzolitic upper mantle. Neither suggests a peridotitic diamond source. RSA diamond mine cpx illustrate a typically diamondiferous cratonic model at ~40mW/m2.

The **ilmenite** $TiO_2$ vs MgO plot is useful as an indicator of host-rock paragenesis. Mt. Carmel ilmenites show 'kimberlitic to para-kimberlitic' derivation with typical megacryst compositions ($Cr_2O_3$, $Al_2O_3$, MgO ).

Abundant **moissanite** and **corundum** also occur as indicator minerals. Natural moissanite is restricted to mantle and meteorite origins whilst 'kimberlitic' corundum occurs in eclogite xenoliths and diamond inclusions.

Upper-mantle indicator-mineral xenocrysts from the Mt Carmel volcanics are compatible with kimberlitic sources, and peridotitic indicators are consistent with remotely sensed lithosphere

depths (~100 km). The thin peridotitic lithosphere precludes the presence of diamond, but an eclogitic component suggests higher pressures approaching the diamond window. The eclogite may be derived from 'carbonated' asthenosphere ponded/stacked below the peridotitic lithospheric plate.

Other similar deep-seated (lithosphere/asthenosphere boundary), proximal plate-boundary volcanic sources may include the unusual volcanic diatremes in Syria and in the Luangwa rift valley in Zambia, which contain rare diamonds.

# A transient fluvial placer in the mid reach of the kishon valley, northern israel: initial results of follow-up exploration

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Shefa Yamim has developed a "source to sink" geological model (sensu Bluck et al.,2005; Toledo et al.,2014) to guide their exploration campaign for gem and heavy industrial minerals in both primary volcanic occurrences and secondary alluvial deposits within the Kishon catchment of northern Israel. The gem minerals are diamond (D), moissanite (M) and the corundum varieties (C) of sapphire and ruby (the DMC suite), with the heavy industrial minerals comprising non-gem corundum, zircon, rutile, ilmenite and garnet (HIM suite). This geological model highlights the structurally-confined, narrow Mid Reach of the Kishon Valley, between Tel Kashish and Jalame Junction, as a high-priority alluvial target accessible for possible development.

We report here the initial findings from the follow-up exploration in which mapping, drilling (133 drill holes) and trenching (24 excavations) methods are used. Results are captured in ArcGIS and gravel volumes are estimated from 3-D reconstructions using StraterTM, SurferTM and VoxlerTM software. To date, the main findings are:

The Kishon Mid Reach trunk stream deposits, preserved in low-lying terraces flanking the modern river, constitute a 4.5km long transient fluvial placer (sensu Bluck et al., 2005) with mineralization confined to the basal, carbonate-dominated, cobble- boulder sized gravels some 0.5-4m thick. These gravels fine upward into clays and silts that form an overburden of some 1-10m thick.

All basal gravels treated from drill intersections (total of 313 meters intersected) and trench samples (1,888 tonnes) have returned, to some degree, positive results for the DMC and HIM suites. Sapphire is the most abundant DMC mineral and non-gem corundum the most common HIM mineral.

The alluvial fans derived from Mount Carmel are instrumental in forming the Kishon Mid Reach transient fluvial placer by:

-Supplying boulder to cobble, oversize clasts into the Kishon trunk stream, thereby generating a coarse framework conducive to trapping the smaller but heavier placer minerals (sensu Ward et al.,1993; Jacob, et al.,1999).

-Infilling the left flank of the Kishon Valley below Mount Carmel, thereby forcing the Kishon trunk stream into a confined, and hence more energetic, course along the right flank of the Mid Reach.

-Introducing the DMC and HIM suite minerals from primary volcanic sources on Mount Carmel into the Kishon Mid Reach placer gravels.

The footwall of the Kishon Mid Reach placer, composed of incompetent marls and carbonates, does not promote the formation of fixed trapsites (sensu Jacob et al.,1999) and thus heavy mineral concentration is associated with semi-mobile gravel bar trapsites.

