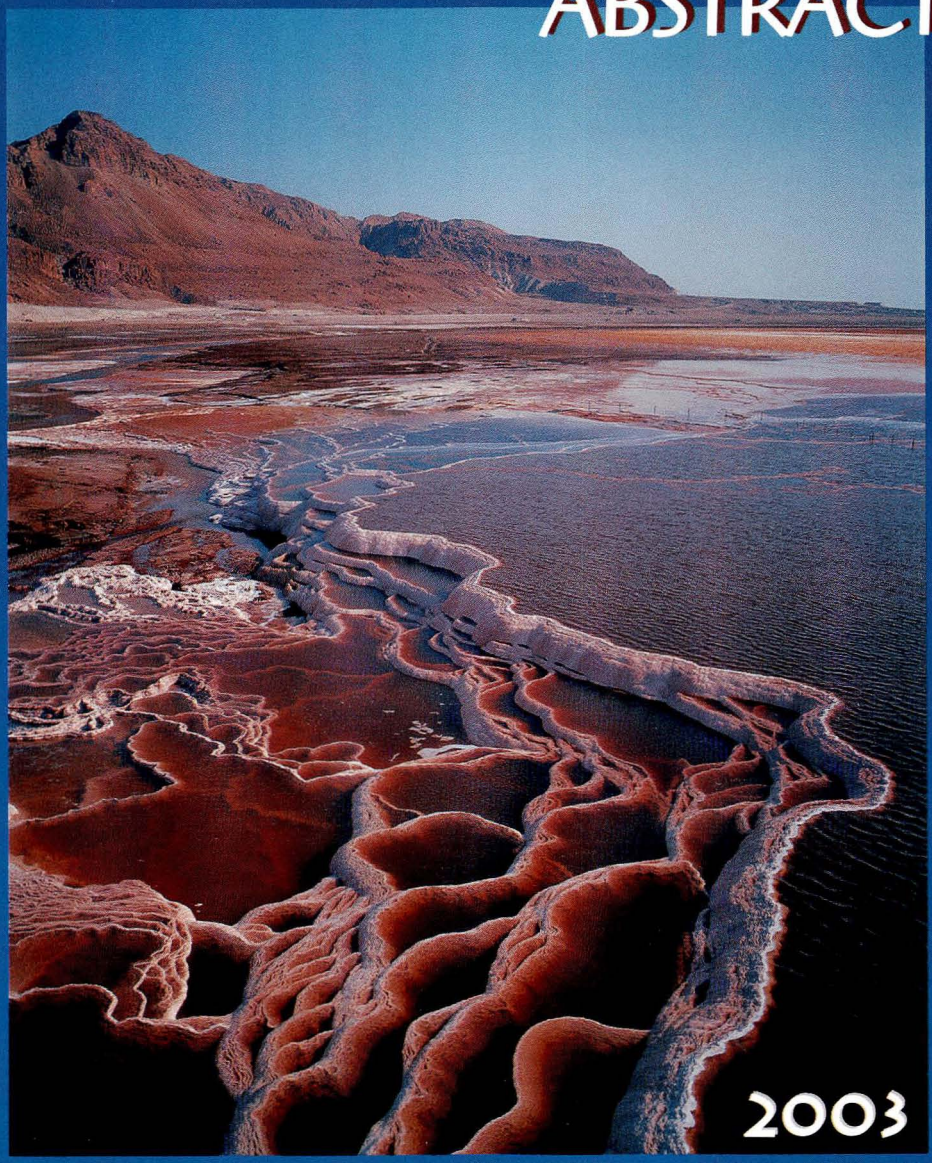
55(569.4)GEOL

החברה הגיאולוגית הישראלית

Israel Geological Society

2003
עין בוקק
כנס החברה הגיאולוגית

ABSTRACTS



ISRAEL GEOLOGICAL SOCIETY, ANNUAL MEETING

EIN BOQEQ

Israel

25-27 MARCH

Cover: Dead Sea

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ISRAEL GEOLOGICAL SOCIETY

ANNUAL MEETING

2003

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המכון הגיאולוגי
הספריה
GEOLOGICAL SURVEY OF ISRAEL
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25-27 MARCH 2003

The Geological Society of Israel thanks the following for their contributions:

Ministry of National Infrastructures
Ministry of Environment
Merkaz Hasbara
The Geological Survey of Israel
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The Geological Society of Israel thanks Anat Bernstein and Shai Shertok for their help in the preparation of the annual meeting and members that volunteered to help in the activities during the year.

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ISOTOPES AS TRACERS IN A CONTAMINATED FRACTURED CHALK AQUITARD

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Clusters of industrial plants often generate contaminant plumes with several potential sources. Prevention of further pollution and designing suitable remedial measures require identification of the contributing source among all potential ones and the sorting of currently active sources from historical ones. In the study area, an industrial complex in the Negev desert, Israel, contaminants could not serve as indicators for the contamination sources because of their extensive spatial distribution across the site. However, stable isotopes of oxygen, hydrogen and sulfur, as well as tritium, proved to be efficient tools for this task.

The isotopic characterization of the potential end members provided the criteria for constraining a contaminating source when several alternative sources appeared viable. The isotopic fractionation of oxygen and hydrogen isotopes could be tied to the various disposal phases of the industrial wastewater. The three case studies presented here confirm the important role of isotopes as tracers in contaminated sites.

A DECADE OF READING EARTHQUAKE RECORDS IN THE DEAD SEA SEDIMENTS

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Since the establishment of surface fault control on Pleistocene Lake Lisan deformed beds (mixed-layers), the research approached in two directions: studying prehistoric events in the longest continuous earthquake record provided by Lisan Formation, and studying Holocene record with historical control on the recent millennia. Both directions of research indicate that the record represents earthquakes of magnitude 5.5 and larger, where the low magnitudes are from nearby ruptures.

The Pleistocene record of mixed-layers, 70-20 ka, shows marked clustering, with alternating quiescent and active10-15 kyr periods. A record of surface ruptures associated with the formation of mixed-layers is available for the upper part of the Lisan Formation. Detailed columnar sections on both sides of well-exposed faults show that each individual fault exhibits a cluster, up to 4 kyr long, with 3-5 slip events on the same plane. While each slip event correlates with formation of a mixed layer, not all mixed layers are tied to the faults studied. These faults are marginal to the main transform, and they may be activated during aftershocks.

A high-resolution Holocene seismic history of the Dead Sea Transform (DST) is established from laminated sedimentary sections drilled at the Dead Sea shores. The exposed top few meters of the section show unconformities that become pronounced with elevation of the section, constraining the lake level history with the earthquake record. Radiocarbon dating and annual lamina counting yield excellent agreement between disturbed sedimentary structures (seismites) and the historical earthquake record: 13 out of 14 events show in a counting interval of 1500 years. For the total length of historical record, 31 events are recorded. Over 95% of the historical earthquakes with local intensity (I) greater or equal 7 are recorded in the sediments. 50% of the earthquakes with $6<I<7$ are also shown, whereas all events with $I<6$ are not recorded. This agreement corroborates both independent data sets, and supports the dating techniques. The total of 78 Holocene events indicate varying recurrence intervals between a few and 625 years, with maximum seismicity during the past 6-8 centuries. During the counting interval of 1500 years the seismicity in the DST is in tandem with the North Anatolian Fault, but both alternate with the seismicity on the intervening East Anatolian Fault. The plate scale elastic coupling indicated by our data may underlie escape tectonics, typical of continental collision.

DISSOLUTION KINETICS OF SMECTITE UNDER ACIDIC CONDITIONS

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In the last decade, soils with low pH have become a serious environmental problem affecting the soil itself and the ground water with which it is in contact. In addition, cation release from clays significantly affects metal mobility and potential injection of toxic elements into these systems. Furthermore, smectite, a major component of many soils, is viewed as a potential sealant in systems designated for storage of radioactive waste.

Understanding and modeling of environmental processes strongly depend on the parameters that control the rate of dissolution and precipitation. Flow-through experiments were carried out to study the effects of pH and temperature on the dissolution rate of smectite. The experiments were conducted using treated smectite in an unstirred apparatus. Smectite dissolution rates were studied at pH 2-4.6 and temperatures of 25, 50 and 70±0.1°C.

Smectite dissolution rate increases with temperature and decreases with increasing pH. In most experiments, dissolution involves stoichiometric release of Al and Si. Low Al/Si ratios were obtained in experiments that were conducted at pH≥ 4. These low Al/Si ratios are explained by precipitation of gibbsite and/or diaspore.

We found that dissolution rates for experiments in which $\Delta G_r \leq -21$kcal mol $^{-1}$ are not affected by deviation from equilibrium. Dissolution rates in most experiments are not affected by the addition of $NaNO_3$ to the input solution.

The dependence of dissolution rate on pH and temperature is described using a simple model. According to the model dissolution rate is linearly proportional to the concentration of adsorbed protons on the mineral surface, which may be described using the Langmair adsorption isotherm. The dependence of dissolution rate on temperature is affected by the activation energy and the adsorption enthalpy. By fitting the proposed model to the experimental data we found an activation energy of 20 kcal mol $^{-1}$ and enthalpy of -14 kcal mol $^{-1}$.

THE EFFECT OF MICROBIAL ACTIVITY ON BIODEGRADATION OF 2,4,6-TRIBROMOPHENOL AND ON THE HYDRAULIC PROPERTIES OF FRACTURED CHALK

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The impact of microbial contaminant degradation on flow through fractured chalk was examined in a single fracture within natural fractured cores (20 cm diameter, 22-45 cm length). Flow along the fracture was defined by measurements of the outflux under various (controlled) hydraulic gradients and through 2-D multi-tracer tests. The 2-D distribution of flow in the fracture was investigated by injecting four non-reactive tracers (fluorobenzoic acids), each along a different section of the fracture inlet. Similarly, the outflux was sampled from four segments at the fracture outlet. Tracer breakthrough curves, mixing ratios and fluxes were evaluated for qualitative assessment of the 2-D flow distribution within the fracture.

Following the characterization of the fracture hydraulic properties, a continuous injection of 2,4,6-tribromophenol (TBP) was initiated. TBP, a representative contaminant, was used as a carbon and energy source for the bacteria. Although TBP was injected for several months at different concentrations and flow rates, its outlet concentration never reached its input concentration mainly due to biodegradation and diffusion into the rock matrix. The limiting factor of the biodegradation process was found to be lack of oxygen. Higher oxygen concentrations were shown to affect both the amount of TBP that was degraded and the hydraulic conductivity of the fracture.

The spatial distribution of the biodegradation processes was monitored throughout the experiment. It was found that the degradation process was distributed along the flow direction and transverse to the flow direction. In both cases oxygen concentrations were shown to control the biodegradation process.

The hydraulic conductance of the fracture fluctuated during the experiments, reaching 70% of its initial value after one year of continuous TBP biodegradation. The conductivity reduction was more significant when additional oxygen supplied to the fracture enhanced the biodegradation process. It was found that a slight reduction in the hydraulic conductivity has also an effect on solute transport within the fracture. Non-reactive tracers traveled faster and in a different 2-D distribution once bacteria were active in the fracture.

DEAD SEA SINKHOLES – A SYMPTOM OF KURNUB AQUIFER RELEASE?

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The recent sinkhole epidemic along the Dead Sea (DS) coast is caused, according to the prevailing model, by salt solution and/or piping within the shallow alluvial aquifer due to fresh groundwater flows modified by the DS recession. Directed pumping from this aquifer has even been proposed for mitigation.

With the above shallow-aquifer model it is difficult to explain the following major observations:

1. Essentially, sinkhole formation at almost every cluster site had a sudden onset, after years of ongoing recession.
2. Generally, the onset time has been steadily delayed going northward.
3. Within each cluster site, usually, the direction of sinkhole formation has not followed the fresh-saline interface seaward migration. Also, sinkholes have formed even under the DS.
4. Sinkhole development appears to be independent of the yearly and seasonal variations in the recharge of the alluvial aquifer.
5. At least within the central Rahaf-Ein Gedi sector, the sinkhole clusters appear to share a rather sharp and smooth western boundary which does not correlate well with any elevation contour or identified feature of the shallow geologic section.
6. Sinkholes have also formed in the south, along the industrial ponds which appear to provide a high and stable base level for the shallow aquifer.

I propose for future research an alternative model which appears to explain all of the above observations. It is based on the notion that the DS recession has recently reached a critical level causing a sharp rise in the inflow of Kurnub aquifer water through faults bounding the deep basin. This is a flow of relatively fresh groundwater, plausibly from depths of hundreds of meters, rising through the column of brine which saturates the bedrock and the overlying sediments. Solution in salt bodies anywhere along this deep path may create voids migrating upwards and eventually causing surface subsidence and sinkholes. Near the DS, flow vectors in the Kurnub aquifer probably have a northerly component. Therefore, the northward migration of sinkhole onset, at a rate of about 4 km per meter of DS recession, is plausibly related to the pressure gradient in this aquifer.

According to this model, sinkhole locations are not necessarily related to any near-surface condition, including the fresh-saline interface and the presence of a shallow salt layer. The aforementioned western boundary probably follows the buried faults bounding the deep basin, which provide the Kurnub outlet.

Researchers have shown that DS recessions during the last several thousand years bottomed about elevation –400 m or slightly below. Inflow of Kurnub water may have been involved in arresting those recessions. This time, the Kurnub inflow may be confronting a recession accelerated by heavy man-made withdrawals. There may be significant implications concerning the future of both the DS and the Kurnub aquifer, as well as the sinkhole prediction and mitigation.

CONTROLS ON THE CHEMICAL AND ISOTOPIC COMPOSITIONS OF URBAN STORMWATER IN A SEMIARID ZONE

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The temporal variations in the chemical and isotopic compositions of urban stormwater under different land use, and their dependence on physical parameters such as precipitation intensity, stormwater discharge, cumulative stormwater volumes or the size of the drainage area were investigated in the coastal city of Ashdod , Israel. During 2000/2001 and 2001/2002, 39 stormwater events were intensively monitored for precipitation distribution and intensity at three stations across the city and for stormwater discharge at seven stations draining 85% of the city area. 39 and 202 precipitation samples were collected and analyzed for chemical and isotopic compositions, respectively. 149 stormwater samples, collected from the drains during 10 of the 39 events, were analyzed for chemical and isotopic compositions. Because the stormwater stations drained areas of different size and land use, their impact on the stormwater chemistry could be evaluated. Land use had only a minor effect on the concentrations of major ions and trace elements. Conversely, the concentrations and variety of volatile and semi-volatile organic compounds were significantly higher in stormwater generated in the industrial area than in that draining from residential areas. Ion and trace metal concentrations were very low (below drinking water standards) in 97 % of stormwater samples collected from all drains. Stormwater concentrations were higher in stations draining a larger area, thereby linking concentrations to the length of stormwater flowpaths. A first flush effect was documented on both a seasonal and event basis for both ions and trace elements. The high concentrations of fecal coliforms bacteria exceeded the drinking water standards and displayed a random pattern. The isotopic ratios of oxygen and hydrogen of the stormwater suggest very little exposure to the atmosphere, resulting in a very limited fractionation. The presence of fecal coliforms, ammonium in some samples, and specific ratios of oxygen and nitrogen isotope ratios, suggest that although the sewer and the stormwater collection systems are separated, wastewater, possibly from overflowing sewers, contributed to the drained stormwater. The chemical composition of stormwater collected from the residential areas in the city of Ashdod suggest that this water can be reused with little treatment (e.g. filtering and chlorination).

EFFECTS OF WATER RESOURCES MANAGEMENT POLICIES, INCLUDING PUMPING AND RECHARGE, ON THE SALINIZATION PROCESS IN THE COASTAL AQUIFER

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The Coastal Aquifer is the most important long-term water reservoir and its future conservation is of a strategic importance. Data indicates that the current management policy, applied to exploit the aquifer, results in a clear trend of increasing salinity of its groundwater. The effect of alternative management policies, based on the suggestions made by Mercado (1998), Zaslavsky (1998), and Assouline (2001), was studied. In particular, we examine the salinity of the aquifer water, the rate of salinization process, and the salinity of the effluent water resulting from the exploitation of the aquifer under the different management policies. Two different but complementary approaches were applied: (1) a single cell balance approach aiming to quantify the impact of management policies on the dynamic changes of mean aquifer salinity and mean effluent water salinity; (2) a two-dimensional numerical solution of the flow and transport equations, which simulates the spatial and temporal changes of the aquifer salinity.

Five management policies were compared. Two of them involve injection of desalinated water before re-pumping. The alternatives are: (a) Desalination of the water from the National Water Carrier [D-NWC]; (b) Allocation of the desalinated water from the NWC to urban use only [D-NWC+Mun]; (c) Injection of the desalinated water from the NWC to the aquifer and re-pumping [D-NWC+Inj.]; (d) Desalination of effluent water before reuse [D-Sew]; (e) Application of alternatives (c) and (d) [D-NWC+Inj&D-Sew]. The calculations considered all these alternatives as if they began in 2003.

The balance approach was applied until 2050. It shows that most of the alternatives suggested (a, b and d) have only a mild reducing effect on the salinization rate of the aquifer. The effect of all these alternatives begins following the assumed 20 years of retention time in the vadose zone. Conversely, the effect of the injection of desalinated NWC water and the increased pumping related to it (alternative (c)) is immediate. The salinization process stops and the mean salinity stabilize around the initial value (year 2003). When, in addition, desalination of the sewage water is applied (alt. (e)), a decrease in the salinity is initiated 20 years later, and rehabilitation of the aquifer begins. The improvement cost of the alternatives involving injection of desalinated freshwater happened to be the lower.

Comparing 2D numerical steady-state solutions, desalination of the wastewater before reuse leads to the lower steady salinity value in the aquifer. However, this steady-state situation is never reached under real-life conditions. The simulated decrease rate of the mean salinity in the aquifer for the [D-Sew] case is half to one-third the rate obtained by the balance approach that assumes immediate and complete mixing and neglect the internal flow and transport processes. When injection of desalinated freshwater and corresponding increase pumping is simulated, a sharp decrease is obtained and significantly lower salinity values are obtained. However, if this alternative affects immediately the mean salinity in the balance approach, the numerical solution shows that flow and transport processes rates delay its effect. The delay interval is strongly related to the specific layout of the pumping and recharge zones.

THE GEOLOGICAL HISTORY OF THE ISRAELI INNER SHELF BASED ON QUATERNARY SUCCESSIONS IN CORES OFF ASHQELON

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The inner shelf of the distal, easternmost end of the Nile River delta records in great detail the history of past climate and sea level change. The transition zone between the land and the deep sea is a key area for paleoclimate reconstruction because of the interfingering marine and continental records. Late Pleistocene – Holocene porous carbonate-rich sands interbedded with silt and clay horizons (Kurkar Group, Hefer Fm) were encountered in two boreholes taken 0.5 and 2.5 km off Ashqelon, at 9.5 and 25 m water depths. Data collected consists of sedimentology (grain size analysis, carbonate content, petrography of indurated horizons), and quantitative foraminiferal studies for correlation and reconstruction of the marine environments. The cores were dated using (AMS) ^{14}C, U-Th (TIMS), luminescence, and magnetic polarity, enabling correlation to the standard marine isotope stage (MIS) chronostratigraphy. Above a basal unconformity at about 80 m depth is a carbonate-rich siliciclastic unit dated at ~330-225 kyBP, which records the interglacial MIS 9 and 7.5-7.3, and the intervening glacial MIS 8. Rapid climate and sea level fluctuations are represented by heterogeneous rocky substrate and lateral facies variants shallowing to the east. This interval is followed by silty-sandy marine sediments, deposited rapidly between 225-172 kyBP, representing major increases in Nilotic input and near-shore marine productivity. Sea level fell towards the end of the penultimate glacial, MIS 6.4-6.3, with the shoreline migrating westwards as demonstrated by intertidal beachrocks in the eastern core. Continuation of sea level fall is evidenced by the overlying paleosol, known onshore as the Poleg Hamra. During the last interglacial MIS 5, between 128-70 ka BP, resumption of Nile River activity is indicated by the accumulation of marine sands, silty sands and some indurated sands. Sea levels were oscillated at a relatively high level, and the warm climate varied from humid to dry. A break in the marine sedimentation occurred during MIS 5.4, when sand dunes formed 2 km west of the present coastline under arid conditions, cooling, and sea level fall. During the early part of the last glacial, ~70-~55 ka BP, marine sands and indurated sandstones accumulated in the west at a low rate, reflecting reduced Nile River contribution. Between ~40 and ~10 kyBP, sea level gradually fell, the entire shelf became exposed and a paleosol corresponding to the onshore Netanya Hamra developed. This paleosol formed under arid conditions; however intensive pedogenetic activity took place during the more humid interval, between 36-25 kyBP, and subsequently during deglaciation. As the early Holocene sea level rose, rates of sedimentation increased rapidly, and sands and silty sands covered the entire pre-Holocene exposed shelf. Towards the east silty clays of a brackish/fresh water origin accumulated. This unit seems to be intimately linked to the rapid sea level rise, high rate of deposition, and humid climate conditions prevailing in the early part of the Holocene, and is known from various parts of the coastal plain.

THE TRANSITION FROM PLUVIAL TO INTERPLUVIAL ENVIRONMENTS IN THE NEGEV HIGHLANDS AS REFLECTED IN SEDIMENTATION AND EROSION PHASES DURING THE LAST 50,000 YEARS

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Two similar drainage basins in the Matred Plateau, Negev Highlands, one with intensive anthropogenic impact (Nahal Zena) and the other one natural (Nahal Sa'ad), were studied. The alluvial units in each basin were mapped in detail and the sediments sampled for luminescence dating. Quartz was extracted from the sediment samples and measured using the single aliquot regenerative dose protocol. Preliminary ages range from 50 ka at the base of the redeposited loess units to 1.4 ka in the anthropogenic terraces.

Deposition events combined with several natural erosion cycles occurred in the Negev Highlands during the upper Pleistocene and Holocene times. During the last glacial event, approximately 60-20 ka, aeolian loess sediments, transported by wind from the northern margin of the Sahara desert, accumulated in the Negev, covering both hill slopes and valleys. After their initial accumulation, these sediments were re-deposited along the drainage systems, mixing with course alluvial sediments of local origin. These sediments often contain carbonate nodules indicative of semiarid environment that prevailed during and after the deposition.

After the last glacial maximum, approximately between 18-14 ka, a shift in the geomorphologic processes related to major climatic change led to an increase in the erosive activity; whereby the amount of dust flux and precipitation decreased, but the intensity of the rainfall increased, producing the desert "flashfloods".

Erosive activity increased during the Holocene, leading to incision of the drainage system within the valleys. Thus, the loessy sediments that accumulated under the pluvial climate of the glacial phase are being removed during the present interpluvial Holocene climate.

The construction of a water-harvesting agricultural farm in Nahal Zena interrupted the natural Holocene cycle of erosion and led to the deposition of more than 2 m of fine alluvial sediments (mostly redeposited loess) behind man-made stone dams. These sediments were dated to 1800–1400 years BP, to the Roman-Byzantine time. No Holocene sedimentation was found in the natural basin of Nahal Sa'ad, indicating that the fine clastic sediments were deposited only due to anthropogenic interference and they have no climatic significance. The ancient farmers constructed stone walls and dams in order to protect the fields from damage caused by active gully incision. The nature and design of their constructions indicate that erosive processes and gully migration were active during the Byzantine period, and these processes were similar to those monitored at present in the Negev Highlands.

INTERSEISMIC DEFORMATION ALONG THE SOUTHERN DEAD SEA TRANSFORM DETECTED BY INTERFEROMETRIC SYNTHETIC APERTURE RADAR (InSAR)

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We present InSAR (Interferometric Synthetic Aperture Radar) measurements of the current deformation along a 300 km section at the southern part of the Dead Sea Transform (DST), including the Arava Valley, Dead Sea, and Jordan Valley segments. The SAR data for this study were collected by the European Space Agency Remote Sensing Satellites, ERS-1 (April 1992 to October 1997), and ERS-2 (since July 1995). In several locations along the DST we detected prominent vertical displacements at rates from 5 mm/yr to 85 mm/yr. In at least three locations, the surface movements could be attributed to interseismic creep events at fault stepovers. We found both upward displacements in compressional steps (e.g., Yotvata area) and downward displacements in extensional steps (e.g., Zofar area). These events are not associated in time with microseismic activity (M>2), however, in one case (Khaditha area, eastern Dead Sea), subsidence that occurred only between 1995 and 1997, may be related to the November 22, 1995, Mw=7.2 Nuweiba earthquake (about 300 km southward along the DST). Creep rates vary in time and may shift in space within a deforming region (e.g., northeastern Dead Sea). We could not detect strike-slip movement along the major segments of the DST. However, as the strike of these segments is sub-parallel to the satellite tracks, small strike-slip motion may be below the detection limit. Our observations suggest that during the last decade, the major segments of the DST are locked at the surface while creep is localized within the step zones. It is also possible that these zones amplify a general creep along the DST that cannot be detected in the linear segments.

MIRROR, MIST, HACKLE AND BRANCHING ON JOINTS

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It has been accepted by experimentalists (e.g. Rice 1984, Fig.1) that fracture development from the origin to advanced propagation is in the following 'conventional order': The mirror plane, mist, hackle and branching. A distinction has been made between the radii from the origin to the hackle boundary and to branching. This is quite surprising, considering the existence of many observations that differ from this pattern (e.g. Rice 1984, Fig. 66b), suggesting a different 'fractographic sequence'. In the latter, the mist is followed by a transformation zone of mist to small hackles, beyond which a drastic change into superposing large hackles on new branches occurs, indicating simultaneous growths of these two features. These observations should equate the radii from the origin to the hackle boundary and to branching. The same 'fractographic sequence' occurs on joint surfaces cutting granites and chalks. What is the meaning of this duality?

Possibly, the repeated four cycles from mirror to branching in a recent experiment (Fig.1, after Bahat et al. 2001, Fig. 2B) can be used for explanation. The first branching occurs at the outer boundary of the first hackle (before M2), following the ' conventional order'. However, the second hackle is already divided into two sub-zones, such that the first one (before M3) belongs to the second cycle, while the second hackle sub-zone rests on the early parts of the third cycle mirrors, M3. The next hackle zone does not occur at the ends of M3, but initiates the fourth cycle M4, i.e. showing superposing hackles on the new branch, indicating simultaneous growths of these two features according to the above 'fractographic sequence'. Thus, both 'conventional order' and 'fractographic sequence' occur adjacent to each other, forming during the early (second cycle) and late (fourth cycle) stages of the same experiment, respectively, while the fractography of the third cycle, M3, shows a transition between the two. The occurrence of the 'fractographic sequence' in geological exposures encourages future efforts to comprehend the meaning of 'cycling fractography' that would help to improve the understanding of the paleostress conditions that cause jointing.

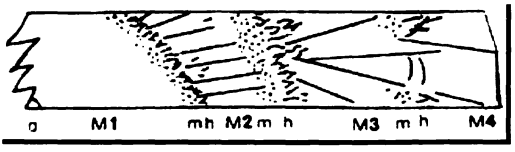

Fig.1. A fractographic drawing from a fractured glass bottle, see explanation in text

RADON FLUX MONITORING AT THE GAVNUNIM SITE, SOUTHERN MAKHTESH RAMON

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High time resolution (15 minute) monitoring of radon, using electronic alpha detectors, is conducted since July 1996 in the southern part of Makhtesh Ramon, some 200 meters north of the Ramon fault in boreholes, at depths of 1.2 and 85-90 meters. The detectors are placed in the massive syenite of the Lower Cretaceous Gavnunim intrusion. Environmental parameters – atmospheric pressure and temperature, and rock temperature and moisture are also recorded. Several patterns of systematic temporal variation are observed, manifesting large relative concentration of the radon in the geogas. Variations include diurnal signals, asymmetric multi-day signals, short spikes (lasting several hours), annual variation and maybe also a multi-year trend. Diurnal variation is manifested in the shallow subsurface and does not occur at depth. The multi-day signals are correlated between the surface and the 90m level, but the sharp decrease of the signal at 90m follows the decrease at shallow level, usually with a lag of several hours. A first evaluation shows that the large variations are not directly associated with the variation of atmospheric pressure. Furthermore, subsurface goegas flow patterns must be assumed to explain at least the fast variation. Therefore the possibility is raised that the phenomena are related to subtle subsurface processes, possibly of geodynamic nature.

STRUCTURAL AND STRATIGRAPHIC STUDIES IN THE NEGEV (1948-2003)

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The work carried out by Y.K.Bentor and A. Vroman within the framework of the Negev Mapping Project (1949-1954), was targeted to collect new geological data on an area which was difficult to access before. It was considered to be of high potential for both its economic and scientific values. Being aware of the work done by their predecessors from foreign oil companies and British government officials, as well as of efforts done by their colleagues, they tried to focus on geological issues that were of interest for the local and international scientific community.

The main topics of their study, which remained as issues and were set as targets for their students to come, were:
-Stratigrafic problems of the entire Phanerozoic column, and their implications on the paleogeography of the entire region; Focused on stratigraphic units which reflected the major tectonic activity phases recorded in the Negev (e.g. the Lower Cretaceous Arod Conglomerate, Senonian Mt. Scopus and Miocene Hazeva Groups), led to the establishment of detailed geological history for these events.
-Structural and tectonic issues concerning the Syrian Arc, Central Sinai Negev Shear Belt, and the Arava Rift Valley were studied in detail. Later, with the application of modern research tools such as geophysical and remote sensing methods, new issues were re-evaluated. Among these - the study of subsurface reverse faulting under the structures of the Syrian Arc, which could be carried out when seismic reflection methods became available
-Regional geological mapping of the Negev was presented at the end of each phase of research, summarizing the new information and concepts gathered.

The opportunity to extend these studies to the Sinai in 1956 and after 1967, as well as the observations that could be reached after the peace treaty was signed with Jordan, enabled a broader view on the geology of the Negev and vicinity. Developments in worldwide leading concepts such as plate-tectonics, and their implications on the local trends of research had also to be taken into account by the Israeli scientific community.

LACUSTRINE SEQUENCE STRATIGRAPHY IN THE LATE PLEISTOCENE - FIELD OBSERVATIONS AND MODELING

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The Dead Sea basin provides excellent sites to test, observe, quantify and model concepts in basin analysis such as sedimentation in the margins and fan-delta complexes. We analyzed the late Pleistocene (125-15 ky) sediments that are exposed at the margins of the Dead Sea basin, based on field analyses of the sequences and by using stratigraphic computerized modeling. The Dead Sea basin is an evolving pull-apart that traps sediments that fill this subsiding basin and records tectonic and climatic events that shaped its structure and fill. This basin exposes exceptionally well its thick sequences and therefore is an outstanding example for a continental basin. Therefore, it can be used as analog for many other modern and ancient, continental basin.

We present a basin analysis that combines detailed field observations and computer modeling to quantify the controlling parameters on the basin fill thus deducing the climate and tectonic signals recorded in the sequences.

From the exposed sequence we deduced the record of lake level variations for the past 120 ky by imposing Exxon's sequence stratigraphy model on the deltaic sediments. In addition, for the last 70 ky an independent lake level chronology was reconstructed based on dating direct lake level indicators (beach and shore deposits). This second curve of lake level variations was an input for the computer forward model (SEDPAK, The University of South Carolina Stratigraphic Modeling Group, 1994). With available reasonable knowledge of subsidence rates of the Dead Sea basin based on field observations, we modeled sediment supply rate variations during different stages of the late Pleistocene precursor of the Dead Sea (Lake Lisan).

We were able to constrain the three factors that control the basin fill (sediment supply, subsidence and base level) and therefore to analyze climate variation not only through lake level history but also through variations in sediment supply. In addition, we were able to compare the sedimentary response in the between a few deltaic sequences and through varying climates of the past.

THE GEODYNAMICS OF THE ASTEROUSSIA UNIT, ANAPHI ISLAND, CYCLADES, GREECE GEOCHRONOLOGY OF GRANITOIDS AND OCEANIC CRUST

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The Cycladic Massif is located at the eastern part of the Hellenic orogen and comprises two main structural units. The lower unit, termed the high-pressure unit, consists of sediments and volcanics with remnants of oceanic crust. This unit was metamorphosed under blueschist to eclogite conditions in the Eocene and was later overprinted by greenschist to amphibolite facies metamorphism in the Oligocene/Miocene. An exotic allochtonous unit termed the Upper Unit overrides the high-pressure unit with low angle normal faults. The Upper Unit is exposed as klippe in the Aegean and is composed of various structural subunits that were not affected by the Eocene high-pressure metamorphism. The Asteroussia unit, a subunit within the Upper Unit, comprises amphibolites, calcsilicates, marbles, gneisses, ophiolite slices and associated granitoid intrusions. Amphibolite facies metamorphism affecting the unit was dated to the Late-Cretaceous around 70 Ma using K-Ar, Ar-Ar and Rb-Sr methods. Whole rock Rb-Sr dating of the granitoids from this unit yielded ages of 66-84 Ma.

In this research we dated plutons and dikes in the Asteroussia Unit on Anaphi Island using the U-Pb system on zircons. Samples included hornblende-diorites, biotite-granites and plagiogranitic dikes intruding ophiolite slices.

Zircon extraction and Thermal Ionization Mass Spectrometry (TIMS) U-Pb dating was carried in the Institute für Mineralogie, Münster University, Germany.

1. Two biotite-granites from the Asteroussia Unit on Anaphi Island yielded U-Pb ages between 77-86 Ma, resembling published Rb-Sr ages on the granitoids from this unit.
2. Cathodo Luminescence (CL) images of zircons extracted from hornblende-diorite plutons and plagiogranitic dikes show complex crystal structure with abundant inherited cores. The CL images indicate that these zircons are not suitable for TIMS dating, as two or more "clocks" exist within them. These complex images also raise the question as to whether the plagiogranitic dikes are part of an oceanic crust complex as interpreted by Reinecke et al. (1982), since plagiogranites are not expected to include inheritance.

In the Asteroussia Unit, the granitoid ages predate the high-temperature metamorphism by only a few million years. The association of granitoid intrusion and HT-LP metamorphism suggests a magmatic arc environment. It is suggested that granitoid intrusion advected the heat necessary to cause the HT-LP metamorphism in the Late-Cretaceous. Reinecke et al. (1982) and Bonneaou (1984) suggested that the Asteroussia Unit is a part of the Pelagonian plate. This correlation proves problematic, as the events characterizing the Asteroussia Unit: Late-Cretaceous granitoid intrusion and HT-LP metamorphism were not reported from the Pelagonian Zone.

FORMULATING A NATIONAL POLICY FOR THE FUTURE OF THE DEAD SEA

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On December 2002 the Government of Israel resolved to start a process that leads towards the formulation of a National Policy for the future of the Dead Sea and its immediate surroundings. The resolution reflects the accelerating drop in sea level which, in turn leads the retreat of the shoreline and exposure of large mudflats, the drying of the Dead Sea southern basin, the collapse of the infrastructure around the lake and the development of sinkholes, onset of halite precipitation, increased groundwater losses, and the cessation of all infrastructure planning and development. A great uncertainty exists with respect to the future of the Dead Sea and the means to cope with the rising problems.

The present situation is the direct outcome of human intervention in the water balance of the Dead Sea system. Since the mid 20th centaury the Dead Sea water level dropped by more than 20 meters and is currently declining at a rate exceeding 1m/yr. The water deficit of the lake is mainly due to the diversion of freshwater upstream by all countries sharing the drainage basin (Israel, Syria, Jordan and to a lesser degree also Lebanon). In addition, extensive evaporation surfaces are artificially maintained in the process of mineral extraction by both the Israeli and the Jordanian industries.

Three alternatives for the future of the Dead Sea exist and need to be examined:

1. Maintaining the present situation. The Dead Sea level is expected to decline further to around -510-550 m.s.l., at which a new equilibrium between inflow and evaporation (which will decrease drastically with the increase in salinity) will be reached. In fact, future inflow to the Dead Sea is only expected to decrease further, as more of the water will be diverted and therefore the expected equilibrium will be reached at even lower levels
2. Construction of the "Peace Conduit" or its like that will divert seawater and/or reject brine after desalination, into the Dead Sea. Such a plan has already been announced by Israel and Jordan during the Johannesburg World Summit.
3. Changing the regional water policy whereby freshwater from the Jordan and the Yarmouk river systems will be diverted back to the Dead Sea. This program requires unprecedented regional cooperation and investments to compensate for the freshwater losses superimposed on the current sever regional water deficiency.

As outlined in the government resolution the above alternatives need to be evaluated with respect to the infrastructure, legal, economical and environmental aspects and implications. The infrastructure aspects are covered by the Geological Survey of Israel who coordinates an integrated wide inter-institutional effort. The current and upcoming activities focus on: 1) Modeling of the Dead Sea limnological evolution with and without implementation of the Peace Conduit, 2) Evaluation and quantification of the geomorphological response to the rapid drop in the base level, 3) Quantification of groundwater loss due to declining water levels of the Dead Sea, and 4) Evaluating the infrastructure collapse and sinkhole problem in context of the sea level declination.

REAL TIME MONITORING OF SOIL EROSION PROCESS IN THE NEGEV REGION USING AIRBORNE HYPERSPECTRAL TECHNOLOGY

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Loss of rain and irrigation water from cultivated fields is a matter of great concern, especially in arid and semi- arid regions. The physical crust that forms on the soil surface during rain events is one of the major causes for increasing run-off and decreasing water infiltration into the soil profile. Based on previous studies that showed significant correlation between crusted soil and their reflectance properties, we applied a systematic study over Loess soil from Israel in order to map the infiltration rate from a far distance, using Hyperspectral (or Imaging Spectroscopy) technology. First, we conducted a simulation for rain events under laboratory conditions, using the selected soil and varying rain energy treatments. After measuring the reflectance properties of the crusted soils, we developed a spectral parameter to assess for the crust status under different areas, sensors and illumination conditions. The parameter is defined as a Normalized Spectral Area (NSA) that uses the area under a ratio spectrum, created using a treated soil against non-crusted soil. The correlation between the NSA and infiltration rates values provided a significant calibration equation for further utilization. Based on these results, we conducted an airborne campaign in which we used the AISA imaging scanner, adjusted to 30 channels data in the VIS- NIR and established on the ground controlled soil plots (crusted and non crusted) to examine the NSA parameter for mapping soils' infiltration property. A reasonable agreement was obtained between the two data sets (laboratory and air) suggesting that infiltration rates values can be estimated remotely. Expanding the analysis into other areas may be difficult as a result of varying CaCO3 and moisture contents. In the current study, the above properties were measured on the ground and questionable areas were omitted from the analysis. It was concluded that sensors covering the entire VIS-NIR-SWIR-TIR region may provide the ability to mask out such questionable pixels. The paper shows that it is possible to assess soil infiltration affected by the soil crust, using spectral reflectance information in the VIS-NIR region, in both laboratory and air domains. It is strongly suggested that future study, in this regard, will use the full optical range (VIS-NIR-SWIR-TIR), as well as a spectral library of crusted soils collected in or within the rain simulator environment.

XENOLITHS OF MAFIC GRANULITES: THE HISTORY OF THE LOWER CONTINENTAL CRUST BENEATH NORTHERN ISRAEL

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A long standing problem in the understanding of continental crustal growth is the formation of the lower crust and its relation to island arc magmatism or the production of batholithic granitoids (e.g. the restite question). For the late Proterozoic Arabian-Nubian Shield (ANS), most of the evidence is derived from the exposed terrains of the upper crust (e.g. the crystalline rocks of Sinai, Arabia and the Eastern Desert of Egypt). Information on the lower crust of the ANS can be derived from xenoliths that are carried to the surface by the Phanerozoic alkali basalts. Xenoliths of mafic granulites collected from the Miocene center near Khan Lubia, 2 km south of Karnei Hitin (Galilee, Israel) provide samples of the lower crust beneath the northern part of the Arabian Nubian Shield. The xenoliths are composed mainly of plagioclase and clinopyroxene ¡: orthopyroxene ¡: garnet ¡: amphibpole ¡: spinel ¡: opaque and show metamorphic gneissic texture with boudins of clinopyroxene embedded within banded plagioclase. The xenoliths can be interpreted as cumulates from rising basaltic melts or as restites after extraction of felsic magmas. High values of Mg# (0.62-0.78; Mg#=Mg/ (Mg+Fet*0.85)), negative correlation between incompatible trace elements and Mg# and positive correlation between compatible trace elements and Mg# suggest that the xenoliths are genetically related and represent a product of an evolving source. As cumulates they represent crystallization from a continuously evolving magma, and as restites they represents various melting degrees of the protolith rock. REE concentrations are very low (less than a few ppm) with moderate negative slope and a positive anomaly of Eu, which reflects plagioclase accumulation. Four granulitic xenoliths found midway between Karnei Hitin and the present site define a positive correlation in the Sm-Nd isochron diagram. Interpreted as an isochron the slope corresponds to an age of ~ 620 Ma with initial value of f_{Nd} = +7. This data suggest a late Proterozoic age for the formation of the lower crust represented by these xenoliths. More analyses of Nd, Sr, Pb isotopes in the xenoliths from Khan Lubia and other sites will be carried to establish the chronology and petrogenesis of the lower crust beneath the region.

NEAR-SURFACE GEOPHYSICAL STUDIES IN A DRAINED WETLAND - THE HULA BASIN, UPPER JORDAN RIVER VALLEY

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The Hula Basin is one of the deep basins along the Dead Sea Transform. To the east and to the west it is bordered by boundary faults, whereas to the south it is bounded by basalt outcrops blocking the Jordan River flow. Draining of the lake and swamps in the early 1950's and the shift to intensive agriculture resulted in increased flow of nitrates to the Sea of Galilee, drying out of the organic-rich soils and changes in hydrological patterns. Previous geophysical surveys conducted in the area for oil and gas exploration indicate that seismic imaging of the shallow part is highly problematic.

The purpose of the present study was to examine geophysical methods for subsurface imaging that would facilitate mapping of preferential pathways, such as buried channels, faults and cracks. The study included two short seismic reflection profiles, together with down-hole survey up to the depth of 15 meters. The reflection data successfully imaged an old channel at depth of few meters that has no topographic imprint but is visible on air photos and was also mapped by soil surveys. The seismic velocities estimated by surface measurements and obtained in the borehole suggest that the media is partly saturated to a depth of over 10 meters, while water table measurements show much shallower depths (0.3 to 2 meters, depending on the season). This may be explained by upwelling of water along open conduits, while the bulk rock remains under-saturated. Further geophysical and petrophysical studies are required to assess this hypothesis. The results of the present study show that seismic methods can be successfully used for optimal location of monitoring wells and placement of subsurface flow detectors.

PRESERVATION OF GEOLOGICAL SITES

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Israel Nature and National Parks Protection Authority The Israeli Geological Society (IGS) together with Israel Nature and National Parks Protection Authority (INPA) have launched a few years ago a joint project aimed for the preservation of important geological sites in Israel. Efforts focus on creating a database of recommended sites and proposing ways to preserve the sites. INPA concentrates on finding legal solutions for defining small scale geological outcrops and phenomena as preservable objects. In addition to the above, a website is being constructed where all located sites appear on the Israel map. Visual and textual information are included for every site. About 80 sites have been reported so far by IGS members, however, many more should be added to the list. A special form that can be downloaded from the IGS website, was prepared in order to assist members to report and describe new sites. An updated list of the reported sites and the website will be presented at the conference.

SPATIAL DISTRIBUTION OF SOLUTE TRANSPORT ALONG FRACTURES IN A SATURATED CHALK FORMATION

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The research objective was to characterize, on a field scale, the hydraulic parameters of two natural fractures belonging to major systematic fracture sets in the Northern Negev, Israel, using tracer transport experiments. The experiments were performed in the Ramat-Hovav area.