The follow-up exploration phase will continue until the Kishon Mid Reach transient fluvial placer has been defined spatially and sampled sufficiently to determine initially an Inferred Mineral Resource, with additional work upgrading the confidence to an Indicated Resource category for conversion to Probable

Mining Reserves (sensu SAMREC Code, 2009).

# On the use of seismic reflection from oil exploration for the below basin sediments mapping.

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There has been a growing interest over the last decades in the application of the seismic reflection for below basin sediments studies. Multichannel seismic reflection profiling techniques have been applied to study geologic and tectonic structures located below basin sediments down to lowermost crustal (Moho) depths.

The Consortium for Continental Reflection Profiling (COCORP) pioneered the use of multichannel seismic reflection profiling for the systematic exploration of the continental lithosphere. COCORP-type profiles routinely probe to the base of the crust and frequently deeper. COCORP has collected over eleven thousand kilometers of profiling at thirty sites in the United States. Among the best known of COCORP's US results are its demonstration of the great advantages of this technique were demonstrated by the COCORP results in the U.S.A. (e.g., Oliver et al., 1967; Oliver and Kaufman, 1976). Since then similar studies have been carried out in other countries. In Israel one line for deep crustal studies was recorded in 1986 (Yuval and Rotstein, 1986).

A very large number of seismic reflection surveys were carried out by the oil industry throughout the world. Some of these surveys are designed to study deep oil traps and may use field parameters which, for the most part, are not significantly different from those used for below basin sediments reflection studies. The one parameter which always varies is the record length (listening time). In the case of a vibratory source, the record length can be increased at the processing stage by the equivalent reduction of vibration time through partial correlation. We have used an oil exploration lines from a deep sedimentary basin in the coastal plain of Israel and extended its record length using this technique. We show that if a survey with appropriated field parameters, i.e., a survey for a deep target is chosen, this lines can be used together with modern lines to map the below basin sediments reflectors. In addition, the lines will be correlated and examined with gravity field measurements from the national gravity dataset of Israel.

# Colloid facilitated transport of lanthanides through discrete fractures in chalk

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Geological disposal of high-level radioactive waste is the internationally agreed-upon, long term solution for the disposal of long lived radionuclides and spent fuel. Eventually, corrosion of the waste canisters may lead to leakage of their hazardous contents, and the radionuclides can ultimately make their way into groundwater and pose a threat to the biosphere. Engineered bentonite barriers placed around nuclear waste repositories are generally considered sufficient to impede the transport of radionuclides from their storage location to the groundwater. However, colloidal-sized mobile bentonite particles eroding from these barriers have come under investigation as a potential transport vector for radionuclides sorbed to them. In addition, the presence of organic matter in groundwater has been shown to additionally facilitate the uptake of radionuclides by the clay colloids.

This study aims to evaluate the transport behaviors of radionuclides in colloid-facilitated transport through a fractured chalk matrix and under geochemical conditions representative of the Negev desert, Israel. Lanthanides are considered an acceptable substitute to actinides for research on radionuclide transportation due to their similar chemical behavior. In this study, the migration of Ce both with and without colloidal particles was explored and compared to the migration of a conservative tracer (bromide). Tracer solutions containing known concentrations of Ce, bentonite colloids, humic acid and bromide were prepared in a matrix solution containing salt concentrations representative of that of the average rain water found in the Negev. These solutions were then injected into a flow system constructed around a naturally fractured chalk core. Samples were analyzed for Ce and Br using ICP-MS, and colloid concentrations were determined using spectrophotographic analysis. Breakthrough curves comparing the rates of transportation of each tracer were obtained, allowing for comparison of transport rates and calculation of overall tracer recovery.

Preliminary results suggest that mobility of Ce as a solute is negligible, and in experiments conducted without bentonite colloids, the 2% of the Ce that was recovered during the experiments travelled as "intrinsic" colloids in the form of $Ce_2(CO_3)_3 \cdot 6H_2O$ precipitate. However, the total recovery of the Ce increased to 9% when it was injected into the core in the presence of bentonite colloids and 13% when both bentonite and the carbonate precipitate colloids were injected. In addition, the maximum relative concentration ($C/C_0$) of the Ce in the samples from the experiments conducted without bentonite colloids is about 0.002, whereas that of the experiments conducted in the presence of bentonite colloids reaches almost 0.2. This indicates that colloid presence does indeed markedly increase the mobility of radionuclides through fractured chalk matrices and should therefore be considered in models representing transport of radionuclide waste originating from nuclear repositories.