Seven large-diameter boreholes were drilled into two vertical fractures, belonging to the 062^0 and the 344^0 average azimuth fracture sets. The boreholes penetrated to depths ranging between 2.20 to 5.00 m. Two multi-tracer tests: under steady-state and under transient flow conditions were performed between four of these boreholes.

Two transport models were used to solve the transport problem. Both models were based on the same transport equations (double-porosity concept), but differed in the ways they described flow configuration. While the first model defines flow within a single, isolated fracture, the second defines flow within a single fracture interconnected with another fracture (dilution effect) at a junction point. At this junction point, mixing and diluting of the tracer plume occurs. The fitting parameters obtained by both transport models were: 1) the effective fracture aperture, 2) the longitudinal dispersivity, and 3) a mass transfer coefficient.

Fracture aperture values obtained by solving the transport problem varied between 16 and 82 micrometers. These values are the equivalent fracture apertures. As fractures surfaces are estimated to be highly heterogeneous (following laboratory experiments that have been performed in borehole cores taken from this site), the spatial distribution of the fracture apertures is expected to display a wide range of values (due to dissolution and bio-turbation channels versus sealing by mineralization and sedimentation along the fracture planes). These values may differ considerably from the equivalent values of the fracture aperture. Comparing the two different transport models suggests that the model defining mixing processes at a junction point describes better the transport phenomena within the investigated fractures.

DRAINAGE RESPONSE TO THRUSTING AT BASIN FOOTHILLS, THE NORTHERN TIEN SHAN, KYRGYZSTAN

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The Tien Shan is a very active intracontinenetal mountain belt that was formed as a post-collisional deformation in response to the India–Eurasia convergence. The aim of the study is to reveal the progressive history of the hydrographic networks in the peripheral foreland of the Issyk-Kul basin, northern Tien Shan, Kyrghysztan and to assess their links to the structural and morphological evolution. The study area is an alluvial piedmont, composed of fans and bajadas and at the center and parallel to the mountain belt is an anticline - the Ak-Teke Hills - which is a thrust-generated front anticline which was up-warped through the piedmont cover, causing partitioning of the foothills into two bajadas, upslope and down slope from the anticline.

The configuration of the drainage network was revealed through the study of the drainage patterns and catchment areas. Field data was supplemented by interpretation of declassified Intelligence photos, satellite images and standard air photos. The age of samples taken from the alluvial surfaces was determined by Luminescence dating.

The water gaps crossing the Ak-Teke anticline reach a maximum valley depth of 60-70 m, indicating the competence of the initial antecedent drainage system, during the up-warping stage, later to 167 ka B.P, to breach and match the rate of uplift and maintain the channels by incising through the growing Ak-Teke anticline. Thus the Ak-Teke did not become a shutter ridge.

By 21 ka, which is our earliest age from a sample from within a recent valley crossing the piedmont, the Toru-Aygyr and the Dyuresu rivers became deeply entrenched and the study area transformed into a terrace-like surface, which is disconnected from the deeply-incised hydrographic system. Thus the present-day drainage basins sourcing the creeks which cross the Ak-Teke through water gaps are extremely small. Since a stream catchment area may be substituted in proxy of discharge (Montgomery and Dietrich, 1994), these recent, very small, beheaded catchments indicate a low erosive capability and seems underfit to have breached the Ak-Teke Hills.

Had the up-warping continued under such underfit conditions, drainage offsets would be expected along the Ak-Teke anticline. The lack of drainage blockings or deflections in the underfit creeks suggest that no major uplift occured after the entrenchment of the Toru-Aygyr and the Kultor rivers to below the surface of the bajadas.

THRUSTING AT BASIN FOOTHILLS, THE NORTHERN TIEN SHAN, KYRGYZSTAN

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The Tien Shan is a very active intracontinenetal mountain belt that was formed as a post-collisional deformation in response to the India–Eurasia convergence and provides an excellent field laboratory for studying young tectonic morphology. The aim of this study is to reveal the progressive history of the geomorphology in the peripheral foreland of the compressive Issyk-Kul basin in the northern Tien Shan, Kyrghysztan and to assess its links to the structural evolution of the area. The study area is an alluvial piedmont, composed of fans and bajadas and at the center and parallel to the mountain belt is a hilly zone named the Ak-Teke.

All former Soviet and Kyrghyzian research related to the study area was examined. The structure was recorded along outcrops of the exposed Issyk-Kul formation and in a few trenches. Field work was supplemented by interpretation of declassified US intelligence aerial photography, satellite images and standard air photos. The age of samples taken from the alluvial surfaces and from the trenches was determined by Luminescence dating.

The structural cross-Ak-Teke sections reveal an asymmetric anticline with a basinward, steep and overturned forelimb. In the trench on the southern boundary of the Ak-Teke Hills this structure is revealed by subvertical to overturned positions, indicating a thrust fault that dips away from the basin. The Ak-Teke is a thrust-generated front anticline which was up-warped through a smoothly sloping piedmont cover, causing partitioning of the foothills into two bajadas, upslope and down slope from the anticline. The fault-propagation fold model is put forwards as an explanation for such common association of asymmetric folds with steep or overturned front limbs adjacent to a thrust belt which bounds the Issyk-kul depression.

Sediments on the northern bajada were dated to167 ka, assigning this surface to Late Pleistocene The upwarp started post 167 ka B.P. and before 96 ka B.P. Samples taken from the alluvial terraces incised into the rising Ak-Teke anticline were dated to 96 ka - 64 ka. This is the timing of the up-warp of the Ak-Teke. A sample taken on the uflifted floodplain in the Toru-Aygyr valley which crosses the piedmont, dates 1.3± 0.21 ka. It records the last tectonic pulse along the southern Ak-Teke fault and suggests that tectonic activity is continuing to the present. The Ak-Teke Hills are the morphologically-mature expression of a frontal fold at a thrust belt edge, propagating into the basin. The study area demonstrates transfer of the displacement to a more forelandward thrust as a stage in the closure of the basin by collision tectonics.

SUBSURFACE STRUCTURE AT THE NW COAST OF THE DEAD SEA, A GEOPHYSICAL STUDY

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The Dead Sea basin is located along the left-lateral Dead Sea transform. The activity along the transform that began during the Miocene as pure left-lateral strike-slip motion changed since the early Pliocene to left-lateral strike-slip with a minor component of normal extension, resulting in the present structure of the rift. While much is known about the rift history and structure from surface geology, borehole and geophysical data, much is still unknown regarding its subsurface structure. The goal of this project is to study the subsurface structure along the NW coast of the Dead Sea.

Three E-W, high-resolution seismic reflection profiles were shot at the Nahal Darga fan-delta, Kalia beach and northern bank of the Dead Sea, by the Geophysical Institute of Israel (GII). A major fault (Kalia fault) is observed in the profile along the northern bank of the Dead Sea but not in the southern profiles. This fault divides the subsurface into two blocks: The eastern block is characterized by horizontal reflectors and low seismic velocity. The reflectors in the western block have a slight dip to the east and higher seismic velocity. The dip and seismic velocity of the Kalia beach profile are similar to those found west of the Kalia fault in the northern profile. As the major fault was not observed in the Kalia beach and Nahal Darga profiles, we concluded that if it extends to the south it should be located along the NW steep slope of the Dead Sea basin east of the Nahal Darga and Kalia beach profiles.

Seismic velocity of P and S waves of rock specimens representing the subsurface rock units of the study area have been measured in the Deichman Rock Mechanics Laboratory at the Ben-Gurion University. The measured velocities (P waves) of the rocks of the basin fill (1300-1500 m/sec) are similar to the velocities calculated by the geophysical model. On the other hand, the measured velocities of the Judea Group rocks (4000-6000 m/sec) are higher than those obtained by the geophysical model of the Nahal Darga seismic profile (2500 m/sec). This difference is attributed to the fact that the measured samples are intact and relatively homogeneous, whereas seismic velocities in the field are attenuated due to jointing and porosity.

GIS-BASED ASSESSMENT OF EARTHQUAKE HAZARDS; EXAMPLE FROM THE CITY OF JERUSALEM

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Geographic Information System (GIS) is a powerful tool for earthquake hazards assessment since it enables quick and accurate concentration, manipulation and analysis of various databases. Furthermore, the products can be immediately implemented in the existing GIS of the relevant planning authority or municipality. We present the GIS methodology used for a comprehensive earthquake hazards evaluation in the city of Jerusalem. The study area extends over 180 km^2 of mountainous terrain (400m-900m above sea level) and consists of diverse geologic units.

The two basic data-sets used for the study area were: 1) Geological map - we compiled the most detailed data available: the geotechnical map of Israeli (1977) on a scale of 1:12,500; and the geological map of Arkin (1976) on a scale of 1:50,000 to cover the gaps left around the geotechnical map. We scanned, rectified and digitized the two hard-copy maps in order to create one polygonal map. 2) A 25m*25m pixel Digital Terrain Model (DTM) of Hall (1993). The DTM was also used to generate the topographic slope map of the area.

Two maps of amplification potential were generated: 1) The potential of lithological amplification – made by attributing the relative shear waves velocities of the different geological units to the geological map. 2) The potential of topographic amplification – made by delineating high hills and steep cliffs on the DTM. In addition, two maps of slope failure potential were produced: 1) The potential of natural slope failure – the geological units were divided to two groups: 'weak' geotechnical units, e.g. the chalky Menuha Fm., and 'strong' geotechnical units, e.g. the carbonates of the Aminadav Fm.. The intersections of these groups with different critical topographic slope values yield the map of the potential of natural slope to fail in a strong earthquake. 2) The potential of 'urbanized' slope failure – includes all of the 'weak' geotechnical units, since future engineering development will probably reduce their mechanical strength.

An alternative approach to evaluate the earthquake hazards was the analysis of seismic intensities of the damage observed in and around Jerusalem during the 1927 earthquake, which were summarized by Avni (1999). We rectified an old geographical map from 1934 in order to correctly identify the geological formation outcrops in the historical area of the villages that appear in the damage reports. At this stage we associated the seismic intensity with the local geology and found the empirical relations between the two, thus showing the possible control of the geological unit on the degree of the damage of man-made structures. On the basis of this association we made a map of the potential increase of seismic intensities during a strong earthquake.

The four amplification and slope failure potential maps were compiled using the GIS into a summary map, which is more readable to the non-geologist user. The map shows areas of no hazard, zones of amplification potential, zones of slope failure potential and zones that include two different hazards.

CONTAMINATION OF THE SATURATED AND UNSATURATED ZONES OF THE COASTAL PLAIN AQUIFER BY VOC's

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Volatile Organic Compounds (VOCs) were detected in the Coastal Plain aquifer over an area of 200 km^2, in 82% of 90 municipal pumping wells supplying drinking water. The main VOC's detected in groundwater are chlorinated solvents such as, Tetrachloroethylene (PCE), Trichloroethylene (TCE), Dichloroethylene isomers, Chloroform and Carbon Tetrachloride.

Exceptionally high concentrations of TCE, up to124,000 μg/L-air in the unsaturated zone and up to 250,000 μg/L-water in the saturated zone, were measured at the former IMI Magen site. Other VOCs were also detected in high concentrations at the saturated-unsaturated interface region in this area.

Many underground parking structures and basements of buildings in the study area extend as deep as the water table. VOCs were detected in 21-46% of more than 50 sites inside buildings and underground parking lots in the neighborhoods of Nahalat Itzhak, Bitzaron and Ramat Israel (tested by the Environmental Quality Authority, Tel Aviv Municipality, 2001) The highest concentrations of measured components were: TCE 628 $\mu g/m^3$ air; PCE 428 $\mu g/m^3$ air; Carbon Tetrachloride 1,133 $\mu g/m^3$ air; Chloroform 2,710 μg $/m^3$ air, and *cis*-1,2-Dichloroethylene 519 μg $/m^3$ air. VOCs can also accumulate in plants. A method for quantitative assessment of VOCs in vegetation was developed and implemented for both field and laboratory samples. Uptake of TCE by vegetation in Tel Aviv was confirmed.

Much of the path of the planned Red Line subway tunnel, both above and below the water table, is through the most severely contaminated region of the aquifer. Evidence for contamination by petroleum hydrocarbons was also found in a Red Line subway-monitoring borehole. Concentrations of hydrocarbon vapors were highest at depth, close to the water table. Hydrocarbon vapors can accumulate in underground structures and at high concentrations may lead to explosions.

Considering that industries using VOCs are found in many parts of the replenishment area of the Coastal Plain aquifer, it is reasonable to assume that Coastal Plain aquifer contamination by VOCs is a widespread phenomenon.

DEVELOPMENT OF MULTIMODEL APPROACH OF GEOPHYSICAL DATA INTERPRETATION AT ARCHAEOLOGICAL OBJECTS

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Geophysical methods are successfully applied to archaeology as rapid, reliable and non-invasive means for revealing a broad range of various targets: buried walls, columns, foundations, water pipe systems, cemeteries, kilns, furnaces, underground cavities, ancient garbage accumulation, etc. Potential geophysical fields (magnetic, direct current, self-potential, gravity and temperature) are often uzed for recognition of buried archaeological targets and development of physical-archaeological models. A mathematical theory of experiment design maybe utilized to acquisition, processing and interpretation of potential geophysical fields at archaeological sites. Quantitative interpretation of these fields was traditionally oriented to identification of a single model of studied object. In the case of existence of several hypotheses about parameters of disturbing body usually was selected only one model roughly presenting disturbing object in some domain Ψ_x of k-dimensional space of physical-archaeological factors. At the same time, ancient remains, as a rule, are complicated objects broken by human activity and various geological processes. Rugged terrain relief, oblique polarization of geological objects and archaeological remains, inhomogeneous medium and some other factors introduce additional noises to observed geophysical fields. As a result, response function $\mathcal{R}_i$ – geophysical field observations – may ambiguously represent ancient target. Besides this, different physical nature of the above-mentioned potential fields may cause different distribution of the response function $\mathcal{R}$. Therefore, we propose that domain Ψ_x maybe divided to several subdomains Ψ_1, ... Ψ_m in each of them will dominate one model. In such a way we could develop several physical-archaeological models of the same target, each correct for separate subdomain Ψ_1, ... Ψ_m. The multimodel approach maybe realized also in a form of multilevel geophysical field observation. A physical level of geophysical field observation at archaeological sites depend on: for magnetic and gravity fields – height of sensor over the earth's surface, for direct current and self-potential fields – depth of electrode grounding under the earth's surface and for temperature – depth of thermometer location in small bore pits. Knowingly changing the distance to anomalous object we can receive different $\mathcal{R}_i$ and utilize various approximation models in the process of quantitative interpretation. Combining several response functions $\mathcal{R}_i$ we could obtain more accurate and reliable generalized physical-archaeological model of studied ancient target.

GEOLOGICAL-GEOPHYSICAL ANALYSIS OF NEOGENE-QUATERNARY BASALT ASSOCIATIONS IN THE LAKE KINNERET AREA

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Map of the total magnetic field of the Lake Kinneret area displays a complex pattern of the magnetic anomalies caused mainly by a combined influence of the Neogene-Quaternary basalt flows surrounding this lake and magnetic sources occurring this lake. Positive and negative magnetic anomalies, recognized in the Lake Kinneret area, correspond to the basalts of normal and reverse magnetization, respectively. These anomalies were investigated using modern procedures developed specially for complicated geological conditions. Applying these procedures quantitative parameters of the targets were determined and their classification was performed. A 3-D modeling of magnetic field has been successfully carried out for refining the data obtained at the previous stage and to computing effects due to proposed geological boundaries and bodies. Generalized chronostratigraphical and magnetostratigraphical columns of the Late Cenozoic basaltic formations of Lake Kinneret area were utilized for compiling of paleomagnetic map of the area. The constructed paleomagnetic map of basalt associations framing Lake Kinneret basin was correlated with the paleomagnetic zones revealed in the lake. The recognized paleomagnetic zones in the lake basin basically are in accordance with the western and northern framing of the lake and have some disagreement with the eastern and southern framing. Performed integrated analysis of magnetic and paleomagnetic data allowed to identify that interpreted magnetic anomalies in the lake correspond to zones of 3r and 3n of the standard paleomagnetic sequence. Analysis of radiometric and paleomagnetic data indicates that in the western part of Lake Kinneret are developed the Early Pliocene basaltic associations. Paleomagnetic profile constructed in S – N direction across the studied area designates that western part of the Lake Kinneret depression maybe interpreted as an inversion trough formed at the area of Pliocene uplift in the northern part of Galilee.

GEOELECTRIC STRUCTURE OF THE SUBSURFACE IN THE SINKHOLE OCCURANCE SITES ALONG THE WESTERN DEAD SEA SHORE LINE

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In the present study we have used geoelectric methods to achieve a better understanding of the subsurface geoelectric structure at sinkhole development sites, taking into account that electric parameters (such as resistivity or conductivity) are very sensitive to medium properties and their variations in time. The Ein Gedi and Nahal Hever southern sites were studied using the Continuous Vertical Electric Sounding (CVES) method. In some cases a Ground Penetrating Radar (GPR) survey added the CVES results.

The Ein Gedi area is situated on the Nahal Arugot young alluvial fan about 20m above DSL. Sinkholes in the holiday village are concentrated along a narrow (50-70m wide) zone about 100m and long trending southeast. The 15 CVES lines were surveyed here during 2001-2002 over an area of 300x550m^2 (Ezersky, 2003). Resistivity cross-sections and maps were constructed. The clearest high resistivity anomaly of 100 ohm-m or over (to 1500 ohm-m), at a background resistivity of 50-60 ohm-m, is expressed on the map at a depth of 10-15m. It is approximately 250x300m in size. The resistivity anomaly is followed to a depth of 21-25m and underlain by a low resistivity (1 to 10 ohm-m) zone. It appears that the high resistivity zone at the holiday village could be interpreted as a zone of strongly decompacted alluvial deposits resulting from soil removal from the sinkhole. This is also confirmed by microgravity mapping recently carried out independently (Rybakov, 2002).

Nahal Hever southern site: 2D CVES measurements and mapping added by the GPR survey were carried out at the site during 2002. The sinkhole sites at the Nahal Hever southern area are characterized by another geoelectric structure than the Ein Gedi area. Increased resistivity anomalies connected with decompaction zones are observed here at the depth interval of 6-12m. Very characteristic low resistivity anomalies (of 1-6 Ohm-m) appear in the lower part of the section above the ground water table. These anomalies have a horst similar structure. Their location coincides with that of the sinkholes. The largest of these anomalies is located under borehole HS-2, which collapsed in December of 2002 within a new sinkhole. The resistivity mapping of the site shows that there is a good correlation between sinkhole location and the resistivity distribution map at a depth of 10-12m from the surface: most of the sinkholes are located above a resistivity zone of 1-6 ohm-m. These horst-like, very low resistivity anomalies could be connected with clayey sediments holding the Dead Sea saline water over long periods of time after regional lowering of the sea level. There may, however, be other reasons as a surface water intrusion.

ROCK QUALITY ESTIMATE USING GEOPHYSICAL METHODS

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Extensive tunnel, road and underground construction will take place in Israel in the near future. With this increase in infrastructure development work, geophysical methods can be useful in determining construction site characteristics such as rock quality, conditions and properties. This information is vital for the engineering design of the structures. Deer (1967) proposed the Rock Quality Designation (RQD-index) which is an index of core recovery obtained by summing the length of pieces of core longer than 10cm and dividing this length by the total length of the borehole. It is an index of fracture frequency and has proved very useful at many sites for estimating the depth of excavation required before good quality rock suitable for foundations is reached. The direct correlation of the RQD-index with some geophysical parameters has been proven. Various theoretical and field investigations have shown that there are inter-relations between joint parameters (such as void volume n, the fracture frequency Jn, Rock Quality Designation RQD-index, joint concentration C, etc) and geophysical parameters such as seismic velocities and electric resistivities. The seismic refraction survey is the geophysical method most closely related to rock mass properties since the longitudinal seismic wave velocity varies with the main features which characterize the rock mass: rock properties, jointing, stress, etc. These inter-relations are caused by the dependence of seismic velocities and electrical resistivities on the degree of jointing and the physical properties of the filling material. The combined use of these methods is based on their various sensitivities to joint parameters. The results of two years research work are presented (Ezersky and Sobolevsky, 2001, 2002). The main aim of this study was to check out the possibilities of using engineering geophysics for rock quality estimates and deformation modulus determination of Israeli rocks, using geophysical parameters (such as P- and S-wave velocities and electric resistivities).

Correlation between the rock quality versus seismic velocities was carried out in order to use the geophysical methods for construction site characterization. The geophysical surveys were performed at different sites in Israel. The correlation obtained during field studies and from technical reports are comprised within a world data bank. The RQD-Vp correlation between metamorphic, igneous rocks and massive fine crystalline dolomite of the Soreq cave area are similar; there is, however, a considerable difference between this correlations for rocks (limestone, basalt and chalk) of the different sites. The correlation graph $(V_F/Vo)^2$ versus RQD-index was obtained facilitating classification of the rock using one of the existing systems. In this ratio V_F is the seismic velocity measured in the field and Vo is the basic velocity representing the site dependent (in situ) velocity for the same intact rock. An example of the characterization of two tunnel traces at a construction site is given using seismic refraction and CVES methods including determination of the structure, rock quality and properties.

THE FATE OF NEOPENTYL-HALIDES IN A FRACTURED CHALK AQUIFER

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The Eocene aquifer underlying the Ramat-Hovav complex is heavily contaminated with an enormous variety of organic contaminants, many of which are still not identified. Assessment of the risk to the aquifer and/or the remediation potential requires understanding of the mechanisms controlling distribution of the pollutants. The most abundant semi-volatile pollutant group in the Ramat-Hovav Eocene aquifer is the Brominated neopentyl alcohols (BNA's). Analysis of data collected in a monitoring program over more than five years shows a changing pattern in the ratio between different BNA compounds along the flow gradient, e.g. a decrease in the ratio Tribromoneopentyl-alcohol (TBNPA)/Dibromoneopentyl-glycol (DBNPG) as a function of distance from the source (factory). The transportation of contaminants in the Eocene aquifer is almost exclusively via fractures. The main processes controlling the attenuation of BNA's in the fractures are diffusion into the matrix, adsorption, chemical transformation and biodegradation. Differences in the effect of each process on these compounds result in differential responses and leave characteristic molecular "signatures".

The steric structure and crowding of the bromine group provide the BNA's with high resistance to biological reactivity. In this respect TBNPA is anticipated to be more resistant than DBNPG molecules due to its higher bromine content. Likewise diffusion of the heavier TBNPA into the matrix should be slower than that of the lighter DBNPG molecules. Hence, neither biodegradation nor diffusion can account for the observed variation in the TBNPA/DBNPG ratio. The BNA's are all relatively soluble. Nevertheless, the solubility of DBNPG is an order of magnitude greater then that of TBNPA. This lower solubility, along with the difference in molecular structure, suggests a considerably greater adsorption of TBNPA, which could account for the variations observed in the ratio of the two BNA molecules. Experimental work with TBNPA and DBNPG shows chemical transformation and formation of relatively "stable" products. The specific chemical identity and molecular structure were determined by GC-MC and NMR. These chemicals are present in the aquifer but are not known to occur in any of the industries draining into the Ramat-Hovav system. Their source was not identified until the present study. Our results indicate that these compounds are products of BNA decomposition. The kinetics of these transformations is currently being determined via a set of experiments performed in a variety of temperature and pH ranges.

THE ORIGIN AND MECHANISMS OF SALINIZATION IN THE LOWER JORDAN RIVER

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We report here on an ongoing research that investigates the origin of salinity of the Lower Jordan River between the Sea of Galilee and Dead Sea. The chemical and isotope data reveal three geographically distinct zones: (1) Northern section - the upper 20-km down-flow, from Alumot dam to Maoz Haim; (2) Central section – 20 to 60 km down-flow, from Maoz Haim to Zarzir Station; and (3) Southern section – 60 to 100 km down-flow, from Zarzir Station to Abdall'a Bridge.

The initial base flow (about 20 MCM/year) of the Lower Jordan River is comprised of the diverted saline springs ("Saline Carrier") and waste water that are artificially discharged to the river. This base flow has a Ca-chloride composition (e.g., low SO_4/Cl), which reflects the initial input of the saline springs. Along the upper 12 km the original base flow composition changes towards a Na-Mg-SO_4 water type with a high SO_4/Cl ratio. These changes are accompanied by an increase in $\delta^{18}O$, and decrease in $\delta^{34}S$ and $^{87}Sr/^{86}Sr$ values. The observed gradual change along the flow path cannot be explained by surface inputs alone because of their small discharge and different chemistry. The linear relationships between Cl^- and other dissolved ions indicate that chemical modification of the Northern section is controlled by mixing of the initial base flow with a groundwater having distinct chemical and isotopic compositions (e.g., high SO_4/Cl). We use the ionic ratios variations in the river to calculate possible mixing relationships between the initial base flow and groundwater discharge. Our results show a contribution of up to 40% of the flow in the first 12 km of the Jordan River.

In the southern section we observed two periods of salinization: In spring salinity increased at a flow distance of 70-80 km, while in summer a gradual salinity increase occurred. We identified several possible inflows to the river: (1) the saline Zarka River; (2) Ca-Chloride brines, and (3) Sulfate-rich groundwater. The mixing relationships in the Jordan River and the change in $^{87}Sr/^{86}Sr$ ratios show that groundwater discharge controls the water quality. The contributing groundwater source is a mixture of the brine and the sulfate-rich groundwater. We use mixing equations to quantify the relative contribution of the postulated groundwater source to the river. Our calculations suggest a contribution of ~10% of the saline groundwater. We suggest that the high salinity of the groundwater that discharges to the Jordan River controls its water quality. The magnitude of salinization depends on the balance between River flow discharge and groundwater discharge.

THE NILE DEEP - SEA FAN CHANNELS OFFSHORE ISRAEL

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Geophysical studies of a 3D seismic data set in the deep-sea off central Israel revealed systems of seabed and sub-seabed channels, faults and folds. Excellent images of channels and faults were achieved by using seismic surface and volume attributes such as amplitudes and derivatives.

The studied area is centered 130 kilometers west of Netanya and covers 900 square kilometers. Water depths range from 1100 to 1350 meters. According to the regional bathymetry this area corresponds to the easternmost part of the Nile deep-sea fan.

The slope is gentle, 0.4° to NE, but the morphology is rugged and characterized by active channels, fault traces, hummocks and depressions. The entire Pliocene to Holocene section is deformed and faulted due to movements in the underlying thick Messinian salt.

The most prominent seabed feature is the network of channels, meandering to the NE-NNE across the area. The channels are 200 to 600 meters wide, 18 meters deep and have the shape of low energy onshore rivers, with typical meanders and levees. Similar deep-sea channel-levee systems have been recently reported in neighboring areas, off the Rosetta and Damietta branches of the Nile. They have been attributed to the Nile distal fan systems (Prismed II and Fanil projects, 1998 and 2000, in Bellaiche, G. at al., CIESM, 2002). The eastern channels off Damietta have been reported to trend NNE and extend as far as the deep basin NE of Eratosthenes. By analogy, the trend of the seabed channels observed offshore Israel indicates that their origin is in the eastern branch of the Nile.

Older buried channel–levee systems appear in the underlying Pleistocene-Pliocene section. They provide an unambiguous evidence for a left lateral strike-slip fault movement. The strike-slip faults trend W-WSW. They disrupt the surface, but do not laterally displace seabed channels. However the deeper late-Pliocene channel clearly exhibits a horizontal displacement of 2200 meters across a left lateral strike-slip fault.

Unlike the younger channels, the Pliocene channel trends to the north and may indicate a Sinai source. Seismic amplitudes of the late Pliocene channel fill are high and indicate a sand rich system, whereas amplitudes of the seabed channels fill are low and indicate a mud rich system.

This study is an independent interpretation of a 3D seismic survey that has been acquired, processed and interpreted by British Gas Group. BG's geophysical work however was the first to recognize, delineate and describe the features presented here (Hall, B and Canning, J., 2001, BG internal report).

THE LATE CENOMANIAN SHELF EDGE OF NORTHERN ISRAEL

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The geometry of sedimentary bodies on the Cenomanian carbonate shelf edge of northwestern Israel may be interpreted in terms of a low angle carbonate ramp, becoming locally steepened through progradation.Vertical and regional trends were placed in a chronostratigraphic and sequence stratigraphic framework following broadly Buchbinder et al. (2000). The dominant cycle begins with a relatively deep basinal facies at the base, develops upwards to shallow inner-ramp facies, and passes upwards to a deep outer ramp facies. Several bounding surfaces are recognized: 1) A Maximum Flooding Surface (MFS) which overlies a transgressive tract (TST), marked by maximal distribution of the most basinal facies. In distal (southwestern) sections its position is not precisely localized within the Deir Hanna Fm, and in the more proximal (eastern) sections it forms the top of the Deir Hanna Fm, coinciding with the overlying diachronous downlap surface; 2) a somewhat diachronous downlap surface, approximately coeval with the extinction datum of *Orbitolina* sp., and recognizable from the Galilee to the Negev; and 3) the overlying late highstand tract (HST) is terminated by a Type-3 Sequence Boundary which represents drowning of the prograding ramp.

Intergrading carbonate facies associations include pelagic-basinal, outer ramp, mid ramp, inner ramp, foreshore, subtidal through supratidal, and lagoonal facies. Basinal sedimentation achieved by the TST was relatively uniform, with slight lithological variants representing either normal basinal conditions, stressed environments inhabited by opportunistic calcispheres, or changes in rate of sedimentation. Above the MFS, a highstand system tracts is developed, represented by a variety of facies, related one to another vertically and a laterally. Early weak aggradational event is followed by small-scale shallowing-upward carbonates, in some cases capped by supratidal horizons which may have been subaerially exposed. Synsedimentary deformations of various types took place in the progradational environment. Deformational features such as extensive breccias, and one recumbent fold in the Adamit HST show mass flows down-ramp from east to west. The HST is terminated by a Type-3 sequence boundary, on which drowning of the inner ramp is demonstrated by a facies shift to deepening-upwards cycles and occasionally laminated outer ramp sediments over the entire area. Upwards in the Bina Fm., deformation again indicates extensive mass movement, to the WNW, in the Adamit area.

Pervasive dolomitization, probably a late feature, affects nearly all progradational facies, as well as basinal facies in close physical contact.

CENOMANIAN-TURONIAN SYNSEDIMENTARY DEFORMATIONAL FEATURES AT ADAMIT, NORTHWESTERN GALILEE

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The Adamit Breccia occurs in a deformed zone, hundreds of meters long within the late Cenomanian- Turonian Deir-Hanna, Sakhnin and Bina fms. It is exposed in the area of Adamit, northwestern Galilee. The features breccia is divided into five subunits by their structural and sedimentological characteristics.

Predominantly soft-sediment deformational features of sediments at various stages of lithification representing translational movements on the distal slope prevail in the breccia of the Deir Hanna Fm. They include fragments that indicate ductile and brittle synsedimentary deformation.

Deformational features in the stratified dolomites of the Sakhnin Fm are associated with subhorizontal planar and slightly curved shear zones sometimes following bedding planes. To the west these dolomites become deformed and gradually pass into two breccia bodies: a stratigraphically confined lower breccia body composed of ramp-derived bioclastic facies, within a matrix of the local outer ramp facies, and a localized upper breccia body which is autoclastic, of inner ramp material. The breccia of the Sakhnin was emplaced by translational sliding towards the west on a gentle slope as indicated by the shear zones. Sedimentological, petrographic and CL observations of the Adamit breccia bodies indicate that differences between the lower and upper breccia bodies may be attributed to highstand progradation, to which the downslope mass-transport may itself have contributed. At first, stratified sediments of the inner ramp glided along shear planes approximately parallel to bedding, forming the lens or fan-shaped lower breccia body on the outer ramp. Subsequently, the upper breccia body was formed as a result of westward mass movement, but by then progradation had modified the environment to an autochthonous inner ramp facies.

In the overlying Bina Fm a lateral gradual increase in deformation is observed, from stratified interbed deformation show slightly thrusted and folded Bivalve shells to mega breccias. Shear planes and folds indicate mass movement towards the WNW.

DEEP-SEATED AND TRANSVERSE KARSTIC FLOW IN THE YARKON-TANINIM AQUIFER

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The Yarkon-Taninim aquifer which supplies about a third of Israel's fresh-water consumption, is commonly referred to as 'karstic'. However, karst hydrology has hardly been considered in past studies which commonly assumed that the aquifer is divided into two homogenic sub-aquifers.
Another approach is suggested herein, which assumes a three-dimensional anisotropy due to the karstic conduits. This approach is based on observations obtained at the central part of the Yarkon-Taninim aquifer, between Lod and Kfar-Uriyah. Preliminary results suggest that the aquifer is divided into three sub-aquifers, associated with fractures and discrete karstic conduits, with partial confinement by non-karstic layers. Meteoric circulation within the lower sub-aquifer reaches a depth of ~1km below sea-level. This deep sub-aquifer is characterized by high hydraulic conductivity, anoxic conditions (high H_2S content), high-salinity and high temperatures. At some spots, mostly at the western part of the aquifer upward flow across the bedding (transverse flow) is detected. In such sites the deep-circulating groundwater rises through sub-vertical karstic conduits, mixing with shallow groundwater adjacent to the water table. The resulting plumes of deep water are observed at shallow depth in Ayalon and Kfar-Uriyah well fields. The rising hydrothermal water is aggressive with respect to limestone, resulting in abundant karstic cavities associated with high hydraulic conductivity.
We intend to construct a numerical flow model that will consider lithologic, structural, hydrological, chemical, isotopic and thermal data from wells, video monitoring of boreholes and cave geomorphological survey.

HOLOCENE PALEOLANDSCAPES IN THE NORTHERN CARMEL COAST, ISRAEL

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Sea level changes, fluvial features and bathymetric data are used to reconstruct paleolandscapes in the region. A reconstructed Holocene sea-level curve based on coastal and submerged archaeological and lithological data, shows two main varying rates of sea-level rise: from ~9.5 to ~6.8 kyr BP (M.S.L. -35 to -7 m; 10 to 12 mm/yr); from ~6.8 to ~4.0 kyr BP (M.S.L. -7 to present sea level; 3.5 to 2.5 mm/yr). In the last 4 kyr no major changes (greater than 1 m) can be observed (< 0.25 mm/yr). Fluvial features include ancient river courses transecting the submerged kurkar ridges, pebbles embedded in and on Late Pleistocene marshy clays (on sea-bottom and on shore), and present-day river courses crossing the easternmost kurkar ridge. Geomorphological reconstruction based on bathymetric maps, coupled with archaeological and fluvial evidence, suggest four main evolving landscapes created by the Holocene sea transgression and changes in fluvial water regime:

1) At 9.5 kyr BP sea level was ~35 m below M.S.L., the coastline between N. Megadim and N. Maharal was straight and sandy. North of N. Oren the coastline was mostly rocky with some shallow rocky barriers off shore. Marshy clays were embedded in the troughs between the coastal kurkar ridges. All rivers, from N. Megadim in the north to N. Maharal in the south crossed the easternmost ridge through the recent canyon of N. Oren and the presently submerged "Oren Gap" to the west. Rivers from N. Mitleh to N. Ahuza (including N. Galim), blocked by the eastern ridge, flowed northward and crossed the coastal ridge at Kfar Samir where the present-day coastal ridge disappears under the sediments. These and other rivers from the north (Ezov, Siah and Amiq) crossed the now submerged ridge through a deep Canyon. 2) Between 8.2 and 7.5 kyr BP sea level was ~16m below M.S.L. and the coastline north of N. Oren was extensively indented creating lagoons and shallow bays. South of Atlit the coast was sandy and straight. Alluvial sediments filled the eastern trough and the water overflow enabled direct flow of rivers (e.g., Galim, Ovadia) to the sea. The overflow created alluvial fans abutting the western slopes of the eastern ridge (south and north of Tel Kones), while depositing limestone pebbles and boulders on top of the marshy clays. 3) Between 7.1 and 6.5 kyr BP the sea was ~9 m below M.S.L. A row of offshore islands were situated parallel to the coast from Atlit northward while to the south the coast was straight and sandy. 4) In historic periods man-cut channels improved the drainage capability of N. Me'arot and N. Maharal.

GYPSUM PRECIPITATION RATE IN RED SEA – DEAD SEA MIXTURES – PRELIMINARY RESULTS

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During the World Summit on Sustainable Development in Johannesburg, Israel and Jordan announced that they plan to build the "Peace Conduit", a pipeline connecting the Dead Sea and the Red Sea, in order to stop the decline in Dead Sea water level and to desalinate seawater for distribution to Jordan. Several studies conducted during the seventies showed that gypsum is precipitating from a mixture of seawater and Dead Sea brines. As part of the new effort to understand and quantify the possible effects of the Peace Conduit on the Dead Sea, the kinetics of gypsum precipitation from 1:1 Red Sea – Dead Sea mixture were studied at 25°C.

Experiments were conducted, using a well-stirred flow-through apparatus, in which precipitation rate (R) is calculated at steady state from the consumption of SO_4:

$$R = -q(C_{out} - C_{inp})$$

where C_{out} and C_{inp} are the concentrations of SO_4 in the output and the input solutions, respectively (mol Kg^{-1}), and q is the fluid volume flux through the system (Kg s-1). As the input solution is mixed inside the reaction cell, its concentration is calculated by:

$$C_{inp} = \frac{C_{DS} * q_{DS} + C_{RS} * q_{RS}}{q_{DS} + q_{RS}}$$

where the subscripts DS and RS refer to Dead Sea and Red Sea, respectively. Seed material was prepared from a transparent crystal of gypsum (selenite), which was crushed and sieved to retain the 53-149 □m size fraction.

Preliminary results show that gypsum precipitation kinetics are controlled by the amount of gypsum. The rate increases linearly with the mass of gypsum at steady state (Fig.1). Precipitation rate at steady state was $2\pm0.6\cdot10^{-9}$ mol s^{-1} g^{-1} (0.03 g gypsum day^{-1} per each g of seed). One of the experiments was conducted with no initial mineral seeding. After less than 24 hours, the amount of gypsum precipitated is sufficient so that further precipitation becomes controlled by the mass of gypsum available.

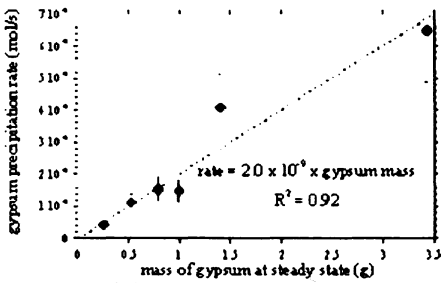

Fig. 1: Gypsum precipitation from a Dead Sea – Red Sea mixture

MESOZOIC TECTONIC PHASES AND HYDROCARBON POTENTIAL OF THE SOUTHEASTERN MEDITERRANEAN BASIN: RESULTS FROM NEW, OFFSHORE SEISMIC SURVEYS

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The structural setting and evolution of the southeastern Mediterranean basin, offshore Israel, were studied utilizing recently acquired regional, 2D seismic, magnetic and gravimetric data. Underneath several kilometers of Upper Cretaceous to Quaternary basin-fill the data show a 6-9 kilometers thick Basement to Middle Cretaceous sedimentary interval.

Deeply buried, graben and horst system extends throughout the basin, between the Israeli coastline and the Eratosthenes seamount. Northeast-southwest oriented normal faults offset Basement to Middle Jurassic stratigraphic levels. These deep-seated, extensional structures are associated with Early Mesozoic, Neotethyan rifting activity. A conspicuous, positive magnetic anomaly located along the structures, is probably related with contemporaneous, Early Jurassic magmatism.

A 50-70 kilometers wide fold belt forms an elevated, upthrusted platform west of the coastline. Dense series of northeast-southwest oriented thrust faults, monoclinal and anticlinal structures affect Mesozoic to Miocene strata. Isolated, subtler folds are found in Lower Cenozoic strata west of the upthrusted platform.

The contractional structures are associated with reactivation of older fault systems during Late Mesozoic closing phase of the Neotethyan basin. The abrupt termination of the fold belt westward reflects a transition between two crustal types indicated also by a negative Bouguer gravity anomaly.

The study reveal various types of large-scale, Mesozoic to Early Cenozoic structures found at 1000-1500 meter water depth, west of the Israeli coastline. Sub-commercial oil and gas shows, were encountered in Mesozoic strata near the cost. These are considered as an up-dip extension of a significant, hydrocarbon province located at the deeper part of the southeastern Mediterranean basin.

FROM PAN-AFRICAN OROGENY TO A STABLE PLATFORM

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Bentor's studies of the basement near Elat and later in Sinai led him to stress the events at the end of the Pan-African orogeny as recording a major change in the tectonic behavior of the region. Since then it was possible to elaborate these ideas and obtain a regional picture of the events during the transition from Pan-African orogeny to stabilization of the orogenic edifice and its conversion into a stable continental platform that was covered by a veneer of mature platformal sediments.

Critical information is provided by volcanic-sedimentary series that occur in many parts of the Arabian-Nubian shield and other parts of the Pan-African orogen in north Africa and predate the mature sediments of the Early Paleozoic platformal cover. Though of different ages – ca. 600 to ca. 550 Ma or even younger – all these series lie directly on exhumed metamorphic and plutonic rocks that formed at depths of ca.10 to 15 km during the peak orogenic activity 650-600 Ma ago. These series are folded, tilted, and/or faulted, but were not affected by the orogenic penetrative deformation, and they show weak metamorphism only in a few places. The sediments are very immature and consist of clasts derived from the young volcanics and from metamorphic-plutonic rocks similar to those exposed today. These features indicate widespread orogen-scale erosion that closely followed, or partly overlapped, the last stages of the batholithic-scale granite magmatism and removed a □10 km thick rock layer within a period of 20 or 30 Ma before the volcano-sedimentary series formed. Later erosion, of smaller extent reduced the relief to a flat and low-lying topography, eventually forming a vast peneplain on which the platformal sediments formed.

Concurrently, the scope of igneous activity diminished considerably and the magmas changed from island-arc related compositions to within-plate compositions. One of the expressions of this change is the widespread emplacement of basaltic dikes. This history is interpreted as expressing a change in magma-sources and magma-generating processes from extensive intra-crustal melting during the main phase of batholithic magmatism to melting mainly in the mantle, and eventually to cessation of melting.

Taken together the changes in the intensity and character of the regional deformation and of the igneous activity are interpreted as expressing a profound change, dominated by cooling, of the crust and the entire lithopshere underlying the Pan-African orogenic edifice. During this period magma emplacement seems to have occurred at progressively greater depths, which probably had an important role in determining the composition of the lower continental crust and mantle lithosphere beneath the Pan-African orogen. Similar sequences of events seem to have occurred also in other continental areas before they were stabilized and became stable platforms.

MODELING SEISMIC TRAVEL TIMES FOR SEISMIC MONITORING OF THE MIDDLE EAST

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Seismic events with ground truth information (GT events), especially calibration explosions (GT0), are the main source of information to develop local velocity models for site-specific travel time determinations that, in turn, are used to determine accurate hypocenter locations. GT0 events also provide data to improve detection and identification of explosions.

In order to extend the Middle East GT0 database, Geophysical Institute of Israel (GII) conducted a series of large (20-25 tons) explosions, using the facilities of local quarries. These are complementary to the Dead Sea underwater calibration shots conducted by GII in November 1999.

A 25-ton single-fired calibration explosion of special experimental design was conducted at Rotem phosphate quarry in the Negev on May 21, 2002. It was preceded by shots of lower yield in order to estimate the safety conditions and the seismic efficiency of the large shot. Obtained results confirmed earlier estimations and the 25 ton explosion yield a seismic event with a magnitude 3.0. The event was recorded by numerous portable and permanent SP and BB seismic stations and by accelerograph stations, in a broad distance range of 0.3 – 450 km.