# New chronology for the southern Kalahari Group sediments: implications for sediment cycle dynamics and early hominin occupation

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Kalahari Group sediments accumulated in the intracratonic Kalahari basin, which started forming during the breakup of Gondwana in the early Cretaceous. These sediments cover an extensive part of southern Africa and form a low relief landscape. The Kalahari Group has poor age control, with chronology restricted to biostratigraphic correlations and OSL dating of the unconsolidated surface sands.

We present new cosmogenic burial ages for southern Kalahari Group sediments obtained from a 55 m core at Mamatwan Mine in Northern Cape, South Africa. Using both classical and isochron 10Be burial techniques we demonstrate that nearly the entire section was rapidly emplaced to its current level at 1.1 – 1.2 Ma. This new chronological framework reveals a dynamic nature of Kalahari Group sedimentation in the southern Kalahari and permits the possibility of many Cenozoic-Mesozoic cycles of deposition and erosion no longer preserved in the sedimentary record.

Further, our data indicate that a stable water body persisted in the southern Kalahari for at least 420 ka prior to this rapid infill. This water body was contemporaneous with an adjacent high density hominin occupation in Southern Africa.

# Stratigraphy of the Golan volcanic succession, revisited

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The Golan Heights is covered with lavas and pyroclastic structures of Plio-Pleistocene age. Based on morphological criteria, the volcanic succession was subdivided by Mor (1986) into three formations, which was later updated to four units (Mor, 1993). This includes, from bottom to top, (1) the Cover Basalt Formation (5.5-3.5 Ma), (2) Mechki Basalt (2.7-1.9 Ma), (3) the Ortal Formation (1.6-0.7 Ma), (4) the Golan Formation (0.5-0.1 Ma). The latter was subdivided into separate mapping units ('members'), based on morphological and geobotanic considerations. Sneh et al. (1997) considered the whole succession, from the Cover Basalt through the Ortal unit as one formation, since activity seemed continuous, with no clear break.

Weinstein et al. (1994) showed that Ortal and the Golan basalts have very similar chemistry (basanitic composition). Moreover, based on detailed chemistry and petrography, they showed that one of the Golan members prototype flow ('En Zivan) is actually an Ortal Basalt, which was later confirmed by Ar-Ar age determination (Weinstein et al. 2013). Weinstein et al. (2006) showed that there is a clear compositional difference between the Pleistocene basanites of the northern and eastern Golan and the Pliocene alkali-basalts of the western and southern Golan.

Here it is suggested that based on the above, the Golan basaltic succession should be divided into two main lithostratigraphic units: the Pliocene (5.5-1.8 Ma) alkali-basalts and the Pleistocene (~1.0-0.1 Ma) basanites. It is emphasized that the combination in one unit of the early Pleistocene basanites from the northern/eastern Golan with the Late Pliocene alkali-basalts of the western Golan based on morphological considerations is lithologically unjustified. Moreover, the geographic distinction together with a volcanic pause of 0.5-0.8 Ma between the two make this combination unlikely.

Recent Ar-Ar ages show that there is also a volcanic gap of 0.4-0.5 Ma (Inbar et al. 2009; Weinstein et al. 2013) during the Pleistocene activity. However, the early and the late series (~1.0-0.6 and 0.2-0.1 Ma, respectively) share similar compositions (basanitic) and locations, therefore the distinction between them is less clear.