The Rotem blast yield a magnitude similar to the Balapan explosion (STS, Kazakhstan) in September 1997, that was conducted under conditions more favorable for generating seismic signals; the charge, the type of explosives used, the configuration of the charge (single shot concentrated in one borehole), the crystalline rocks in which it was detonated, and propagating path of the seismic waves through high Q-value crust of the Kazakhstan platform.

The closely spaced (~50 km) Dead Sea and 25-ton Rotem calibration explosions were recorded by the same stations in Israel, Jordan, Cyprus and Saudi Arabia and thus provided seismograms from different sources but with similar distances and propagation path characteristics . These data enable the study of the effects of different sources on amplitudes, waveforms and spectral content of regional phases. The Rotem 25-ton explosion, although slightly smaller in magnitude than the 0.5-ton Dead Sea underwater explosion (M_L=3.1), yield stronger P-waves and more accurate phase pickings at different distances.

The recorded explosions and nearby earthquakes which occurred in the Dead Sea fault zone, provided travel time corrections for regional phases relative to the IASPEI91 model and to the GII models, for regional seismic stations, they enabled verification and improvement of velocity models, assessment of the attenuation (amplitude-distance) and magnitude-yield relations, characterization of new seismic sources and local mining practices, and multi-station discrimination analysis between explosions and earthquakes.

EARLIEST EVIDENCE FOR DELIBERATE HEAT TREATMENT OF ARCHAEOLOGICAL OCHRE FROM A 100,000 YEAR OLD HORIZON AT QAFZEH CAVE, ISRAEL

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Using the thermal activation characteristics (TAC) of quartz grains embedded in ochre fragments from an archaeological context dated at 100,000 years ago, we provide the first direct evidence for heat treatment of ochre by early modern humans. Two of three ochre fragments from archaeological levels of Qafzeh Cave, Israel had been heated in antiquity at temperatures and durations similar to that tested experimentally (600s at 390°C). Although ordinary hardwood hearth fires reach 1000°C, ochre turns black if heated beyond 450°C. Thus, the TAC results imply that the temperatures achieved were closely controlled during the ancient heat treatment, and argue against accidental heating. A third fragment from Qafzeh showed TAC properties similar to an unquestionably unheated hematitic ochre recently collected from a geological context. These findings are consistent with the mineralogy (hematite vs. goethite) and colouration (red vs. yellow) of the ochres. The fact that very early modern humans may have utilised deliberate heat treatment for the production of a variety of ochre colours has important implications for the early evolution of our artistic and religious behaviours. The direct luminescence dating of heated ochre fragments from archaeological sites is suggested and demonstrated. It should be achievable on a routine basis, provided that TAC analysis confirms that they had been heat-treated in antiquity to a sufficiently high temperature to have reset the luminescence clock, and that information essential to annual dose rate reconstruction is collected at time of excavation.

DEVELOPMENT OF REGRESSION MODELS FOR ESTIMATING THE DISSOLVED-SOLIDS CONCENTRATION IN WATER OF AQUIFERS IN ISRAEL

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Evaluation of wells drilled for fresh water presents special problem in log analysis. The main problem is to determine the quality and quantity of water that may be obtained from various sources. In oil field interpretation, formation water resistivity (Rw) determination through SP analysis is usually satisfactory. Another source of Rw is formation resistivity measurements, which are of considerable value in the exploration and production of fresh water. The groundwater salinity in this case is obtained using the Rwa method which is based on resistivity-porosity information, where the porosity data can be extracted from Acoustic Log. In practice, however, the SP data are often corrupted owing to unfavorable borehole conditions. On the other hand, in water wells, the Acoustic Log may be lacking or of unreasonable quality due to technical, environmental or other reasons. In such a situation, Electrical Logs are often the only source for estimation of the aquifer characteristics. The main goal of this research is to develop statistical models based on the analysis of real field data in order to estimate aquifer parameters from available well logs. Data from approximately 100 oil and water wells were collected and carefully analyzed in order to correlate aquifer characteristics from logs with parameters from water analyses. In conclusion, we note that Electrical Logs can provide data for evaluation of fresh water wells. However, while we demonstrate the basic relationship between log data and water well parameters, we emphasize the importance of collecting and using more extensive sets of water analyses and well logs from water wells to ensure more reliable and accurate empirical relations in local areas. Much of the information required for extension of this technique is already available in Israel. Many water wells have been logged and have also provided water analysis data.

CHARACTERIZATION OF GROUNDWATER SALINITY IN DIFFERENT SUB-AQUIFERS OF THE COASTAL AQUIFER USING TIME DOMAIN ELECTROMAGNETIC (TDEM) METHOD

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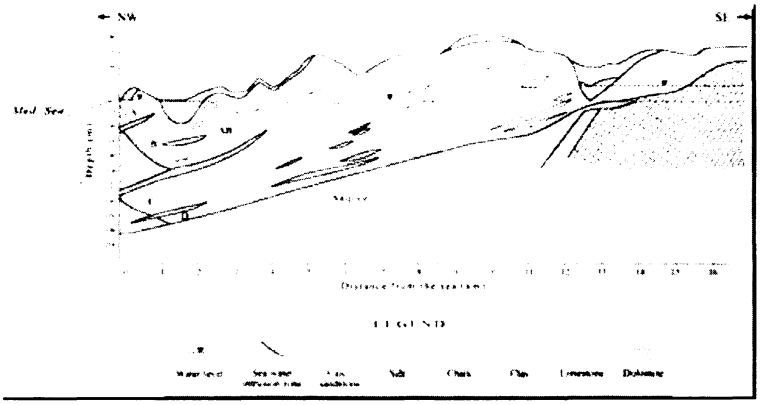
The western part of the Mediterranean coastal aquifer extending from the shoreline to about 4 km inland, includes impermeable (mostly clay) horizons which subdivide the aquifer into generally four sub-aquifers herein denoted A (phreatic), B (phreatic or confined), C and D (primarily confined).

Schematic hydrogeological cross-section of the coastal aquifer



TDEM resistivities below 2 ohm-m uniquely characterize salinity of seawater intrusion into upper sub-aquifers A and B. The depth to the interface within the upper sub-aquifers is detected by TDEM measurements with an accuracy similar to that of direct borehole conductivity measurements. In most cases TDEM is also able to characterize groundwater salinity within the lower sub-aquifers. However, if the sub-aquifers are fully or partially saturated with fresh or brackish water with thicknesses smaller than those of the clays within C and D, the resolution of TDEM could be insufficient to detect the fresh/brackish water bodies. Since this phenomenon is relatively rare (found in approximately 20% of the calibration measurements) and since the TDEM resistivities within C and D consistently testify to much higher salinities than those actually measured in the observation wells, TDEM can still be used to characterize groundwater salinity in C and D at the regional scale.
The appropriate regional mapping of the Mediterranean coastal aquifer allowed the delineation of large areas with potentially fresh/brackish groundwater within the lower sub-aquifers despite a few outliers showing apparently saline water in C and D in these areas.

SEAFLOOR MORPHOLOGY IN THE NORTHWESTERN PART OF LAKE KINNERET

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The seafloor morphology and shallow structures in the northwestern part of lake Kinneret, between Tabgha in the north and Fuliya in the south, were studied in details. Data were collected in a high-resolution shallow geophysical survey, which was conducted in April 2002. The seafloor morphology is characterized by smooth areas of low sedimentary transport, generally at deeper water depths, areas with ripple marks resembling high energetic conditions and areas of gas (probably Methane) release. In some areas the gas release is localized "vent like" while in others it is characterized by non-localized regional "bubble like" diffusions. Large (meter scale) holes were mapped in the study area. These holes range from 1 to 30 meter in diameter and 0.3 to 8 meter in depth. The majority of these holes are found within areas that are bounded by faults. We suggest a possible mechanism for the formation of these holes by salt- water transport preferentially in recent faulted areas. The size of these holes might correspond to the amount and duration of this flow. Small size holes can be young or "inactive" (short life) while large holes probably represents strong salt flow during long periods. Further geochemical measurements are planed for May 2003 to validate this hypothesis.

ON THE CORRELATION BETWEEN SURFACE GEOLOGY AND SITE RESPONSE ALONG THE COASTAL PLAIN OF ISRAEL

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In an attempt to map site response characteristics across Israel, a pilot project was carried out by the Seismology Division of the Geophysical Institute of Israel along a ~10 Km wide strip between Ashqelon and Haifa. Ambient seismic noise measurements were made at 190 sites in different lithological conditions within this area. Site response was determined by applying the technique of horizontal-to-vertical noise ratio.

Lacking detailed information about the subsurface lithology and the geotechnical properties of the soil layers, except in few locations, we attempted to correlate site response functions at limited number of sites with the local surface geology, grouped into few units.

The generalized site classification scheme was proposed based on site response analysis:

- calcareous sandstone resting on clay of the Yafo Fm. does not show significant amplification effects.
- the loose sediments of sand, alluvium and hamra units lying on kurkar and having thickness from 10m to 50m yield amplification factors of 2-3 in the frequency range 1.2-3.5 Hz.
- the bedrock represented by either hard calcareous sandstone or limestone can increase up to factor 6 in the frequency range 1.5-2.5 Hz.
- in the Carmel coast, the complex of calcareous sandstone and loose sediments, with a total thickness of 15-30 m, that covers the Judea Group carbonates, may yield amplification factor up to 8 at frequencies ranging from 2 to 6 Hz.

The correlation between the surface geology and the main features of the evaluated site response functions were analyzed. A statistical analysis of the 190 amplification values acquired in this study indicates that as a first approximation surface geology of the central coastal plain is correlated with distribution of amplification values and the loose sediments in the Coastal Plain may be considered as one unit with a median amplification factor of 3, differing from both the calcareous sandstones (Kurkar) (median amplification less than 2) and the thin loose sediments in the Carmel coast overlying the Judea Group, with appreciably higher values (median amplification up to factor 7).

However surface geology alone does not properly reflect the amplification values, because the main effect is created by the impedance contrast between the underlying hard rocks and the overlying softer rocks. Thus correlation between the lithological units and site amplification effects should be limited to the area where the study was carried out and preparing earthquake scenarios for a city should be based on detailed site response investigations.

THE NATIONAL BATHYMETRIC SURVEY (NBS) A SAMPLER OF RESULTS FROM THE SECOND YEAR OF OPERATION

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The National Bathymetric Survey (NBS), a joint undertaking of the GSI, SOI, and IOLR, has completed its second year of operation. The areas surveyed now cover from Rosh Haniqra to Akko, Ashqelon, Herzliya, inshore Hadera, and proposed pipeline tracks. This poster presents a sampler of first looks at the offshore topography, different bottom types and bedforms, and wrecks from the data collected during the first two years.

Northern Israel: The area is marked by two segmented extensions of known onshore faults, at Shave Zion and Nahariya. Some fifteen shore-parallel kurkar ridges can be traced. A number of slightly elevated irregular areas with distinct inshore margins and surficial dune-like upper surfaces are observed at depths around 30 m. Backscatter imagery shows features seemingly unrelated to the topography that are possibly related to sedimentary changes, bottom porosity etc. On a transit track within Haifa Bay an unreported sunken barge some 23 by 25 m was found.

Herzliya:The area off Herzliya deeper than 30 m is generally smooth. This area, some 30 km from Bat Galim to Hadera, and to depths of 50 m, is being mapped for the Offshore Islands project. Some 2.5 km off Tel Baruch a detailed survey was made to look for explosives that were improperly disposed of about 40 years ago in depths of 30 m. The poster will show the results of this 85 minute search, in which the R/V Etziona was slowed to 4-5 kts and the usual 150°spread of the system's 111 beams was reduced to 90°with equidistance spacing, in order to survey on a 0.5 m grid.

Ashqelon: The area has a generally smooth seafloor, which is punctuated by kurkar outcroppings at about 30 m depth that are rarely linear. Of interest in the mapping is the ability of the multibeam swath mapping to discern the star-like infrastructures of the two northern vessel mooring stanchions of the Elat-Ashqelon pipeline, with their eight giant sinkers and exterior anchor chains. Most of the bottom features are marked by scour, which makes a moat around the kurkar outcrops, a wreck found in the north, and over the filled-in trenches made to bury the oil pipelines. Many of these features are unknown to local divers. Two navigational charts recently published by the Survey of Israel for Herzliya and Ashqelon will also be displayed.

SUBSURFACE STRUCTURE AND SEISMIC AMPLIFICATION

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As part of the efforts to prepare for a strong earthquake that might strike Israel, we study the relations between subsurface structure and ground motion amplification. In general, amplification is expected wherever soft layers (with relatively low S wave velocities) at the surface overly much harder and thicker layers (with relatively high S wave velocities). In such a case the upper layer may enter a state of resonance in which specific frequencies of vibrations are enhanced. For practical purposes, two parameters are needed: the resonance frequency and the amplification factor.

The results reported here are based on a new study in the Shefela region between the cities of Binyamina and Ramla. In the first stage of the study the entire rock column overlying the Judea Group was generalized to one unit with an average seismic velocity significantly lower than that of the Judea Group. This 1-layer-model allows the use the top Judea structural map for a quick first order evaluation of seismic amplification in the entire region. The question, however, is whether or not this simplification is correct.

To examine this question we used the Nakamura technique and measured site effects in a few hundred sites. The results confirm the 1-layer-model with the following limitations: (1) It is valid only where the rock column overlying Judea Group is thinner than ~500 m. (2) It provides the frequency value within an error of plus minus 0.5 Hz. (3) It provides a poor estimation of the amplification factor.

In the second stage of the study we try to improve the prediction ability by dividing the rocks covering Judea Group to 4 subunits: Shefela, Lower Saqiye, Upper Saqiye, and Kurkar Groups. Distribution maps were prepared for each of the subunits and by plotting them one on top of the other several different stratigraphic combinations were defined (i.e., all units; only A; A&C; A,C&D etc.). The combination, which is most dangerous, is Kurkar Group directly overlying Judea Group. In that case the contrast in shear wave velocities between the unconsolidated rocks of the Kurkar Group and the much harder rocks of the Judea Group produce amplification in the order of 8-10. In contrast, the combination which appears as the least dangerous is the outcrops of the Shefela chalks overlying the Judea limestones. This combination produces amplification in the order of 2-3.

Furthermore, the division of the stratigraphic column to 4 subunits reveals an excellent correlation between the measured frequencies and the stratigraphic combination. This opens the gate for a much better prediction of the resonance frequency. The prediction of the amplification factor, on the other hand, is still not satisfying, neither by geological data nor by direct measurements.

MINERALOGY, PEROGRAPHY AND $^{87}sr/^{86}sr$ RATIOS OF FINE-GRAIN DETRITAL SEDIMENTS OF THE DEAD SEA GROUP: ORIGIN AND MEANS OF TRANSPORTATION

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The mineralogy, petrography and $^{87}Sr/^{86}Sr$ ratios of fine-grain detrital sediments of the Dead Sea group are used to constrain the origin and means of transport of these sediments to the basin. Samples were collected in several exposures of the late Pleistocene Samra, Lisan, and the Holocene Ze'elim Formations in the Dead Sea basin and from recent floods over the drainage basin.

Mineralogical compositions and grain-size distribution were determined by XRD, electron-microprobe and Mastersizer. The sediments are composed mainly of calcite, dolomite, quartz, feldspar and clay minerals. They are mostly silt size with some clay fraction and a few sand grains. Flood sediments from the drainage area reveal similar mineralogy and grain-size distribution. Overall, the modern and the Quaternary fine grain detritus bear striking mineralogical and grain size similarity to airborne dust in Israel and to the loess deposits. Moreover, $^{87}Sr/^{86}Sr$ isotopic ratios in the detrital sediments lie in the range of 0.7100-0.7117, ratios that are consistent with the isotope composition of dust material from the sandy deserts of North Africa and Arabia. Monitoring the characteristic of the fine detritus throughout the stratigraphic section of the Dead Sea water-bodies will be used to constrain modes of dust transport to the region during the Quaternary.

PROJECT GOMaP, GEBCO, IBCM, AND THE ISRAELI NBS

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GOMaP, or the **G**lobal **O**cean **M**apping **P**rogram lays out the necessity and requirements (see http://mp-www.nrl.navy.mil/marine_physics_branch/thsoa_paper.pdf) for a program to swath map the 73% of our Earth that is water-covered. This is urgently needed in order to arrive at a model of the planet's bathymetry on a 0.1'grid (.185.2 m).Such a grid is comparable to what was obtained for 82% of the continents in 2001 by the Shuttle Radar Topographic Mission (SRTM), and what was obtained earlier in the Magellan radar mapping of Venus, the Mars Global Surveyor on that planet, and the Galileo mission to the moons of Jupiter. The fact that only some 10% of Earth's oceans have been mapped in similar detail reflects the fact that marine exploration is funded at about an order of magnitude less than space. GOMap estimates that ~200 ship years are needed for mapping water depths greater than 500m, and >600 years for the 10% that is between 50 and 500 m depth. Given the proper funding, on the order of $10-20 billion, and within the constraints imposed by issues of sovereignty and UNLOS (United Nations Convention on the Law of the Sea), this is probably possible provided that such mapping becomes cheaper, more efficient, and automated.

Preceding pro-active GOMaP by several decades, the author has been an active participant in the non-pro-active IOC-IHO compilations of bathymetry for the IBCM (International Bathymetric Chart of the Mediterranean) and GEBCO (General Bathymetric Chart of the Oceans) projects. IBCM is currently preparing the IBCM-II, a digital terrain model (DTM)of the Mediterranean and Black Seas on a 0.1'grid,while GEBCO will celebrate its centenary in April 14,2003 with the new GEBCO Digital Atlas of the World on a 1'grid.These efforts have attempted to construct grids of the oceans from soundings digitized from thousands of nautical charts, survey fair-sheets, and ocean transits. These grids offer the potential for automating the swath mapping of the shallower areas of the seas.

Supporting GOMaP on the local level, the Israeli National Bathymetric Survey (NBS)project is busy mapping the detailed submarine topography around (and eventually within) Israel. The author views the NBS as a test-bed for examining how these other compilational efforts can assist GOMaP, partly by automating the mind-numbing process of following the local contours as 'the lawn is mowed', and partly by examining how the sophisticated equipment and complicated analysis procedures can be made 'idiot-proof' to facilitate the many years of shallow water mapping, much of which will eventually be done by third world littoral states under UNCLOS.

KNICKPOINT RETREAT AND DRAWDOWN REACH EVOLUTION ALONG THE ARID ESCARPMENTS OF THE DEAD SEA BASIN

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Knickpoint retreat processes may govern the pattern and rate of bedrock channel evolution. As such they play a major role in setting the boundary conditions for hillslope development, conveying tectonic and climatic signals, and dictating sediment flux. Despite their importance they are still poorly understood. Lithologically-controlled, sheer bedrock knickpoints, reaching up to 300 m in height, prevail along the Dead Sea arid escarpments. Although field observations suggest that rockfall rather than direct fluvial abrasion is the dominant retreat process, drainage area strongly controls retreat velocity. This points to a linkage between the frequency of mass wasting events and drainage area. Since no buttressing of the knickpoints faces or plunge pool erosion was observed another process should account for the observed dependency. A probable candidate is groundwater sapping whose intensity relies on infiltration of flood water through joints and potholes. Cosmogenically-derived (^{36}Cl) short-term retreat rates calculated in two channels with an order of magnitude difference in drainage area were found to be 0.45 m/ka and 1.2 m/ka. Assuming temporally constant retreat rates the estimated minimum age of the Dead Sea western escarpment is 5.3-6.5 Ma. If indeed Amora Formation is first to record prominent relief along the western margin of the Dead Sea its age may be older than previously assumed.

A free-fall of flowing water across a sheer knickpoint is expected to increase the shear stress above the free-fall lip and thus to accelerate incision and create an oversteepened drawdown reach (Gardner, 1983). Relying on hydraulic engineering equations (Rouse, 1936; Hager, 1984; Stein and Julien, 1993) we derive an expression predicting the increase in erosion rate (E) due to a free-fall effect: $E_{freefall}/E_{normal}=(1+0.4/Fr^2)^3n$, where Fr is the Froude number and n ranges between 0.6-2. This relation suggests that erosion rates above the lip can be more than 5 times higher than the expected erosion rates away from the knickpoint. Initial results of a numerical incision model comply well with measured profiles of several Dead Sea drawdown reaches. Though the uniqueness of the results, as well as complete sensitivity analysis, is yet to be tested, we suggest that landscape evolution models should explicitly account for drawdown effects. It appears that the interplay between abrasion above the knickpoint lip and mass wasting along the knickpoint face can lead to lengthening, shortening or steady state drawdown reaches.

CONTRASTING MODES OF LEVEL CHANGES IN LAKE KINNERET AND THE DEAD SEA

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The fresh water Lake Kinneret (Sea of Galilee) and the hypersaline Dead Sea are remnant water bodies after ancient lakes that existed along the Dead Sea Transform (DST) during the Neogene- Quaternary. The reconstruction of level curves for the late Pleistocene and Holocene lakes is accomplished via chronological and sedimentological investigation of exposed sedimentary sections and archeological sites: the ~ 22 kyr BP Ohalo-II archeological site and the Galei Kinneret site where Roman to Arabic buildings were excavated. Large level changes in the late Pleistocene lake Kinneret were synchronous with those of the southern Lake Lisan, but display significantly smaller amplitude, e.g. the maximum rise of Lake Kinneret at 26-24 kyr BP high stand was ~ 60 m, compared to ~120m rise of Lake Lisan, and the minimum stands at ~ 40 Ka and 12-13 Ka. The synchrony in level changes reflects the modulation of the regional hydrological system by the East Mediterranean climate. Yet, low amplitude changes in the level appear to be out of phase in the Holocene lakes. At ~ 2000 years BP Lake Lisan was higher than 400 m bsl, while Lake Kinneret was lower than 212 m bsl. The opposite behavior is observed during the Arabic period. Around 700 AD Lake Kinneret rose a few meters, covering the archeological site of Galei Kinneret, while the Dead Sea was at a low stand. This contrasting behavior could be the result of several processes. The minor rises in Lake Kinneret could reflect damming of the Jordan channel by the Yarmouk alluvium and shallowing of channel itself during periods of low rain precipitation and slow sediment transport. Minor rises in the Dead Sea would be delayed until the Jordan River deepened and incised the sill. Then, Kinneret level could drop slightly. Only when the water level surpassed the topographic sills of Wadi Malich and Yarmouk River (as in 26-24 kyr BP) the lakes united and level fluctuated synchronously.

GEOCHEMICAL AND ISOTOPIC (BORON AND STRONTIUM) CHARACTERIZATION OF GROUNDWATER FROM THE LOWER CRETACEOUS KURNUB SANDSTONE AQUIFER

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The Nubian Sandstone (Kurnub) aquifer of the Negev is one of the largest groundwater reservoir in Israel. Future exploitation of this aquifer will have to take into account two fundamental limiting factors: the lack of replenishment and the salinity of the groundwater (600 to 3500 mgCl/l). Previous studies have suggested different and often contradict explanations for the origin of the salinity. Tease explanations includes flushing of brines and dissolution of evaporite salts.

The present study aims to investigate the origin of the salinity of groundwater in the Nubian Sandstone and Judea aquifer by investigating their chemical and isotopic (boron, strontium, oxygen, hydrogen) compositions. Based on data generated from groundwater sampled from 43 wells in the Negev and Arava we are able to distinguish between five principle water types:

(1) Brackish groundwater (700-1500 mgCl/l) located in both the Nubian and Judea aquifers in the north-eastern Negev and is characterized by Na/Cl~1, low Br/Cl ($<1.5x10^{-3}$), $^{87}Sr/^{86}Sr$ range of 0.70773 to 0.70780, and $\delta^{11}B$ values of 25 to 35‰.

(2) Saline groundwater (2000-90,000 mgCl/l) located only in the Judea aquifer in the north-eastern Negev in the vicinity of the Rift valley and is characterized by low Na/Cl (<0.86), high Br/Cl ($>1.5x10^{-3}$), a $^{87}Sr/^{86}Sr$ range of 0.70780 to 0.70793, and $\delta^{11}B$ values of 35 to 55‰. The composition of this water type reflects mixing of water type (1) with Ca-chloride brine having high $^{87}Sr/^{86}Sr$ (>0.7080) and $\delta^{11}B$ values (>55‰).

(3) Brackish groundwater (650 mgCl/l) located in the Nubian aquifer in the northern Arava and is characterized by low Na/Cl (<0.86), low Br/Cl ($<1.5x10^{-3}$), a $^{87}Sr/^{86}Sr$ range of 0.70774 to 0.7078, and $\delta^{11}B$ values of 28 to 32‰.

(4) Brackish groundwater (650 mgCl/l) located in the Nubian aquifer in the southern Arava and is characterized by low Na/Cl (<0.86), high Br/Cl ($>1.5x10^{-3}$), a $^{87}Sr/^{86}Sr$ range of 0.70730 to 0.70739, and $\delta^{11}B$ values of 32 to 38‰The chemical composition of this water type reflects mixing of water type (3) with Ca-chloride brine.

(5) Saline groundwater (1000-3000 mgCl/l) located in both the Nubian and Judea aquifers in the north-western Negev and is characterized by Na/Cl between 0.86 to 1, low Br/Cl ($<1.5x10^{-3}$), $^{87}Sr/^{86}Sr$ ratio of ~ 0.70771, and $\delta^{11}B$ values of ~38‰.

These five distinguish water types may be interpreted by different geochemical evolution along three principle flow paths in the Nubian Sandstone aquifer (from the Nubian sandstone outcrops in Sinai to north-east Negev, north-west Negev, and northern Arava) and mixture with hypersaline Ca-chloride brines along the Rift Valley.

IDENTIFICATION AND CHARACTERIZATION OF COLLAPSES IN SINKHOLES ALONG THE DEAD SEA SHORE USING SEISMIC METHODS

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We conducted seismic measurements in the vicinity of one of the sinkholes in the Ein Gedi area that is reported to be active. We could identify many events that indicated collapses of material inside the sinkhole. The events last between 0.1 second (short event) to several seconds (long event). Most of the energy is concentrated in the frequency range of 30 to 40 Hz. The rate and occurrences of the events are irregular, and are probably a function of the local structure of the sinkhole. Several events can be characterized as an avalanche-type event. We present several cases of these collapses including a major one (estimated weight of collapsed is above 30 tones). We located many events and found them to be at depths of about 10 to 20 meters.

THE AFAR DEPRESSION: INTERPRETATION OF THE 1960-2000 EARTHQUAKES

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We studied the seismic activity of the Afar Depression (AD) and adjacent regions during the period 1960 to 2000. We define 7 distinct seismogenic regions using geological, tectonic and seismological data. Based on the frequency-magnitude relationships we get *b*-values of about 1 for the different regions. The pattern of the distribution of the location of epicenters fits with the known active fault zone in the AD and the axial volcanic ridges. The Bab el Mandab area and the Danakil-Aysha'a blocks are less active. For 125 intermediate to strong earthquakes the seismic moment and source parameters were calculated. The results of the fault plane solutions for the Afar Depression indicate mainly strike-slip and normal sense of movement originating from fault planes striking NW-SE. These results indicate a clockwise block rotation described previously as a bookshelf model in central AD. There are a few right-lateral faults east of Massawa with E-W striking fault planes. At the southern Red Sea, north of the Danakil block, the mixed focal mechanisms, with axial plane striking NW-SE, comprise several reverse faulting, strike-slip motion and normal faulting. Right-lateral movement was also calculated for a cluster of seismic events between the Manda Hararo and Alyata volcanic ridges along NW-SE striking faults. Along the N-S striking faults in the escarpment, at the western Afar margins, there are two distinct clusters of epicenters. The strong earthquakes at the southern cluster exhibit normal or strike-slip motions. The intermediate to small earthquakes in the northern cluster exhibit reverse and strike-slip motions. Mainly normal faults were calculated along NE-SW striking faults of the Ethiopian East African Rift. Estimates of the seismic efficiency suggest that the maximal values are about 50% or less, implying that most of the motion is taken aseismically.

BATHYMETRIC AND BOTTOM TYPE MAPPING USING COMPACT AIRBOTNE SPECTROGRAPHIC IMAGER (CASI) AND IN SITU MEASUREMENTS: THE NORTHERN COASTAL AND INNER SHELF AREA OF ISRAEL.

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The northern coast and inner shelf of Israel, between Rosh Hanikra in the north and Achziv in the south, is characterized by a large variability in topography, bathymetry and stratigraphy. The bathymetry is irregular due to submerged kurkar ridges, which rise in several places above sea level as small islands. The stratigraphy varies from shallow to deep water and is composed of alternations of calcareous sandstone (kurkar), red loams (hamra), dark clays and uncemented sands. The purpose of this research was to study geological and geo-morphological processes that influence the present bathymetry and stratigraphy. This was done by using remote sensing techniques for bathymetric mapping and sea floor classification together with multibeam data that was recently collected and other related data. Hyperspectral data was collected on October 1999 using the CASI sensor which receives data between 430 nm to 950 nm. The CASI was flown at a height of 3000 m which gave a pixel size of about 3X3 m. Data was collected using predefined 19 spectral channels along east-west lines and with 48 spectral channels along a northeast-southwest line. During the study analysis and development of algorithms that describe the relationships between the reflected radiance that was received at the sensor versus variations in water depth and seafloor type were made. This is possible because the electromagnetic radiance that is reflected from the sea surface is influenced by the optical properties of the water column and by the seafloor type. High-resolution bathymetry and seabed type maps were generated using integration between two-band differencing algorithm with 497 nm and 551 nm bands and combination of 529 nm and 551 nm bands. Spectral data was compared and verified with bathymetric data derived from multibeam survey, echo sounder and side scan sonar data that was recently collected in the study area.

THE IMPACT OF CLIMATE CHANGE ON THE NATURAL AND HUMAN ENVIRONMENTS OF THE NEAR EAST

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It is now widely accepted that increasing concentrations of greenhouse gases in the atmosphere are affecting the earth's radiation balance, resulting in higher global atmospheric temperatures. However, there is still a great deal of uncertainty about the likely effects of such a temperature rise on climate, and even more about the impacts of climate change and variability on the world's hydrological regimes and thus socio-economic systems. Studying the effects of climate variability in the past can give clues as to possible future effects. The study herewith presented provides a comprehensive review of the effects of climate variability on hydrological and human systems in the Holocene in the Near East. The main conclusion is that global warming will bring about a decrease in precipitation this region.

DETAILED GROUND MAGNETIC PROSPECTING OF ARCHAEOLOGICAL SITES IN ISRAEL

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Recent improvement in magnetometers sensitivity extends the implication of magnetic studies of archaeological sites. About fifty sites were studied in Israel by magnetometry since 1992, due to extensive building/infrastructure development and growing demand for salvage excavations. The surveyed sites are located in different areas, with various physical, geological and topographical environments and they represent various historical periods and materialistic cultures. Magnetic anomalies produced by near-surface small archaeological targets often do not exceed a few nanoTesla and may be obscured by effects of time variations of Earth's magnetic field, complex topography, magnetic soil, weathering crust, and industrial disturbances. In addition, the basic inversion methods were developed for high-latitude regions where magnetic inclination is close to 90°. Hence, imaging of archeological remains by magnetic method in our region where inclination is about 45° requires an appropriate method. The methodology developed in this study for imaging of archeological remains by magnetic method in our region includes: a) classification of natural and artificial disturbances; b) optimization of measurement techniques; c) optimization of processing and interpretation of magnetic data. Quantitative interpretation in complex environments includes a number of important steps: a) study of the magnetic properties of targets and host medium; b) selection of appropriate geometrical approximation of desired targets; c) analysis of topography effects; d) inversion of the magnetic anomalies and estimation of the target parameters; e) forward modeling and construction of a physical-archaeological model. Examples of targets and corresponding geometrical models are given in Tables 1 and 2.

Table 1. The approximation of targets by simple geometrical bodies

Archaeological targets	*Approximation*
Walls of buildings	Thin bed
Outer walls of fortress or settlement	Thick bed
Floors, pavements	Horizontal plate or disk
Columns, pillars, wells	Vertical circular cylinder
Tunnels, ditches	Horizontal circular cylinder
Pits, kilns, graves	Sphere

Table 2. Magnetic susceptibility (χ) of main building materia

Building materials	χ, units SI x 10^{-5}
Weak magnetic: limestone, mud bricks, kurkar	0-70
Magnetic: basalts, backed bricks, ceramics	500-2000

SEISMIC PATH CHARACTERIZATION BY SONOGRAM ANALYSIS IN THE EASTERN MEDITERRANEAN AREA

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Several investigations of crustal heterogeneity in the Eastern Mediterranean and Middle East region have mapped out zones of low propagation efficiencies for different phases. These heterogeneity maps differ both in the quality of their resolution and with respect to the area they cover. The diversity of the crust and the complexity of the tectonic structure of the region show that the use of the standard discrimination ratios (P_n/S_{max}), with their narrow restricting frequency ranges is suboptimal.

The approach adopted here is to characterize the transfer function through the use of sonograms (Power Spectrum Density matrices): a broadband, self-adaptive optimum filter for signal energy. A robust bulletin of over 200 high quality selected waveforms from regional natural events recorded by three broadband Israeli stations (01/01/1999- 31/12/2001) was analyzed. This new approach enhances the characteristics of each individual waveform and path instead of collectively treating hundreds of raypaths with statistical tools. The broadband (20Hz to 25 s) analysis of individual waveforms also enables treatment of outliers as a source of meaningful information on path effects rather than as statistical refuse. Sonograms also help in the identification of mixed signals, e.g. local event in coda of regional event, distinguishing monochromatic noise from events and discovering signal energy outside the standard analysis filter bands. Since Sonograms display dispersion features, body and surface wave behavior can be better analyzed.

The results of seismic path characterization that we propose for the East Mediterranean region corroborate available data from the fields of exploration seismology, tectonics, and geology and further validate the use of Sonograms for the purpose waveform analysis.

A PERIODIC LONG-TERM RECURRENCE PATTERN FROM A 180-KYR PALEOSEISMIC RECORD FROM CAVE DEPOSITS

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The long-term recurrence pattern of large earthquakes is of considerable consequence for earthquake physics and hazard assessments. Records derived from instruments, historical documents, and soft sediments, are inherently limited in temporal and spatial span. Cave deposits (speleothems), on the other hand, offer significant advantages for recovering histories of damaging earthquakes. Here we introduce the first rigorously dated record of earthquakes from damaged speleothems. Well-preserved pre- and post-seismic precipitates in the Soreq and Har-Tuv caves, 60 km off the Dead Sea Transform (DST), are dated by the U-Th method. The precision of dating is the key to resolving individual events and the pattern of their recurrence. Therefore we enhanced precision in dating of the precipitates directly at the paleoseismic contact by a novel correlation method with the comprehensive oxygen and carbon stable isotope record recovered in the Soreq Cave in previous paleoclimate studies. Our record of up to sixteen of the largest earthquakes of the DST in the last 180,000 years exhibits a quasi-periodic behaviour with a mean recurrence interval of about 11.5 kyr, with a 6 kyr standard of deviation.

DEVELOPMENT OF 1-D MODELS FOR SEISMIC HAZARD ASSESSMENT USING MICROTREMOR MEASUREMENTS: THE CASE OF ISRAEL COASTAL PLAIN

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For preparation of earthquake damage scenarios the necessary is information about modification of ground motion by site condition. The ground shaking characteristics, i.e. resonance frequencies and amplification factors were obtained from the 190-microtremor observations across the Coastal Plain from Ashqelon to Haifa. Analytical models derived by fitting theoretical transfer function to empirical one were used to compute the Uniform Site-specific acceleration spectra for 90 sites applying SEEH method (Shapira and van Eck).
In order to facilitate estimations of earthquake loss scenarios, we divided the Coastal Plain area into six geographical zones; each one is characterized by fundamental frequency and amplification factor. For each zone we adjusted the overall 1-D subsurface model taking into consideration borehole data and geophysical information. Parameters of generalized models are presented in Table 1. Zones 2,3,4 are located in the Central Coastal Plain from Ashqelon to Binyamina. Impedance contrast in these zones is formed by loose sediments and underlying calcareous sandstone of the Kurkar group, but not clay of the Yaffo Fm. as was assumed previously according to geological data. Zones 4 and 5 distinguishing owing to higher amplification level are located in the Carmel coast. Impedance contrast in these zones is formed by Quaternary sediments and Turonian-Cenomanian carbonates. Zone 1 is distributed both in Central part and in Carmel coast and characterized by amplification factor ranging from no amplification up to factor 1.7.
Suggested generalized models allow calculating response spectrum throughout the whole zone and can be useful for making regional hazard decisions.

Table 1. Parameters of the generalized soil-column models

Zone	Thickness, m	Density, g/cm^3	Vs, m/sec	Frequency, Hz	Amplification factor
1	Half-space			-	< 1.7
2	15	1.6	200	1-2	2-3
	35	1.7	350		
	Half-space	1.8	700		
3	25	1.6	250	2-3	2-3
	Half-space	1.8	700		
4	25	1.6	250	2-4	4-5
	Half-space	1.9	1000		
5	15	1.6	200	2-3	5-6
	50	1.8	700		
	Half-space	2.2	1600		
6	15	1.6	250	3-6	3-5
	20	1.8	700		
	Half-space	1.9	1000		

THE IMPACT OF WASTEWATER AND FRESHWATER IRRIGATION ON THE CHEMISTRY OF SHALLOW GROUNDWATER: THE ISRAELI COASTAL AQUIFER

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The impact of irrigation with fresh water and wastewater on the quality of underlying shallow groundwater was investigated in Nitzanim area. Several research boreholes were drilled to the water table region (WTR) of the coastal aquifer in the center of agricultural fields.

The salinity of the shallow groundwater at the WTR (550 mgCl/l) is higher than that of wastewater that was used for irrigation (200-300 mgCl/l). Similarly, shallow groundwater underlying freshwater irrigation show relative high salinity (240mgCl/l).. In addition to the salinity enrichment we show significant differences in the chemical compositions between the irrigating waters and the underlying groundwater at the WTR. These differences are explained by water-sediment interaction in the unsaturated zone, mainly ion exchange. The high values of SAR (Sodium Adsorption Ratio) in wastewater lead to absorption of Na onto the clay and release of Ca into the water resulting in exceptionally low Na/Cl molar ratio of 0.4. The opposite exchange reaction occurs under the freshwater field, accounting for the very high Na/Cl ratio of 2.0 in the WTR. The above processes are accompanied by calcite precipitation and dissolution, respectively, as indicated by changes in the Ca/Cl and HCO_3/Cl ratios. The high NO_3 concentration in the WTR below the fields (100 and 170 mg/l in the freshwater and wastewater fields, respectively) reinforce the concept that the agricultural activity contributes elevated levels of NO_3. No NH_4 was encountered below the wastewater irrigated field, despite the original high content of the latter, indicating complete uptake or nitrification of the original high content of NH_4 in the wastewater.

NUMERICAL SIMULATION OF COMPACTION BANDS IN HIGH-POROSITY SEDIMENTARY ROCK

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Geologists have recently discerned naturally occurring discrete localized planar zones of deformation, associated with compaction of initially high-porosity rock. Compaction results in bifurcation in elastic properties of the material, due to localized significant porosity reduction and grain crushing. Compaction bands may act as natural barriers to fluid transport in homogeneous material and influence stress and strain distribution in sedimentary formations. Thus, it is important to understand the conditions whereby compaction bands form and develop. A theoretical continuum approach of Issen and Rudnicki, associates an instability in the elastic constitutive relation with the emergence of planar compaction bands, perpendicular to the compressive principal stress. In order to gain insight into the formation mechanisms of the compaction bands under a variety of boundary conditions, we developed a discrete model, where the material is represented as a hexagonal lattice of springs that can transfer only normal forces (Central Force Spring model). In contrast to a continuum formulation the discrete lattice model allows for a statistical distribution of material properties (e.g., Young modulus, stress threshold etc). The occurrence of grain crushing and porosity reduction is represented by a change in the elastic properties of each element that exceeds a certain stress threshold. The emergence of compaction bands is simulated by the response to the redistribution of forces of the subsequent modified spring-network (with now altered elements) under the same tri-axial loading regime. Parametric analysis is conducted to explore the conditions under which compaction bands form and develop.

SALINE WATERS ALONG THE DEAD SEA RIFT VALLEY: THEIR ORIGIN AND MUTUAL RELATIONSHIPS

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Major questions pertaining to the Dead Sea, its composition and age, have been raised for the first time by Yaacov Bentor in his 1961 paper (GCA 25, 239-260). The intensive research on the Dead Sea basin waters that followed later allows reexamining the same queries as well as new ones, in light of the accumulated data.

The marine origin of chloride, bromide, sodium and potassium, as well as the major role played by brine-rock interaction on the magnesium, calcium and strontium dissolved in the modern Dead Sea are agreed about by most geochemists. However, the sequential presence of several different water bodies in the Dead Sea basin call check whether the transfer of salts from the ancient marine Sedom Lagoon was direct, or had each following water body to build up its chloride salt inventory from scratch.

Complete evaporitic dry-out of marine brines, even under the extreme climatic conditions prevailing over the region, are ruled out by thermodynamics, which indicate equilibration of atmospheric humidity with the water activity in the brine well before dry out is achieved. Hence, unless a complete drain-out of the brine from an existing water body occurs, an unlikely scenario in the deepest point on Earth, the next lake that will follow will directly inherit its salts.

Recent work shows, moreover, that all the major saline waters in the Dead Sea basin between and including the Dead Sea and Lake Kinneret have formed by mixing between two marine evaporitic end-member brines. The latter were produced in an inland basin that operated under two modes: a terminal marine lake which achieved an extreme degree of evaporation (within the bischofite field) and a flow-through basin in which the seawater was concentrated by a factor around x13, precipitating mainly halite. The excellent linear mixing line obtained for the Dead Sea rift brines excludes significant salt contribution into evolving saline lakes, such as the modern Dead Sea, from sources other then the two original end members.

STRESS-INDUCED DAMAGE: COMPARISON BETWEEN THEORETICAL PREDICTIONS AND MICROSCOPIC OBSERVATIONS IN DEFORMED GRANITE

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The stress-induced damage is analyzed for the medium grain-size granite from Mount Scott, Oklahoma. The experiments were conducted on cylindrical samples, 25.4mm in diameter, subjected to confining pressure of 41MPa under room temperature conditions. The strength of Mount Scott granite under these conditions is 586±16MPa and its Young modulus is 74±3GPa. The stress-strain curves display the typical five stages of brittle rocks loaded to failure.

We use two independent methods to quantify the damage intensity. The first is based on the experimental stress-strain relations that indicate systematic reduction of the deformation modulus, D. D is the local slope of the stress-strain curve and it is equivalent to the Young modulus of the recoverable, elastic deformation, however, D may also include inelastic deformation that is attributed to stress-induced damage. The value of D decreases for loads larger than 0.19 rock strength, first at modest rate up to the transition point of 0.81±0.03 rock strength, and then, at an accelerated constant rate until failure. The D modulus is not well constrained close to failure, when it is in the general range of 30-50GPa. The expected relations between the observed reduction of D and the microscopic damage intensity were derived in several works; for example, the 'non interacting cracks' and the 'differential scheme' models of Kachanov (1992) and the 'self consistent scheme' of Budiansky and O'Connell (1976).

The second method to quantify damage intensity is based on direct microscopic measurements of damage in the deformed samples. We mapped the microfractures in thin-sections that cover the full loading range: 0.00, 0.57, 0.88, 0.96 of the rock strength and failure. The mapping was performed on scanned images (x150), microscope (x40-200), and on SEM (x400 magnification). Two groups account for more then 80% of the microfractures: (A) tensile fractures trending subparallel to axial load; and (B) shear fractures trending 15°-40° off the loading axis. Short, tensile microfractures dominates the low load sample, and under higher loads, the frequency of tensile and shear is approximately equal with significantly longer shear fractures that are eventually coalesce to form through going fault. The density of the mapped microfractures was used to calculate the expected reduction of the deformation modulus, D, according to three models mentioned above. We then compared the damage density predicted from the macroscopic D with the actual measured microfracture density. The 'non-interacting cracks' model (Kachanov, 1992) best fits the data even for high fracture densities (that probably induce interactions).

CALCITE-CORUNDUM OXYGEN ISOTOPE FRACTIONATIONS IN NAXOS META-BAUXITES: SELECTING SAMPLES FOR THERMOMETRY

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Discontinuous horizons of corundum-rich lenses, interpreted as meta-karst bauxites, are enclosed within greenschist (~400°C) to amphibolite facies (~700°C) marble on Naxos, Cyclades, Greece. The large range of metamorphic temperature, mineralogy, grain size, and modal proportions permit tests of different strategies to improve accuracy of oxygen isotope thermometry.

Diffusion modeling predicts that Refractory Accessory Minerals (RAM) will provide accurate thermometers when applied to rocks modally dominated by a mineral with faster diffusion and below the closure temperature (T_c, for diffusion of oxygen) of the RAM (Valley, RIMG 2001). Corundum (Crn) has T_c > 700°C even for slow cooling and fine grain size. Calcite (Cc) has significantly faster diffusion. Appropriate samples for RAM thermometry should have: (1) high modal Cc/Crn ratio; (2) absence of thick Ca-Al silicates reaction rims (0.1-1 m) and low abundance (<10%) of margarite and anorthite within the sample; (3) lack of secondary or recrystallized calcite; and (4) no growth zoning in corundum.

Corundum and calcite coexist abundantly in cm-scale lenses and boudins from the kyanite-staurolite pelitic zone. Of the 14 rocks sampled from different localities within this zone 4 have observable calcite-veins, 4 are Ca-Al-silicate-rich and have low Cc/Crn and 6 satisfy all the criteria for RAM thermometry. Corundum was separated either by hand picking and/or as acid-residue. All samples show highly reproducible $\delta^{18}O_{Crn}$ (±0.1 ‰ in a single sample) regardless of grain-size, color or separation method. Crn-Cc is thus an accurate RAM thermometer in the bauxite-marble system on Naxos. Cm-scale variability of $\delta^{18}O_{Cc}$ is ± 1.5 ‰ in the veined samples, ± 0.5 ‰ in the Cc-poor samples and ± 0.12 in the ones defined as suitable for thermometry. The latter give average $\Delta^{18}O_{(Cc\text{-}Crn)}$ = 3.80 ± 0.15 ‰. Calcite-magnetite oxygen isotope thermometry in these samples gave 607° ± 15°C, in agreement with petrologic estimates. Meta-bauxites characterized as suitable for RAM thermometry yielded reproducible and geologically reasonable results, whereas other samples yielded $\Delta^{18}O_{(Cc\text{-}Crn)}$ = 3.74 ± 0.80 ‰. This lays the groundwork for new studies of the thermal gradient during orogenic extension on Naxos that have not been previously possible.

LATE HOLOCENE DEAD SEA LEVELS AND THEIR IMPLICATION TO REGIONAL PALEOCLIMATE

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A high-resolution densely dated lake level curve of the late Holocene Dead Sea is presented. The curve is based on 46 radiocarbon ages of organic remains and elevations of paleo-shores described from well-exposed sedimentary sequences along the Dead Sea shores. Shore ridges, coarse sand units, ripple marks, and aragonite crusts observed in the modern Dead Sea shore environment are recognized within these sequences, marking past lake-shore elevations.

The lake fluctuated between 390 to 415 m below sea level. For most of the time the lake was confined to the deeper northern basin (now 730 m below sea level) and did not rise above the topographic sill (at 400-402 m below sea level) separating between the northern and southern sub-basins of the Dead Sea. Lake rises occurred in the 1st century BC and the 4th century AD (the Roman and Byzantine periods), in the 11th-12th century AD (the crusader period) and at the end of the 19th century AD. The curve indicates also drastic drops that exposed the sedimentary sequences to erosion. The oldest and probably deepest drop in the lake culminated during the 15th–14th century BC after a retreat from a higher lake stand. Another significant drop occurred after the Byzantine period and continued until the 10th century AD. The arid conditions associated with this level drop coincide with the invasion of Moslem-Arab tribes into the area during the 7th century AD.

The lake level curve reflects the regional hydrological variations in the drainage basin, which represents the Levant paleoclimate. Using the modern instrumentally-measured record of natural levels and comparing it with annual precipitation in Jerusalem we estimate that rising level trends are associated with 648 mm/yr, level drops with 445 mm/yr, and stable lake levels with 553 mm/yr all with uniform standard deviation of approximately 120 mm/yr. The results indicate that level rises and flooding of the southern Dead Sea sub-basin mark a significant positive change in the annual rainfall in the region. Late Holocene level drops point to prolonged devastating droughts with probably frequent occurrences of annual precipitation of less than 400 mm/yr in Jerusalem. As Jerusalem rainfall is highly correlated with many rain stations in northern Israel these conclusions can be extended to larger areas in the Levant.

BRINES FROM THE DEPTH OF THE EARTH'S MANTLE

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Diamonds are xenocrysts in kimberlites and lamproites rising from the depth of the earth. Most diamonds grow in the upper mantle at depth of 150-200 Km. Many diamonds are older than 1 Ga thus diamonds are rare ambassadors form ancient time and unreachable depth.

Fluid micro-inclusions in diamonds provide information on the pristine composition of mantle fluids. The fluid composition ranges between four end members; carbonatitic melts rich in Mg-Ca-Fe-carbonate-water; hydrous-silicic melts rich in Si-Al-K-water; brines rich in K-Cl-water and sulfide melts rich in S-Fe-Ni-carbonate-water. The carbonatitic melts mix with all other fluids while mixing between the other components was never found.
We explored the composition of micro-inclusions in twelve diamonds from the Diavik mine, Canada. Four types of micro-inclusions were found: minerals, brine inclusion, carbonatitic inclusions and hydrous-silicic inclusions.

The mineral assemblage contains olivine, Cr-diopside and chromite, characteristic of the peridotitic paragenesis. One diamond carries inclusions with composition that lies halfway between the hydrous-silicic and the carbonatitic end members. The average melt composition is $K_{27}Na_5Ca_{14}Mg_8Fe_{10}Si_{26}Al_4Cl_3P_3$ (water and carbonate could not be determined by IR in this opaque sample).

Ten diamonds carry brine, rich in H_2O, Cl and K (K/Cl molar ratio of 0.64±0.06) and show variable enrichment towards the carbonatitic end-member. The average composition is $K_6Na_4CaMgFeBa(Si,Al)Cl_9(H_2O)_{12}(CO_3)_4$.
One diamond carries both brine and carbonatitic melt, each in a different growth zone. The brine is different from that found in the other diamonds, shows considerable enrichment in Na and maintains K/Cl ratio of 0.68±0.17. The average composition of this brine is $K_{19}Na_{27}Ca_6Mg_9Fe_4Ba_3Si_4Cl_{28}$ (opaque sample, no water and carbonate IR data). Both brines show K/Cl ratio similar to that of the South-African brine (K/Cl=0.64±0.12) and mix with different carbonatitic components. The carbonatite is highly enriched in Na and Mg compared with the carbonatitic end-member defined for Botswanan diamonds, the average carbonatite composition is $K_{13}Na_{24}Ca_{11}Mg_{22}Fe_5Ba_2Si_8AlCl_{12}P_2$. Inclusions with intermediate compositions were found in the contact between the two zones, implying simultaneous occurrences.

We propose a model where crystallization of carbonates from a carbonatitic melt leads to enrichment of the melt in silica, alkalies and chlorine and to its separation into two immiscible fluids: a hydrous-silicic melt and brine.

Using carbonate rich fluids as solvent for diamond synthesis allowed growth at lower temperature and pressure. Better understanding fluid formation and evolution in nature may lead to further improvement of diamond synthesis.

"HATRURIM" –THE MOTTLED ZONE

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Mapping of the "El Hatrura" region the (Hatrurim basin) east of Rosh Zohar, was among the first field tasks Y. K. Bentor led immediately following the War of Independence in what was to become the great effort of the "Negev mapping". Following his predecessors Bentor was deeply impressed by these rocks. He endorsed the proposition of organic matter burning as a source of energy for their alteration. The recognition of the very diverse mineralogy of the MZ rocks (Gross, 1977) and of the fact that these are principally metamorphic rock of the sanidinite –pyroxene hornfels facies of high-T - low-P enabled the multi-faced study of this intriguing formation. The emerging scenario of events is indeed of metamorphism in which combustion of organic matter is the source of metamorphic energy. Combustion has occurred at least twice since the formation of the Ghareb Fm. and Taqiye Fm. protoliths: first when these bituminous rocks were first exposed to air oxygen prior to the deposition of the Hazeva Fm (about 16 m.y. ago), and again after the removal of the Hazeva Fm. cover following the Rift Valley formation, between 1 and 3 m.y. ago. The above scenario is in good accord with a large number of mineralogical, geochemical, isotopic and paleomagnetic evidence. First-order estimates show that the amount of organic carbon in the protoliths was more than sufficient to sustain the required temperature. The duration of combustion in a single focus was apparently between a year and several years.

THE PROVENANCE OF LOWER PALEOZOIC SANDSTONE IN SOUTHERN ISRAEL AND JORDAN: U-PB SHRIMP DATING OF DETRITAL ZIRCONS

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Phanerozoic silisiclastic detrital sequences cover large parts of NE Africa and Arabia. East of the Nile, including in southern Israel and Jordan, thick Phanerozoic siliciclastic sequences (often referred to as Nubian sandstone) rest upon the Pan-African crystalline basement of the Arabian -Nubian Shield (ANS) that was deeply eroded at the end of the Neoproterozoic. This late to post Pan-African unroofing is a logical source for the thick Phanerozoic sequence that was deposited over the northern Gondwana margin.

Previous U-Pb ages from detrital zircons throughout Gondwana's margin in northern Africa and Arabia (including Israel) did not show Pan-African age (900-550 Ma) zircons in the Phanerozoic section, but the analyses were made on multigrain concentrations and are thus not completely reliable. In the present study, we performed U-Pb SHRIMP measurements on detrital zircons from Cambrian sandstone in southern Israel and from Cambrian-Ordovician sandstone in southern Jordan.

In contrast with previous studies, our data reveal ubiquitous Pan-African detritus in these rocks. The Cambrian-Ordovician section contains an important contribution of individual zircons that yield concordant $^{206}Pb/^{238}U$ ages between 530-900 Ma. These grains are idiomorphic to slightly rounded, typically showing oscillatory, euhedral concentric Cl zoning. They were derived from a Pan-African terrain, most probably from the ANS. The analyses also revealed the presence of a moderate proportion of pre-Pan-African zircons, 1-1.1, 1.8-1.9 and 2.65-2.7 Ga. in Cambrian samples from Israel. A similar picture was obtained from the Jordanian samples but the group of 1-1.1 Ga zircons is more significant there. Because the Arabian-Nubian Shield is generally considered to be juvenile Pan-African crust, the provenance of the pre-Pan-African zircons should be at the shield's margins or outside it.

These results show that the lower Paleozoic sandstone in Israel and Jordan were derived from a number of sources in Africa: The dominant existence of Pan-African detritus indicated that most of the section derived from short distance areas, probably from the ANS. The pre-Pan-African zircons, whose proportion increases gradually towards the upper parts of the sections, indicate that a certain amount of grains have been transported from the south, potentially from areas like Gebel Uweinat, Egyptian Western Desert and the Afif terrain. The presence of the 1.1 Ga zircons seems to indicate a longer distance transport in the range of several thousands km.

THE ISOTOPIC COMPOSITION OF SOIL-GAS CO2 IN ISRAEL

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The initial carbon isotopic composition of the dissolved inorganic carbon (DIC) is an important datum needed when using carbon isotopes in tracing and dating groundwater. The dissolution of soil-gas CO_2 from the unsaturated zone plays an important role in establishing the initial groundwater DIC isotopic makeup. $\delta^{13}C$, $\delta^{18}O$, and PCO_2 of the soil –gas CO_2, along with important soil properties (e.g. porosity, moisture content, percent carbonate, and the $\delta^{13}C$ and $\delta^{18}O$ of the soil itself) were measured at different geographic regions in Israel. In the Upper Galilee and the Judean Hills, having the highest rainfall, the $\delta^{13}C$ of soil-gas CO_2 ranges from approximately -20 ‰ to -22 ‰. These values are generated firstly by respiration and/or microbial oxidation of plants that use the C_3 photosynthetic pathway, followed by diffusive isotopic fractionation of ~4 ‰ across the steep PCO_2 gradient between the soil and the atmosphere. The arid Judean Desert and the Negev exhibit $\delta^{13}C$ values that range from ~-10 ‰ to -19 ‰, demonstrating the presence of flora using the C_4 photosynthetic pathway (an adaptation to decreased precipitation) in addition to C_3 species. The PCO_2 of the soil –gas is approximately half of that of the humid regions. The soil –gas CO_2 in the Shefela region exhibits $\delta^{13}C$ values similar to the Galilee and Judean Hills, though lawns of the Weizmann Institute of Science generate typical C_4 $\delta^{13}C$ values.

Ideally, the $\delta^{13}C$ and $\delta^{18}O$ should be expected to exhibit trends of isotopic enrichment with decreasing PCO_2 as the atmosphere-soil interface is approached. The very thin soil cover generally encountered hindered the taking of detailed soil-gas CO_2 / depth profiles. In the three profiles that were achieved, one shows the ideal case, while no clear change is noted in the others. Perhaps, this is due to the relatively high PCO_2 of the soil –gas encountered through-out the soil sections sampled.

AQUITARD CHARACTERIZATION THROUGH FRACTURE OBSERVATIONS AT DIFFERENT SCALES

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The hydraulic behavior of fractured aquitards cannot be predicted using a continuum approach and traditional small-scale tests. Instead, observations on fracture traces at various scales can provide essential information about the aquitard's hydraulic characteristics. Fracture observations coupled with hydraulic tests and/or analysis at different scales in a fractured chalk aquitard in the Negev desert – Israel, were carried out.

Interference and tracer tests in saturated regions and tracer tests in the vadose zone were held on single fractures, appearing permeable in the dry outcrop. These tests often revealed very low permeability. Furthermore, high hydraulic conductivity values calculated from slug tests in corehole intervals did not correlate with either televiewer images showing large apertures, or stains and erosion marks on the fracture faces at the same interval.

Fracture surveys in outcrops and coreholes, followed by hydraulic tests that were preformed at a 10 to 100 m scale, suggest that the fracture set statistics of orientation, length and density are good predictors of the hydraulic behavior at this scale. The hydraulic conductivity of tested intervals intersected by fractures from the set with higher density and trace lengths was found higher than that measured in intervals intersected by fractures from the set with lower density and trace length.
On a larger scale (kilometers) fractures/faults tracers are not pronounced. In addition, conducting hydraulic tests at this scale is not trivial. Lineaments identified from air photos and geologic surveying, indicate a dominant orientation of these linear features. A semivariogram cloud analysis of the residual of the water table height detrended from the regional drift, indicates anisotropy expected from the lineament and geologic surveys (Kurtzman et al., submitted).

RADON AND CHLORINITY MONITORING IN THE GROUNDWATER SATURATED ZONE AT ENOT ZUKIM, DEAD SEA

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Continuous monitoring of radon flux was conducted by the Geological Survey since 1992 in the unsaturated graben fill at the Enot Zukim site. A correlation between some of the short term (few days) radon fluctuations and earthquakes was reported. Seasonal and multi year fluctuations were encountered as well. Since there is no evidence for a radon source in the unsaturated zone adjacent to the measurement site, it is reasonable to conclude that the hydrologic system plays a role in controlling the radon flux. Boreholes drilled in 1996 adjacent to this site to the depth of 61 m showed the presence of two sub-aquifers. In the above wells, water level heads, radon content and salinity of the water from five depths were intermittently monitored between 1996 and 1999 using samples of water collected usually twice a month. The two sub-aquifers differ by their water level head, water temperature, range of salinity and radon content. The salinities are a result of the dilution of Dead Sea (DS) brine with fresh groundwater in different proportions. In the upper sub-aquifer the detected water level depletion due to the DS level drop is accompanied by a salinity increase. In the lower one the salinity decreases in time. The Rn values seem to decrease in time in the upper sub-aquifer and increase in the lower one. Consequently, a negative correlation between Rn content and salinity appears in both sub-aquifers. Therefore, the salinity appears to be one of the factors controlling the radon content in water. Regardless the source of radon in water, it is obvious that the radon fluctuation in the unsaturated zone is controlled by its fluctuation in the saturated zone.

The hydrogeological system obviously controls the seasonal and the multi year Rn fluctuations in the unsaturated zone. Very low Rn concentrations (around background levels) recorded in winters, appear between the beginning and end of the rainy seasons as recorded in the Jerusalem and the Jericho stations. The progressive increase in summer radon averages recorded after 1992 in the unsaturated zone seems to be related by the unusual rainy 1991-1992 winter, followed by a decrease of the amount of precipitations in the following years. The time interval between the water sampling does not provide information about the short term radon fluctuations recorded in the unsaturated zone. Nevertheless, we consider that a competent radon study in this area should be based on monitoring of radon and other parameters in the water column rather than in the unsaturated zone.

A COMPREHENSIVE INVESTIGATION OF THE JERICHO - DEAD SEA BASIN AREA

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A comprehensive, multi-disciplinary study of the northern Dead Sea Basin was carried out. In addition to submersible and paleoseismic trench studies, approximately 100 seismic lines, from land and from the lake, were examined with the intention of shedding new light on the tectonic setting of the region. The area examined extends from around 15 km north of Jericho to Ein-Geddi in the south. Information on the deep structure was provided by digital multichannel records from land and from the lake. In addition, paper records of marine data collected in the 1970's and 1980's were scanned and converted to digital seismic data (seg-y). All seismic lines were loaded on a workstation and interpreted using Landmark's "Seisworks" interpretation package. This allowed for positioning, internal ties and mapping to be carried out in the most dependable and accurate way. Due to the unreliability of the Jericho 1 borehole, reflectors were chosen initially according to the strength of reflection and then correlated with known stratigraphy (outcrop and shallow well data). Horizons were mapped out and tied consistently on all lines.

Results show that the fault regime is more complicated than previously thought. A map of the Top Judea was produced, which differs from the existing map (Fleischer et al 2001). The "accepted" main fault – the Jericho Fault, shows no indications of vertical offsets of the amount previously assumed (500-1700 meters) and may not follow the trend suggested in the past. A series of normal, sub-parallel, crescentic faults, form a sequence of step blocks, downfaulted towards the Jordan River, suggesting that the main fault zone lies further east than previously suspected. Multi-channel profiles from the lake support this theory, and clearly show a zone of major faulting in the vicinity of the Jordan River Delta.

Structurally, the lower Jordan Valley is comprised of a series of sub-basins, which continue the Dead Sea Basin northwards from the lake. This pattern of sub-basins that are divided by structural saddles is also evident in the lake itself. These basins seem to be bounded by the crescentic faults mentioned above. The ability to tie seismic profiles from land and from the lake raises questions as to the nature of the basin, subsidence and sedimentation rates. An initial physical model is presented.

Fleischer, L., Bruner, I., and Gafsou, R., 2001. Top Judea Group - structural map of Israel, Phase IV (Supplement) the Jericho Valley, Prepared for the Ministry of National Infrastructures, Report #875/96/01(S).

ISRAEL'S PHOSPHATE DEPOSITS AS A BASIS FOR THE PHOSPHORUS INDUSTRY – DIFFICULTIES AND FUTURE TRENDS

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Phosphate is one of the sole mineral deposits in Israel. This has led to the development of an extensive phosphate-based industry at plants in Israel and, in part, at Rotem-owned plants abroad. Phosphate is utilitized as a raw material in producing agricultural phosphoric acid, and for technical uses, fertilizers, salts for the detergent industry, and salts as food additives. This entire range is produced in both Israel and at the company's plants abroad. The continuing operations of the plants that manufacture phosphate-based products and their derivatives depend on available raw material reserves. These plants were established in the Negev Desert near the phosphate fields in order to exploit and process the material into exportable products. The employees who work at the Israel-based plants live in the Negev towns of Dimona, Yeroham, Arad and Beersheba. The company's annual turnover for its combined activity in Israel and abroad is approximately one billion dollars. Over 90% of its products are intended for export. The phosphate mining process is the final implementation stage in the set of activities that defines the sources of the raw materials and reserves. This process is carried out by means of: a geological survey, chemical and process compatibility tests by means of refinement simulations for adaptation of the ore processing procedure, applicability testing, selection of the mining technology, governmental permits, and mining plans. The mining process takes into account constraints involving quality, quantities and timetables, as the information accumulates in geological/engineering/economic models to form a basis for the decisions. The overall vision for economic exploitation of the phosphate reserves hastens the need to develop unique processes and improve utilization of the existing processes in order to slow down and lower the cost of mining. The company operates open-pit mining method, using the largest possible mining and transport equipment based on the structure and scope of the deposit and the needs of the nearby plant. The main part of the operation involves removal of waste material covering the phosphate layers, and constitutes 70% of the ore mining costs. The processing is carried out by extracting primary contaminants and beneficiating the ore. The processing methods used at the various plants are linked to the mining techniques, the nature of the deposit, and cost-effectiveness. Rotem operates in a business environment characterized by greater demand for fertilizers at the rate of increases in population and disposable income; implications for the environment; climatic factors, and strong linkage to grain prices. The global trends in the fertilizer market are characterized by price fluctuations in phosphate-based fertilizers, a supply surplus, a lower demand in the Western Europe compared with growing markets in Eastern Asia and South America, and a reduction in phosphate rock trade. The company's policy, which is adapted to the business environment characteristics and global fertilizer market trends, includes full exploitation of the plants' operate capability; an increase in the captive acid markets; a reduction in the relative portion of products for agriculture and simultanous development of special fertilizers and elements containing additional nutrients such as potassium, nitrogen, sulfur, microelements, etc.; increased optimization of marine and land conveyance of potash and phosphorous products as a result of a marketing merger between the Dead Sea works and Rotem, and consolidation within the primary target markets, namely South east Asia, Oceania and South America; and exploitation of beneficiated rock sales as a logistic impetus to fertilizer sales while maintaining dominance in the Western Europe fertilizer market. It should be noted that part of the company's policy involves large environmental investments so that it can comply with the highest environmental standards.

DISPERSION AND FATE OF CONTAMINANTS IN GROUNDWATER, HADERA LANDFILL

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The Hadera landfill is situated in a series of abandoned quarries within a carbonate cemented sandstone ridge parallel to the mediteranean shore. 28 water sources were samples and analyzed. The stratigraphy, lithology and mineralogy of the country rocks were studied. Water table maps for the vicinity of the landfill were constructed and the hydraulic conductivity and flow directions were studied. The chemical and Isotopic composition of the landfill waters was studied. The detailed water table maps reveal a local depression under the landfill. This local depression is situated on the regional Hadera hydrological depression and slows or cancels the flow of water and transport of contaminants from the landfill to the direction of the larger drawdown depression at Hadera township. The contaminated groundwater of the landfill has high concentration of dissolved matter (Na about 1000 mg/l, K up to 600 mg/l' NH4 up to 2000 mg/l, HCO3 up to 9000 mg/l and Cl up to2000 mg/l. The characteristic trace elements are Cd, As, Fe (2 orders of magnutude above background concentrations), B,Va, Cr (one order of magnitude above background) and Ni and Al. The isotopic composition of C, H and O is typical to landfill as described in the literature. The contamination diminishes usually away from the landfill. It seems that the contamination plume is limited horizontally to a distance of about 100 metre from the landfill in east and northeast direction. The downward mobility of the water and the solutes is slowed by the presence of thin clay and thick loam beds. The depth of those beds below surface drops from about 20 m. below the landfill to about 15 m. below Hadera swamp eastward to the landfill. The significant difference of the contaminants concentration above and below the clay zone shows the importance of clays in stopping of contaminated leachates from getting into aquifers.

MAP OF COASTAL AQUIFER SENSITIVITY TO PUMPING (PRELIMINARY RESULTS)

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Coastal Plain Aquifer represents one of the most important water sources of Israel. The importance of this aquifer, as an operative storage reservoir, even increases today - at the epoch of water desalination (due to its high storativity and low hydraulic conductivity, this aquifer provides unique storage reservoir, situated in the central part of the country). Water quality of this aquifer is affected by several factors. Some of them take their origin in the anthropogenic activity on the surface) irrigation, farms, industry etc.), while other factors are result of salinization from natural sources, which is contributed by the geological structure of the aquifer (air born salts, sea water intrusion, saline water in the eastern part and at the bottom of the aquifer). A wide spectrum of hazardous pollutants can be found in the Coastal aquifer water as a result of anthropogenic contamination. However, natural sources are considered as the main salinization hazard. Salinization is usually associated with water level decrease due to overpumping. Intensified pumping in the 1950's-60's, had led to formation of hydrological depression (up to 3 m below sea level) in the central part of the aquifer. This depression appeared in the central part of the aquifer, from Gaza up to Rehovot. In the 1980's, the depression have disappeared as a result of decrease in pumping. In areas characterized by different geological structure, the response of water salinity to fluctuation level was different. In some areas, a decrease in water levels caused increase in water salinity. This increase does not stop after water level recovery. In other areas, water level fluctuation did not affect water salinity. These phenomenon can be illustrated on the example of two wells situated at a distance of 4.8km: Gevar-Am 12 - decrease in water levels by 9 m caused an increase in chloride concentration of 250 mg/l; Zikim 3 – water level fluctuation up to 8 m did not affect water salinity of 100 mg/l of Cl. Preliminary analysis of the salinity response to water level/pumping fluctuation has been provided for southern part of the Coastal aquifer. The results of this analysis have been compared with location of possible salinization sources (Interface, zone, Eocene aquifer and fault zones). Based on the findings, a map of aquifer sensitivity to pumping was compiled for the southern part of the aquifer. This map distinguishes three types of areas: low sensitivity zone, relatively low sensitivity zone and high sensitivity zone. The high sensitivity is caused by sea water intrusion and the joint effect of Eocene aquifer and the faults and fault zones.

HIGH RESOLUTION IMAGING OF FAULT AND SEDIMENTART SYSTEMS OFFSHORE EILAT

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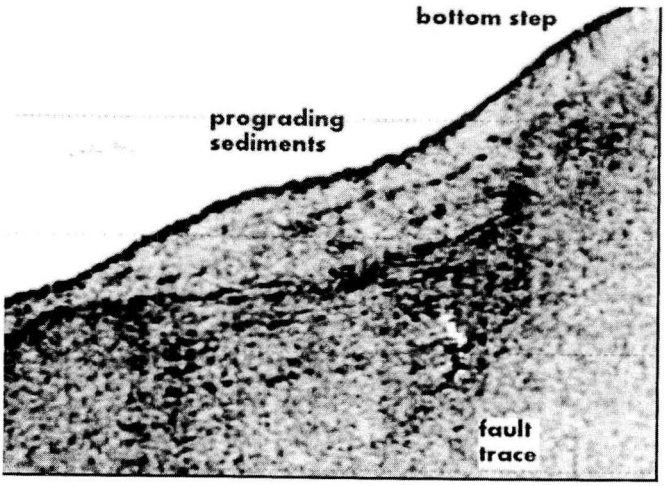
Eilat is located at a zone of transition between major segments of the Dead Sea fault system. This is apparent both from morpho-tectonic mapping on land (Garfunkel 1981), and geophysical data collected in the Gulf of Eilat (Ben Avraham, 1985) and onshore (Frieslander, Ph.D.). However, the detailed faulting pattern around the town of Eilat is not well constrained. Onshore mapping is limited by human development and disruption, and by the difficulty in acquiring high quality seismic data. Pre-existing marine geophysical data were limited by their resolution and did not cover the coastline area. We used the IOLR Chirp to acquire single channel high resolution acoustic reflection profiles along, and perpendicular to, the coast line of Eilat. The cruise covered the entire 7km shelf to a depth of 120 m with nominal line spacing of 100m. Data processing, interpretation, and 3D correlation are underway. Our data suggest a major fault zone ("the Eilat Fault"?) that stretches parallel to the western coast of Eilat from the area of the airport to offshore the harbours area. Sharp morphology of the bottom and shallow sedimentary basins underscores faulting patterns yet to be explored. In addition we plan to obtain a qualitative assessment of faulting history from the interaction between faulting patterns and sedimentary features including coral reefs.



THE RADON FLUX AT THE MARGIN OF THE SOUTHERN ARAVA - INITIAL RESULTS OF HIGH-TIME RESOLUTION MONITORING

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High time resolution monitoring of radon, using alpha and gamma detectors, is conducted at three sites along a 20 km long sector of the southern Arava – at Nahal Shelomo, Roded and the Amram tunnel (Har Amram). All sites are placed in basement rocks in the marginal structural blocks of the Arava Rift. Systematic temporal variation is observed, manifesting large and very large relative signals. The main types observed are diurnal and multi-day variations and also a seasonal-annual variation. Locally measured pressure or temperatures seem not to be the main driving force for the observed phenomena.

The extreme temporal variations - multi-day and diurnal - at the Roded site imply that geogas flow is active at a depth of 9 meters in the massive basement rock, probably occurring in the joint system. An apparent correlation of the temporal variation of radon is observed among the sites of Nahal Shelomo and Amram (distance = 17 km). This correlation occurs with a time-offset of the signal, the registration of which at Nahal Shelomo precedes the registration in Amram by 2-5 days. At this stage this is considered to indicate that subsurface geodynamic processes are at hand.

A connection between multi-day radon flux variation (Radon Events) and earthquakes in the Rift system was demonstrated for radon time series collected in the NW Dead Sea area. Therefore, extending monitoring in the southern Arava and in the Gulf should be considered in light of the high seismic activity in the Gulf and the hazard it presents.

THE SURFACE RUPTURE OF THE JANUARY 18, 749 EARTHQUAKE EXCAVATED IN TIBERIAS

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Historical records of earthquakes can significantly contribute to understanding active faulting and seismic hazard. However, pre 20th century historians were unaware of the association of earthquakes and fault ruptures. Consequently historical texts usually report the time and damage caused by earthquakes but not the associated faults. On the other hand, observed fault ruptures are often difficult to date. In order to overcome these difficulties we analyze faulted archaeological and sedimentological strata in the *Galei Kinneret* excavations in the ancient city of Tiberias and combine them with interpretation of historical accounts. Tiberias was founded in 19 AD by King Herod on the western shore of the Sea of Galilee (Kinneret). Herod's stadium, exposed for the first time, was damaged by boulder-bearing flash-floods and again by an earthquake. Later buildings, dated up to the early 8th century, are all covered by alluvium and lake deposits. They are also damaged and offset by normal faults, whereas buildings from the late 8th century are intact. We therefore attribute the damage to the earthquake of 18 January 749. The paleoseismic observations are in good agreement with the distribution of damage, based on historical records. Both datasets, combined with a previous identification of the 749 rupture near Jericho by Reches and Hoexter (1981) indicate a 100-km-long rupture segment between the Kinneret and the Dead Sea, demonstrating that it is capable of generating M>7 earthquakes.

DOES THE HULA NATURE RESERVE FUNCTION AS A SINK OR SOURCE TO PHOSPHORUS AND NITROGEN THAT MIGHT ENTER LAKE KINNERET?

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The biogeochemical function of the Hula Nature Reserve (HNR) was examined in **relation to** the planned rehabilitation of the reserve. The question raised by the planners is meant to predict the future water quality at the outlet of the reserve after the rehabilitation process is completed and the water quality of the inlet is much better than it is today.

The biogeochemical examination was carried out by using the geochemical parameters measured in different sampling stations in the HNR through 1993 to 2002. Since no water flux data was measured, conservative ions (Cl^- and Na^+) were used to assess the amount of mixing between different water sources and the evaporation rate of the mixed water. A mass balance of total phosphorus and total nitrogen showed that the HNR functioned as both sink and source for both nutrients during the research period. On an average, HNR functioned as a sink for both nutrients with an average sinking value of 0.5 and 9 tons of total phosphorus and total nitrogen respectively. These values relate to inlet loads of 1.5 tons total phosphorus (removal of 33%) and 20 ton total nitrogen (removal of 45%). The average removal rates of HNR are similar to those suggested by previous works. The periods when the HNR functioned as a source for phosphorus and nitrogen were mainly during the winter months. These periods may relate to many different management parameters such as the inlet water quality, the water level and birds wintering.

IS THE TECTONICS OF THE EASTERN MEDITERRANEAN CONSTRAINED BY THE WESTWARDS ANATOLIAN ESCAPE?

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The tectonics of the eastern Mediterranean is constrained by the northwards subduction of the lithospheric relicts of the Tethys Seaway, which occurs along three arcuate Benioff zones, the Calabrian Arc to the west, the Hellenic Arc in the center and Cyprus Arc to the east. The Hellenic subduction caused the evolution of the Aegean Sea in the overriding slab as a marginal basin, which has been expanding since the middle Miocene, concurrently with the southwards migration of the deformation front. Structural experiments that used a large centrifuge to simulate the subduction processes show that gravity drives the "oceanic lithosphere" under the "continental lithosphere" into the "asthenosphere" under constrains of reduced seismic friction. The upper part of the subduction zone migrates seawards during the thrusting processes, leading to intensive extension at the edge of the overriding "continental" slab in the model. Since a thick sequence of sedimentary rocks, which probably reduces the seismic friction, overlies the marine Tethyan lithosphere located at the front of the African Plate in the eastern Mediterranean, there is reason to link the findings of the model to the southward migration of the Hellenic Arc, to the opening of the Aegean Sea and to the motion of Anatolia to the west-south-west. The intensive westwards motion of Anatolia it was attributed, until recently, to the tectonic collision between northward moving Arabia and the southward moving Eurasia. Anatolia, according to this model, is pushed westwards by the colliding plates. This tectonic system was named "Anatolian Escape". Other models associated the rate of westwards motion of Anatolia with the rate of tectonic motion of Arabia along the Levant rifts. However, GPS measurements that were acquired in the last decade showed that rate of the Anatolian offset is not uniform. East Anatolia move westwards at average rate of 20 mm/yr, western Anatolia reaches 30 mm/yr, and the Aegean region the tectonic motion reaches 35-40 mm/yr. Observations of structural extension in East Anatolia, at the intersection between the East and the North Anatolian Faults, complement the evidence needed to reject the tectonic association between the northward motion of Arabia and the westward motion of Anatolia. We suggest that, considering the findings of the geophysical marine surveys and the laboratory experiments, the migration of the Hellenic Arc toward Africa is the main cause both for the opening of the Aegean Sea and the westward motion of Anatolia.

FROM BENTOR TO THE MAKHTESHIM COUNTRY

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In 1953 the late Prof. Ya'akov Bentor headed a geological expedition of detailed studies at Makhtesh Ramon. The team, including several M.Sc. students, resided at Kibbutz Sde Boqer. The following year Machzavei Ysrael Co. built a number of cabins at a hill overlooking the makhtesh, and several years later they served the first settlers of Mizpe Ramon. A set of pioneering reports and papers resulted from this expedition. In the following years the topic of the Makhtesh advanced in the following steps:

- In 1980 the Nature Reserves Authority founded the Ramon Reserve National Geological Park.
- In 1990 was the Ramon Science Center established, its scientists residing at Mizpe.
- In 1994 and 1996 a Special Government Decision was approved: "The Protection of the Makhteshim Country".
- In 2001 The Makhteshim Country has been enlisted as a candidate of the World Heritage List of UNESCO.
- The research of the makhteshim, lead by several investigators including members of the Ramon Science Center, disclosed the intrinsic relation between the excavation of the makhteshim and the post-Hazeva subsidence of Dead Sea Rift Valley, the former well recording the stages of this active subsidence. The tectonic and seismic activity have been shown to go on.
- This scientific activity lead to a recently gathered international workshop, organized by the Israel Committee of UNESCO, related to the Great Rift Valley as a world Heritage concept, with a list of specific Heritage Sites along it.

The scientific and educational activity related to the Makhteshim Country had its seeds with the activity of Prof. Bentor and are part of his legacy. The Mizpe Ramon Council decided to name the street leading to the Visitors Center "Ma'aleh Bentor".

INCORPORATING THE PHOSPHATE QUARRYING WITH THE DEVELOPMENT OF THE NEGEV - THE ENVIRONMENTAL APPROACH

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Phosphate is quarried on a large scale in the Negev, coupled with ore dressing and fertilizer production. The latter activities have a negative environmental impact, especially on the groundwater resource - a topic that will be addressed elsewhere. The present communication concentrates on the quarrying alone and how it can be incorporated with environmental and thematic development of the Negev. Major points are:

- We are committed to leave adequate amounts of the phosphorite ore to the next generations.
- Ourselves and the coming generations deserve a land with well preserved Nature landscapes.
- The quarried space has a high potential for a latter use, e.g. storing of ammunition; storage and distribution centers of gas and other fuels; compact cemeteries; solar collector farms; sport stadiums, residential quarters, building materials landfills, and restored open landscapes. The ongoing quarrying has to be directed to the discussed uses. In this way destruction of other land areas can be saved.
- Quarrying is interesting with regard to natural history and human needs. It is warmly recommended that every site will be organized to host visitors and guide school students in their mini-research projects. This will be part of a "transparent" management.
- Work has to be well planned ahead in order to minimize deterioration of the natural landscape surrounding each authorized quarrying site - e.g. minimum coverage of surrounding areas by waste materials, minimum new roads, minimum dust.
- It is recommended that every authorized quarrying area will (a) have a name, (b) its borders will be marked by posted signs, (c) at the entrance the name of the company, and the name and phone of the person responsible for the environmental quality, will be clearly posted.
- To encourage optimum management, according to the official guidelines, it is recommended that a detailed air photo of the site and its surroundings is presented before work is initiated, and every year an environmental report will be submitted along with an updated new air photo - this will be a condition to go on with the quarrying for another year.

SUBSURFACE IMAGING OF THE EASTERN RAMON FAULT, NAHAL NEQAROT, NEGEV

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The Ramon fault is a major element within the Central Sinai – Negev Shear Zone, extending across the Negev and central Sinai, from the Arava Valley to the Gulf of Suez. Right-lateral strike-slip motion, dated as post early Miocene, has been recorded along several elements of this system. Some evidence of earlier activity has been noticed along several faults belonging to this system, but only in few cases the nature of this activity is known. The eastern part of the Ramon Fault, from Nahal Geled to the Arava valley, is known from surface geology as a high angle reverse fault. A vertical separation of almost 200 meters is based on Lower Cretaceous sandstone of the Hatira Formation abutting upper Cretaceous units of the Hazera Formation. Recent seismic lines carried out by the Geophysical Institute of Israel (GII) across the eastern segment of the Ramon Fault reveal new subsurface information concerning the geometry and history of the Ramon fault zone. In this research we suggest two alternative models to image the subsurface, both leaning on interpenetrated seismic lines across the fault. No other subsurface stratigraphic information, apart from a single borehole north of the fault that penetrates the Hatira Fm is available. The first model shows three phases of deformation: (a) post Triassic tensional phase, forming a normal fault. This fault plane changes its inclination from sub-vertical close to the surface to sub-parallel to bedding at depth of few hundred meters. During this event a thicker section of the Hatira and Hazera fms was deposited north of the fault. (b) A compressional phase, which took place during the late Cretaceous, is recorded by thicker section of the Turonian and Senonian units south of the fault. (c) A third deformation phase is of post early Miocene age, is based on surface geology. The second model, which is based on structural considerations, might also consist of two phases of deformation: (a) post Triassic normal faulting phase, forming a listric fault, and (b) post Miocene reverse faulting, a reactivation phase along the same fault plane that is also responsible for the formation of antithetic reverse faults.

OPEN CREAK SYSTEM ALONG THE FAULT ESCARPMENT OF THE DEAD SEA AND ITS POSSIBLE LINK TO THE 1927 EARTHQUAKE

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In the second half of 2002, an open creak system, 15 km long, has been discovered along the fault escarpment of the Dead Sea basin between Qumran in the north and Nahal Qane in the south, from Coord. 1931/1267 to Coord. 1886/1131.

The creak appear in various lengths: from few meters to several hundreds of meters, their depths are from half a meter to more than 3 meters and they are few centimeters to more than a meter wide. The most intensive sits are in the vicinity of the following locations: around cooed. 1931/1267, between coord. 1906/1196 and coord. 1897/1175, between coord. 1887/1140 and coord. 1886/1131. Most of the creaks are approximately north-south oriented. In the vicinity of coord. 1930/1263, a large east- west creak, 30 m long, more than 2 m deep and 0.8 m wide, was discovered.

The creaks are developed in the alluvial sequence, which covers the coastal plain of the Dead Sea, as well as in the hard carbonate sequence of the Judea Group exposed along the cliffs bordering the Dead Sea basin from the west. Near the open creaks, large peaces of rocks are widespread, most of them are not stable and without patina (desert varnish). Near the southern tip of the creak system, a cave, more than 4 m deep, was exposed, containing dry speleotems and travertins.

In an excursion done with Yoav Avni, few geomorphological evidences were found indicating that the creak system may be connected to a recent earthquake event:
1.The creaks are deep and open. No sedimentation occurred along them except on the small segments crossed by active channels draining the cliffs.
2. Large blocks are still unstable and they are still ready to collapse.
3. There is no desert varnish on the fresh rock fragments.

The most probable seismic event that can generate the described fetchers is the 1927 earthquake, which its epicenter was located in the near-by Deragot delta. The occurrence of the dry speleotem cave along one of these creaks my indicate that the buried fault, activated during the 1927 event, has been active also in some past event.

The dating of this surface rupture and its past history, as well as the history of some other creak systems discovered along the cliff system west of the Dead Sea, are under research as part of a planed Ph.D thesis.

BENTOR AND PHOSPHORITES

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Phosphorites were one of the many subjects, which interested and intrigued Bentor. He wrote some 20 papers and reports on this subject. His interest was aroused when he discovered the Oron deposit during the Negev mapping. At that time phosphates where known only in Jordan. He immediately realized the importance of this discovery to the economic development of the young state of Israel and the development of the Negev desert. He summarized his results in a paper "The phosphate deposits of Israel" published in the "Israel Economic Forum" in 1954. Bentor never differentiated between applied and basic science and already in 1953 he gave a lecture in the International Geological Congress in Algiers on "Relations entre la tectonique et les depots de phosphates dans le Negev Israelien". This seminal paper changed the technique of looking for phosphorite deposits.

It is typical for Bentor who not only a great scientist but also a great teacher that one of his most recent papers was "Phosphorites; the unsolved problems". He was always looking forward and raising new questions. We can only hope that we, his students, have some of his enthusiasm and can pass it to the next generation of students like he did.

GEOLOGY AND PHILOLOGY, ARABIC WORDS IN THE GEOLOGY OF ISRAEL

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Geology names periods, phenomena and processes, minerals, rocks and stratigraphy to signify items. Several lithostratigraphic units in Israel have Arabic names, such as Bi'na, Saqiya etc., following the locations of their studies. Arabic names entered the geological dictionary, but their meenings have been lost. Several of these are hereby discovered.

The Arabic word Hamra means "red". This name was given to several types of red soils of different origins, such as quartzic sand, sandstone and volcanic. In the Israeli geology and pedology the name Hamra was given to red quartzic sandy soils, which had been developed from dunes during wet climatic stages in the Coastal Plain of Israel.

Kurkar is the calcarous sandstone which developed from the coastal dunes during arid climatic stages. This name was given to the lithostratigraphic group which forms the Coastal Plain. The Atabic term Kurkar means a round pebble. The Arabic root KRKR, or KKR, like the Hebrew כרכר or ככר, pertains to a rounded object. This term passed several transfigurations. A pebble was used for the plumb line, thus giving the name Kurkar both to the plumb and to the vertical building technology. Later it became the name of the stones of which houses were built in the Plain. The name of the stone was adopted for the main rock of the Plain, and the Kurkar Group was named after the rock.