# Crustal structure and seismic activity in Northern Israel

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In this work, we study the structure and tectonics of the Galilee area, including the northern section of the Dead Sea Transform (DST), and its association with recorded earthquake activity. A 3-D lithosphere model is constructed including the geometry and mechanical properties of the main geological layers of the study area using geological observations, gravity field modeling, seismic refraction and reflection surveys, and teleseismic observations. Deviation from the local isostasy is calculated using the regional density model, as well as 3-D stress distribution that highlights regions with elevated stresses, where seismic activity is expected. We compare the spatial distribution of the stressed areas with the mapped faults and earthquake locations. In order to improve earthquake location, more than 2,500 earthquakes within the earthquake catalogue of the ISN (Israeli Seismic Network) were re-analyzed in the Galilee area, the northern part of Israel, between 1985 and 2015. We utilize first order re-location procedure using Antelope software, and a second order double-difference algorithm; hypoDD. The first-step relocation provides better results than the original location in the catalogue, especially in the distribution of event-depths, provided here for the first time. The second step relocation leads to more localization of the events into discrete zones, whereas in some cases, seismicity indicates distinctive spatial seismic trends.

Our new seismicity map highlights the activity of several faults, including the Fari'a, Samia, Gilboa, Bet Qeshet, Almagor Faults, and the continuation of the Carmel Fault towards the Sea. Other areas, including the main Carmel Fault and the northern Jordan Valley segment of the DST, indicate relative quiescence. These results provide higher resolution and better understanding of the seismogenic zones at Northern Israel, and their relation to active faults, seen in the geological maps.

# The mineral and bacterial composition of rock crusts in arid and hyper-arid environments

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Tafoni combines different rock weathering patterns and morphologies, it was objected at different lithologies (i.e. limestone, dolomite, sandstone and granite) both in arid and hyper-arid environments. Many studies attempted to explain the mechanism of this weathering morphology by isolatingspecific variables and exploring their contribution. Here, we use a multi-disciplinary approach to explore the mechanism of rock weathering in arid to hyper-arid environment.

Rock crusts are super-imposed on the rocks, as such they are shaped by atmospheric conditions, thus their characterization may elucidate some of the mechanisms associated to tafoni formation and morphology. To that end, we collected rock crusts in Uvda valley (Gerofit formation) and Sde Boqer slopes (Shivta and Tamar formations) and analyzed their mineral composition as well as bacterial composition.

Rock crusts mineralogy analysis was conducted at the cap rock and within the weathering front using XRD. The major elements within the cap rock included calcite and dolomite, while the rock-weathering front was also characterized by gypsum, quartz and halite, indicating the effect of crystallization pressure caused by different salts leading to weathering.

The crust bacterial community was characterized by deep sequencing and was found to be dominated by Proteobacteria (42%) and Cyanobacteria (10%). Actinobacteria, Bacteroidetes, Candidate-division TG-1 and Firmicutes were less abundant jointly composing ~5% of the community. We further characterized the crust chemical composition by using FTIR analysis revealing the presence of organic compounds that could include extracellular polymeric substances (EPS). The EPS molecules usually shape the structure of microbial biofilms, form a protective hydrophobic film and can bind different materials, such as dust particles.Wefurther elucidated the physical role of the crust and found that it can increase the residual water content of rocks by 30% compared to rocks lacking crust.

Our results suggest that rock crusts may clog the rock pores and change the physical properties of rocks such that desiccation rates are reduced, while absence of these crusts may increase significantly weathering rates.In line with our hypothesis we note that thinner crusts were observed in the wadi where weathering rates were higher compared to the adjacent slopes.

# Potential pedogenetic mechanisms and spatial organization of Terra Rossa Soil

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Terra-Rossa is a highly structured, uniform textured, shallow red soil associated with sedimentary carbonate rocks in the Mediterranean region (classified as lithic Rhodexeralf). The genesis of Terra Rossa has long been a matter of controversy. Two hypotheses have been formulated to address its formation: (1) The Residual Origin theory suggests that Terra Rossa is the result of carbonate dissolution and subsequent accumulation and transformation of limestone residue (2) The Detrital origin theory suggests that this soil is unrelated to the underlying rock and is allochthonous in origin, assuming that Terra Rossa is an accumulation of detrital material such as alluvial mud, volcanic ash or aeolian dust on an (assumed pre-existing) karst limestone. In all scenes, these soils are found side by side in immediate transaction with brown soils with strong texture contrast.