Nazaz is a clay layer within Hamra soils. The Arabic root NZZ is related to water spray as well as a flooded area. This property fits the Nazaz, which prevents water permeability and causes decay of roots in plants.

Husmas is a type of soil developed from Hamra and inhibits calcareous nodules, which harden and seal its upper horizon. This soil is unfit for plantations. The Arabic root HSM, like the Hebrew חסם, means to harden and to block, and is well fitted to the properties of this soil.

Nari is a hard crust developed on chalky rocks in semi-arid zones. NAR means fire in Arabic, נור in Hebrew. The popular explanation is that limekilns were constructed of this stone and the fire had given the name to the stone. But, unfortunately, Nari made kilns have not been found. It is suggested that Nari was originally used to describe the lime which was produced in the kilns. The name stuck later to the hard crust.

Hawar is the Hebrew word for Marl, the fine-grained combination of chalk and clay. This name comes from the Arabic Hawr, which means pale, the Hebrew חִוָּר. The Hawar is one of the units which compose the white-gray Lashon (Lissan) Formation. The Hawar has lost its original meaning with the Moza yellow-green marly Formation.

CONTAMINATION OF GROUNDWATER UNDER CULTIVATED FIELDS IN AN ARID ENVIRONMENT, CENTRAL ARAVA VALLEY, ISRAEL

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The aim of this study was to understand the processes of contamination of groundwater in arid environments due to agriculture activity. A combination of physical, chemical and isotopic analyses is used to describe the hydrologic system and the trends in recharge of water and salts into the Fill Aquifer in the Central Arava. Our results indicate that intensive irrigation and fertilization substantially affected the quantity and quality of groundwater recharge.

Low irrigation efficiency of about 50% produced recharge of approximately 3.5-4 million cubic meters of recycled water per year. This recharge is expressed by the variation of the shallow lens (2-5 m depth) water levels, which rose during the agriculture season (September – March) by about 35 cm. During the research period, the natural recharge from floods was found to be negligible in relation to irrigation water.

Soil profiles, measured to depths of 2.5 m, show low salt concentrations in cultivated fields and Wadi Arava, indicating that the irrigation water and intermittent floodwaters infiltrated and leached the salts downward. In contrast, there was an accumulation of various salts near the surface in undisturbed natural soil.

Mixing lines of various ions versus TDS indicate that the dominant source of contamination is irrigation water, which infiltrates and contaminates the aquifer units gradually. The two main salinization processes are: (1) salinization due to circulation of salts dissolved in the irrigation water itself, mainly chloride, sulfate, sodium, and calcium; (2) contribution of salts from excess fertilizers, mainly nitrate, and some potassium.

Nitrate concentrations have been increasing in the aquifer, mainly in the last ten years. In parts of the aquifer that are closer to the surface, the increase was more rapid and the nitrate concentrations are higher. The nitrate concentration in a shallow local lens ranges between 100-300 mg/l and in the upper sub aquifer is over 50 mg/l. The background nitrate concentrations, as measured in the lower sub-aquifer, are 5-10 mg/l. Nitrate concentrations of drainage water at 60-120 cm below the cultivated fields range between 150-700 mg/l during the fertilization season.

The isotopic compositions of $\delta^{15}N\text{–}NO_3$ also imply that the main source of contamination of nitrate is the fertilizers in the irrigation water. Another local source could be, in places, from nearby sewage ponds. Other evidence of contamination in groundwater includes high concentration of K (20-120 mg/l) and Total Organic Carbon (about 10 mg/l).

THE G1 GPS GEODETIC - GEODYNAMIC NETWORK: PROCESSING RESULTS OF THE CAMPAIGNS 1996-2002

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Repeat geodetic measurements had established itself as a valuable, and generally viable, technique for quantifying the amount and direction of contemporary crustal deformation at local, regional and continental scales. The G1 GPS geodetic-geodynamic project was initiated as a common GSI-SOI project focusing on the monitoring measurements and geological interpretation of ongoing tectonic deformation processes in Israel at a local scale. One of the goal from this GPS network is to obtain an integrated 'kinematic model' that will accurately describe (spatially and quantitatively) the geodetic strain distribution throughout Israel.

We describe the geodetic results of the project based on combined analysis of the two GPS campaigns in 1996 and 2002. The G1'96 GPS campaign included observations of 156 stations with a homogeneous spatial distribution of 15-20 km. The results of processing indicate that an overall site position accuracy of 2-3 mm in horizontal coordinates and 6-8 mm in vertical coordinates have been achieved. The G1'2002 is the second phase of a long range geodetic-geodynamic project. The G1'2002 observation campaign took place from 9 December 2001 to 15 May 2002, and was conducted by the SOI and the Drakar Geodetic Company. The campaign included re-observation of 100 points of the G1'96 network and the surveying of 5 additionally constructed sites. Also, the G1 network was linked with the Israel GPS permanent network, commonly referred as GIL. All in all, more that 3000 baselines were computed in the G1'2002 campaign. We obtained the same precision values of the coordinate solutions as in G1'96 campaign, i.e. 2 mm for horizontal coordinate components and 6 mm for the vertical one. This means that the resolution of the relative horizontal velocities at the level of 1-2 mm/yr is possible. A comparison between the G1'96 and G1'2002 station coordinates gives mean rms values within the coordinate residuals of 8, 7 and 14 mm for latitude, longitude and height.

Geodetic conclusions will hopefully improve the understanding of the relationship between strain accumulation and seismic hazard by integrating geodetically derived strain information with existing GII seismic catalogue and other geological data.

SURVEYING MOUNT SODOM SALT DIAPIR, DEAD SEA

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Mt. Sodom is a salt diapir located on the western margin of the southern basin of the Dead Sea Depression. A number of salt diapirs exist in the Dead Sea Depression, mostly along the western margin, however Mt. Sodom is the most impressive and the only one which is exposed. GPS and geodetic leveling measurements on Mt. Sodom's and its near vicinity are every surveyor's nightmare. The Sodom area is known for its harsh arid environment, steep topography, lack of vegetation and its marl ground causing dust storms. In our study of calculating Mt. Sodom's uplift using InSAR, we use field surveys as reference measurements. A GPS survey is conducted once every three months and a leveling survey once a year. Each survey includes great logistical, physical and financial efforts. Measuring uplift rate with in the mm scale demands us to perform a high accuracy survey using a special geodetic layout. This layout was designed and deployed on Mt. Sodom and vicinity including Amiaz cliffs. The layout consists of 16 benchmarks, of which 10 are composed of a steel plate anchored to a large (2 ton) concrete platform and the rest, located in areas with no available concrete platforms, were built on coated pipes mounted on a concrete base and buried 6 m under the surface in order to eliminate possible surface fluctuations. These benchmarks are used both for leveling and for GPS measurements. Here we show the uplift rate calculated from two-year observations of field surveys. The geodetic results on the southern block of Mt. Sodom show that the deformation is not uniform and its maximal average uplift rate is 6-8 mm/yr. These results are in good agreement with the uplift rate calculated using the InSAR method (~ 7 mm/yr).

PC-BASED SOFTWARE FOR EMPIRICAL DETERMINATION OF DYNAMICAL CHARACTERISTICS OF FULL-SCALE STRUCTURES

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Information regarding dynamic characteristics is absolutely necessary for the anti-seismic design and for estimating seismic vulnerability of existing structures. For estimation of fundamental frequency and damping ratios following observations are usually used: ambient vibration, free oscillations of constructions induced by transport passes and specially designed impulse impacts. The special software was designed for processing of these data, based on the Matlab Graphical User Interface (GUI) technique and Fast Fourier Transform method. Structural resonance frequencies are estimated at peaks of spectral amplitudes and corresponding damping ratios from the width of the peaks:

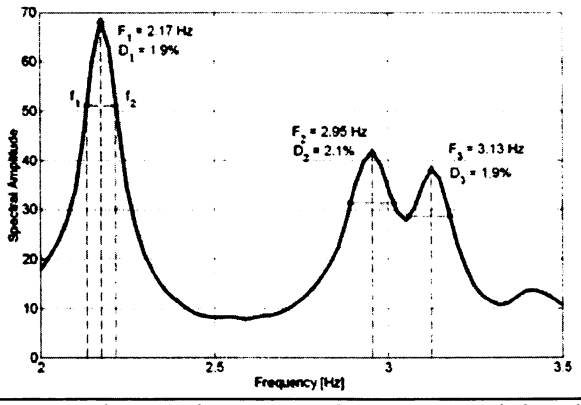
$$D = (f_2 - f_1)/2F_j$$

where F_j is fundamental frequency of j-mode, D is the critical damping ratio and $(f_2 - f_1)$ is frequency interval at 75% of the largest spectral amplitude.

The program realizes following interactive possibilities:

- Visualizing, editing and printing input data (Fourier velocity spectra)
- Computation of resonance frequencies and damping ratio
- Drawing, editing, printing and saving all results as graphical and ASCII files.

This program was used for computation of dynamic characteristics for a set of ten buildings in the Qiryat-Shemona .



Average Fourier velocity spectra of the 6-story reinforced concrete building under ambient excitation and calculated dynamical parameters of this structure.

ROBUST INTERPRETATION OF SEISMOLOGICAL OBSERVATIONS

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Multivariate data processing often meets with situations, when a part of the "channels" has poor Signal-to-Noise ratio or systematic distortions or spoiled by sporadic noise. Usual least square and maximum likelihood modeling, based on regular statistical assumptions fail in all these cases or reduce effectiveness. General robust criterion yet states a rescue assumption that a cluster of observations still remains that fit a model well. The cluster of "true" observations is detected by using characteristic sum of discrepancies, weighted by a function, tending to zero for large deviations and leaning to 1 for small ones. The bell shape of the characteristic function helps to eliminate outliers and highlight true values. The search process is realized as a grid-scanning algorithm, which stops at a point, providing maximum to the characteristic sum, which is then roughly equal to the number of "channels" fitting the model. New automatic algorithms, based on this principle and utilizing grid search in a source space, have been designed recently for network event location, array signal processing and site-effect estimation. The seismic network model is established by the distance-traveltime dependency from the source, determined by origin time and hypocenter. The network procedure input: P and S waves first arrival times are estimated automatically via a chain of signal processing programs. The array recordings model is described, as usual, by the waveforms shifted according plane wave arrivals to the array stations, where a slowness vector grid presents the source space. However, instead of usual beamforming, we use robust f-k analysis (beamforming) looking for the maximum of characteristic sum (non-linear beamforming). For correlated noise suppression, noise spectral matrix is utilized to provide robust adaptive beamforming. In the site-effect estimation method using 3C microtremor observations, source space is presented by the two variables: frequency and amplification, while the model is determined by maximum of Horizontal-to-Vertical ratio in frequency domain, which is repeatedly measured at a set of time-windows ("channels"). For better performance the program is supplied by sophisticated routines of time-windows pre-selecting and data preprocessing, as well as possibility of interactive interference. The robust routines of network location, array signal parameter estimation and site-effect determination have been successfully applied to the artificial and real data.

ENVIRONMENTAL INTERPRETATION OF PEBBLE BEDS IN LOWER ZIN AREA

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The Late Pleistocene lacustrine sediments of the Lisan Formation are deeply penetrating the lower reaches of Nahal Zin intercalating in the structure of highest fluvial terrace. As distinct from the Lisan Formation in the inner part of the Dead Sea basin, the coarse pebble-sandy facies dominate in the composition of this terrace. The pebble beds were analyzed for further revealing their environmental characteristics. Two sites remote one from the other were studied using paleocurrent analysis. The Hazera section is located in the Nahal Hazera valley approximately 1 km upstream of the confluence with Nahal Zin. The second studied section a 50 m thick fills an ancient meander of Nahal Zin near the Zin waterfall. Both sections have been thoroughly dated using TL method. Among different features of a sedimentary rock that can be used as paleocurrent indicators, the azimuth of bedding reflects the direction of movements. The orientation of pebbles was measured by geological compass with an accuracy of 50. Some 30 to 50 measurements were taken at each sample point, which is sufficient for accurate results. The measurements were grouped into classes of 22.50 and then plotted on rose diagrams. Although the dominant paleocurrent directions are obvious from a rose diagram, some standard statistic procedures were made. To test statistical significance of differences among paleocurrent directions, we used ?2 test. This analysis has shown that besides the typical thin-laminated lacustrine sandy-silty sediments both sections consist of alluvial and near-shore lacustrine facies. Alluvial and near- shore beds differ significantly in the pebble orientation. Alluvial units on the base and on top of the highest terrace were deposited in a pure fluvial environment, and the pebble orientation corresponds to the present-day wadi directions. Orientation of near-shore pebbles agree with the orientation of the overlying sandy-silty unit of the lacustrine intercalation. The recognition of the environmental conditions of the deposition and the age of the pebble beds will be applicable to the reconstruction of the rate of Lisan transgression and the level dynamics of Lake Lisan outside of the Dead Sea Basin. Paleocurrent analysis can contribute also to facial correlation between remote outcrops.

THE CHALK ROCK MASS QUALITY AS A PARAMETER FOR THE COST OF A ROAD TUNNEL

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The cost of a road tunnel is depended on its dimensions and the rock mass quality in the site. But while the dimensions, height and width, are known and fixed, the rock mass quality is changing from site to site.

For example to this principle we'll use the road tunnel of Ramat-Menashe, which is suggested as a replacement for road no. 6. This road tunnel is planed as a dual two-lane motorway tunnels with a horseshow cross section, length of 7,260 meters and span of 10 meters.

The Ramat-Menashe area is a synclinorium with an axis of North-East to South-West direction that is built from Eocene rock that includes:

- ✓ The Adulam Formation, which is build from well bedded white chalk and silicified chalk, containing concretionary and bedded brown flint.
- ✓ The Maresha Formation, which is build from soft white chalk that is sometimes harder.

The tunnel will cross mainly the massive rock from the Adulam Formation. In the rock mass two sets of joints ($N65^0W$ and $N25^0W$) and random joints were measured. The joints are mainly closed and filled with Calcite while the joints surfaces are rough. The density of the rock is very low, between 0.5 to 0.7 joint/meter. The bedded planes are not continuous; therefore the thickness of the rock layers changes from 20 to 90 centimeters. The expected REC value is 90% to 100%, and the RQD value is 80% to 100%. Water inflows are not expected within the rock matrix, except of temporal and limited local inflows in joints and faults as a result of local rains. Significant faults that cross the road tunnel were not found. The expected uniaxail compressive strength value is 9.50 Mpa.

The Classification of the rock mass quality for tunneling purposes, were made in two methods:

- ✓ Q method (Rock Quality): the expected rock mass quality is between good to very good (21.4-60), locally is medium (6.22).
- ✓ RMR method (Rock Mass Rating): the expected rock mass quality is between good to very good (74-82), locally is medium (49).

It was proved that tunnels with span of 10 meters and more, which were constructed in Israel in Eocene chalk rock mass, are with self stability, or were becoming as such, as a result of primer support only. Therefore, the construction of a road tunnel in Ramat-Menashe needs a primer support only, and there is no need in extra support as casting reinforced concrete. The practical meaning is that the cost of a road tunnel construction will be dramatically lower than the traditional cost of recent constructed road tunnels in Israel.

The final conclusion is that the estimate cost of a road tunnel should be based on a geomechanical survey that will classify the rock mass quality for tunneling.

IDENTIFICATION OF NITRATE SOURCES IN THE COASTAL AQUIFER OF ISRAEL: NEW INSIGHTS FROM NITROGEN AND OXYGEN ISOTOPE MEASUREMENTS

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The degradation of the water quality of the Coastal aquifer is a major concern for future sustainable water supply. Among the different mechanisms of water pollution, nitrate contamination affects a large section of the aquifer. The nitrate level in many pumping wells has exceeded the international drinking-water regulations (45 mg/l) and even the Israeli regulation (90 mg/l), which limits water supply for domestic application.
The objective of this study is to trace the sources of nitrate pollution by determining the nitrogen and oxygen isotope ratios in the nitrate molecule of contaminated groundwater. We used the long-term variations of the nitrate concentrations in the groundwater to reconstruct nitrate pollution trends. We found that some wells show no variations since 1980's, meaning that the nitrate pollution has been stabilized as argued by previous studies. However, many wells show an increase of nitrate concentrations during the last ten years, indicating a continuation of the pollution phenomena. We collected 64 groundwater samples from 10 nitrate plumes (>85 mg/l) in different parts of the aquifer and measured their chemical compositions and the nitrogen and oxygen isotopic ratios of nitrate.Our results show a $\delta^{15}N_{NO3}$ range from +3‰ to +16‰ (mean=+6.8‰) and $\delta^{18}O_{NO3}$ values ranging from –8‰ to +10‰ (mean= +1.9‰). The high $\delta^{15}N_{NO3}$ values (>8‰) are attributed to sewage pollution. Indeed, nitrate contamination associated with the recharge of treated wastewater in the vicinity of the recharge basins of the Dan Region Reclamation Project yielded high $\delta^{15}N_{NO3}$ values. We also found a positive relationship between the dissolved HCO_3 concentrations and $\delta^{15}N_{NO3}$ values implying degradation of organic matter derived from a sewage source. In contrast, most of the contaminated groundwater (47 out of 64 wells) has $\delta^{15}N_{NO3}$ values between +3‰ to +8‰. This range suggests that the nitrate pollution can be derived by either mineralization or subsequent nitrification of soil organic nitrogen induced by cultivation or from application of fertilizers over the aquifer. The relative low $\delta^{15}N_{NO3}$ signature of synthetic fertilizers (typically 0-2‰) can be modified by isotopic fractionation induced during ammonia volatilization followed by nitrification in the unsaturated zone. Most of the contaminated groundwater (41 out of 64 wells) has $\delta^{18}O_{NO3}$ values between 2 to 5‰. Since the $\delta^{18}O_{NO3}$ value is controlled by contribution of 2/3 water oxygen and 1/3 of soil oxygen with oxygen isotope ratios similar to those of atmospheric O_2 (23.5‰), the $\delta^{18}O_{NO3}$ values corresponds to a $\delta^{18}O_{H2O}$ range of –6‰ to –4‰, which are consistent with that of the coastal aquifer. In sum, the nitrogen and oxygen isotopic data show that nitrate in most of the contaminated groundwater is derived from mineralization and nitrification of soil organic nitrogen and/or from fertilizers application. In some cases we were able to monitor the impact of nitrogen derived from sewage effluents.

THE HULA VALLEY SUBSURFACE STRUCTURE INFERRED FROM GRAVITY DATA

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The complete Bouguer gravity data set was reinterpreted for the first time in a 3D mode to model the shape of the Hula basin, a pull-apart basin along the Dead Sea Transform. The 3D gravity inversion technique was carried out using the Notera-3 well density log and current geological knowledge of the area. The resultant geological model obtained after inversion clearly shows a rhomb shaped graben filled with approximately 4 km of young sediments in the deepest part of the basin. The reliability of this model was verified using the 3-D forward modeling with an accuracy of ±0.5km. Curvature attributes of the gravity field depict the main fault pattern. The tectonic configuration of the Hula graben is represented by a subsiding rhomb shaped block, bordered by steep sided, deep basement faults (Qiryat Shemona and the Jordan River) on the western and eastern sides, respectively, and by gradual, en echelon step faults on the southern and northern margins of the basin.

THE NATIONAL BATHYMETRIC SURVEY (NBS): SECOND YEAR OF OPERATION

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The National Bathymetric Survey (NBS),a joint undertaking of the GSI, SOI, and IOLR, has completed its second year of operation in the Mediterranean offshore of Israel. The areas surveyed now cover from Rosh Haniqra to Akko, Ashqelon, Herzliya, inshore Hadera, and proposed gas pipeline tracks. This computer presentation will describe the surveys that have taken place, and show details of the different bottom types, topographic features, and wrecks and other man-made influences on the seafloor.

Operationally the project is still suffering from a limited number of days at sea, occasioned primarily by the predominance of waves in excess of 150 cm, the prescription against the R/V Etziona operating over the two day weekend, the limited number of qualified operators, and by the vessel's other duties. The equipment has operated without failure for more than a year. All shipboard equipment, including a special winch with 1000 m capacity for the CTD probe, has now been acquired and installed.

At the same time the analytical capability of the survey has been greatly improved. Agreements have been worked out for accommodating commercial search and mapping projects. Several students are now using the data acquired by the NBS for graduate degree programs, including the author in the Geography program at Tel Aviv University. The number of computers has risen to nine, and their speed and capacity greatly increased. The original UNIX based Kongsberg-Simrad NEPTUNE analysis, POSEIDON sidescan mosaicking, and TRITON sediment classification, as well as the Roxar C-FLOOR visualization software packages have been upgraded and converted to Windows 2000 on PC platforms. The CARIS GIS,HIPS/SIPS analysis, and GEMM geological mapping packages have been upgraded. The complete ERDAS and ER Mapper image analysis suites, Blue Marble GEOGRAPHIC TRANSFORMER and GEOGRAPHIC CALCULATOR coordinate conversion packages, and the GLOBAL MAPPER image and DEM handling program have been acquired. The existing ESRI GIS,IVS FLEDERMAUS visualization, Able Software R2V digitization, and Golden Software SURFER packages have also been upgraded.

An adjunct to the GSI website is planned which will include digital raster, vector, and gridded bathymetric charts done in the past, PDF files reporting the results of each new survey or sub-survey, details on the Kongsberg-Simrad EM1002 system and its methodology, links to other bathymetric and swath mapping websites, marine bibliographies, and details on ongoing compilations of the topography and bathymetry of the lands and seas making up the Arabian Plate and its environs.

THE NATIONAL BATHYMETRIC SURVEY - COMPUTER VISUALIZATION OF THE DATA: A SOUND AND LIGHT SHOW

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The National Bathymetric Survey (NBS)provides a vast amount of digital data that is very amenable to computer visualization. This stand-alone digital poster will attempt to show the range and scope of the data as well as the visualization techniques available to us. The Kongsberg-Simrad EM-1002 swath sonar equipment obtains three types of data. The 111 1½°wide beams obtain either equidistant or equiangular points on a grid beneath the ship. A much larger array of backscatter intensities are also interpolated between these beams, to give a sidescan type of picture. The third type of data is the measure of backscatter versus angle of incidence from the 111 beams. All data are quite precisely located within a geographic framework.

Using a number of visualization programs, but primarily the IVS FLEDERMAUS, and OZI EXPLORER, these data can be displayed in 2D or 3D,with animation, and accompanying sound track. The basic sounding data defines the bathymetry of the area, and can be displayed in 2D or 3D in various combinations of contours, and colored landform-shaded surfaces. The interpolated sidescan or backscatter data provides a raster image that can be in grayscale or color. The backscatter as a function of angle can be analyzed by software such as Simrad's TRITON to provide an indication of the bottom sediment type, according to various classification schemes. This information is usually displayed as a GIS layer defined by polygonal shapes. Other ancillary data can also be introduced. Examples are: seismic profiles suspended below the bottom; scanned 2D charts and maps; gridded land topography, magnetic and gravity anomalies etc.; vector overlays of shorelines, ships'tracks etc.; labels identifying objects in other databases, etc.

Free browsers are available for some of these pre-scripted presentations, with the result that the planned NBS portion of the GSI website will probably offer animations of some of the more interesting areas and finds.

MULTISCALE, 3D ARCHITECTURE OF THE MARGINS OF THE DEAD SEA PULL-APART

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We present structural analysis of the western margins of the Dead Sea basin. This area is an elongated N-S belt with an intricate three-dimensional pattern of zigzag faults, flexures and joints. The dominant structures are four sets of oblique-normal faults, arranged in orthorhombic symmetry. The faults are steep with prevalent strike directions of NNW and NNE. Large flexures developed along and above these faults, forming tilted blocks and localized asymmetric folds. Two sets of subvertical joints that dominate the area trend NNE and NNW, sub-parallel to the strikes of the dominant fault sets. The parallel relations between these structures at all scales suggest that they formed during a single tectonic phase. Three-dimensional fault modeling reveals a 3D strain field with a large vertical shortening, a minor horizontal shortening in N-S direction (belt-parallel), and a large horizontal E-W extension (basinward). The calculated stress fields associated with the zigzag fault segments are compatible with the observed fault-parallel flexures. Further, the calculations predict the formation of local tensile-belts above the faults, and these tensile belts could explain the penecontemporaneous development of the two joint sets. Architecture similar to the western margins of the Dead Sea basin is likely to develop on rifted margins wherever 3D deformation is required by the rifting kinematics.

The observed faults in the field and their analysis lack evidence of a detectable component of left-lateral displacement parallel to the Dead Sea transform. The strike-slip components of the measured oblique slip axes are about equally split between right- and left- lateral faults and therefore we interpret them to be an intrinsic part of faulting under 3D strain field. This interpretation implies strain partitioning: the sinistral strike-slip motion of the Dead Sea transform is accommodated solely along the major fault system east of western margins of the Dead Sea, whereas the fault belt itself accommodated only the horizontal extension.

A PROPOSED HYDROSTRATIGRAPHIC SCHEME FOR THE YARQON–TANININ- BEER SHEVA AQUIFER

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A hydrostratigraphic configuration for the Yarqon-Taninim-Beer Sheva aquifer based on the correlation of the Albian, Cenomanian and Turonian lithostratigraphic units in the area is herein proposed. This structure forms a basis for setting up a three-dimensional quantitative hydrogeological model in order to simulate the flow and transport of salts in the aquifer.

The aquifer extends over a wide area, along which many of the rock units change significantly. Its exposed section in the north is defined by the Ramot-Naftali and Umm-el-Fahm nomenclature, along the Judean Hills it follows the Jerusalem-Bet Shemesh classification, and in the south it goes by the division of the Northern Negev. But the most dramatic change occurs in the west, where the lithofacies of the aquiferous Judea Group changes into the aquiclude of the Talme-Yafe Formation, thus limiting the westernmost extend of the aquifer.

The litho-hydrostratigraphic division of the Judea Group in the subsurface area of the aquifer is based mainly on electric logs because of the loss of circulation in most of the deep drillholes.

As already suggested by Shachnai (1980), we also found that the division of the section by Arkin and Hamaoui (1967) into four units (Kuj 1-4) reflects the hydrostratigraphic structure of the aquifer quite well. The aquifer is built of a lower sub-aquifer that is defined by unit 1, which is correlative to the Yagur Formation, and an upper sub-aquifer that is defined by units 3 and 4, which are correlative to the upper part of the Negba and the Bina formations. The sub-aquifers are separated, at least in part of the area, by unit 2, which comprises dense carbonates and marls and correlates with the lower part of the Negba Formation (the Moza and Bet Meir formations). This division seems to be valid across most of the aquifer area.

In accordance with the present approach, we designed a GIS data-base structure that will enable us to develop the 3D configuration of the aquifer system. The data-base is flexible and will allow us to examine alternative approaches to the aquifer configuration without having to rebuild the data-base. Parallelly, the data-base, together with geophysical data, will serve to construct vital layers of information such as the boundaries of the aquifer, structural maps of the top and the base of the aquifer, and isopach maps of sub-aquifer and aquiclude units.

It is usually assumed that the top of the Yakhini Formation constitutes the base of the aquifer. However, the Telamim 1 and King David 1 borehole logs suggest that this formation is not necessarily an aquiclude. Therefore we suggest investigating the possibility that, at least over part of the area, the base of the aquifer is deeper and comprises of Lower Cretaceous rock units below the Yagur Formation.

EARTHQUAKE HAZARDS EVALUATION FOR THE CITY OF JERUSALEM

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A comprehensive evaluation of the seismic hazards of the city of Jerusalem was conducted for the purposes of areal planning, land use and environmental development. Generally, earthquake hazards depend on the areal geology, but the specific effects are highly dependent on the geotechnical properties of the particular location. Hence the findings are inherently qualitative and are aimed at drawing the attention of the planner in order to guide development in accordance with the expected hazards.

During a strong earthquake seismic waves will hit all of Jerusalem, without exception. Nevertheless, worldwide experience shows that only part of the damage is caused by the 'regular' seismic oscillations, while the rest are caused by other hazard effects. Here we analyzed the near-surface geological conditions in the municipal area of Jerusalem and identified its relevant earthquake hazards. Our findings are qualitatively summarized in a series of subject maps for each of the following factors:

i. Potential of lithological amplification
ii. Potential of topographic amplification
iii. Potential of natural slope failure
iv. Potential of 'urbanized' slope failure
v. Potential increase of seismic intensities during a strong earthquake. The map is based on data from the damaging 1927 event.

Since the subject maps are professionally formulated, there is a need for a summarizing map that will serve as a working tool for the planner who is not a geologist. The map qualitatively presents the hazardous areas in graded categories and thus enables the planner to identify the problematic zones and consider them during areal and land use planning. Moreover, the map will help to define the requirements for a specific site survey for engineering purposes. The summarizing map includes the following graded sensitivity categories:

i. No sensitivity: areas with no specific hazards, yet seismic oscillations will still occur in these regions during a strong earthquake.
ii. Zones of potential amplification: areas likely to have significant lithological or topographic amplification during a strong earthquake.
iii. Urbanized slopes likely to fail: Possible failure during a strong earthquake of soft geotechnical units, due to overloading, slope steepening and high water content.
iv. Zones of potential amplification + urbanized slopes likely to fail: areas where both factors are relevant.
v. Natural slopes likely to fail during a strong earthquake.

Intelligent use of the summarizing map may possibly minimize the seismic risk and reduce loss of lives and property during a strong earthquake.

PLATFORM DOLOMITES: A TESTIMONY TO PALEOCEANOGRAPHY AND PALEOCLIMATOLOGY

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The origin of dolomite is still a controversial issue, and involves a wide array of hydrochemical, hydrological, climatologic and lithologic considerations.

The study of dolomites in Israel started with the pioneering work of Bentor in the 40's. Extensive observations carried out since then on the Cretaceous dolomites in the country indicate that they formed during early diagenesis in a widespread carbonate platform, under conditions of elevated and varying salinities. The implications of these conclusions are: (a) The area was arid. This straightforward conclusion involves a basic problem concerning paleoclimatic reconstruction, since during the Cretaceous the area was located only slightly north of the equator. (b) Water exchange across the platform was restricted, enforcing salinity increase, which at times reached the range of evaporite precipitation. Water exchange across the platform was controlled primarily by barrier reefs, but was also affected by general water depth, local channel ways, and other bottom irregularities (basins, shoals).

The effects of the restricting factors varied with time, giving rise to the observed vertical lithological section. Thus, during the *Albian* and *Cenomanian* the restriction of water exchange with the Tethys Ocean was at its maximum, due to shallow water depth and the presence of well-developed barrier reefs at the edge of the platform. The predominantly dolomitic strata that accumulated at that time bear evidence to an elevated salinity on the average, displaying either irregular or cyclic variations, which were punctuated at times by almost normal salinities. The *Turonian* witnessed the elimination of barrier reefs from the edge of the platform, and the local development of patch reefs on its inner parts. The predominant limestone lithology of the Turonian sections reflects, accordingly, the improved water exchange and prevailing normal salinity. Dolomites, however, are not entirely absent, pointing to restricted areas of higher salinities in the lee of local reefs. During the *Senonian* times conditions changed drastically, turning the previous shallow carbonate platform into a sloping shelf, or ramp. The significantly improved water circulation and resulting normal salinity account for the predominating chalk lithology and for the virtual absence of dolomites from the rock record.

In summary, the carbonate lithological nature of the stratigraphic section reflects the salinity of the depositional environment. The salinity is directly controlled by climatic conditions and water exchange with the open sea, and indirectly by biological factors and relative sealevel variations, due to diastrophic or eustatic effects.

OFFSHORE EXTENSION OF THE CARMEL STRUCTURE AND ITS ROLE IN THE TECTONIC SETTING OF THE LEVANT BASIN: INITIAL RESULTS

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The Carmel Structure is a prominent morphotectonic element in the geology of Israel. The offshore extension of the Carmel Structure was studied by various methods throughout the years. Nevertheless, several unsettled issues obscure the tectonic picture of the area, such as plate boundary relations, nature of movement along the Carmel Fault, crustal structure and lithosphere evolution.

During February 2002,the German Research Vessel Meteor conducted a high-resolution geophysical study along the Israeli Mediterranean coast (Leg 52/2).About three days of ship time (~700 km track lines)were devoted to studying the offshore continuation of the Carmel Structure.

Systems employed during the cruise included multichannel seismics reflection, Parasound (a dual-beam sonar subbottom profiler), Hydrosweep for swath mapping, Ocean Bottom Seismometers and Hydrophones, gravimeter and magnetometers. The diversity of data collected enables high resolution imaging of various aspects of shallow as well as deep subsurface structures.

During the Multichannel seismics reflection survey an array of two GI-guns and two streamers (143.5 m and 575 m long)were deployed. The GI-guns were utilized in order to eliminate the bubble effect caused by the energy release, while producing a high-resolution broadband signal. Ocean Bottom Seismometers along with a second cluster of two G-Guns were used to obtain seismics refraction/wide-angle reflection.
Data from previous geophysical surveys were also examined (e.g. the Horizon survey).Compilation of the wide range of geophysical data presents a comprehensive picture of the presiding tectonic regime. Initial results are presented.

DYNAMIC LIQUEFACTION CAUSED BY POROELASTIC WAVES: A NOVEL MECHANISM TESTED ON A SHAKING TABLE

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Dynamic liquefaction in unconsolidated sediment, a novel mechanism for earthquake devastation, is tested on a shaking table.

Liquefaction is the transformation of granular material from a solid into a liquid-like state as a consequence of increased pore-water pressure: when the pore water pressure equals the total stress the matrix looses its strength and flows. Standard liquefaction experiments are conducted under simple shear cyclic loading conditions. Shearing drives compaction and pore collapse, accompanied in turn by water capture in the pores and pore-pressure build-up. The effective stress, given by the difference between the total stress and the pore pressure, is therefore reduced and the sample liquefies. In these standard quasi-static tests, the criterion used for liquefaction potential is the void ratio of the soil (the volume ratio between the voids and the solid): if the void ratio is above critical, the soil may liquefy.

The void ratio criterion does not provide sufficient estimation for recurring liquefaction. Therefore a new mechanism with a new criterion for soil liquefaction potential is tested in this study. A recent theoretical analysis based on Biot's formulation for acoustic wave propagation in porous media suggests that compaction is a consequence and not a cause of liquefaction. The trigger for dynamic liquefaction is inertia rather than compaction; liquefaction is driven by P (pressure) waves rather than S (shear) waves. The liquefaction is the product of resonance between elastic waves and the flow in the porous sediment.
According to the analysis the medium has a characteristic frequency for diffusing momentum given by the ratio between kinematic viscosity of the pore fluid and the hydraulic permeability. This characteristic frequency scales with the frequency for dynamic liquefaction, as confirmed by numerical results. For a typical sand bed with a thickness of 1m the liquefaction frequency is in the order of 1 Hz, which is expected to exhibit considerable amplitudes in strong earthquakes.

Laboratory tests are conducted on a shaking table (LDS V-850). A tank of saturated sand specimen is vibrated vertically in a range of frequencies. Accelerometers and pressure gauges are installed at several points at the boundaries and within the sediment. The tank is designed so that its normal mode frequencies are far outside the range predicted for liquefaction. The height of the sample is 20cm and horizontal dimensions are 10cm x 50cm. The tank is carved in an aluminum block with a minimum wall width of 2 cm, and a plexiglass window (20cm x 50cm x 5cm).
Preliminary results on sand of 38% porosity (void ratio of 0.61) show a distinct pressure drop at a frequency of about 60 Hz, as anticipated by the theoretical analysis for a 20cm thick layer of saturated sand with permeability of about 1 Darcy.

FIRST GEOMAGNETIC PALEOINTENSITY RESULTS FROM ISRAEL

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This study aim at recording the past magnetic field intensity and direction (inclination and declination) in the last 3 millennia in Israel. For the magnetic paleointensity we sampled 9 archeological heat sources such as ceramics production, lime production, fireplaces and thermal baths. These installations were heated to above the Curie temperature and acquired the magnetic field when they cooled down. The archeological objects date as 1st - 19th century AD. The paleointensity measurements were performed in the paleomagnetism laboratory in Rennes, France using the original Thellier method. Corrections for the anisotropy of thermoremanent magnetization were performed.only few samples show a non-ideal behavior during the Thellier experiment. Our paleointensity results show good correlation with measurements from Europe. The combined results show a trend of intensity decrease during the last few centuries. The data for the past field directions were collected from 17 archeological objects in 10 archeological sites. Their ages are estimated as the 8th century BC till the 19th century AD. The mean direction is 001°/50° (Dec./Inc.), which is nearly identical to the present direction (003°/48°). The accuracy is R= 0.979, a95= 5.2, k= 45.6. These results were compared to high-resolution coeval sediments in Ze'elim Terrace, at the Dead Sea shore. There is a good agreement between the two kinds of results. We suggest that paleomagnetic direction curves (inclination and declination) obtained in Ze'elim Terrace sediments can be used to estimate ages of archeological sites and geological units.

THE LEVANT AND SOUTHEASTERN MEDITERRANEAN LITHOSPHERIC STRUCTURE AND ISOSTATIC COMPENSATION SINCE THE PLIOCENE

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Four lithospheric layers were constructed, from top to bottom: a)the Pliocene-Recent accumulated sediments within sedimentary basins versus eroded sequences on the high continental parts; b)The sedimentary sequence; c)The crystalline crust; and d)The lithospheric mantle.

These layers were delimited by five interfaces:1)The elevation (topography and bathymetry) – adopted from available data sets; 2)The Pre-Pliocene interface –established by removing the loaded Pliocene-Recent sediments and adding the eroded contemporaneous sections from the Arabian, Sinai and African continental parts; 3)The top of the crystalline basement – based on previous low-resolution data set, which significantly improved by additional information from deep boreholes, seismic refraction profiles, and quantitative interpretation of magnetic anomalies; similarly 4)The Moho discontinuity – improved mainly by teleseismic data; 5)The lithosphere-asthenosphere boundary constructed by published petrologic evidence and teleseismic data.

For detailed isostatic calculations, the heterogeneous rock densities were distributed according to several principles. For the upper part (down to ~2 km depth) of young sedimentary basins the density is changing vertically depending on compaction formula. The layer of sedimentary sequences in the area studied has been subdivided into three main lithofacies: 1)Sandy, include predominantly continental sandstones at the southern and the southeastern part, averaging a density of 2.55 g/cm $_3$; 2)Carbonate, include predominantly marine platform carbonates mainly along the Levant continental margins, averaging a density of 2.65 g/cm $_3$;and 3)Shaly, include predominantly marine shales from the deeper part of the eastern Mediterranean basin, averaging a density of 2.4 g/cm $_3$ below the maximum compaction depth of ~2 km. Deep continental basins and Cenozoic volcanic fields were also treated in our data set. The crystalline crustal densities are gradually changing across the continental margins depending on the ratio between the upper felsic crust, which is wedging out toward the oceanic part, and the lower mafic crust.

The top layer serves as accumulated (loading)versus denuded (unloading)rock mass, since the Pliocene times, for calculating the isostasy. This allows tracking the changes in topography/bathymetry during the last 5 m.y.

UNUSUAL KARST IN A LOESS CUT OF THE HEVRON RD. AT OMER: AN EXCELLENT LOCALITY TO TEACH BEGINNING GEOLOGY STUDENTS HOW TO OBSERVE WITH CARE AND TO INTERPRET FIELD RELATIONSHIPS

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The cavities exposed in the road cut suggest enhanced erosion brought on by steepening of the slope in the course of excavation for the road bed. However, most cavities are not located at the knickpoint defining the change from original land surface to road cut, where one would expect a sharp increase in downward incision. Moreover, in many cases the cavities are sited where there is no erosion channel or only a very small one.

Apparently, the holes have formed by solution. The dissolving ground-water must have moved sub-laterally towards the road cut. At some point, as supporting sediment was dissolved away, roof-collapse occurred and the cavities appeared at the surface in the cut.
As ground-water seepage approaches the cut, gravity imposes a downward vector of seepage accompanied by further solution and collapse. Such further effects of solution lead to cavities further down the slope of the cut. The clastic material from collapse is deposited as deltas and fans where the ground-waters issue from the base of the cut. A visual estimate of the volume of sediment in the deltas and fans suggests that much of the road cut is a hollow shell suggesting near-future general collapse of the surface of the cut. The importance of solution to the formation of the cavities is indicated by the fact that the bottoms of some cavities lie below the base level represented by the ditch at the base of the cut.

The loess overlies a gravel composed mainly of Eocene chalk pebbles. In turn the gravel overlies well bedded Eocene chalks from which it was derived; moving SW the contacts between the three lithofacies appear in the cut and rise to the SW. In parallel fashion the headwalls of the cavities rise up to the SW. Clearly movement of ground-water is tied to the geometry of the loess.

Loess is wind-deposited silt; because most of the bed rock which crops out in the region is limestone the silt is dominantly composed of calcite which is soluble in rain-and ground-waters. The road cut at Omer, shaped by solution of ground-water, exhibits karst topography which is assumed only because of the steep slope of the road cut.
Away from the road cut where the land surface slopes gently solution cavities also occur and common karst topography is in process of formation.
All the features described above are readily within the ability of beginning students to comprehend and interpret after a brief introductory lecture.

LARGE EARTHQUAKES KILL CORAL REEFS AT THE NW GULF OF AQABA

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Fringing coral reefs are complex systems that record a variety of terrestrial and marine processes. We show how careful 3D examination of reefs and their environment can reveal a series of tectonic events, likely associated with destructive earthquakes. Here we combine information on coastal geology with the study of coral reefs to describe tectonic displacements and sedimentary response. The northwestern margin of the Gulf of Elat-Aqaba is our case study. We excavated a Holocene reef buried beneath clastic beach sediments, examined its morphology and collected coral samples *in-situ*. The reef morphology and the corals are preserved in pristine condition due to the sedimentary cover and its position below the sea level. Radiocarbon and uranium series dating of coral samples from the reef set the temporal framework for events.

At least two down-faulting events are recorded by the buried reef, at ~4.7ka and ~2.4ka. Following the second event the reef at the excavation site was completely buried and fossilized, and the shoreline propagated 100 m eastwards into the sea. While segments of the reef were perfectly fossilized and preserved beneath a veneer of clastic sediments, other segments were abraded, settled by nomads, and re-submerged under 4m of water. Submergence was fast as evident by the intact non-cemented archaeological structures. Hence the present shoreline was shaped by recurrent tectonic displacements followed by sediment influx events.

THE ACTIVE STRUCTURE OF THE NORTHERN DEAD SEA DEPRESSION (JERICHO-FAZA'EL VALLEY)

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The northern part of the Dead Sea depression (DSD), the Jericho-Faza'el valley, is occupied by a broad (up to 25km), asymmetric, and generally flat-bottomed valley. It is bounded on the west by faults of alternating NNE and NNW strike. This bi-modal distribution also characterizes local and regional fracture and, morpho-lineament systems, oriented arrangements of collapse sinkholes along the Dead Sea shores and earthquake focal mechanisms. The so-called "Jericho Lineament", striking 009° and previously mapped as the northwestern strand of the presumed Dead Sea pull-apart basin, have not been clearly identified as a fault in the field or in paleoseismic and seismological observations.

We investigate the fault structure in the northern DSD based on the following data: (1) Five new, E-W trending high-resolution seismic reflection lines, three focused to a depth of 3-4km and two, partly overlapping the former, to a depth of 300-400m; (2) A suite of reprocessed E-W and N-S oil-exploration seismic reflection lines; (3) 44 earthquakes of $M_L \geq 2.5$, relocated using integrated data from the Israel and Jordan seismic networks; (4) Focal mechanisms of selected seismic events using first motion polarities; (5) Previously published geological and structural maps, fracture measurements and trench data.

Our results show that the Jericho valley is bounded by two major normal-dextral fault zones striking 025°-030°, namely the Kalia-Almog faults in the south and the Nuweime fault in the north. This fault pattern is penetrative and seems to extend northward in the Faza'el, resulting in NNE-trending blocks that are bounded on the west by the NNW-trending normal boundary faults. The DSD thus extends northward from the Dead Sea into the Jericho valley, filled with at least 2.0km of apparently fluviatile and lacustrine sediments. The absence of an unambiguous fault zone in trenches crossing the 'Jericho lineament', its indistinct seismic character north of Kalia and the lack of earthquake activity along its trace, all suggest that it does not represent a distinct, let alone a major fault strand of the DST. The described block structure either occupies the entire width of the rift valley or leans against a ~N-S trending major DST branch east of the Jordan River, where seismic activity seems to disappear. In either case, this structure expresses a broad shear zone accommodating part or all of the current sinistral motion between the Israel-Sinai and Arabia plates.

THE DEAD SEA DEPRESSION: AN ACTIVE PLATE BOUNDARY SHEAR ZONE

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The ~220km long gravitational and structural Dead Sea Depression (DSD), situated along the Dead Sea Transform (DST), is centered by the Dead Sea basin *sensu strictu* (DSB), which has been described since the 1960's as a pull-apart basin over a presumed left-hand fault step. However, several observations, or their lack thereof, question this scheme, e.g. (i) It is not supported by recent seismological and geomorphic data. Specifically, it is inconsistent with the orientation of seismically active faults within the Dead Sea and Jericho Valley, e.g., the Lynch and Nuweime faults; (ii) It does not explain the fault pattern and mixed left- and right-lateral horizontal offset along the western boundary fault system; (iii) It does not simply explain the presence of intense deformation outside the presumed fault step zone; (iv) It is apparently unrelated to the symmetry of the DSD structure; (v) The length of the DSB exceeds the total offset along the Dead Sea Transform.

In this study, newly acquired and analyzed data (high resolution and petroleum seismic reflection data, earthquake relocation and fault plane solutions) in the Jericho-Faza'el valley (Shamir et al., this volume) is integrated with previously reported structural maps, fracture orientation distributions, Bouguer anomaly maps, sinkhole distributions, geomorphic lineaments, InSAR and paleomagnetic data. It is suggested that the active upper crustal manifestation of the DSD is a broad shear zone dominated by internal fault systems oriented NNE and NNW. Motion on the former system is normal-dextral, while on the latter large normal offsets accompanied by dextral as well as sinistral offsets are observed. These data are consistent with a broad shear zone, occupying the entire width of the rift valley, that accomodates the left lateral transform motion between the Arabian and African plates. Within the shear zone, dextral-normal faults, currently oriented NNE, bound blocks that have presumably rotated counterclockwise, in agreement with the axial N-S extension of the shear zone suggested by gravity data. If the rate of convergence between the two plates across the DSD is negligible relative to the rate of lateral plate offset, then the extra space thus created is sufficient to cause subsidence on the order of the width of the shear zone. This subsidence is achieved by northeastward down-faulting of the rotated blocks. This scheme, if true, may have far-reaching implications in the context of seismic hazard and oil exploration.

IS THE LARGEST FLOOD ON RECORD (8-9/9/2002) ON THE GARDON RIVER (FRANCE), INDEED THE LARGEST?

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A paleoflood study in the Gardon River in southern France reveals ancient extreme floods, larger than any historically observed flood. During the course of our study, an extreme flood on the 8-9 of September 2002 claimed the lives of 21 people, and caused millions of Euros worth of damage to the towns and villages along the river. The magnitude of this flood is larger than any known historical flood on record, and considered by the media and professionals as "The largest flood on record". An autumn storm, typical of this region struck with immense force. The rain cell migrated from the lower reaches of the basin on the evening of 8 September to the upper parts of the basin, producing 680 mm of rain in 20 hours. The flood's peak discharge is estimated at 6000 m3 sec-1. The Gardon River (1990 km2), located in the southeast of the Massif Central (C'vennes Region) is approximately 135 km long from its headwaters at 1500 m above sea level to its confluence with the Rhŭne River at 6 m above sea level. In its lower eastern reaches the Gardon River flows in a gorge incised into hard carbonate rocks. Paleoflood field research was carried out a few months prior to the flood in that gorge, downstream of Pont St. Nicolas and upstream of the famous Pont du Gard. Caves at the wall of the gorge serve as natural stage gages and trap deposits of the largest floods. In a cave +17 m above the normal base flow the highest five flood events were identified. Three of these five units were dated to AD 1400-1800 (420±40 BP to 250±40 BP), using the radiocarbon method on charcoal found within the units. The September 2002 flood reached a stage of +14 m above the normal base flow at this site, overtopping all other lower flood deposit sites but not this specific cave. Therefore, the extraordinary flood, which has just occurred, is not the largest by any mean. Similar, and even larger floods occurred a few times in the recent past. These results indicate that paleoflood studies can provide a better view on the magnitude of the largest floods that can affect a drainage basin. Using a longer time scale than the human collective memory, paleoflood studies can put in perspective the occurrences of the extreme floods that hit Europe and other parts of the world this summer. Our conclusion is that even if in some areas the floods reached magnitudes that were never experienced, witnessed or documented historically, we should be cautious claiming them to be the largest.

HIGH-ELEVATED LISAN SEDIMENTS IN THE ZIN VALLEY: WOULD A TECTONIC EFFECT BE A CAUSE OF THEIR REPLACEMENT?

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Deposits of Lake Lisan, the Late Pleistocene precursor of the Dead Sea, fill mainly the bottom of the Dead Sea rift valley. Investigations (Sheinkman, 2000, 2002) have shown that the Lisan sediments also extend as the deep invaded into the valleys running to the Dead Sea from the Eastern Negev. These sediments occur at a distance of 8-10 km from the thalweg of the Dead Sea rift valley, at altitudes 20-30 m higher than the highest findings of the same sediments in the Dead Sea rift valley.

We carried out an exploration within the former estuary of Lake Lisan in the lower Zin valley, where the Lisan lacustrine deposits are observed best of all. Our purposes were (i) to study evidences of tectonic activity in structure of Lisan sediments and bedrocks covered by these sediments, and (ii) to explain high elevation (to −130m altitudes) of these sediments by their possible vertical replacement.

Surroundings of the Dead Sea rift valley are in the active tectonic zone including the lower Zin valley. Numerous proofs of tectonic activity occur therein. The main of them are cracking and displacement of rocks. The tectonic cracks form a network, in which two directions prevail: (a) in parallel with the strikes of the main faults of the Dead Sea rift, and (b) transversely to these faults. (Just this network determines development of the valley system, when streams process the cracks and turn them into river channels). The cracks cleave through both bedrocks and deposits, including Lisan sediments. The displacements of rocks have been revealed either as vertical shifts along the cracks or as horizontal sliding along brecciated foliated layers.

We believe that the tectonic processes in the lower Zin valley are controlled to be by continued development of the Dead Sea graben. Along with sinking the bottom of the graben, some blocks within the Dead Sea surrounding, including the lower Zin valley, have been also descended. The proof is that most of the vertical shifts are of down-lifts, strikes of which are parallel to the main faults of the Dead Sea rift, whereas the horizontal sliding displays as gradual gravitation motion of bedrock blocks, which have been moved towards the thalweg of the Dead Sea rift valley. This moving is accompanied with development of brecciated foliated layers, along which the sliding has been realized.

Thus, the revealed high Lisan sediments in the Zin valley, which have been placed 20-30 m higher than the highest findings of the same sediments in the Dead Sea rift valley, may be really explained by an effect of tectonics. However, it is not a result of tectonic elevation. Quite the contrary, we suppose that the difference in altitudes between the Lisan sediments in the Zin valley and in the Dead Sea rift valley is conditioned on to be by sinking rock blocks as a result of development of the Dead Sea graben and its surrounding. The most elevating sediments in the Zin valley, within the graben surrounding, could remain in their original position whereas the same sediments downstream could be settled as a result of tectonic replacements.

TL DATING LISAN SEDIMENTS IN THE ZIN VALLEY ON THE BASIS OF DENSE SAMPLING: RESULTS, PROBLEMS AND ASPECTS

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TL dating entails intensive discussion because of occurring contradiction in TL ages. The reason is that TL dating, as a dosimetric technique, is less studied than the most reliable radiometric technique, as ^{14}C, U/Th etc. Use of the latter is however limited to be. In studies of Quaternary deposits we have no alternative to the TL method and need clear up how to lessen ambiguity of TL ages. With this aim, we have undertaken dense sampling used firstly by Frechen (1998); in Israel such an experiment was not carried out yet.

We used a section of 50m Zin terrace 2 km upstream of the Dead Sea graben escarp. 43 samples were collected from there. 10 samples were identified as the unfit for dating and 33 samples yielded TL ages shown, layer-by-layer, in the Table. These are: No 1, 2 sampled from the 3-10 m thick flood alluvium in the top of the terrace, No 3-25 sampled from the 15-25 m thick Lisan lacustrine horizon in the central part of the section, No 26-29 sampled from the 5-15 m thick coastal pebble-gravel sediments below the lacustrine horizon, and No 30-33 sampled from the 15 m thick alluvial base of the terrace.

Table

Altitude	−165 m		−168 - −170 m			−172 - −173 m		−175- −176 m		
Sample No;	1	2	3	4	5	6	7	8	9	10
TL age, Ka	31.8±6.5	27.0±3.5	19.6±2	22.5±2.2	23.2±2.3	32.6±3.3	34.0±3.6	27.1±3.2	43.2±5.8	38.4±4.6
Altitude	−177 - −178 m					−180 m		−183 m		
Sample No;	11	12	13	14	15	16	17	18	19	
TL age, Ka	39.8±5.5	24.9±3.4	31.2±3.5	31.7±5.0	32.9±5.2	40.6±4.9	47.2±3.0	38.2±4.1	29.6±2.7	
Altitude	−188 - −189 m						−190 m			
Sample No;	20	21	22	23	24	25	26	27		
TL age, Ka	40.6±4.7	42.3±3.7	40.0±3.0	30.5±2.7	44.4±3.2	39.3±3.2	33.7±4.0	35.7±4.0		
Altitude	−193 m		−198 m			−203 m				
Sample No;	28	29	30	31		32	33			
TL age, Ka	36.3±5.1	43.0.±6.1	50.3±6.3	45.8±6.3		58.4±6.8	53.8±6.7			

On the whole, the TL ages confirms belonging of the lacustrine sediments in the Zin valley to those of the highest elevation of Lake Lisan. However the experiment shows that the samples collected even close to one another in a single layer can yield significant scattering of TL ages, although the revealed TL signals from these samples are clean and undistorted. Inversions occur as in the top flood alluvium, also within the sandy-silty horizon formed under wholly homogeneous conditions in the Zin estuary of Lake Lisan.

So, the experiment demonstrates that interpretation of TL ages must be carried out very gingerly, especially in the case of rare sampling, taking into account all factors that can yield distortion of data. Dense sampling is the most progressive technique that allows us to reveal and to except age overshoots. However to solve the problem of ambiguity of TL ages entirely, we need continue the experiment and look more thoroughly into physical and geological processes that can entail distortion of TL signals in studied sediments.

HOW PHENOCRYSTS FORM IN BASIC VOLCANIC ROCKS OF MAKHTESH RAMON

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The volcanic rocks of western Makhtesh Ramon are of alkaline type, belonging to the basanite- nephelinite suite. The most common texture of the volcanic rocks in the study area is porphyritic. The phenocrysts are represented mainly by pyroxenes and olivines. The common phenocryst size is between 0.2 and 10 mm long. Some megacrysts of pyroxenes up to 10-60 mm may be found. Clinopyroxene phenocrysts are present in all types of volcanic rocks, they are represented by augite, Ti- bearing augite, titan- augite and aegirine-augite. This research presents petrographic evidence, suggesting a new mechanism, for the formation of phenocrysts in rocks. The microscopic study of basic volcanic rocks of Makhtesh Ramon permits insight into the process of growth of phenocrysts by aggregation of tiny grains and transition into large grains, accompanied by optical homogenization and formation of euhedral crystal boundaries In some cases transformation is not complete (intermediate phase) and one finds a cluster of two or more crystals enclosed in the boundary of the phenocryst. The foregoing was observed for pyroxene crystals. In summary, we view the sequence of events in formation of these phenocrysts as follows: a) Nucleation of crystals in magmatic melt. b) Grouping of initial single nuclei into aggregates. c) Modification of these anhedral aggregates into one euhedral crystal shape. d) Homogenization of these aggregates into a single crystal of unified optical orientation. e) Grouping of single crystals into larger crystal aggregates. f) Modification of these crystal aggregates into one large single phenocryst

THE GEOMORPHOLOGY OF THE NAFTALI MOUNTAIN RANGE

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The research examines the geomorphic response to tectonic activity on the western edge of the Hula Valley. The study area extends from Nahal Kedesh to Metula. Its sedimentary succession is composed of Cretaceous dolomite, limestone and chalk, as well as sandstone and clay in the lower part of the stratigraphic column. The southern segment of the study area is characterized by a N-S step fault pattern combined with a narrow horst and graben system, while the northern segment is characterized by a different NW fault system.

This study aims to analyze the geomorphological features reflecting neotectonic processes and applies various methods such as GIS based morphometric analysis, geomorphic, sedimentologic and pedologic tools, dating and geophysical methods.

Preliminary findings:

a) The measured detailed morphometric values are evidence of a young morphological landscape, similar to other values obtained for young tectonic escarpments in other parts of the world.
b) Most faults are covered by alluvial-colluvial sediments. However, a few young fault planes are exposed, partly eroded by fluvial activity.
c) It appears that the river system is diverted by the Rom Fault, as two channels are diverted approximately 200 m northward, forming sharp bends.
d) Streams flowing westward to the Duba River are characterized by wide U-shape, overfit, solutional valleys, located a short distance from the water divide. Opposite streams flowing eastward display straight, narrow, steep V-shape channels. In addition, rounded pebbles found close to the water divide indicate river capture processes.
e) At least three generations of alluvial fans are exposed throughout the southern area: ① A well consolidated unit of "nari" type composed of carbonate and chert pebbles, cemented by carbonate, is present throughout the whole area. In situ basalt pebbles were observed in three locations. ② A stratigraphically younger unit is constituted by a dense conglomerate with fine-red matrix, well cemented by carbonates. ③ A sub recent red unit composed mostly by unconsolidated gravel and red sediments covers the surface.
f) Alluvial fan relicts are found up to 300 m above the erosion base level, displaying steep gradients (30%). Relicts were also found over downthrown faulted blocks along the secondary faults.
g) "Emek Yesha", east of Kibbutz Yiftach, is controlled by a N-S fault system. Basaltic boulders and pebbles, of yet unknown origin, were observed in a limited area within the valley. These elements will be the focus of future geophysical research (GPR, seismics and magnetics).

Channels are incised on the upper part of the basin but do not reach the base level. Fluvial processes are negligible in present channels, which are partially filled with recent unconsolidated sediments. This may be evident for a low tectonic activity along the escarpment.

"REY" PATTERNS AND GEOPHYSICAL EVIDENCE FOR INTERAQUIFER FLOW IN THE GOLAN- HEIGHTS

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Recently, REY patterns (rare earth elements and yttrium) have been analyzed in groundwaters from numerous locations in the Lake Kinneret area, the Golan Heights and in the Jordan Valley (Moeller et al., Applied Geochemistry, in press). The water pumped from well Alonei HaBashan 3 was hitherto regarded as to originate from a basaltic aquifer. However, it's REY pattern is completely different from REY patterns found in waters from basaltic sources. The observed REY patterns are typical of water originating in limestones recrystallized at high temperatures generated by the overlying basalts. This is supported by geophysical evidence derived from the interpretation of a seismic profile that runs in a N-S direction along the eastern border of the Golan Heights. It occurs that the water well Alonei HaBashan 3 is located in the vicinity of a major extensional fault zone (Fig. 1). This 5 km wide graben-like feature is intensely faulted and is oriented WSW-ENE. The conspicuous thickening of the basalt above the fault zone suggests that during the time of the volcanic eruptions, the extensional zone already existed as a major structural-morphological depression into which the basalt flew. The basalt fill is in direct vertical and lateral contact with carbonates of the Eocene and the younger sediments. At a later stage, the two major controlling faults were rejuvenated displacing also the basalts.

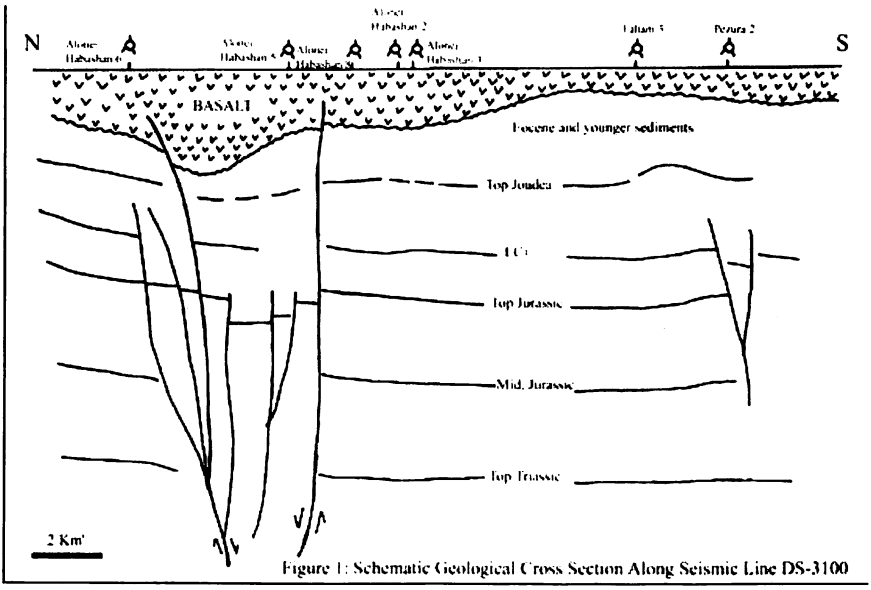

Figure 1: Schematic Geological Cross Section Along Seismic Line DS-3100

THE HIDE AND SEEK GAME BETWEEN GEOLOGICAL FACTORS AND GROUNDWATER FLOW IN THE JERICHO FAZAEL REGION

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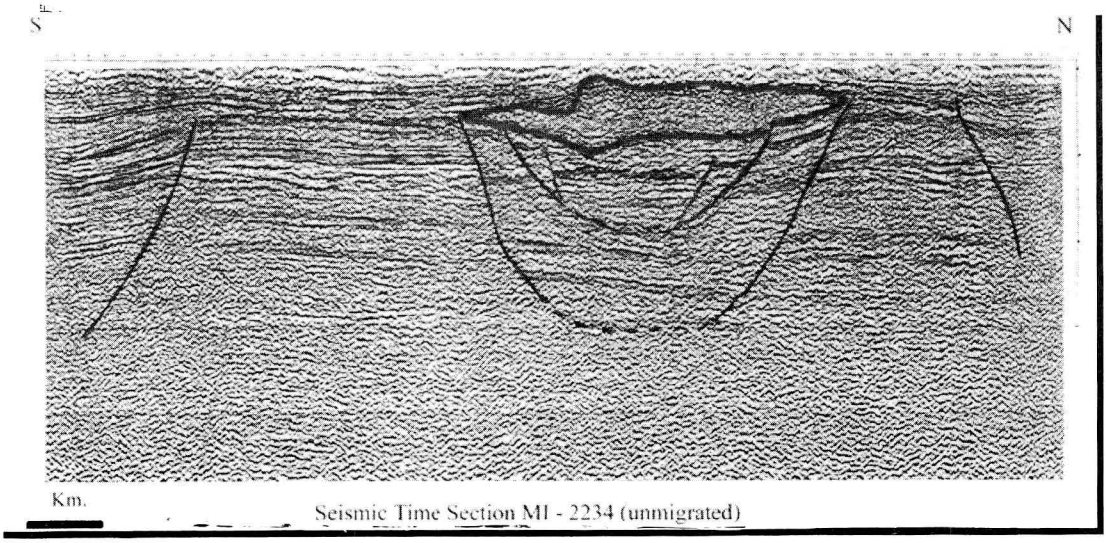
The geology of the Central Jordan Valley in the study area is ambiguous. Interpretation of available seismic sections reveals several conspicuous structural and stratigraphic features, which are of considerable hydrological importance. The Judea Group aquifer is encountered at relatively shallow depth, which varies from a few hundred meters east of the Cretaceous outcrops to more then 1000 m in the east close to the Jordan River. Several east stepping fault blocks were encountered in the area. Some of these faults exhibit elements of "flower structure" at the Judea Group level, suggesting also lateral displacement. A lenticular shaped sedimentary body was deposited within a structural depression located east of Auja. The analysis of seismic evidence suggests that this 10 Km long and 700 m thick body is probably composed of interbedded evaporites and clays and thickens eastwards. The results of this study are in good agreement with the study of Kashai and Crocker (1987) as well as preliminary seismic interpretation done in Jordan (El Zoubi, personal communication). The inferred existence of the salt body matches the occurrence of Zaarat Qurein salt diapir (Belitzky and Mimran, 1996). The interpreted structural and stratigraphic features enable better evaluation of the hydrological regime and salinization processes.



Seismic Time Section MI - 2234 (unmigrated)

NATIONAL PHOSPHORITE RESOURCES: GEOLOGICAL INVENTORY AND PERSPECTIVES FOR THE FUTURE

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Phosphorites of potential economic value occur in Israel in three main geographic areas: 1) in the northeastern Negev, 2) along the northern 'Arava margins, and 3) in central Negev (southern edges of Ramon high). This localized distribution of economic phosphorite rocks in the Negev space is in direct response to the structural configuration and the sedimentation patterns that prevailed in this region during the late Campanian. The main factor behind the production of economic phosphates is the rate of sedimentation (i.e., the rate of sediment burial). Among others, this controls 1) the redox conditions of organic matter (OM) decomposition and, as a result, the relative proportions of carbonate-fluroapatite (CFA) and carbonate precipitated in bottom sediments, 2) the chemical composition of the CFA phase, 3) the formation of CFA-coated inter-granular microbial matrices in sediments, and 4) the extent of secondary concentration of previously-formed ("primary") CFA particles to produce phosphorite beds. As a result of different sedimentation rates, the phosphate sections in the three geographic Negev areas quite differ in their sediment composition as well as in P enrichment of the phosphorites.

As a rule, the economic Negev phosphate beds are restricted to the uppermost part ("Phosphorite unit") of the Phosphate Member of the Mishash Formation. While this is the case in most of the phosphate deposits situated in basinal ("synclinal") Mishash settings, economic phosphorite beds are locally also represented in lower parts of the Phosphate Member when approaching the Campanian highs (condensed Mishash sections). By now, more than 30 phosphate deposits (not all economic) are known in the Negev. Most richest in general, and the only mined today, are the phosphate deposits of northern Negev. The commercial (geological) phosphate reserves in this area are presently estimated to some 350 Mt, allowing 25- 45 years of exploitation at the today mining rate (about 8 Mt/yr). In addition, about 300 - 350 Mt of bituminous/non commercial phosphate rocks also occur in this area. The phosphate resources along the 'Arava margins amount to some 140 Mt. Because of rapid lateral variations of the phosphate section in this area, only part of this phosphate amount is considered as potentially economic. In central Negev, at least 350 Mt of phosphorites have been evidenced, part of them bituminous and with a relatively low P content. Although displaying common lateral compositional changes, this area remains quite attractive because of its wide areal extension. As part of the phosphate-bearing areas of the Negev are also destined to other uses, a rational planning is required to save up most of the national, potentially economic phosphate resources for exploitation in future times.

CONTROLLING FACTORS IN THE GEOCHEMISTRY OF THE NEGEV PHOSPHORITES: CLARIFYING THE RULES OF THE GAME

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Research on the geochemistry of Mishash phosphorites during the last years, combining electron probe measurements, FTIR spectroscopy, wet chemistry and mineralogical analyses, enabled us to better understand the factors constraining the chemistry of these rocks and its variations in space. Two main geochemical phosphorite facies featuring two separated stages in phosphogenesis are differentiated in the Mishash sequence: 1) a pristine, microbially generated, P-poor phosphorite facies, more preserved in basinal sections, and 2) a recycled (reworked), amalgamated phosphorite facies, predominant in condensed sections near the Campanian highs and forming most of the economic phosphorites. The distribution of the U(IV) fraction, Cd, Zn, F/P_2O5, CO_2/F, Y, as well as REEs including Ce (Ce/Ce*) and Eu (Eu/Eu*) anomalies and HREE enrichment, is closely regulated by these two facies. The F/P_2O_5 ratio is much lower (0.090-0.107) in the pristine than in the recycled facies (0.107-0.120), and F deficient francolites (CFA) with F/P_2O_5 ratios as low as 0.80 (lower than the stoichiometric ratio in fluorapatite) are commonly found in the pristine facies. In addition, the lower F/P_2O_5 in the pristine facies is coupled with a higher Cd and Zn concentration, a considerably reduced U(IV) fraction, lower REE/P_2O_5 and Y/P_2O_5 ratios, less negative Ce and Eu anomalies, a lower HREE (Dy-Er) enrichment, an increase in Fe-rich smectites in the clay fraction, and a presence of structural OH in CFA. These geochemical trends in the two Negev phosphorite facies may be explained by varying time-spans of CFA growth, changes in sediment burial rates, and principally, by different residence times of the phosphate phase in the suboxic, diagenetic zone near the sediment – water interface where CFA precipitates. Transit of the CFA phase from the pristine state to the recycled state is associated with: 1) entry of more F, CO_2, and U(IV) in the CFA lattice, 2) oxidation and removal of sulfide bound Cd and Zn, and 3) uptake of more REE and Y. Considering the response of the Mishash section to the Campanian structure, these results enable us to make some predictions as to the chemical composition of the Mishash phosphorites across the Negev depositional space.

A STATISTICALLY SIGNIFICANT RELATION BETWEEN RN FLUX AND EARTHQUAKES IN THE DEAD SEA RIFT (DSR) VALLEY

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Detailed monitoring of Rn flux in gravel was carried out for a period of 8 years near the active Dead Sea Rift fault. The temporal relationship between hundreds of weak earthquakes ($4.6 \geq M_L \geq 0$) and Rn flux was tested for 110 Rn flux signals with relative amplitude >1.9. Earthquakes located within the DSR pull-apart grabens (Dead Sea, Kinneret and Hula) preferentially occur within the first 3.5 days after the start-time of these Rn anomalies. The excess of earthquakes (67% relative to the expected value) is highly significant (χ^2 =13.71; p=0.02%). This result is a first demonstration of a statistically significant relationship between Rn flux and earthquakes. A similar relationship is not found for 3 weeks preceding and following this time interval, and is also not found for earthquakes occurring out of the DSR or between the DSR pull-apart grabens.

We propose that movement along the DSR episodically deforms the DSR tectonic blocks. At a certain deformation level a source rock may emanate Rn at the NW Dead Sea, and/or affect the upward transfer rate of Rn, by up-flowing carrier gas. As the overall deformation continues, further strain may either result in a-seismic slip, or else it may exceed the failure threshold somewhere within the DSR grabens, so that an earthquake occurs there few days after the generation of a Rn anomaly in the Dead Sea area. On the other hand, some earthquakes occur in the DSR Valley as a result of strains that are not recorded as Rn anomalies at the NW Dead Sea. Hence, although the results show that Rn flux in the Dead Sea can be considered a sensitive indicator of changes in the local crustal stress, only a statistical connection is to be expected between Rn anomalies recorded at the NW Dead Sea and earthquakes that occur in the DSR Valley. At this stage of research, this high sensitivity prevents the use of variations in radon flux as predictors of earthquakes, but the study opens a way to progress in this direction.

MANGANO-SIDERITE (OLIGONITE) AND RHODOCHROSITE IN THE HYDROTHERMAL SEDIMENTS OF ATLANTIS II DEEP, RED SEA

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Siderite – oligonite - rhodochrosite $(Fe,Mn,Ca,Mg)CO_3$, a solid solution of four major components from the hydrothermal sediments of Atlantis II Deep, was studied in samples collected from the SW basin and the SW passage. Usually it appears as a mono-mineralic thin layer, slightly admixed with clay minerals, short range ordered round particles, goethite and halite.

The euhedral to subhedral, 2-3 μ crystals, often form clusters. Point analyses using HRTEM yielded the following results: $0.17<Mn/Fe<0.21$, $0.04<Ca/Fe<0.13$ and $0<Mg/Fe<0.09$ with variation within and between the crystals in Mn-siderite, and Fe/Mn=0.05, Ca/Mn=0.11 and Mg/Mn=0.05 in rhodochrosite.

The phase studied is a solid solution with 4 components (siderite, rhodochrosite, calcite and magnesite) that crystallize in the same space group and form an inhomogeneous solid solution. Siderite is usually the major component, whereas rhodochrosite, calcite and magnesite are minor. Since cell parameters of calcite and magnesite differ significantly from those of siderite and rhodochrosite, diffraction patterns are mainly shifted by Ca phase concentration, than by that of iron concentration. Thus unit cell parameters reach values close to those of rhodochrosite.

The samples can be grouped into two main subgroups, based on their oxygen and carbon isotopic composition. The first group, from the lithostratigraphic Central Oxidic /Central Oxidic Sulfidic zone (CO/COS) has $\delta^{13}C$(PDB) values of –3.8‰ - –4.26‰, and $\delta^{18}O$(SMOW) ranges between 30.5‰ and 28.9‰. $\delta^{13}C$(PDB) values of the second group of samples from the Detritic Pyritic Zone (DOP), Lower Sulfidic (SU1) and uppermost Amorphous Silicate (Am) zone, are slightly lighter than Red Sea Deep Water, and their $\delta^{18}O$(SMOW) ranges between 30.5‰ and 28.5‰, indicating crystallization under elevated temperatures. These data suggest that Fe^{2+} originate from the lower brine, whereas the Red Sea Deep Water is probably a principle contributor of the carbonate phase.

TECTONIC CONTROL OF PETROLEUM GENERATION FROM UPPER CRETACEOUS (SENONIAN) SOURCE ROCKS IN THE MIDDLE EAST AND NORTH AFRICA

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Organic-rich carbonates have been recognized as major hydrocarbon source rocks in many prolific basins. The present study focuses on the Upper Cretaceous (mostly Senonian) sequence in the Middle East and North Africa. These Senonian bituminous rocks (SBR) mainly include carbonates but also phosphorites and siliceous rocks (C-P- Si association) deposited along the southern margins of the Tethys Ocean. The bottom conditions were dysoxic to anoxic, resulting in accumulation of abundant marine sapropelic organic matter with organic carbon values as high as 20 wt%. The SBR kerogen is sulfur-rich (type II-S), tending to generate oil in early stages of maturation. The related oils are characterized by Pr/Ph ratio of less than 1, predominance of n-alkanes with even carbon numbers, high concentration of tricyclic terpanes and high concentrations of C35 hopane and gammacerane. Thick sedimentary sections (occasionally >1000m) are found where syntectonic deposition of SBR took place in basins developed in response to the ongoing Late Cretaceous collision between the African and the Eurasian plates (Fig 1). Most of the SBR in the study area are immature due to shallow burial. However, where significant Tertiary tectonics occurred, oil generation and accumulation is evident. Three tectonic settings that control oil generation in the region are distinguished: 1) Late Cretaceous grabens (e.g., Sirt basin in Libya, Euphrates graben in Syria and Azark basin in Jordan), with thick SBR sections, where continued subsidence during Tertiary provided the necessary overburden for maturation, 2) Plate collision zone (Taurus Thrust Belt, southeast Turkey) where SBR, deposited in foreland basin, is deeply buried under thrust sheets, and 3) Fast SBR burial in Neogene grabens (e.g., Gulf of Suez, Egypt and Dead Sea basin, Israel and Jordan) formed subsequent to the Arabian plate northward migration and the opening of the Red Sea. The Dead Sea basin is presented as a case study of this type of tectonic setting. It is a small pull-apart basin, located along a left-lateral transform boundary, the Dead Sea rift, between the Arabian and Sinai plates. The basin formed at about 15 Ma, but major subsidence took place in the last 4 m.y. Hydrocarbons in various forms (gas, oil, asphalts) were encountered in beds ranging from Paleozoic to Recent. Correlation studies, including products from hydrous pyrolysis experiments, clearly established the SBR as the source for these hydrocarbons. A unique aspect of the basin is that the combination of fast SBR burial to great depths (<10 Km), with the labile, sulfur-rich kerogen, gave rise to early oil generation and to an exceptionally short-lived oil window (several hundred thousands of years).

MICA BO GEOBAROMETRIC STUDIES FROM THE PHYLLITE-QUARTZITE UNIT IN EASTERN CRETE.

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The *bo* value, the b cell parameter in potassium micas, can be used as an empirical barometer, *bo* values rise; as a function of the amount of Fe and Mg in the octahedral sites. Muscovite lacking Fe and Mg is replaced by phengite in high pressure regimes. Measurements of the 060 reflection are done using X-ray powder diffraction. This technique has been established for greenschist facies and for "high grade anchizone" conditions. This work expands the method to sub-blueschist facies conditions.

Meaningful results require the samples to have similar chemical bulk compositions. The 47 samples taken in Eastern Crete comprise three mineral assemblages: 11 are illite-albite, 22 are illite-paragonite (Na-rich) and 14 are illite-pyrophyllite ± paragonite (Al-rich). The illite-albite assemblage gives average *bo* values of 9.028 ± 0.011Å, fitting the H*P*/L*T* gradient established for the study area from metamorphic mineralogy. The Na-rich assemblage has *bo* values which span though much of the *bo* range reported in the literature, 9.013 ± 0.016Å. This is thought to represent two cooling regimes as reported by Jolivet *et al.* (1996) based on extent of carpholite preservation. A very fast cooling regime, in which most of the cooling occurs at relatively high pressure, and a slower cooling regime, where the rocks were initially isothermally decompressed and were finally cooled at low pressures, giving lower *bo* values. Ten Na-rich samples from fast cooling rate locations gave *bo* values of 9.023 ± 0.016Å, representing H*P*/L*T* gradients. Sixteen Na-rich samples from locations reported to be of a slower cooling rate gave values of 9.002 ± 0.009Å, representing Barrovian, almost L*P*/H*T* gradients. The Al-rich samples all derive from the "slower cooling" areas and give very low *bo* values of 8.998 ± 0.009Å.

$\delta^{34}S$ IN GYPSUM AS A LIMNOLOGICAL TRACER OF LAKE LISAN

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The Lisan Fm. deposited by the Late Pleistocene Lake Lisan (~70-14 kyr B.P.) comprises alternating laminae of aragonite and detritus (termed *aad*), gypsum layers and clastic units. Here, we use the isotope composition of gypsum (expressed by $\delta^{34}S$) to constrain the conditions of gypsum precipitation and reconstruct the limnological history of the lake in terms of configuration and redox-conditions.

Samples were collected in several exposures of the Lisan Fm. at the Dead Sea basin: Bet-Ha'Arava, Mishmar Valley, Massada and Perazim Valley. Two major gypsum units were studied: The "Three Gypsum Unit", which tops the Lower Member of the formation, and the "Upper Gypsum Unit", which tops the Upper Member. Both units can be followed over large geographical distances in the basin.

The two major gypsum units were deposited after several thousands years of positive water balance when the lake developed stratified configuration and deposited mainly sequences of *aad*. The gypsum deposition followed drastic level regression events occurring at 56 and 17 kyr B.P. respectively. Each of the main gypsum units yielded distinct $\delta^{34}S$ values. The "Three Gypsum Unit" shows $\delta^{34}S$ = 17-20‰, while the "Upper Gypsum Unit" displays significantly higher values of $\delta^{34}S$ = 26-28‰. Variations are noticed within the units. The "Three Gypsum Unit" comprises massive gypsum sandwiched between lower and upper laminated sequences. A slight increase in the $\delta^{34}S$ values exists from the bottom of the lower laminated sequence towards the middle massive gypsum.

The $\delta^{34}S$ values in the lake are dictated by the composition of sulfate that enters the lake and exchange between the lower and upper water layers. Microbial activity in the reduced lower layer of the lake transformed sulfate to sulfide, leading to significant isotopic fractionation and the build up of heavy $\delta^{34}S$ values.

The trend of $\delta^{34}S$ increase in the Three Gypsum Units can reflect a gradual mixing of the upper water layer ($\delta^{34}S$ lighter) with the lower layer ($\delta^{34}S$ heavier) during lake fall and overturn event. The significantly more heavier $\delta^{34}S$ values in the Upper Gypsum Unit probably reflect the long isolation time of the lower brine during the high stand of the lake (prior to the gypsum deposition).

Lateral uniformity (over the size of the Dead Sea basin) of $\delta^{34}S$ values in the major gypsum units indicates homogeneity of the water body. Yet, somewhat lower $\delta^{34}S$ at the Bet-Ha'Arava section point to enhanced contribution of fresh water in the mixture.

STABILITY OF UNDERGROUND OPENINGS IN STRATIFIED AND JOINTED ROCK MASS – A NUMERIC APPROACH USING DISCONTINUOUS DEFORMATION ANALYSIS (DDA)

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Most rock masses contain discontinuities such as bedding planes, joints, and shear zones. At shallow depths where stresses are low, the behavior of the rock mass movements are controlled by sliding on the discontinuities. A realistic stability analysis in such a rock mass should account therefore both for geometrical and mechanical properties of these discontinuities. The analysis of underground opening stability in stratified and jointed rock masses is complicated by the absence of analytical solution for the interaction of rock blocks. Classical methods for assessing the stability of underground openings in discontinuous rock mass are consequently either observational or semi-analytical. The observational methods lack a mechanistic basis, while the semi-analytical solution is limited to interactions of only two blocks. It is therefore necessary to use numeric methods for a realistic stability analysis. The presence of a large number of discontinuities, and the requirement for large displacements degrade the accuracy of continuum – based numerical methods, such as the Finite Element Method (FEM), and limit the applicability of these methods for the stability analysis of multi-block rock structures. For such cases a discrete approach is more suitable. Discontinuous Deformation Analysis (DDA), a novel method of the Discrete Element Method (DEM), satisfies both conditions. DDA, a displacement based method, incorporates dynamics, kinematics, and deformability of the rock, and models the displacements of individual blocks within the rock mass using a time step marching scheme.

The stability of an ancient water reservoir at Tel Beer-Sheva (1000 B.C.) excavated in a sedimentary rock of blocky structure (Ghareb Formation) is studied using DDA. The numeric solution is compared with the semi-analytical Voussoir solution. The influence of joint geometryl and mechanical properties is investigated, and different failure modes are described. DDA stability analysis is compared with Terzaghi's classical observations (Terzaghi, 1946), and the results are applied to field observations.

THE BOUNDARY SHIFT OF SAHARO-ARABIAN DESERT BELT INTHE EASTERN MEDITERRANEAN DURING THE PLEISTOCENE AS EVIDENT FROM SPELEOTHEMS

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The vast expansion of the Sahara desert to the south during the last glacial maximum, the increased humidity of Sahara region during the Early Holocene, and the aridification of the Sahara during the last 4000 years were most probably caused by changes in the summer monsoon intensity. However, little is known on the migration of the northern boundary of Saharo-Arabian desert belt in the Eastern Mediterranean region. Periods of speleothem growth allow us to determine when enough water reached the unsaturated zone. Previous studies on speleothem growth from Ma'ale Efrayim cave located in the present-day "rain-shadow"of the eastern flanks of the central mountain ridge, showed that deposition occurred only during cool pluvial marine isotopic stages (Vaks et al, 2003, Quaternary Research). Moreover, their oxygen and carbon isotopic composition showed that during these periods the climate conditions on the western and the eastern side of the central mountain ridge were similar, indicating that the "rain shadow" effect developed during warm interglacial conditions. Whereas speleothem growth in Ma'ale Efrayim cave is indicative of climatic variations in the Mediterranean rain shadow zone, speleothem deposition in caves from the Negev desert reflect changes in the location of the northern part of a much larger desert, the Saharo-Arabian desert belt. The large number of speleothems found in Negev caves show that the region was more humid in the past. The top sections of fifty-six speleothems were dated using 230Th-U method by means of alpha spectroscopy. Their ages are indicative to the last period when water reached the unsaturated zone in the cave area. They were collected from seven caves from various locations: the ridge crests in the northern Negev, caves from the "rain-shadow" area of NE Negev, and caves from the central Negev. The caves are almost completely dry with no speleothem formation today. One speleothem from the central Negev was dated to 111 ± 9 ka, whereas the others were older than the limit of the dating method (about 300 ka). The ages of four speleothems from caves in the "rain shadow" region are 110 -195 ka (marine isotopic stages 5 and 6) and the ages of other five are older than 220 ka. The ages of fifteen speleothems from the northern Negev ridge crests are 6 - 75 ka (early Holocene and marine isotopic glacial stages 2 - 4), eight other speleothems were dated to be from 110 ka and older. Thus, our preliminary results show that the last time wetter conditions prevailed in the northern Negev was during last glacial, followed by a short early Holocene moist phase. However, in the central Negev and the "rain-shadow" region of the NE Negev, the most recent wetter conditions occurred during early marine isotope stage 5.

GEOCHAMICAL AND ISOTOPIC MAPPING OF GROUNDWATER IN THE COASTAL AQUIFER: THE INFLUENCE OF ARTIFICIAL RECHARGE ON THE WATER QUALITY

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Artificial recharge of imported water into depleted aquifers is one of the important remediation mechanisms for compensating water deficit and a long-term storage. While water balance can be deduced from known volumes of recharge, the water-quality changes that are induced by the artificial recharge are often neglected. Here we examine the impact of recharged water on the quality of groundwater by using geochemical investigation. Systematic analyses of the chemical (Cl, B, Br) and isotopic (O, H) compositions of more than 400 pumping wells in the Mediterranean coastal aquifer of Israel enabled us to distinguish between the recharge water (Sea of Galilee; $\delta^{18}O$=-1‰; Br/Cl=3x10^{-3}) and the regional groundwater ($\delta^{18}O$=-4 to -5‰; Br/Cl≥1.5x10^{-3}). We also detected the impact of wastewater ($\delta^{18}O$>-4‰; Br/Cl~1x10^{-3}; B/Cl≥x10^{-3}) and saline groundwater ($\delta^{18}O$<-4‰; Br/Cl~1.5x10^{-3}) in the aquifer. We used the $\delta^{18}O$ distribution in the aquifer to reconstruct the flow paths and mixing relationships of the recharged water in the aquifer. The geochemical data show that the rate of salinization particularly in the eastern part of the coastal aquifer has been decreased due to extensive recharge (accumulated volume of 280 x10^{6} m^{3} in Zohar site) of imported water.

TRACING SALINITY SOURCES IN THE SOUTHERN COASTAL AQUIFER AND THE GAZA STRIP

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The southern Mediterranean coastal aquifer is a transboundary aquifer and is suffering from a severe water quality crisis that endangers future exploitation for a population of over one million living in the Gaza Strip. The most conspicuous phenomena for water quality degradation are the ongoing salinization coupled with boron and nitrate pollution. In the framework of the European research project BOREMED, co-financed by the EU, geochemical and isotopic (B, Sr, O) investigation of groundwater were conducted in the southern coastal aquifer of Israel and the Gaza Strip in order to reveal the sources and mechanisms of salinization. Our data show that the saline groundwater emerges from the Eocene aquitard (Na/Cl~0.86; 87Sr/86Sr ~0.70797) is mixed with Na-HCO3-SO4 boron-enriched saline groundwater (Na/Cl>1; 87Sr/86Sr~0.70802 to 0.70819; B/Cl~9x10-3; d11B~46-48‰). Mass-balance calculations indicate that base- exchange reactions, coupled with carbonate and gypsum dissolution, have formed the Na- and B-rich groundwater. It seems that these reactions took place in the loess deposits. This saline groundwater is the major salinity source in the Gaza Strip as groundwater flow rates have been accelerated due to over-exploitation and formation of deep hydrological depressions within the Gaza Strip. This is reflected by the chemical composition of most of the saline groundwater located in the eastern and central parts of the Gaza Strip. Nitrate pollution in the Gaza Strip is associated with increase of Ca2+ and 87Sr/86Sr ratios (0.70815 to 0.70875), implying that nitrification process induces dissolution of the carbonate matrix of the aquifer. Since the source of the salinity in the southern coastal aquifer is natural, future salinization in the aquifer is inevitable. Groundwater is, however, the only source of water in the Gaza Strip. Future joint management should therefore focused on regional plan of reducing the eastern saline groundwater flow towards the Gaza Strip and use the saline water as an alternative source for desalination.