New evidences propose that Terra Rossa forms by replacement of limestone by authigenic clay at a moving metasomatic front several centimetres wide. Accordingly, replacement of the host calcite takes place not by dissolution-precipitation, as is generally thought, but via pressure solution driven by the crystallization pressure exerted by the growing clay. Furthermore, since the clay is authigenic, its major elements—Al, Si, and Fe—probably come to the front as aqueous ions, most likely resulting from dissolution of dust at the rock surface. This soil is unique due to its clay mineralogy, particle size distribution and the divergence of oxygen isotopic ratios of associated fine quartz, formation of hematite over goethite and Al substitution vary to a rather limited extent which may indicate the specific pedo-environment under which this soil is formed.

Of the five classical factors of soil formation, climate, parent-rock, topography, time, biology, and recently recognized human activity, it is the latter factor which discretely includes fire and post-burn impacts. Wildfires are an integral part of Mediterranean ecosystems, where their number and intensities has increased during the past decades. While ecologists have long been inferring differential evolutionary processes of plant persistence traits in the Mediterranean fire-prone ecosystems, fire-induced soils are considered to undergo merely short-term modification, often labelled as 'temporarily disturbed' soil or soil 'under restoration/rehabilitation'. In fact the suggested seventh factor can act both dependently and independently of the other soil forming factors.

Given the widespread and prolong appearance of forest fires in the Mediterranean ecosystem and its well documented effects on the local vegetation, the main aim of this study is to present the potential pedogenetic mechanisms and spatial organization of Terra Rossa soils. The results are reported for the following physical and colloidal properties: texture, structure, clay and heavy minerals, cation exchange, pH, and organic colloids, measured by: particle size distribution, microscope for morphologic image processing, and two spectrometers across 0.35-25 micrometres.

# The Nature and the Process of Platform Formation along the Carmel and Galilee Coast

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Stretches of Israel's northern Mediterranean coast are rocky shores characterized by a steep escarpment of several meters and a horizontal seaward platform. The escarpment and its associated platform are cut into a calcareous aeolian sandstone (kurkar). On the land side of the platform, an evident basal notch typically occurs in the cliff. Most studies attribute the notch to wave abrasion. Whereas wave direction is westerly, basal notches are also found in the eastern side of small kurkar islands along the coast. Studies conducted in Israel show the Kurkar rocks to have a compressive strength of 50 kg /sqm-1. The hydraulic force excreted by the 6m high waves is 1.6 kg/ sqm-1. Hence, it is possible to discard wave force as a dominant process. Since wave force doesn't seem to be an important force, subarial weathering must be considered in the cliff's development.

This study utilizes man-made rock-cut structures in the proximity of the coast to show that notch development is a product of subaerial weathering processes induced by wetting and drying on an intertidal shore. Weathering rate is about 10 cm per millennia. Since platform width is of the order of tens of meters, these weathering processes do not appear to be the dominant process in the formation of the rock platforms. The rock platforms are probably a product of ashlar quarries where kurkar stones were quarried as ashlar down to sea level, leaving behind a nearly flat platform. Evidence to such quarries can be seen in many sites along the coast from Achzive to Yavne Yam.

# Ground Motion Analysis in the Amiaz Plain based on 3-D Forward Computational Modeling

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The Amiaz Plain caps a sedimentary basin known as the Amiaz basin. This basin is nested within the seismically active Dead Sea basin. The Amiaz basin has a complex geometry, bounded on the east by the walls of the Sedom salt diapir and on the west by the Dead Sea Western border faults and escarpments. The top of the Sedom salt Formation is considered as the floor of the Amiaz basin. It wedges from south to north, from depth of -2,000 m to -1,000 m below sea level, respectively. Sedimentary basins can significantly amplify earthquake ground motion and lead to longer shaking duration by trapping the seismic energy. The Amiaz basin exhibits an unusual abundance of late-Pleistocene seismites and injection clastic dikes, suggesting that strong and local ground motions have occurred over the geological record. This research studies two possible cases of source location and mechanism, which may lead to significant ground motion in Amiaz basin: a) dip-slip source located on the western border fault, b) strike-slip source, located on the eastern fault of the Dead Sea basin (transform).Seismic wave propagation was simulated using a second order node-based finite difference formulation for 3-D heterogeneous earth (WPP ver. 2.2 by Petersson and Sjogreen 2010). A 3-D geological model was constructed based on an available geological data from well logs, geophysical surveys, structural and geological maps. Distributed Seismic Moment (DSM) fault model (Shani-Kadmiel et al. 2014) was employed in order to consider rupture directivity and near-field seismic radiation pattern. The simulated ground motion is analyzed for peak ground velocities and response spectrum. Each simulation is compared against a reference model with lying horizontal units, in order to isolate the influence of the basin's structure, and quantify the ground motions amplification. For the scenario of dip-slip source, the following observations can be made: 1) Amiaz basin traps the seismic energy and funnels it northward; and 2) the maximum horizontal ground velocities in the basin are a function of the epicentral distance. For the scenario of strike-slip, preliminary results indicate that a significant radiation pattern of seismic energy occur perpendicular to the rupture direction. Thus, it is estimated that a northern strike-slip source will result in a significant radiation pattern directly into Amiaz basin.