NE-TRENDING MULTI-LAYER JOINTS AS POSSIBLE WAYS OF THE UNDERGROUND WATER MOTION FROM RAMAT HOVAV TO BEER-SHEVA

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It is suggested (Rophe et al., 1992; Bahat, Adar, 1993; Livshitz, 1999) that the underground water motion in the aquifer Avedat (Lower and Middle Eocene Chalks) occurs mainly along multi-layer joints, which in contrast to single-layer joints slice a number of beds (Bahat,1988;1991). By recognizing that multi-layer joints are best suited to underground water motion in this aquifer and, specifically, to the underground space between Ramat Hovav and Beer-Sheva, we have investigated the orientation of the multi-layer joints in Beer-Sheva- Ramat Hovav area. We have investigated joints in outcrops and also lineaments (on the topographic map of 1:50,000 scale), assuming that they are appropriate to joints direction. The lineaments have been measured on the area between Beer-Sheva valley and the wadi Seker (zone Ramat Hovav). Those are the straight lengths of the temporary streams channels, straight lengths of the wadies and the Beer-Sheva channel. Summary rose-diagram of the lineaments reflects dominating role of the NE-trending lineaments. The directions 20-25°, 45-55° and 70-75° are most characteristic. The maximum coincides with 50-55° interval.

A correlation with the results of the field investigation of joints in the Ramot district of Beer-Sheva (multi-layer joints are oriented as following: 40°, 50°, 52°, 53°, 55°) suggests that NE-trending lineaments (45-50°, and particularly 50-55°) in many cases are likely to be reflect the position of the multi-layer joints, that is, such joints that could be the ways of underground water motion. It is possible that some NW-trending lineaments are also the indicators of the multi-layer joints in the NNW (340-350°) joint system (Eyal,1996). Such joints are observed, specifically, in the marlstones of the Sheva Fm in the Beer-Sheva Great Quarry.

From the above, it might be assumed that there are real ways of underground water motion from Ramat Hovav to Beer-Sheva. It seems likely that direction of the underground water motion is dictated primarily by structural factors (see Rophe et al., 1992), as for instance in the Judea, where the underground water flow direction deviates considerably from general direction of the hydrological gradient (Laronne, Gvirtzman, 2002). Supposedly, motion of the underground water in the Beer- Sheva- Ramat Hovav area proceeds in zigzag fashion, mainly, along NE-trending (45-55°) and NW-trending joints extended both horizontal and vertical. It is believed that one of the most real ways of the underground water penetration from Ramat Hovav to Beer-Sheva lies initially in a WNW direction, along wadi Seker, then in NE direction, along wadi Shairim, and next through zones with reduced level of the water-table toward Beer-Sheva.

THE FALL OF LAKE SAMRA AND RISE OF LAKE LISAN: THE TRANSITION BETWEEN THE LAST INTERGLACIAL TO THE LAST GLACIAL PERIODS IN THE DEAD SEA BASIN

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During the Quaternary several lakes occupied the tectonic depressions along the Dead Sea Rift valley. The lakes were developed on the ancient Sedom brine and their dilution by freshwater input and their level changes reflect the hydrological history of the region that evolved through arid and semi-arid conditions. Here, we describe the fall of Lake Samra and the rise of Lake Lisan that accompanied the transition from the last Interglacial to Glacial periods at ~ 70 kyr (MIS5 to MIS4). Both lakes extended during their highest stands over the entire Dead Sea-Jordan Valley and approached elevation of > 160 m below mean sea level (M.S.L.). Upon the MIS5 termination, Lake Samra shrunk to the elevation of the present Dead Sea (< 420 m below M.S.L.). The high stands of Lake Samra are characterized by deposition of laminated aragonites, which reflect the interaction between the freshwater (which brings alkalinity to the lake) and the brine. The extreme low stand is characterized by appearance of erosional channels and sinkholes, thick clastic units, sands and travertines. The clastic sequence and the erosional features represent a time interval of ~10 kyr (the difference between U-Th ages of aragonite laminae beneath and above the sequence). The clastic sequence overlies calcitic marls and laminae of calcite and detritus. It appears that during its extreme shrinkage the lake became a fresh water-body that precipitates calcite. The deposition of aragonite resumed only upon the rise of Lake Lisan. Thus, the transition between lakes Samra and Lisan saw a dramatic change in the limnology and chemistry of the water-body as well as in the morphological characteristics of the shoreline. Similar processes occur today on the retreating and collapsing shores of the Dead Sea.

CHEMICAL TRANSFORMATION OF LAKES IN THE DEAD SEA BASIN: THE FALL OF LAKE SAMRA AND RISE AND RISE OF LAKE LISAN UPON THE TRANSITION FROM THE LAST INTERGLACIAL TO THE LAST GLACIAL PERIODS

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During the Quaternary several lakes occupied the tectonic depressions along the Dead Sea Rift valley. The lakes were developed from the ancient Sedom brine by dilution with freshwater input. Lake level changes reflect the hydrological history of the region that evolved through arid and semi-arid conditions. Here, we describe the fall of Lake Samra and the rise of Lake Lisan that accompanied the transition from the last Interglacial to Glacial periods at ~ 80-70 kyr (MIS5 to MIS4). During highest stands both lakes extended over the entire Dead Sea- Jordan Valley and approached elevations of approximately 160 m (Lake Lisan) below mean sea level (M.S.L.), or even higher (Lake Samra). Upon MIS5 termination, Lake Samra shrunk below the elevation of the present Dead Sea (approximately 415 m below M.S.L.). The high stands of Lake Samra are characterized by deposition of laminated aragonites, which reflect the interaction between the freshwater and the brine. The extreme low stand, which extended over ~ 10 kyr is characterized by appearance of erosional channels and sinkholes, thick clastic units, sands and travertines. The clastic sequence overlies marl layers and laminae of calcite and detritus. It appears that during its extreme shrinkage the lake became a fresh water-body that precipitates calcite instead of previously precipitated aragonite. The deposition of aragonite resumed only upon the rise of Lake Lisan. Thus, the transition between lakes Samra and Lisan saw a dramatic change in the limnology and chemistry of the water- body as well as in the morphological characteristics of the shoreline. Similar processes occur today on the retreating and collapsing shores of the Dead Sea.

MISLIYA CAVE, MOUNT CARMEL: CHANGES IN SITE CONFIGURATION DURING THE LAST CA. 300,000 YEARS

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Misliya Cave, Mount Carmel, Israel, contains a rich Middle Paleolithic (defined as "Tabun D-type" Mousterian) faunal and lithic assemblage. Archaeological deposits extend over a fairly large area and go down to an equally promising depth. Bones, transported principally by the site's inhabitants, appear to be well preserved and some spatial differentiation in both lithic and faunal assemblages could be demonstrated. Significant, furthermore, is the occurrence of Lower Paleolithic (Acheulo-Yabrudian) stratified layers. Today the site appears as a rock shelter or overhang, carved within a rudistic reef. Strongly cemented archaeological sediments (breccia), appearing in three topographical terrace-like surfaces, extend from the base of the cliff westward, to a distance of ca. 35 m.

Different lines of data suggest that Misliya is a collapsed cave that had undergone major changes in its configuration, most likely related to the collapse and subsequent regression of the cave's ceiling and enclosing walls. These include: various states of breccia consolidation related to possible differential durations of exposure; large rocks along the northern part of the slope and especially within the breccia constitute evidence for previous rock falls, which may account for an eastward movement of the cliff; pieces of fallen speleothems occasionally occur within the archaeological breccia, suggesting episodes of increased humidity; the general form of the site, together with the bell-shaped configuration of the remnants of the enclosing walls of the Upper Terrace, is also suggestive of a former, more delimited, cave; considerable parts of the reefal cliff at Misliya are covered by flowstones, whose deposition is indicative of a vadose regime; water is still dripping in places suggesting that karstic processes remain active.

A luminescence date (130±33 ka) for the most recent breccia is a minimum age due to signal saturation. U-series dating of the stalagmites may provide some idea regarding previous episodes of speleothem formation. The tentative dating of the sequence is based on absolute dating of comparable cultural units in other Levantine sites.

In summary, location of brecciated layers, the incorporated blocks and speleothems, the dating of various features, and the configuration of the enclosing walls suggest a gradual step-wise recess of the cave's ceiling. Results of this study may enable conclusions regarding formation and depositional processes at the site, and the length and duration of its occupation.

NANOSEISMIC MONITORING AND ANALYSIS OF EXTREMELY LOW-ENERGY SIGNALS ASSOCIATED WITH SUBSURFACE MATERIAL FAILURES IN THE DEAD SEA AREA

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The sudden failure of near-surface cavities resulting in the development of sinkholes along the shores of the Dead Sea is a recent hazard affecting the populations, lifelines and the economy of the region. A series of new techniques have been developed in order to allow for the continuous nanoseismic monitoring and analysis of these subsurface processes. This innovative approach integrates Seismic Navigation Systems (SNS) together with the SparseNet modules for interactive and automated seismogram analysis (Joswig, 1999), originally designed for seismic discrimination purposes.

The detection of extremely low-energy signals triggered by material failure occurring in highly layered but inhomogeneous unconsolidated material at a reasonable distance (dozens to hundreds of meters) is not a trivial undertaking. In order to locate extremely low-energy signals under such conditions, it is necessary to down-scale techniques previously developed for the analysis of local seismic events. This down-scaling process poses a series of seismological challenges, mainly:

- The high level of background noise masks the onset of the events, thereby making their precise detection impossible or at best inaccurate.
- The high diversity of the transfer function alters the recorded waveform so significantly that event coincidence is difficult to establish.
- The extreme complexity of the medium induces intense signal scattering and emergent waveforms that prevent the detection of clear phase onset and obscures part of the source parameters.
- The very low-energy nanoseismic signals have to be calibrated to suit existing magnitude scales designed for events that are orders of magnitude stronger.

Setting the sensors into mini-array geometry and consequently processing waveforms by array methods has met the first challenge. The learning dynamics and openness of the pattern recognition modules of SparseNet allow for the most unconventional events to be matched and associated with a unique set of similar source parameters, addressing the second issue. The use of Power Spectral Density maps, identifying clear first phase onsets allows for a meter-accurate location of the event, for signal characterization as well as for source parameters identification despite the low quality of the waveform, thus providing a solution to the third problem. Redesigning and adapting the existing M_L scale to very low magnitudes have overcome the final obstacle.

EFFECTS OF BASE (LAKE) LEVEL CHANGES ON RELATED GROUNDWATER SYSTEMS – CASE STUDY OF THE DEAD SEA

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The effects of changes in base (sea) level on related groundwater systems was studied in the Dead Sea area, using FEFLOW and SUTRA groundwater modeling codes. Regional scale simulations, from the Dead Sea to the water divide in the Judean Mountains, were conducted using the FEFLOW code. In addition, smaller scale (1-2 km from the shoreline) simulations were conducted using the SUTRA code, since it copes better with the large density variations for the different water bodies.

Simulations were conducted for both the past and future scenarios as follows: (1) The time of the Lisan Lake, some 15,000 years ago and lake level some 230 m above that of the present Dead Sea. (2) 200-400 years from now when the continuous drop of the lake level attains a new steady state some 100-150 m below the present level.

The preliminary results indicate that:

1) The decline in groundwater level is progressive within several km from the shore line inland and the water divide location and elevation are not expected to be significantly effected.

2) The hydraulic gradient increase due to the drop in the DS levels, and as a result the discharge to the sea is also expected to increase, on the expense of the storage.

3) The velocity of groundwater is expected to increase toward the DS, due to the decrease in the thickness of the aquifer, above the fresh-saline water interface.

4) The marginal fault zone affects the flow regime and gradients, as well as the location of the fresh-saline interface.

SITE RESPONSE CHARACTERISTICS ON HARD ROCK

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A bedrock site on a high plateau near the escarpment top, in the seismically active Dead Sea rift system, showed an amplification by a factor of 5, between 2 and 3 Hz, due mainly to an EW oscillation of the NS topographic feature. Mount Masada, also located on the Dead Sea rift, exhibited amplifications near 1.3 Hz, by a factor of 3.5 for EW motion and 2 for NS motion. The weathered and cracked granite bedrock near the Red Sea port of Eilat showed amplifications by a factor of about 4 in the frequency range of 6 to 7 Hz, which is within the range of engineering interest as regards low-rise buildings. Recorded ground motion in a hard rock tunnel near the Dead Sea shore showed amplification by a factor 2, near 3 Hz. We explain this effect as being due to the interference between incident (upgoing) and surface-reflected (downgoing) waves.

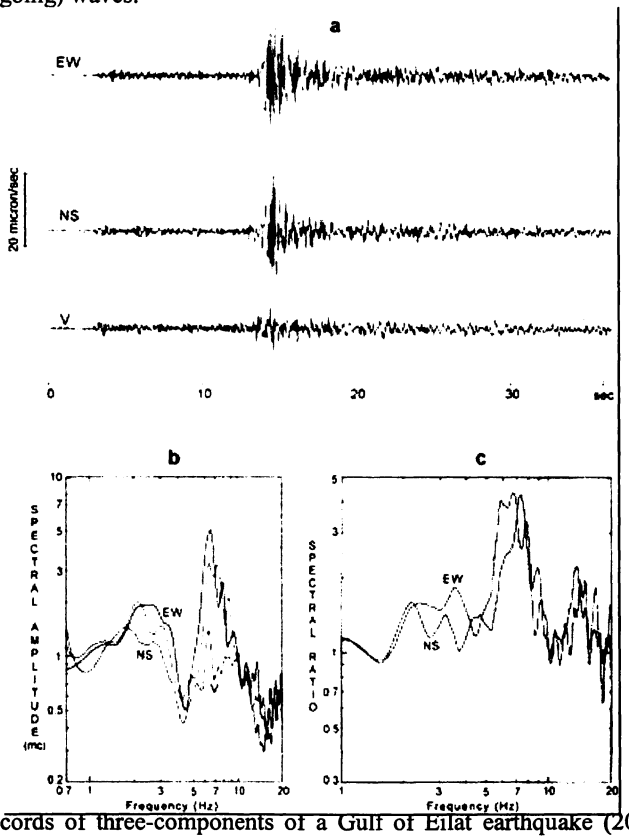

Figure 1 (a) Records of three-components of a Gulf of Eilat earthquake (2001-01-14 18:31, M_L=3.2, epicentral distances R=35 km) recorded at outcrop of granite near Eilat; (b) the corresponding Fourier spectra and (c) spectral ratio obtained for that event.

GENERALIZATION OF SITE EFFECTS FOR EARTHQUAKE SCENARIO APPLICATIONS: THE COASTAL PLAIN AREA

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About 2 million inhabitants in Israel, almost one third of total population of the country, live in the strip of Coastal plain between the towns of Ashqelon and Haifa about 140 km long and 8-10 km wide. Due to the population density here, this region may be considered a high seismic risk zone.

In order to characterize the seismic response of the Coastal plain area (130x10 km^2), the ambient noise survey was carried out at 190 sites. The measurement points were selected to provide good coverage of the area, considering different surface sedimentary deposits, thickness of sediments and the shear-wave velocity contrast between sediments and bedrock. The quantitative assessment of seismic response was made from the horizontal-to-vertical spectral ratios of ambient noise. Results indicate site amplifications ranging from 1.0 to 8.0 within the frequency band 1.0-6.0 Hz. We constructed two maps that reflect the fundamental characteristics of site effects in the area: predominant frequency and maximum relative amplification. The observed resonance frequencies and their amplifications were correlated with analytical functions that correspond to 1-D subsurface model. Collection of available geological, geotechnical and geophysical data relevant to local geology and combining theoretical and experimental response functions provided reliable estimations of analytical site effects.

We used the adequate analytical transfer functions and Stochastic Evaluation of Earthquake Hazard method (Shapira and van Eck, 1993) to predict the site dependent Seismic Ground-Motion Hazard Maps in terms of ground motion parameters used for engineering purposes: Spectral Acceleration at different frequencies for a probability of 10% during an exposure time of 50 years and a damping ratio of 5%. The databases created for the investigated area allowed preparation of a number of realistic Earthquake Hazard scenarios.

In order to facilitate estimations of earthquake loss scenarios, we divided the Coastal Plain area into six geographical zones, each one characterized by fundamental frequency and amplification factor. For each zone we adjusted the overall soil-column model, which allows calculation of the response spectrum throughout the whole zone.

TRACING SALINIZATION AT THE SOUTH OF THE COASTAL PLAIN AQUIFER BY EOCENE GROUNDWATER USING DISSOLVED SILICA

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All possible sources of groundwater salinization in the southeastern part of the Coastal Plain aquifer such as groundwater from the Eocene Avedat Group aquifer, water from the unsaturated zone and from a "deep source", have Na-Cl composition. It is extremely important to find tracers for distinguishing between the various sources of salinization.

In the Coastal Plain aquifer one of such tracers could be dissolved silica (SiO_2). In all aquifers, from the uppermost to the deep Jurassic aquifer, SiO_2 concentrations are usually in the 10-20 mg/l range, except of water from basaltic aquifers and from aquiferous beds in Senonian (Mt. Scopus Group) and Eocenian (Avedat Group) formations, in which SiO_2 concentrations are essentially higher. For the brackish groundwater from the Avedat Group aquifer, which replenishes the Coastal Plain aquifer from the east, SiO_2 concentrations exceeding 35-40 mg/l are typical, being probably produced by dissolution of cherts and diatoms from lower Eocene beds in the Avedat Group. Natural SiO_2 concentrations in the Coastal Plain aquifer are typically of 10-15 mg/l. SiO_2 concentrations in irrigation water (in the National Water Carrier) range 4-9 mg/l (6 mg/l, at average), whereas in rainwater they are almost nil. Therefore, SiO_2 concentrations exceeding 15-20 mg/l in the eastern parts of the Coastal Plain aquifer could be indicative of its salinization by groundwater from the Avedat Group aquifer. Since groundwater temperatures and pH in the Coastal Plain aquifer vary within narrow limits, quartz does not precipitate at low temperatures, and measured SiO_2 concentrations are essentially lower than at equilibrium with amorphous silica (96-106 mg/l), SiO_2 could be used as a conservative tracer of salinization by Eocene water. Maps indicate that areas of relatively high background Cl^- concentrations of 250-400 mg/l (in the Ashqelon area reaching the sea) correspond well to the areas with elevated SiO_2 concentrations of 15-20 mg/l. High SiO_2 concentrations (20-44 mg/l) were found all over the 5-km wide eastern portion of the Coastal Plain aquifer. These high concentrations occur both in the salinity spots and between them (at Cl^- concentrations of 250-400 mg/l). Nevertheless, factor analysis shows connection of both Cl^- and SiO_2 to the same factor. The percentage of Eocene water in the southern parts of the Coastal Plain aquifer in the early fifties, under "undisturbed conditions", has been estimated (using SiO_2 as a tracer) as close to 17%.

As traced by SiO_2, it seems that the widely spread mild salinization in the south-eastern part of the Coastal Plain aquifer (250-400 mg/l Cl^-) is caused by lateral penetration of groundwater from the Avedat Group aquifer. Severe salinization of groundwater and formation of salinity spots are caused by an additional vertical flux of Cl^-, mostly from the unsaturated zone (as traced by Cl^--NO_3^- correlation).

COMPREHENSIVE ASSESSMENT OF NATURAL HAZARDS BY G.I.S WITHIN THE WESTERN DEAD SEA BASIN, ISRAEL

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The Dead Sea rift is a unique ecosystem that is affected by many types of natural hazards. The impacts of natural hazards in this region are numerous. They could have direct effects on existing and future infrastructures, buildings and lifelines as well as the ecosystem and the tourism industry. This work consists of mapping natural hazards along the western shores of the Dead Sea basin with a special emphasis on earthquakes, ground and soil instabilities. The analysis of the hazards is done by G.I.S – Geographic Information System (ArcView software), using a method for producing digital seismic landslides hazard map, which links earthquakes to landslides and rock instabilities. The work examines a module of seismic hazard assessment and a module of soil and ground instabilities assessments separately. The next step examines a module that integrates these two types of hazards. It carries out a comprehensive analysis of their interactions and produces ground displacement as result from earthquakes. The Final step consists in adding lifelines in order to produce risk map. The area of Ein Gedi is used as a test case. After testing the model, this work will include larger area of the Western Dead Sea region. Preliminary results show the weakness of sections of the "boundary step" cliffs and suggest their possible failure during strong ground motions.

שקע ים המלח: אזור גזירה פעיל של גבול לוחות

שמיר, ג.

המכון הגיאופיזי, לוד 71100

מגוון רחב של נתונים גיאולוגיים וגיאופיזיים מתיישב עם תיאור שקע ים המלח כאזור גזירה התופס את כל רוחב עמק הריפט, מתארך בכוון N-S, ועובר רוטציה פנימית. בתוך אזור הגזירה אפשרית שקיעה ניכרת אם התכנסות הלוחות זניחה יחסית להסטה ביניהם.

השטפון הגדול ביותר אי פעם (8-9/9/2002) בנהר הגרדון (צרפת) – האמנם?

שפר, נ.,[1] אנזל, י.,[1] גרודק, ת.,[1] ולדמן, נ.,[1] בניטו, ח.[2]

1. האוניברסיטה העברית בירושלים, 91904, ישראל
2. המכון הגבוה למדעים, מדריד, 28006, ספרד

ממצאים פלאוהידרולוגיים בנהר הגרדון (דרום צרפת), מראים כי השטפון של 8-9/9/2002 אינו "השטפון הגדול ביותר בכל הזמנים", כפי שכונה. עדויות לחמישה ארועים נוספים נמצאו במערה הגבוה בכשלושה מטרים מעל מפלס השיא של שטפון זה. מתיארוך חומר אורגני משלוש יחידות שטפוניות במערה עולה כי כל היחידות הושקעו בין 1400 ל-1800 לספה"נ.

דולומיטים של פלטפורמות: עדות לשחזור תנאים אקלימיים ואוקיאנוגרפיים

שש, א.

המכון למדעי כדור הארץ, האוניברסיטה העברית בירושלים

עבודתו החלוצית של בן תור על סלעי הדולומיט בהרי יהודה בשנות הארבעים נעשתה כאשר "בעיית הדולומיט" הייתה עדיין בחיתוליה. בעקבות מחקרים רבים על הדולומיטים הקרטיקוניים בארץ, הצטברו עדויות כי סלעים אלה נוצרו על פני פלטפורמה קרבונטית נרחבת, מתמיסות היפרסליניות, ובשלב דיאגנטי מוקדם. מסקנות אלה מעידות כי הגורמים הישירים שהשפיעו על יצירת סלעי הדולומיט הם אקלים מדברי וחילוף מים מוגבל עם אוקיאנוס הטתיס, וכי חילוף המים המוגבל נקבע על ידי גורמים ביולוגיים ועל ידי שינויים במפלס האוקיאנוס וגורמים טקטוניים רגיונליים.

מבנה תת-הקרקע של החוף הצפון-מערבי של ים המלח – מחקר גיאופיסי

שטרית, מ.,[1] פיינשטיין, ש.,[1] אייל, י.,[1] ברונר, א.,[2] שמיר, ג.[2]

1. המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן-גוריון בנגב, באר-שבע 84105
2. המכון הגיאופיסי לישראל, ת.ד. 182, לוד 71100

נבדקו שלושה חתכים סייסמיים, בנחל דרגה, ליד חוף קליה, ומצפון-מערב לים המלח. העתק קליה נמצא בחתך הצפוני אך חסר בחתכים שמדרום. מכאן, אם הוא נמשך דרומה הוא חייב לעבור במדרון התלול של ים המלח ממזרח לשני החתכים הדרומיים.

נערכה השוואה בין מהירויות גלי P שנמדדו בדוגמאות סלע למהירות המחושבת מהחתכים הסייסמיים. בסלעי המילוי המהירות הנמדדת דומה למהירות המחושבת אך בסלעי חבורת יהודה היא שונה. סידוק ופורוזיות של הסלעים בשדה גורמים להאטת הגלים בהם ולמהירות מחושבת נמוכה יותר.

מנגנון חדש להיווצרות פנוקריסטים של פירוקסן בסלעים וולקניים בסיסיים במכתש רמון

שימשילשווילי, א., יהודלביץ, ז.

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון, ב"ש

במחקר מוצגות עדויות פטרוגרפיות המצביעות על מנגנון חדש להיווצרות פנוקריסטים של פירוקסן בסלעים. אגרגטים של גבישי פירוקסן קטנים עם אורנטציה אופטית שונה, הופכים לגבישים יוהדרלים גדולים עם אורינטציה אופטית אחידה.

המבנה הפעיל של צפון שקע ים המלח (בקעת יריחו-פצאל)

שמיר, ג.,[1] ברונר, א.,[1] אייל, י.[2]

1. המכון הגיאופיזי, לוד 71100
2. המחלקה לגיאולוגיה, אוניברסיטת בן גוריון, באר שבע

אינטגרציה של נתוני רפלקציה סיסמית ורעידות אדמה עם נתונים סטרוקטורליים ופליאוסיסמולוגיים שהתפרסמו בעבר מראה כי המבנה הרדוד של צפון שקע ים המלח הוא של בלוקים מוגבלים על ידי שברים נורמלים-ימניים בכוון NNE ושברים נורמלים בכוון NNW-NW. האגן הסדימנטרי בבקעת יריחו נראה כממולא בסדימנטים נחליים ואגמיים לעומק של לפחות 2-1.5 ק"מ.

מערכת זרימה בין אקוויפרית ברמת הגולן – גיר ובזלות מעקב בעזרת עפרות נדירות וייטריום (REY) ופענוח קווים סיסמיים

שולמן, ח.[1] מלר, פ.,[3] רוזנטל, א.,[1] פלכסר, ע.,[1] גוטמן, י.[2]

1. החוג לגיאופיזיקה ולמדעים פלנטריים, אוניברסיטת תל אביב
2. מקורות – חברת המים הלאומית
3. המכון לחקר מדעי האדמה, פוטסדאם, גרמניה

אנליזות של עפרות נדירות וייטריום ממי התהום , אשר נשאבו מאקויפר בזלתי בקידוח אלוני – הבשן 3 מצביעות על כך שמוצאן בסדימנטים קרבונטיים שעברו גיבוש מחדש בטמפרטורות גבוהות. פענוח סיסמי מראה שקידוחי אלוני – הבשן ממוקמים סמוך לאזור פתיחה טקטוני שהמילוי הבזלתי בו מצוי במגע אנכי ולטרלי עם סדימנטים אאוקנים וסדימנטים צעירים יותר.

הגיאומורפולוגיה של רכס הרי נפתלי

שטובר זיסו, נ.,[1] גרינבאום, נ.,[2] ענבר, מ.,[2] פלכסר, ע.[1]

1. החוג לגאופיזיקה ולמדעים פלנטריים, אוניברסיטת תל אביב
2. החוג לגיאוגרפיה, אוניברסיטת חיפה

ממצאי השדה מראים כי מתלול שבר הרי נפתלי מחורץ על ידי אפיקים מסדר ראשון, היוצרים דורות של מניפות סחף שונות זו מזו, בחלקן כוללות גם חלוקי בזלת. עמקים קרסטיים רחבים המתנקזים מערבה, נמשכים כערוצים צרים ותלולים מזרחה מקו פרשת המים. בקעה טקטונית, מזרחית לקיבוץ יפתח מנתקת את מערכת הניקוז הקדומה.

המשכו הימי של מבנה הכרמל ותפקידו במערך הטקטוני של אגן הלבנט: תוצאות ראשוניות

שטנר, א.,[1] בן-אברהם, צ.,[1] האובשר, כ.[2]

1. המחלקה לגיאופיסיקה ולמדעים פלנטריים, אוניברסיטת תל- אביב
2. המרכז למחקר ימי ואקלימי, אוניברסיטת המבורג

מבנה הכרמל מהווה אחת התופעות המורפו- טקטוניות המרכזיות בגיאולוגיה של ישראל. המשכו הימי נחקר רבות אך היבטים שונים עדיין ממסכים על התמונה הטקטונית של מזרח הלבנט. במהלך חודש פברואר 2002 אספה ספינת המחקר " מטאור" נתונים גיאופיסיים בצפיפות גבוהה מול חופי צפון ישראל, לאורך כ – 700 ק״מ. במהלך השייט (מספרו52/2) הופעלו מגוון שיטות מחקר: רפלקציה סייסמית רב ערוצית, רפרקציה רחבת זווית, והדמיה אקוסטית, מגנטיקה וגרבימטריה. במסגרת המחקר נבחנים גם נתונים גיאופיסיים שנאספו בסקרים קודמים. תוצאות ראשונות יוצגו.

מבנה הליתוספירה באזור הלבנט ודרום - מערב הים התיכון והאיזון האיזוסטטי החל מתקופת הפליוקן

שגב, ע.[1] ריבקוב, מ.[2] ליחובסקי, ו.[1] הופשטטר, א.[2] טיבור, ג.[3] בן- אברהם, צ.[4]

1. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים 95501
2. המכון הגיאופיסי לישראל, ת. ד 182. לוד 71100
3. המכון לחקר ימים ואגמים, ת. ד 8030., חיפה 31080
4. החוג לגיאופיסיקה ולמדעים פלנטריים, אוניברסיטת תל אביב, רמת אביב 69978

נעשה מודל סימולציה של התנועות האנכיות באזור הלבנט כתוצאה מהעמסת הסדימנטים שהצטברו בדר-י מז' הים התיכון(בייחוד אלו של הנילוס,) החל מהפליוקן, והסרת עמודת הסלעים שנגדעה בתקופה זו מהאזור היבשתי. בנוסף, נעשתה סימולציה רגיונלית לפלקסורה של הליתוספירה, תוך התחשבות באזור החולשה של טרנספורם ים המלח, המסבירה את התנועות האנכיות באזור הלבנט במהלך חמש מליון השנים האחרונות.

הדפורמציה של שולי אגן ים המלח ומשמעותה הטקטונית

שגיא, א., רכס, ז.

המחלקה למדעי כדור הארץ, האוניברסיטה העברית, ירושלים, 91904.

בשוליים המערביים של אגן ים המלח שולטים העתקים נורמלים תלולים מזוגזגים, כפיפות א-סימטריות, בלוקים נטויים מזרחה וסדקים. מבנים אלו נוצרו בשדה מעוות תלת-ממדי תוך מתיחה אנכית ובכיוון מזרח-מערב, והתקצרות בכיוון צפון-דרום. מעוות זה משקף כפיפה והתמוטטות של השוליים אל הבור, והוא מופרד מהתנועה האופקית ומהמתיחה בכוון צפון-דרום בתוך אגן ים המלח.

על "משחק המחבואים" בין הגורמים הגיאולוגיים וזרימת מי התהום באזור פצאל יריחו

שולמן, ח.[1] פלכסר, ע.[1] גוטמן, .[2] ילין-דרור ע.[1] רוזנטל, א.[1] אנקר, י.[1]

1. החוג לגיאופיסיקה ולמדעים פלנטריים, אוניברסיטת תל-אביב
2. מקורות – חברת המים הלאומית לישראל בע"מ

פענוח של קווים סייסמיים קימים באזור המחקר, תומך בעדויות שנצטברו דרומה ליריחו ומצביעה על כך שאקוויפר חבורת יהודה מצוי בעומק רדוד יחסית של כ – 500 מ' ומשתפל באמצעות העתקי מדרגות מזרח. הפענוח הסייסמי מגלה קיומו של גוף אוופוריטי ותופעות הלוקינטיות. למכלול תופעות אלה עשוייה להיות השפעה על זרימת מי התהום ואיכותם.

פרקציונציה איזוטופית של חמצן בין קלציט לקורונדום במט-באוקסיטים מנקסוס: לקראת כיול התרמומטר

קציר, י.,[1,2] ואלי, ג.וו.,[2] ספיקוזה, מ.ג'.[2]

1. המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון בנגב, באר שבע
2. המחלקה לגיאולוגיה ולגיאופיסיקה, אוניברסיטת וויסקונסין – מדיסון, ארה"ב

טמפרטורת הסגירה לדיפוזיה של חמצן בקורונדום גבוהה מ- 700°C. בקלציט, לעומת זאת, קצב הדיפוזיה מהיר הרבה יותר. לכן, תרמומטריה איזוטופית בעדשות מט-באוקסיטים באופקי שיש בנקסוס שהותמרו ב- 400-700°C, נראית אפשרית. באזור הקיאניט-סטאורוליט ערכי $\delta^{18}O$ בקורונדום הראו חזרתיות מרשימה של ‰ 0.1±. חזרתיות דומה נרשמה בקלציט רק בדוגמאות חסרות קלק-סיליקטים ובעלות יחס קלציט/קורונדום גבוה.. בדוגמאות אלו $\Delta^{18}O_{(Cc\text{-}Crn)} = 3.80 \pm 0.15$ ‰. הונח הבסיס לקביעת הגרדיינט התרמלי בזמן מתיחה בנקסוס.

שימוש באיזוטופים של חנקן וחמצן לזיהוי מקורות ותהליכי זיהום חנקות באקוויפר החוף של ישראל

רודד, ד.,[1] ונגוש, א.,[1] מאהייר, ב.[2]

1. המחלקה לגיאולוגיה ומדעי הסביבה, אוניברסיטת בן-גוריון בנגב, באר-שבע
2. Departments of Physics & Astronomy and Geology & Geophysics, University of Calgary, 2500 University Drive NW, Calgary, Alberta, Canada T2N 1N4

מחקר זה עוקב אחר מקורות הזיהום השונים של חנקה באקוויפר החוף ע"י שימוש באיזוטופים יציבים של חנקן וחמצן המרכיבים את מולקולת החנקה. האנליזות האיזוטופיות המוצגות מבוססות על 64 בארות שונות לכל אורכו של האקוויפר, בהן נמדדו ריכוזי חנקה גבוהים (>85 מג"ל).

מבנה תת הקרקע של עמק החולה עפ"י פענוח מידע גרבימטרי

ריבקוב, מ.,[1] פלישר, ל.,[1] טן ברינק, א.[2]

1. המכון הגיאופיסי לישראל, רחוב הבעש"ט 6, לוד, 71100
2. המכון הגיאולוגי ארצות הברית

תמלחות ממעמקי המעטפת

קליין בן-דוד, ע., יזרעאלי, א.ש., נבון, ע.

המכון למדעי כדור הארץ, האוניברסיטה העברית, ירושלים, 91904.

במהלך גידולם לוכדים יהלומים מינרלים ונוזלים. ביהלומים מקנדה נתגלו נוזלים בהרכבים שבין נתך סיליקטי נתך קרבונטיטי ותמלחת. המודל להיווצרותם: גיבוש מינרלים קרבונטים מנתך קרבונטיטי והפרדת הנוזל הנותר לשני מרכיבים אימיסיביליים.

פיתוח מודלים חד-ממדיים להערכת הסיכון הסיסמי על בסיס מדידות של רעש הרקע: משור החוף של ישראל

קלמנוביץ', מ., גורשטיין, מ., זסלבסקי, י.

אגף הסיסמולוגיה, המכון הגיאופיסי לישראל, ת.ד. 182, לוד, ישראל 71100

במטרה להקל על הערכת סיכונים סיסמיים חילקנו את הרצועת מישור החוף בין אשקלון לחיפה ל-6 אזורים גיאוגרפיים בהתאם לערכי תדר תהודה והגברה. על בסיס מדידות לכל אחד מהאזורים נבנה מודל כולל אשר שימש בהמשך להערכת ספקטרום התאוצות. אנו מאמינים כי מודלים כלליים אלו יעזרו בהסקת מסקנות לגבי סיכון סיסמי מקומי באזורי מישור החוף שונים.

הרכב מי התהום מתחת לאזורים המושקים במי קולחין ומים שפירים באקויפר החוף

קס, ע.[1,2] גבריאלי, א.,[1] יחיאלי, י.,[1] ונגוש, א.,[3] סטרינסקי, א.[2]

1. **המכון הגיאולוגי, רח' מלכי ישראל 30, ירושלים 95501.**
2. **המכון למדעי כדור הארץ, האוניברסיטה העברית, גבעת רם, ירושלים 91904.**
3. **המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון, באר שבע 84105.**

המחקר התמקד בהשפעת ההשקיה בקולחין ובמים שפירים על הרכב מי התהום בחלקו העליון ביותר של אקויפר החוף. ההבדלים הגדולים בין הרכב מי ההשקיה ומי התהום העליונים מתחת לשדות המושקים מוסברים בעיקר על ידי תהליכי שיחלוף יונים בין המים לסדימנטים באזור הלא רווי. השפעת ההשקיה ניכרת גם בריכוזי הניטרט הגבוהים (מעל 100 מג'/ל) ובמליחות הגבוהה, במיוחד מתחת לשדה המושקה בקולחין.

מקור החתך הקלסטי מגיל פליאוזואיקון תחתון בדרום ישראל וירדן: תארוך צירקון דטריטי בעזרת מכשיר ה SHRIMP-RG

קולודנר, ק.[1] אביגד, ד.[1] וויסברוד, ט.[2] מקוויליאמס, מ.[3] וודן, ג.[4]

1. המכון למדעי כדור הארץ, האוניברסיטה העברית בירושלים, ירושלים 91904
2. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501
3. המחלקה לגיאולוגיה ומדעי הסביבה, אוניברסיטת סטנפורד, סטנפורד, קליפורניה 94305-2115
4. המכון הגיאולוגי האמריקאי, מנלו פרק, קליפורניה

בדרום ישראל וירדן חשוף חתך עבה של אבני חול מגיל פליאוזואיקון אשר מונח על התשתית הקריסטלינית של המסיב הערבו-נובי. בעבודה המוצגת תוארכו גרגרי צירקון דטריטי במטרה לקבוע מהו מקור אבני החול. תוצאות ראשוניות מראות שהמסיב הערבו-נובי היה המקור הדומיננטי אך קיימת תרומה גם ממקורות עתיקים ורחוקים יותר.

אפיון הידראולי של האקוויטרד הקרטוני ברמת חובב ע"י תצפיות בסדקים בסקלות שונות

קורצמן, ד.[1] נתיב, ר.[1] אדר, א.[2]

1. המחלקה לקרקע ומים, הפקולטה לחקלאות, האוניברסיטה העברית, ת.ד. 12 רחובות 71600.
2. המחלקה להידרולוגיה ומיקרוביולוגיה, המכון לחקר המדבר, אוניברסיטת בן גוריון שבנגב, שדה בוקר.

החזוי של ההתנהגות ההדראולית של אקוויטרד סדוק בגישת הרצף, בעייתי. לצורך זה תצפיות בסדקים, בצמוד למבחנים או ניתוחים הידראוליים, נעשו בסקלה של סדק בודד (מטרים), בינונית (עשרות מטרים) וגדולה (קילומטרים). בעוד תצפיות בסדק בודד יכולות להטעות, סקרי סדקים בסקלה הבינונית נמצאו יעילים לחזוי הידראולי. חזוי אנאיזוטרופיה מלינאמנטים בסקלה הגדולה אפשרי בעזרת אנליזה של העומד.

התנהגות מחזורית ארוכת-טווח של רעידות אדמה מרקורד פלאו-סייסמי ממשקעי מערות

קייגן, א.[2,1] עגנון, א.[2] בר-מטיוס, מ.[1] איילון, א.[1]

1. המכון הגיאולוגי, ירושלים
2. המכון למדעי כדור הארץ, האוניברסיטה העברית, ירושלים

פיתחנו שיטת תיארוך של נזקים מכניים למשקעי מערות. התיארוך מבוסס על שיטת U-Th וקורלציה של איזוטופים יציבים. תיארכנו רעידות אדמה בשתי מערות באזור בית שמש, מערות שורק והר-טוב. ב-180,000 השנים האחרונות נרשמו שישה-עשר אירועים גדולים המראים התנהגות מחזורית. האחרון התרחש לפני כ-5.4 אלפי שנים.

הערכה ומיפוי של סכנות טבע בחוף המערבי של ים המלח תוך שימוש ב G.I.S

ציון, כ., בן אברהם, צ., ווסט בלוך, ה., טיבור, ג.

החוג לגיאופיזיקה ומדעים פלנטריים, אוניברסיטת תל אביב, רמת אביב 69978 , תל אביב

בעבודה זו מתבצע מיפוי והערכה של סכנות טבע בים המלח, תוך שימוש במערכת מידע גיאוגרפית .G.I.S בעבודה נבחנים סיכונים סיסמיים, אי יציבות קרקע, גלישות סלעים והקשר ביניהם.

יציבות חללים תת קרקעיים בסלע משוכב וסדוק – פתרונות ספרתיים באמצעות מודל הדפורמציה הבלתי רציפה

צסרסקי, מ., חצור, י. ח.

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון בנגב, באר –שבע 84105

ניתוח היציבות של חללים תת קרקעיים בסלע משוכב וסדוק מחייב שימוש במודלים נומריים בלתי רציפים. בעבודה זו נחקרה יציבותו של חלל תת-קרקעי עתיק (תל באר שבע) אשר נחצב בסלע משוכב וסדוק באמצעות שיטת ה- DDA , שיטה חדשנית ממשפחת האלמנטים הדיסקרטיים. נחקרו מנגנוני הכשל השונים ותלותם בחיכוך לאורך מישורי הסידוק וצפיפות הסידוק.

חתרורים – האזור המגוון

קולודני, י.

המכון למדעי כדור הארץ, האוניברסיטה העברית, ירושלים

בן תור החל במיפוי סלעי "חתרורה" עוד בשלהי מלחמת השחרור. הכרת המינרלוגיה שלהם, וההכרה באופים כסלעים מטמורפיים הובילו יחד עם שורה של מחקרים גיאוכימיים ואחרים להבנת תהליך השריפה של חומר אורגני כמקור האנרגיה המטמורפית. אירוע השריפה לא היה בודד (לפחות לפני 16 מ.ש. ושוב לפני 1-3 מ.ש.). זמן הבערה בכל מוקד היה בין שנה לשנים בודדות.

תוכנת עיבוד מדידות שיטתיות לחישוב תכונות דינמיות של מבנים

פרלמן,נ., זסלבסקי,י.

אגף הסיסמולוגיה, המכון הגיאופיסי לישראל, ת.ד. 182, לוד, ישראל 71100

על בסיס מחשב אישי פותחה על ידינו תוכנת עיבוד אוטומטי של תנודות סיסמיות של מבנים לחישובי תדר תהודה וריסון. התוכנה היא בעלת אפשרויות אינטראקטיביות סטנדרטיות (יישומי חלונות) להצגה גרפית ושמירת נתונים. התוכנה שימשה לביצוע חישובים ל-10 מבני מגורים בקריית שמונה.

תופעות מעוות סינסדימנטריות בקנומן-טורון של אזור אדמית, צפון-מערב הגליל

פרנק, ר., בנימיני, ח., אייל, י.

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן-גוריון בנגב, ת.ד. 653, באר-שבע, 84105.