# The nitrogen cycle in Lake Kinneret - evidences from nitrogen isotopes

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The sources and dynamics of dissolved nitrogen species in Lake Kinneret and their relations to the seasonal variations and the limnological cycle were studied. The study uses the isotopic composition of the dissolved inorganic species of nitrogen, nitrate (NO3-), nitrite (NO2) and ammonium (NH3+) as well as particular organic matter (POM), in the lake to track the origin and cycling of these species. Depth profiles were collected seasonally over three annual limnological cycles and the concentration and d15N values were determined. The total nitrogen content in the water column shows significant seasonal changes expressed in variations of up to 50% during the annual cycle, indicating a significant external source, and outputs to and from the lake.

During winter, nitrate concentration increases as a result of nitrification as well as nitrate supply by external sources (run-off). δ15N(NO3) is depleted relative to the ammonium from which it is formed, whereas the remaining enriched ammonium is assimilated, explaining the enriched isotopic composition of POM. In spring, nitrate concentration decreases due to assimilation (which likely begins after ammonium has been fully consumed) and denitrification. δ15N(POM) values indicate that it is derived from the nitrate available in the epilimnion. These processes are associated with an increase in the δ15N(NO3) values of the residual nitrate. During summer, ammonium accumulates in the hypolimnion as a result of ammonification of the organic matter which sinks from the epilimnion. δ15N(NH4) was found to be more enriched than the isotopic composition of the organic matter from which it is derived. This could point to either selective decomposition of different organic compounds contained in the particles and show, a-priori, a different isotopic composition or of isotopic fractionation during the decomposition where by the bacteria take up heavier nitrogen and the lighter N remains in the undecomposed solid particulate phase. Early fall is characterized by heavy δ15N(POM) in the upper water layer and low δ15N(POM) values in the bottom layer. Deepening of the thermocline in late fall supplies ammonium to the oxidized epilimnion, where it is subject to nitrification or to direct assimilation. The residual ammonium is characterized by significantly heavy isotopic composition.

# Recent Metal Contamination in Dora Urban Seasonal Pond (Netanya, Israel)

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4. Royal Netherlands Institute for Sea Research (NIOZ), The Netherlands

Dora Pond is a small urban winter pond located in the city of Netanya at the densely populated Coastal Plain of Israel. Although the surrounding area has changed tremendously over the last few decades, the pond remained roughly in the same state at least since 1880. Winter flooding with typical water depth of 30-80 cm, allows growth of wetland vegetation, which wilts by late-summer with the drying of the pond. Three short cores were retrieved from the center, the northern- and the southern- margins of the pond. Detailed geochemical, sedimentological and geographical data from the pond were integrated with local and regional historical data derived from historical maps.

In the center of the pond, profiles of metal concentrations (Pb, Zn, V, Ni, Cu, Cr, Co, Cd, Hg) and Pb isotopic composition denote two main eras of pre- and post- 19th century. Lead fluxes and isotopic composition point to national/regional petrol-Pb emissions as the major contributor to Pb contamination, overwhelming other potential local and transboundary sources. Traffic-related metals are correlated with Pb, emphasizing the polluting inputs of traffic. The Hg profile, however, implies global pollution rather than local source.

The sediment at the margins of the pond appears to be affected directly by the construction activities in the pond's watershed. The constructions of neighborhoods in the 1970s (northern margin) and in the 1980s-90s (southern margin) have led to transport of sandy material that buried and preserved vegetation residue. In the southern margin, the highest accumulation rate was dated (210-Pb) to the early 1990s, coinciding with the construction of the nearest neighborhood.

While the center profile exhibits a stable deposition environment, which enabled the historical reconstruction of exposure to Pb emissions and to other anthropogenic metals, the margins' sandy inputs have enabled down profile metal mobility. The heterogeneous sedimentary profiles in the margins of the pond lead to high anthropogenic metal concentrations with recent Pb isotopic signature in deep parts of the profiles.

In the urban Dora winter pond, the center reveals the impact of regional-to-global atmospheric dispersal of pollutants, while the marginal area is strongly affected by construction within the watershed and records local development history.

# "הפארק הוולקני גולן" – 45 שנה של חלום

דורון מור

הגולן מלא וגדוש בתופעות וולקנית מרתקות, שהקהל הישראלי אינו מודע להם כלל היות ואין הן מונגשות, משולטות ומוסברות לו בשפה השווה לכל נפש. הרעיון הועלה תחילה בפגישה עם פרופ' עמנואל מזור ופרופ' עקיבא פלכסר בכנס החברה הגיאולוגית ב-1970, לפני 45 שנה.

בשנים 96-1990 נעשה נסיון ראשון להקים פארק וולקני בגולן, כדוגמת פארקים כאלה בעולם, אך הניסיון נכשל.

בשנים 2008-2013 הוקם "אתר אביטל", ביזמת הקרן לשיקום מחצבות והמועצה האזורית גולן. אתר זה יכול לשמש דוגמה כיצד יש להנגיש ולהסביר אתרים וולקניים: מאז פתיחתו לקהל באפריל 2013 עברו בו כבר עשרות אלפי מבקרים, התגובות הן נלהבות ביותר ומראות כי ניתן לפתח בגולן "נישה תיירותית" וולקנית ייחודית בארץ (גם נדירה מסוגה בעולם), דבר שיגביר את עניין הציבור באטרקציות שהגולן יכול להציע למבקריו.

היות וקיים בלבול מסוים במונחים הקשורים לפארק הוולקני – רצוי לדייק בהגדרות, כמקובל בעולם: "אתר וולקני" – מקום בו מתגלה תופעה/ות וולקני/ות, משולט/ות (למשל – "אתר אביטל") או לא. "נתיב/שביל וולקני" – שביל (רגלי בדרך כלל) לארכו קיימות תופעות וולקניות שאינן משולטות אך מודרכות ע"י מדריכים מוסמכים. "פארק וולקני" – אזור נרחב בו מתגלות תופעות וולקניות רבות, המונגשות למבקרים, משולטות ומוסברות. לרוב קיים בו גם מרכז מבקרים (למשל – במכתש רמון קיים פארק גיאולוגי).

בתכנית המוצעת כאן 13 אתרים אפשריים לפיתוח במרכז הגולן (יש עוד אתרים רבים נוספים בצפון ובדרום, אבל בהם איננו עוסקים כרגע) להקמת "פארק וולקני" כהלכתו. האתרים המוצעים הם:

1. הג'ובה הגדולה: תעלומת דרך יצירת הג'ובות, והתיאוריות השונות לכך.
2. נחל עורבים: תחנה אחת להסבר מבנה קילוח לבה, וכן הסבר מדוע נוצרים מפלים דווקא בבזלות, ותחנה שנייה בתצפית הקניון, הממחיש כיצד בנוי הגולן לעומקו.
3. מעיין האמיר: דוגמה למעיין קילוח, תופעה ייחודית לגולן.
4. תחנת הפאליאומגנטיזם: שיקום התחנה שנבנתה מלכתחילה בשגיאות רבות, גם הוזנחה מאד מאז.
5. מבתר בנטל: הדגמה כיצד ניתן לשחזר את ראשו של הר געש קטום, וכן תצפית על הר אביטל ודרך יצירתו הייחודית, בשילוב של אש ומים.
6. תצפית בנטל-מערב: תצפית על קילוח בנטל, שלקח איתו "כצידה לדרך" גם חצי הר.
7. תצפית בנטל-צפון: הוולקניזם הצעיר בגולן ותחזית על עתיד הוולקניזם באזורנו.
8. תצפית בנטל מזרח: הוולקניזם בדרום סוריה.
9. "אתר אביטל" (הקיים).
10. האיגנימבריט בקבר הצ'רקסי: אסון נורא שהפך להיות אוצר טבע, שאינו בידינו.
11. מניפת זנב היונה: מבנה משושים מוזר ביותר, בתוך תעלת נ.ט.
12. תל טבעת: תופעה מסתורית, נדירה בעולם.
13. הר שיפון החצוי: כולל תצפית על טורי הגעש לאורך הגולן.

ברור שאי אפשר יהיה לפתח ולהנגיש לציבור את כל האתרים בבת אחת, אבל, לפי הפתגם הסיני הידוע, "גם דרך בת 13 אתרים וולקניים מתחילה בצעד אחד" – ואת הצעד הראשון הרי כבר עשינו, ב"אתר אביטל"....

# שטפי הזרחן לשכבה הפוטית בכינרת

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1. המעבדה לחקר הכינרת
2. מדעי כדור הארץ האוניברסיטה העברית

הכינרת משוכבת תרמית במשך 9-10 חדשים בשנה (מרץ-דצמבר). השכוב מאופיין בטמפרטורות גבוהות (~30 מעלות) ואחידות בשכבה העליונה (אפילימניון), טמפרטורות נמוכות בשכבה התחתונה (בערך 15 מעלות) וגרדיאנט תרמי חריף בשכבת הביניים (המטלימניון). הפרופיל התרמי מצביע על כך שבשכבה התחתונה יש למעשה 2 תת-שכבות האחת העמוקה צמודה לקרקעית ומעורבבת יחסית (ה- BBL) והשניה (ההיפולימניון) מצויה מעליה גובלת במטלימניון ומאופיינת בערבליות אנכית מינורית. העברת מומסים מהשכבה התחתונה לאפילימניון מתרחשת בעיקר באמצעות ערבוב שחל בשולי האגם. חלקיקים אורגניים ששוקעים מהשכבה העליונה לתחתונה מתפרקים בה ותוצרי פירוק כגון זרחן מומס (SRP) ואמוניום (NH-N4) מצטברים בשכבה התחתונה. הפרופילים של האמוניום בשכבה זו מצביעים על קיום מקור עיקרי בקרבת הקרקעית (BBL) ודעיכה הדרגתית מעלה לכיוון המטלימניון. מאידך הפרופילים של הזרחן המומס מצביעים על כך שרובו ככולו מצוי ב- BBL וכמעט ואין SRP בהיפולימניון. כך היחס הסטוכיומטרי הטיפוסי של N-NH4/P(SRP) ב- BBL הוא בערך 30 ואילו בהיפולימניון הוא כ- 100. זאת למרות שהמקור העיקרי של שני מומסים אלה הוא פירוק חומר אורגני. נראה שבניגוד לאמוניום הזרחן המומס מסולק באופן דיפרנציאלי מההיפולימניון ומצטבר ב-BBL ולכן במשך תקופת השכוב כמעט ואיננו מועבר לאפילימניון. על סמך: א. עדויות ניסיוניות, ב. נוכחות מוגברת של פוליפוספט בחלקיקים, ו-ג. ההרכב האיזוטופי של החמצן ביון הזרחה במים, אנו סבורים שמכניזם הסילוק ממי ההיפולימניון הוא באמצעות צריכה בקטריאלית של זרחן מומס בתת שכבה זו--> מעבר בתוך החיידקים לצורה של פוליפוספט --> פירוק אנזימטי תוך-תאי של הפוליפוספט --> המשך שקיעת החלקיקים ל-BBL --> ושחרורו כיון זרחה למי ה- BBL .