גופים מעוותים של סלעים קרבונטיים באזור חתך הכביש של אדמית מציינים תנועה מערבה של סדימנטים על הרמפה הקרבונטית הקרטיקונית. בתצורת דיר-חנא, מעוותים בסדימנט הרך מציינים תנועה בקצה התחתון של הרמפה. בתצורת סחנין ניתן להבחין במישורי גזירה תת-אופקיים, עליהם נעו סדימנטים שבקצה נערמו בגופי ברקציה. פאזה נוספת התרחשה בטורון.

קצה המדף של ישראל בקנומן המאוחר

פרנק, ר., בנימיני, ח., אייל, י.

קנומן, גליל, ישראל, פציאס קרבונטי

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן-גוריון בנגב, ת.ד. 653, באר-שבע, 84105.

רמפה קרבונטית אפיינה את קצה מדף היבשת של ישראל בקנומן המאוחר. אגרדציה ב- Transgressive system tract עוברת דרך – Maximum flooding surface ל- Highstand system tract המחולק על ידי- Downlap surface, שמציין פרוגרדציה במחזורי הרדדה כלפי מעלה. מעוותים כתוצאה מגלישה מערבה מופיעים בגליל המערבי בפזה זו. המחזור מסתיים במישור המייצג הטבעה, שלאחריו הושקעה תצורת בענה.

תעלות של מניפת הנילוס בים העמוק שמול ישראל

פולקמן, י

ישראמקו, גרניט 8, פתח-תקווה, 49222

בקרקעית הים ומתחתיה התגלו תעלות הדומות במאפייניהן לנהרות יבשתיים. הן מהוות חלק ממניפת הים העמוק המזרחית של הנילוס. מלוי התעלות בהולוקן עשיר בבוץ ואלו בפליוקן בחול. התעלות מוכיחות קיום מערכת שבירה אופקית שמאלית.

זיהוי מקורות ומנגנוני המלחה לאורך נהר הירדן התחתון

פרבר, א.[1] ונגוש, א.[1] שביט, א.[2] הולצמן, ר.[2] סגל, מ.[2] גבריאלי, א.[3] בולן, ט.[4] מאייר, ב.[5]

1. המחלקה לגיאולוגיה ומדעי הסביבה, אוניברסיטת בן גוריון, באר שבע, 84105
2. הפקולטה להנדסה חקלאית, טכניון, חיפה 32000
3. המכון הגיאולוגי, רח' מלכי ישראל 30, ירושלים 95501
4. המכון הגיאולוגי האמריקאי (USGS), מנלו פארק, קליפורניה 94025
5. אוניברסיטת קלגורי, קנדה

עוצמת ההמלחה של מי הירדן הדרומי בחודשים השונים נקבעת על ידי הרכב מי התהום המלוחים ותרומתם היחסית למי הנהר. זיהוי התרומה להרכב הגיאוכימי של מי הירדן נעשה על ידי שימוש ביחסי יונים ויחסים איזוטופים של גופי המים השונים באגן הירדן התחתון.

זרימה קרסטית עמוקה וטרנסורסלית באקוויפר ירקון-תנינים

פרומקין, ע.[1] גבירצמן, ח.[2]

1. המחלקה לגיאוגרפיה, האוניברסיטה העברית, ירושלים 91905
2. המכון למדעי כדור הארץ, , האוניברסיטה העברית, ירושלים 91904

במרכז אקוויפר ירקון-תנינים הובחנו שלושה תת אקוויפרים. בתת האקוויפר התחתון זורמים מי מטאוריים מליחים בעומק של עד כ-1 ק"מ, בתנאים מחזרים, מוליכות הידראולית גבוהה וטמפרטורו גבוהות. מים אלה עולים במחילות קרסטיות תת אנכיות עד סמוך לפני מי התהום ומובחנים בקידוחי איילו וכפר אוריה.

קינטיקת המסה של סמקטיט בתנאים חומציים

עמרם, ק., גנאור, י.

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן-גוריון בנגב, ב"ש

בניסויי מעבדה נבדקה השפעת החומציות והטמפרטורה על קצב ההמסה של סמקטיט. התוצאות מוסברות באמצעות מודל המניח תלות ליניארית של קצב ההמסה בריכוז הפרוטונים הספוחים על פני השטח. תלות קצב ההמסה בטמפרטורה (משוואת אהרניום). מושפעת הן מאנרגיית האקטיבציה (20 kcal/mole) והן מהאנטלפיה (14- kcal/mole).

מדידות קצב התרוממות הר סדום בעזרת מדידות שדה

פארי, ש.[1] בן-אברהם, צ.[1] זבקר, ה.[2] פרומקין, ע.[3] שטיינברג, ג.[4]

1. החוג לגיאופיסיקה ומדעים פלנטריים, אוניברסיטת תל-אביב, רמת אביב
2. החוג לגיאופיסיקה, אוניברסיטת סטנפורד, פאלו-אלטו, קליפורניה, ארצות הברית
3. החוג לגיאוגרפיה, האוניברסיטה העברית, ירושלים 91905
4. מרכז המיפוי לישראל, לינקולן 1, תל אביב

מדידות שדה מדוייקות (GPS) ואיזון באזור הר סדום הן מורכבות וקשות מבחינה פיזית ולוגיסטית. חשיבותן העיקרית של מדידות אלה במסגרת מחקר "קצב התרוממות הר סדום בעזרת InSAR" היא שימוש כמדידות ייחוס לקצב המחושב בעזרת חישה מרחוק. תוצאות קצב ההתרוממות המתקבלות ממדידות ה GPS -מצביעות על קצב התתרוממות דומה.

איכות מסת סלע קירטונית כמדד מכתיב עלות מנהרת תעבורה

פולישוק, צ.

ד.א.י.י. מנהרות, החורשה 17 רעננה, 43613

עלות מנהרת תעבורה מותנית במימדי המנהרה ובאיכות מסת הסלע בה תיכרה. בעוד שממדי המנהרה, רוחב וגובה, הם גורמים קבועים הרי איכות מסת הסלע משתנת ממקום למקום. לכן, קביעת עלות מנהרה על פי עלויות מנהרות שבוצעו בפועל, לוקה בחסר. אומדן עלות מנהרת תעבורה חייב להיקבע על פי איכות מסת הסלע למינהור.

הצעה למבנה ההידרוסטרטיגרפי של אקוויפר ירקון - תנינים - באר שבע

סלמון, ע., גיל, ד., קלבו, ר.

המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501

מוצעת בזאת תבנית הידרוסטרטיגרפית מרחבית לאקוויפר ירקון – תנינים - באר שבע על בסיס קורלציה של היחידות הליתוסטרטיגרפיות במרחב הזרימה שלו. התבנית תסייע להציב מודל הידרוגיאולוגי מרחבי כמותי להדמיית הזרימה והסעת המלחים באקוויפר. המודל יהווה כלי לבחינת ההשלכות של תרחישי תפעול שונים ולהתוויית הנחיות לתפעול אופטימלי של האקוויפר.

הערכה של סיכוני רעידות אדמה בתחום העיר ירושלים

סלמון, ע., כץ, ע., כרובי, א.

המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501

מוצגת בזאת הערכה מקיפה של הגורמים לסיכוני רעידות אדמה בירושלים. הממצאים מרוכזים על גבי מפת רגישויות מסכמת המיועדת למתכנן ומאפשרת לו להעריך את מכלול הסיכונים באזורי העיר השונים. המפה מיועדת לצורכי תכנון מרחבי ושימושי שטח. שימוש מושכל במפה יאפשר להתאים את הבניה לסיכון הסיסמי ולהקטין את הנזקים הצפויים למינימום האפשרי.

אבולוציה והסעה של אורגנו-הלידים כבדים מקבוצת ה-Brominated neopentyl alcohol בקרטון סדוק.

עזרא, ש.[1] פיינשטיין, ש.[1] בילקיס, י.[2] אדר, א.[1,3] גנאור, י.[1]

1. המחלקה למדעי הגאולוגיה והסביבה, אוניברסיטת בן גוריון בנגב.
2. הפקולטה למדעי החקלאות, המזון ואיכות הסביבה האוניברסיטה העברית בירושלים
3. המחלקה להידרולוגיה ומיקרוביולוגיה סביבתית, אוניברסיטת בן-גוריון בנגב

ה- Brominated neopentyl alcohol הינם המזהמים האורגנים החצי-נדיפים הנפוצים ביותר במי התהום מתחת לרמת חובב. תוצאות הניטור מצביעות על דפוס השתנות בין מולקולות שונות מקבוצה זו. ניתוח דפוס זה מראה כי ניתן לייחס השתנות זו לספיחה דיפרנציאלית של המרכיבים. בנוסף בנסויי פרוק כימים יתקבלו תוצרי פירוק יציבים, תוצרים הנמצאים במי התהום.

תוצאות ראשונות של עצמת השדה המגנטי בישראל

סגל, י.,[1] מרקו, ש.,[1] שוואן, א.,[2] ברבה, ח.[3]

1. החוג לגיאופיסיקה ולמדעים פלנטריים, אוניברסיטת ת"א
2. החוג לגיאופיסיקה, רן, צרפת
3. רשות העתיקות, ירושלים

העוצמה והכיוונים של השדה המגנטי ב-3000 השנים האחרונות תועדו לראשונה בארץ באתרים ארכיאולוגיים. עוצמת השדה ירדה בעשרות אחוזים במאות השנים האחרונות. כיווני השדה שנמדדו גם בסדימנטים של ים המלח מלמדים שניתן להשתמש בשינויים שחלו בו לצורך קורלציה ושיפור תיארוך של יחידות גיאולוגיות וארכיאולוגיות.

הגיאוכימיה של הפוספוריטים של הנגב: גורמים קובעים והבהרת כללי המשחק

סודרי, ד., נתן, י.

המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501

מחקרים שבוצעו בשנים האחרונות שופכים אור חדש על הגורמים הקובעים במידה רבה את הכימיה של משקעי הפוספוריט של הנגב בזמן הסדימנטציה. ממצאים אלה מאפשרים לנבא שינויים בהרכב הכימי של סלעי הפוספט במרחב הדפוזיציונלי של הנגב בהתאם לסביבת ההשקעה.

מקורות הפוספט של ישראל: מצאי גיאולוגי ומבט לעתיד

סודרי, ד.,[1] לוי, י.[2]

1. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים 95501
2. רותם אמפרט נגב בע"מ, מישור רותם, ד.נ. ערבה

פוספוריטים כלכליים מצויים בישראל בשלשה אזורים עיקריים: 1) בנגב הצפון-מזרחי, 2) בשולי הערבה הצפונית, ו- 3) בנגב המרכזי. היות וחלק משטחים אלה מיועדים גם לשימושים אחרים, נחוץ תכנון מושכל כדי לשמר את מרבית מקורות הפוספט הכלכליים של ישראל לניצול בעתיד.

האם שמורת החולה מהווה קולט או מקור לזרחן וחנקן העלולים להגיע לכנרת?

מרקל, ד.,[1] ואורון, ט.[2]

1. נציבות המים, קניון הגליל העליון, ת.ד. 8, חצור הגלילית, 30100
2. רשות הטבע והגנים, שמורת החולה, ת.ד. 340 , דאר יסוד המעלה, 12105.

לאור שיקומה הצפוי של שמורת החולה, הועלה הצורך בבחינה של תפקודה הביוגיאוכימי של השמורה כקולט או כמקור לנוטריאנטים. מאזן מסה לזרחן וחנקן הראה כי שמורת החולה תיפקדה גם כקולט וגם כמקור לזרחן כללי וחנקן כללי בשנים 1993-2002, אולם בממוצע רב שנתי שימשה כקולט של כ- 0.5 טון זרחן (מתוך 1.5) ו- 9 טון חנקן (מתוך 20).

גאולוגיה ופילולוגיה, מלים ערביות שנכנסו לשימוש בגאולוגיה של ארץ-ישראל

נצר, מ.

המחלקה לגאוגרפיה, אוניברסיטת בר-אילן

מילים ערביות חדרו כמושגים לגאולוגיה הישראלית ואין זוכרים מקורן. קרקע חמרה היא אדומה, כורכר במקורו הוא חלוק נחל ונעשה שם לסלע ולחבורת מסלע, הנזאז העוצר מים פרושו מותז ומוצף והחוסמס עם תרכיזי הגיר פרושו קשה וחוסם. נארי, שהוסבר כאבן חסינת אש אינו כזה והחואר חיוור הוא כמשמעותו בערבית ועברית.

בן-תור ופוספוריטים

נתן, י.

המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501

פוספוריטים היו בין הנושאים הרבים אשר ענינו את בן-תור. בן-תור לא הבדיל בין מדע שימושי למדע בסיסי ותרומתו בשני השטחים שימשו יסוד לכל מחקר הפוספוריטים בארץ.

שפיעת ראדון בשולי הערבה הדרומית – תוצאות ראשונות של ניטור ברזולוציית זמן גבוהה

מליק, א., גזית-יערי, נ., שטייניץ, ג.

המכון הגיאולוגי, ירושלים

ניטור ראדון מתבצע בשלושה אתרים הפרושים על מרחב של כ- 20 ק"מ ובעומק עד כמה עשרות מטר, בסלעי התשתית הפרקמברית, בשולי הערבה הדרומית. נמדדים שינויים סיסטמטיים – יומיים ורב יומיים, בחלקם בעוצמה גדולה. המופעים של הסיגנלים והמתאמים בין התחנות מצביעים על קיום תהלכי תנועת גז סדורות במערכות הסלע ועל מערכות שחרור מכניות של הראדון מהסלע אל הגיאו-גז.

הדמיה ברזולוציה גבוהה של מערכות שבירה והשקעה בראש מפרץ אילת

מקובסקי, י.,[1] בן אברהם, צ.,[1] עגנון, א.,[2] שקד, י.,[2] שמש, א.,[3] גולן, א.,[4] גדעון, א.[4]

1. המחלקה לגיאופיסיקה ומדעים פלנטריים, אוניברסיטת תל אביב, 69978 תל אביב.
2. המכון למדעי כדור הארץ, האוניברסיטה העברית, 91904 ירושלים.
3. מדעי הסביבה ומחקרי אנרגיה, מכון ויצמן למדע, ת.ד. 26, 76100 רחובות.
4. המכון למחקר אוקיאנוגרפי ולימנולוגי בישראל, ת.ד. 8030, 31080 חיפה.

אזור אילת הוא אזור מעבר בין סגמנטים ראשיים במערכת השבירה של ים המלח כפי שמעידים תוצאות מיפוי מורפוטקטוני ביבשה ונתונים גיאופיסיים שנאספו במפרץ אילת. סדרת קווי רפלקציה אקוסטיים ברזולוציה גבוהה שאספנו באחרונה בראש מפרץ אילת מעידים על קיומו של אזור שבירה ראשי ("שבר אילת") הנמשך מכיוון שדה התעופה ובמקביל לחוף אל אזור הנמלים. מורפולוגיה חדה של הקרקעית ומפתני השקעה בתת הקרקע מעידים על קיומם וגילם הצעיר של תוואי שבירה נוספים. בכוונתנו למפות תוואים אלה על ידי פענוח מלא וקורלציה בשלושה ממדים של הקווים השונים.

העתק של רעידת האדמה ב-18 בינואר 749 נחשף בטבריה

מרקו, ש.,[1] הרטל, מ.,[2] חזן, נ.,[3] לב, ל.,[1] שטיין, מ.[4]

1. החוג לגיאופיזיקה ומדעים פלנטריים, אוניברסיטת תל אביב
2. רשות העתיקות, ירושלים
3. המכון למדעי כדור הארץ, האוניברסיטה העברית, ירושלים
4. המכון הגיאולוגי לישראל, ירושלים

מניתוח של עדויות היסטוריות ושל העתק שחוצה מבנים ארכיאולוגיים וסדימנטים שהתגלו בחפירה אריאולוגית באתר גלי כינרת בטבריה עולה שברעידת האדמה של ה-18.1.749 התרחשה העתקה בין הכינרת לים המלח.

מערכת סדקים פתוחים בחוף ים המלח למרגלות מצוק העתקים וקשר אפשרי לרעידת האדמה של 1927

מוצן, צ.

רח' עציון גבר 4 ירושלים 97803

במחצית השניה של שנת 2002 התגלתה מערכת סדקים הממוקמת למרגלות מצוק העתקים בקטע שבין קומראן בצפון ואזור נחל סמר בדרום. המערכת נמשכת באופן מקוטע, במקביל למצוק ההעתקים לאורך כ-15 ק"מ מנ.צ 19311267 ועד נ.צ 18861131. הסדקים הפתוחים הם ככל הנראה ביטוי להפרעת פני השטח במהלך רעידת אדמה גדולה שהתרחשה באזור, ככל הנראה הרעידה של 1927.

מבנתור ועד לארץ המכתשים

מזור, ע.

מדעי הסביבה וחקר האנרגיה, מכון וייצמן למדע

ב- 1953 עמד פרופ' בן תור המנוח בראש משלחת גיאולוגית לחקר מכתש רמון והצריפים שימשו את מתיישבי מצפה. המחקר סוכם בעבודות תואר, מאמרים ומפות. ב- 1980 הוכרזה שמורת הרמון פארק גיאולוגי לאומי; ב- 1990 הוקם מרכז מדע רמון; ב- 1994 נתקבלה החלטת הממשלה לשימור ארץ המכתשים; ב- 2001 הוגשה ארץ המכתשים כמועמדת לרשימת אתרי המורשת העולמית ליד אונסקו. אלו הן דוגמאות לתולדות של מורשת בן תור.

שילוב סביבתי של כריית הפוספטים בפיתוח הנגב

מזור, ע.

מדעי הסביבה וחקר האנרגיה, מכון וייצמן למדע

לשילוב הסביבתי של ההפקה מומלץ: להשאיר מחצב גם לדורות הבאים; לתכנן מראש את שימושי החלל הסופי (אחסון תחמושת, חוות גז ודלקים נוספים, בתי עלמין, חוות סולריות, רובעי מגורים, איצטדיוני ספורט, פינוי פסולת בניה) או שיקום נופי; צילום אויר ודו"ח סביבתי אחת לשנה; תצוגות רלבנטיות וקליטת מבקרים; ממשק שקוף. נושא תעשיות הפוספט המזהמות ידון במקום אחר.

מחקר מקיף של אזור יריחו – צפון אגן ים המלח

לזר, מ., בן-אברהם, צ., שולמן, ח., רשף, מ.

החוג לגיאופיסיקה ולמדעים פלנטריים, אוניברסיטת תל אביב, רמת אביב, תל אביב 69978

מחקר מקיף, הכולל תצפיות מצוללת, עדיות מתעלה פלאיו-סיסמית, ופענוח של כ- 100 קווים סיסמיים מהים ומהיבשה בוצעו על מנת לפתור את מערך השבירה באזור ים המלח. התוצאות שיוצגו מראות על שבירה מסובכת ושונה מהמקובל בעבר. כמו כן, יוצע מודל פיזיקלי לתופעות השונות הנצפות באזור.

מפת הרגישות של אקוויפר החוף הדרומי לשאיבה (ניתוח ראשוני)

ליבשיץ, י.,[1] ליבשיץ, י.,[2] בן-אברהם, צ.,[1]

1. אוניברסיטת תל-אביב, המחלקה לגיאופיזיקה והמדעים הפלנטריים 69978
2. השירות ההידרולוגי, ת"ד 63118, ירושלים 91360

מליחות המים באזורים בעלי מבנה גיאולוגי שונה התנהגה בצורה שונה. במקומות מסוימים ירידת המפלסים לוותה בעלייה חדה בריכוזי הכלוריד והמליחות המשיכה לעלות גם לאחר שיקום המפלסים. לעומת זאת, באזורים אחרים, השקע כמעט לא השפיע על רמת המליחות. על בסיס תוצאות ניתוח ראשוני של תגובת המליחות לשינויים במפלס ומיקום מקורות המלחה פוטנציאליים, הוכנה מפת רגישות לשאיבה של חלקו הדרומי של אקוויפר החוף.

נטור כלוריניות ורדון במי תהום באזור עינות צוקים, ים המלח

לנג, ב.,[1] כפרי, א.[2]

1. רח' פרי מגדים 38/3, מעלה אדומים, 98480
2. המכון הגיאולוגי, רח' מלבי ישראל 30, ירושלים, 95501

נטור כלור ורדון בשני תת אקויפרים של המלוי בין השנים 1999-1996 מצביע על קשר בין שפיעת רדון למשטר ההידרולוגי. שנויי שפיעת רדון בחתך הבלתי רווי מושפעים מהחתך הרווי וממשטר הגשמים באזור.

שימוש בממ"ג (GIS) להערכת סיכוני רעידות אדמה בתחום העיר ירושלים

כרובי, א., סלמון, ע., כץ, ע.

המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501

מוצגת בזאת שיטת השימוש במערכת מידע גיאוגרפית (ממ"ג) להערכת סיכוני רעידות אדמה בירושלים. ארבע מפות פוטנציאל הגברה ופוטנציאל כשל מדרון נוצרו על ידי חיתוכים בין שתי שכבות המידע הבסיסיות: המפה הגיאולוגית והמודל הטופוגרפי הממוחשב (DTM). מפות אלו שימשו בסיס ליצירת מפה מסכמת המציגה את מכלול סיכוני רעידות האדמה באזור ירושלים.

מרבצי הפוספט בישראל כבסיס לתעשיית הזרחן- בעיות ומגמות לעתיד

לוי, י.

"רותם אמפרט נגב בע"מ", מישור רותם דאר נע הערבה 86800

הפוספט הוא מהמחצבים הבודדים המצויים במדינת ישראל. על בסיס הפוספט התפתחה תעשיה רחבת היקף במפעלים בארץ וחלקה במפעלים בבעלות חברת רותם בחו"ל. הפוספט משמש כחומר גלם לייצור חומצה זרחתית חקלאית ולשימושים טכניים, דשנים לסוגיהם, מלחים לתעשית הדטרגנטים ומלחים כתוספות למזון. מיגוון המוצרים הללו מיוצר בארץ ובמפעלי החברה בחו"ל. פעילות המפעלים המייצרים את מוצרי הפוספט ונגזרותיו, תלויה בקיומם של עתודות חומר גלם זמינות. מפעלים אלו הוקמו באיזורים מדבריים בנגב בקירבת שדות הפוספט לשם ניצולן ועיבודם למוצרים ברי ייצוא. עובדי החברה במפעלים בארץ גרים ביישובי הנגב: דימונה,ירוחם,ערד ובאר שבע. מחזור מכירות החברה של הפעילות בארץ ובחו"ל הוא כמיליארד דולר. למעלה מ-90% מתוצרתה מיועדים לייצוא. תהליך כרית הפוספט הינו השלב הביצוע האחרון של מערך פעילויות המגדיר מקורות הגלם והעתודות באמצעות סקר גיאולוגי, בדיקות התאמה כימיות ותהליכיות ע"י סימולציות השבחה להתאמת תהליכי עיבוד העופרה, בדיקות ישימות, התאמה לתחזיות השיווק, בחירת טכנולוגית כריה, אישורי רשויות ותיכנון כריה. תהליך הכריה מביא בחשבון אילוצי איכות,כמויות ולוחות זמנים כאשר המידע מצטבר במודלים גיאולוגיים\הנדסיים\ כלכליים כבסיס להחלטות. הראיה הכוללת לניצול כלכלי של רזרבות הפוספט, מאיצה את הצורך בפיתוח תהליכים ייחודיים ושיפור ניצולת בתהליכים הקיימים הדרושים לשם האטת קצב הכריה והוזלתה. הכריה מתבצעת במכרות פתוחים –Open Pi באמצעות ציוד כריה והובלה גדול ככל שניתן והוא מותנה במבנה המרבץ, היקפו וצרכי המפעל המצוי בקרבתו. עיקר הפעילות הינה בהסרת הטפל העליון המונח מעל שכבות הפוספט ומהווה מרכיב של כ- 70% מעלות כרית העופרה. תהליכי ההשבחה נעשית ע"י סילוק מזהמים עיקריים ויצירת עופרה עשירה יותר בתחמוצת זרחן. שיטות ההשבחה במפעלים השונים שנבחרו קשורות לשיטות הכריה לאופי המרבץ ולכדאיות כלכלית. שיטות ההעשרה הפיזיות מסלקות עפ"ר את המקטעים הדקים והמקטעים הגסים של העופרה העשירים יחסית במזהמים, בעוד שיטות ההעשרה האחרות מסלקות ישירות את המרכיב המזהם (גיר ,חומר אורגני). מאפייני הסביבה העיסקית בה פועלת רותם הם: עליה בביקוש לדשנים בקצב של גידול האוכלוסיה וההכנסה הפנויה, השפעות לאיכות הסביבה וגורמי האקלים וקשר הדוק למחירי הגרעינים. המגמות העולמיות בשוק הדשנים מאופינות בתנודתיות במחירי דשני הפוספט, עודף היצע, צימצום הביקוש במערב אירופה מול שווקים צומחים בדרום מזרח אסיה ובדרום אמריקה והקטנת הסחר בסלע (אינטגרציה אנכית). מדיניות החברה מותאמת למאפיני הסביבה העיסקית והמגמות העולמיות בשוק הדשנים היא כוללת: ניצול מלוא כושר הייצור במפעלים ללא עליה משמעותית בהיקפי כרית חומרי הגלם, גידול בשווקים השבויים של החומצות, הגדלת החלק היחסי של מלחי פוספט וכימיקלים לתעשיה בעלי ערך מוסף גבוה והקטנת החלק היחסי של המוצרים לחקלאות, פיתוח דשנים מיוחדים ומורכבים המכילים נוטריאנטים נוספים כאשלגן, חנקן, גופרית , מיקרואלמנטים וכדו', הרחבת האופטימיזציה בשינוע הימי והיבשתי של מוצרי האשלג והזרחן כתוצאה ממיזוג השיווק בין מפעלי ים המלח לרותם והתבססות בשווקי היעד המרכזיים: דרום מזרח אסיה, אוקיאניה ודרום אמריקה וניצול מכירות הסלע המועשר כמנוף לוגיסטי למכירת דשנים תוך כדי שמירה על דומיננטיות בשוק הדשנים במערב אירופה. יש לציין, שחלק ממדיניות החברה הן השקעות גדולות באיכות הסביבה על מנת לעמוד בסטנדרטים סביבתיים גבוהים.

השפעת שינויי מפלס של בסיס הניקוז על מערכות מי תהום שבסביבתו – דוגמא מים המלח

יחיאלי, י., ליחובסקי, ו., כפרי, א.

המכון הגיאולוגי, ירושלים 95501

ההשפעה של שינויים במפלס ים המלח על מערכת מי תהום בסביבתו נבדקה בעזרת מודלים הידרולוגים. נבדקו שני מקרים שונים: 1) עבור ירידת מפלס ים המלח עד הגעה לשיווי משקל במפלס נמוך יותר ב- 100-150 מטר, 2) עבור המקרה של אגם הלשון שמפלסו היה כ- 230 מטר גבוה יותר ממפלס ים המלח הנוכחי.

תמלחות בבקע ים המלח: מקורן והיחסים ההדדיים ביניהן

כץ, א.

המכון למדעי כדור הארץ, האוניברסיטה העברית בירושלים, גבעת רם, ירושלים 91904

המלחים הקונסרבטיביים בים המלח נתרמו במישרין מגופי מים מלוחים קודמים מאז ים סדום. הדבר מתבקש מכך שלא ניתן לייבש כליל תמלחת דומה בהרכבה הכימי למי ים המלח ולכן יורש כל גוף מים את מלחי קודמיו. נפילתן של תמלחות הבקע על קו עירבוב בין שתי תמלחות קצה מריניות, שוללת גם היא תרומות מלחים ממקורות אחרים.

מודל נומרי של היווצרות רצועות דחיסה בסלע סדימנטרי בעל נקבוביות גבוהה

כצמן, ר., אהרונוב, ע., שר, ה.

המחלקה למדעי הסביבה, מכון ויצמן למדע, ת.ד. 26, 76100 רחובות

רצועות דחיסה שהתגלו לאחרונה בסלעים סדימנטריים בעלי נקבוביות גבוהה, מהוות אזורים מישוריים ודיסקרטיים המאופיינים ע"י הקטנה משמעותית של נקבוביות הסלע וגריסת הגרגרים. רצועות הדחיסה עלולות להפריע לתהליכי זרימת מים ולשנות את פילוג הלחצים בתוך הסלע. אנו מציגים מודל נומרי לסימולציה של היווצרות רצועות דחיסה בסלעים הומוגניים ובלתי-הומוגניים בתנאי שפה שונים.

קונטרול טקטוני על היווצרות נפט מסלעי מקור מגיל קרטיקון עליון (סנון) במזרח התיכון וצפון אפריקה

טננבאום, א., ד. לואן, מ.[2]

1. קימרון נפט ומחצבים, רח ההסתדרות 19, הוד השרון
2. המכון הגיאולוגי (USGS), דנוור, קולורדו, ארה"ב

באזורים נרחבים של המזרח התיכון וצפון אפריקה החתך הסנוני הוא ביטומיני (לדוגמא, "פצלי השמן" של תצורת ע'רב). סלעים ביטומינים אלה לא נחשבו כסלעי מקור חשובים להידרוקרבונים עקב בגרותם הנמוכה. דעה זו השתנתה בעקבות מחקרים גיאוכימים וכיום ברור כי רב הנפטים בפרובינציות חשובות כגון אגן סירט בלוב, סואץ במצרים וכן בסוריה וטורקיה (וכמובן ים המלח!) נגזרו מסלעי הסנון. פעילויות טקטוניות מגוונות בטרציאר באגנים השונים יצרו את התנאים הדרושים להיווצרות הנפט.

הערכת איכות סלע באמצעות שיטות גיאופיסיות

יזרסקי, מ., סובולבסקי, ל.

המכון הגיאופיסי לישראל – ת.ד.182, לוד 71100

קורלציות בין Rock Quality Designation (RQD) למהירויות גלי לחיצה וגזירה בדוקות לסלעי גיר,דולומיט, בזלט וכו' מכל מיני אתרים של מדינת ישראל. קורלציות אלו משמשות לתחזית תנאים לאורך מסלולי שתי מנהרות.

מיבנה גיאוחשמלי של חתך רדוד באזורי יווצרות בורות לאורך חוף מערבי של ים המלח

יזרסקי, מ.

המכון הגיאופיסי לישראל – ת.ד.182, לוד

סקר בשיטת CVES בוצע בשני אזורי התפתחות הבורות בים המלח : עין גדי ונחל חבר דרום. בחלק רדוד של חתך באזורי הבורות מתגלה אנומלית התנגדות חשמלית גבוהה. ניתן לפענח אנומליות אלו כאזורי דקומפקצית קרקע. חוץ מזה בנחל חבר דרום מתחת לבורות מתגלה אנומלית התנגדות חשמלית נמוכה מאוד (כ-1 עד 6 הום). צורת אנומליה זו דומה להורסט עם חלק עליון הנמצא מעל מפלס מי תהום. יש להניח שאנומליות אלו קשורות לחומר חרסיתי שמחזיק מים מלוחים אחרי ירידת מפלס ים המלח. סיבה נוספת אפשרית היא ינטרוזיות מים מפני השטח.

ההרכב האיזוטופי של גפרית כעוקב אחר ההתנהגות הלימנולוגית של אגם הליסאן

טורפשטיין, ע.,[1,2] גבריאלי, א.,[1] שטיין, מ.[1]

1. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501
2. המכון למדעי כדור הארץ, האוניברסיטה העברית, ירושלים, 91904

ההרכבים האיזוטופים של הגבס בתצורת הליסאן (המבוטאים ביחס $\delta^{34}S$) משמשים לקביעת תנאי שקיעת הגבס באגם ולשחזור ההיסטוריה הלימנולוגית בהקשר לתקופות שיכוב עמודת המים ופוטנציאל החמצון-חיזור ששררו בגוף המים התחתון. אופקי גבס מסיבים ולמינרים וכן למינות ארגוניט נדגמו ברזולוציה גבוהה והתקבלה תמונה מפורטת של שלבי ומנגנוני שקיעת הגבס בתקופות של מפלסי מים גבוהים ונמוכים.

מנגנו-סידריט (אוליגוניט) ורודוכרוזיט במשקעים בשקע אטלנטיס II בים סוף

טייטל-גולדמן, נ.,[1] יזרסקי, ו.,[2] מוגילינסקי, ד.,[3] זינגר, א.[4]

1. האוניברסיטה הפתוחה, תל אביב
2. המחלקה להנדסת חומרים, אוניברסיטת בן גוריון בנגב, באר-שבע
3. היחידה למחקרים שימושיים, אוניברסיטת בן גוריון בנגב, באר שבע
4. המחלקה לקרקע ומים, הפקולטה לחקלאות האוניברסיטה העברית בירושלים, רחובות

מנגנו-סידריט (אוליגוניט) - רודוכרוזיט, תמיסה מוצקה של קרבונט הברזל, מנגן, סידן ומגנזיום נמצא במשקעים בשקע אטלנטיס II בים סוף. גבישים בגודל 2-3 מיקרון ובהרכב $0.17<Mn/Fe<0.21$, $0.04<Ca/Fe<0.13$ ו-$0<Mg/Fe<0.09$, יוצרים שכבות מונו מינרליות. מינרל זה התגבש ככל הנראה בתמלחת הידרותרמלית, אנאירובית.

שימוש ב- *bo* כגאו-ברומטור ביחידת הPQ ממזרח כרתים

טילדן, ר., קיש, ח.י.

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון בנגב, באר –שבע 84105

מדידת גודלי ה *bo* באיליט מיחידת ה PQ במזרח כרתים מלמדת על שני משטרי קירור: ערכי *bo* גבוהים מאפיינים עלייה מהירה מהעומק תוך כדי התקררות. ערכי *bo* נמוכים מאפיינים עליה מהעומק בשני שלבים נפרדים: שלב ראשון – ירידה בלחץ ללא התקררות ושלב שני שבו יש התקררות ללא ירידה גדולה בלחץ.

נסיגת נקודות נקע והתפתחות מקטעי ערוץ בעלי תלילות יתר לאורך מצוקי ההעתקים של אגן ים המלח

חביב, א.,[1,2] אנזל, י.,[1] זילברמן, ע.,[2] וויפל, ק.,[3] סטון, ג'.,[4] מטמון, א.,[5] פיפלד, ל.[6]

1. המכון למדעי כדור הארץ, האוניברסיטה העברית בירושלים, ירושלים 91904, ישראל.
2. המכון הגיאולוגי , מלכי ישראל 30, ירושלים 95501, ישראל.
3. המחלקה למדעי האטמוספירה וכדוה"א, המכון הטכנולוגי של מסצוסטס, קיימברידג', מסצוסטס 02139, ארצות הברית.
4. המחלקה למדעי כדוה"א והחלל, אוניברסיטת וושינגטון, סיאטל, וושינגטון 98195, ארצות הברית.
5. המכון הגיאולוגי האמריקאי, מנלו פארק, קליפורניה 94025, ארצות הברית.
6. המחלקה לפיזיקה גרעינית, האוניברסיטה הלאומית של אוסטרליה, קנברה, אוסטרליה.

קצב הנסיגה של נקודות נקע בערוצים הסלעיים של אגן ים המלח נמצא תלוי בגודל אגן הניקוז. ניכר כי תלות זו מוכתבת בעיקר ע"י תהליכי אירוזיה המושפעים משפיעה של מי תהום רדודים בחזית מפלים. קצבי נסיגת נקודות הנקע נמדדו בעזרת איזוטופים קוסמוגנים. פונקציית ההתחתרות בראש נקודת נקע פותחה תיאורטית ושולבה במודל נומרי להתפתחות ערוץ במעלה מפל.

מגמות נוגדות בשינויי מיפלס ימת כינרת וים המלח

חזן, נ.,[1] שטיין, מ.,[2] מרקו, ש.[3]

1. המכון למדעי כדה"א, האוניברסיטה העברית, גבעת רם, ירושלים, 91904
2. המכון הגיאולוגי, רח' מלכי ישראל 30, ירושלים, 95501
3. המחלקה לגיאופיזיקה ומדעים פלנטריים, אוניברסיטת תל אביב, רמת אביב, 69978

ים המלח וימת כינרת המודרניים הינם גופי מים שאריתיים אחרי אגמים קדומים שהתפתחו בפלייסטוקן ובהולוקן תוך שינויי מיפלס תכופים. בעוד ששינויי מיפלס גדולים (עשרות מטרים) היו סינכרונים בשני האגמים. שינויים קטנים (מטרים ספורים) אינם תואמים בזמן. אנו מסבירים זאת בחסימה (חלקית) או בפתיחת ערוץ הירדן לזרימת מים מהכינרת לים המלח

המינרלוגיה, פטרוגרפיה ויחסי $^{87}sr/^{86}sr$ בסדימנטים דטריטים דקים מחבורת ים המלח: מקור ואמצעי הובלה

חליווה, ע.,[1,2] סטרינסקי, א.,[1] שטיין, מ.[2]

1. המכון למדעי כדה"א, האוניברסיטה העברית, גבעת רם, ירושלים, 91904
2. המכון הגיאולוגי, רח' מלכי ישראל 30, ירושלים, 95501

המינרלוגיה הפטרוגרפיה ויחסי $^{87}sr/^{86}sr$ נילמדו בסדימנטים דקי גרגר מתוצרת סמרה ליסאן וצאלים וכן בחומר דטריטי דק משיטפונות באגן ים המלח. מרבית הסדימנטים הם סילטים עם מעט חרסיות וחול. המינרלים הם בעיקר: קוורץ, קלציט, דולומיט, פלצפר וחרסיות. גודלי הגרגר המינרלים ויחסי $^{87}sr/^{86}sr$ דומים לנתוני אבק מדברי שנישא בהווה לאיזור ולמשקעי הלס הפלייסטוקניים.

המלחת דרום אקויפר החוף ע"י מים אאוקניים: שימוש בסיליקה מומסת כסמן

זילברברנדת, מ.,[1] רוזנטל, א.[2]

1. השירות ההידרולוגי, ת. ד. 36118, ירושלים 91360
2. החוג לגיאופיסיקה ומדעים פלנטריים, אוניברסיטת תל-אביב

ריכוז סיליקה מומסת במי תהום אאוקניים (35-45 מג"ל) עולה בהרבה על ריכוז הסיליקה הטבעי באקויפר החוף (10-15 מג"ל). על סמך זה נחקרה המלחת דרום אקויפר החוף מהמזרח. התברר שהמלחת רקע רחבה של 250-400 מכ"ל קשורה עם כניסת מים אאוקניים. בתנאים "בלתי מופרים" של שנות החמישים דרום אקויפר החוף כלל כ17%- של מים אאוקניים.

הכללת תגובת האתר למטרת בניית תרחיש של רעידת אדמה לאזור מישור החוף

זסלבסקי,י., גורשטיין,מ., קלמנוביץ',מ., פרלמן,נ., גילר,ו., ליבשיץ,י., גילר,ד., דן,י., אקסיננקו,ט., אטייב,ג., שברצבורג,א., שפירא,א.

אגף הסיסמולוגיה, המכון הגיאופיסי לישראל, ת.ד. 182, לוד, ישראל 71100

להערכת תגובת האתר נערכו מדידות ב-190 נקודות ברצועת מישור החוף מאשקלון עד חיפה. התוצאות גילו שינויי תדר תהודה מ-1 עד 6 הרץ וערך הגברה מ-1 עד 8. על בסיס נתונים ניסיוניים ובהתחשבות בנתונים גיאולוגיים, גיאופיסיים וגיאוטכניים נבנו מודלים חד ממדיים של תת הקרקע אשר שימשו לחישוב ספקטרום תאוצות לתדרים שונים

מאפייני תגובת האתר לסלע קשה.

זסלבסקי, י., שפירא, א., ארזי, א.

אגף הסיסמולוגיה, המכון הגיאופיסי לישראל, ת.ד. 182, לוד, ישראל 71100

שני אתרים באזור ים המלח, אחד ממוקם על תשתית סלע ושני במנהרה בתוך סלע קשה, וכן אתר בקרבת אילת, הממוקם על סלע בלוי וסדוק, גילו ערכי הגברה ניכרים המבצעיים על סיכונים סיסמיים גבוהים מבחינת בנייה אזרחית. אנו סבורים כי סיבת התופעה היא התאבכות בין גלים פוגעים לבין גלים מוחזרים.

נדידת גבולה הצפוני של רצועת המדבריות הסהרו-ערבית במזרח הים התיכון במהלך פלייסטוקן מתוך רקורד משקעי מערות

ווקס, א.,[1-2] בר-מטיוס, מ.,[2] איילון, א.,[2] פרומקין, ע.,[3] מטיוס, א.[1]

1. **המכון למדעי כדור הארץ, אוניברסיטה העברית, גבעת רם, ירושלים 91904**
2. **המכון הגיאולוגי הישראלי, מלכי ישראל 30, ירושלים 95501**
3. **המחלקה לגיאוגרפיה פיזית, אוניברסיטה העברית, הר הצופים 91905**

מיקומו של הנגב בגבולה הצפוני של רצועת המדבריות הסהרו-ערבית ועושרו במערות המכילות משקעי מער (ספלאוטמים) מאפשרים לקבוע כיצד השתנה גבולו הצפוני של המדבר. תיארוך הספלאוטמים מהנגב הראה תנאים לחים מאלו השוררים היום, התקיימו לאחרונה בנגב הצפוני בתקופת הקרח האחרונה ובהולו המוקדם, ובנגב המרכזי רק בתחילתה של התקופה הבינקרחונית הקודמת.

תמורות במבנה מערת מיסלייה בכרמל ב 300,000 השנים האחרונות

וינשטיין-עברון, מ.[1], זיידנר, י.[1], צצקין, א.[1], פרומקין, ע.[2] ושוורץ, ה.[3]

1. **מכון זינמן לארכיאולוגיה, אוניברסיטת חיפה.**
2. **המחלקה לגיאוגרפיה, האוניברסיטה העברית, ירושלים.**
3. **ביה"ס לגיאוגרפיה וגיאולוגיה, אוניברסיטת מקמסטר, המילטון, אונטריו, קנדה.**

במערת מיסלייה בכרמל השתמרו שכבות ארכיאולוגיות מהפליאולית התחתון (אשלו-יברודי) והתיכון (מוסטרי מטיפוס טבון D). גיל השכבות מוערך בהשוואה לרצפים מקבילים באזור. צורת המצוק, מפולות הסלעים על המדרון, אופי הברקציה הארכיאולוגית ושברי נטיפים בשכבות מצביעים על כך שזו מערה שהתמוטטה, תוך כדי הישוב הפרהיסטורי באתר.

מיפוי גיאוכימי ואיזוטופי של מי התהום באקוויפר החוף: השפעת החדרת מי כינרת על איכות מי התהום

ולדר, א.,[1] ונגוש, א.,[1] אילון, א.[2]

1. **המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון, באר- שבע**
2. **המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501**

השפעת החדרת מי הכינרת על איכות מי התהום באקוויפר החוף נבחנה על רקע ההבדלים הגיאוכימיים והאיזוטופים של מי כינרת לעומת מי תהום באקוויפר וגופי מים אחרים. השונות האיזוטופית מאפשרת מיפוי המים המוחדרים באקוויפר ולימוד מגמות זרימה. נמצא כי באזור אגן זוהר החדרה משמעותית של מי מוביל גרמה להאטת קצב ההמלחה של האקוויפר.

אפיון גיאוכימי ואיזוטופי (בורון וסטרונציום) של מי התהום באקויפר אבן החול הנובית מגיל קרטיקון תחתון

הניג, ש.[1] ונגוש, א.[1] גנאור, י.[1] בולן, ת.ד.[2]

1. המחלקה לגיאולוגיה ומדעי הסביבה, אוניברסיטת בן-גוריון בנגב, באר שבע, ישראל
2. המחלקה לחקר מים, המכון הגיאולוגי האמריקאי, מנלו פארק, קליפורניה

עבודה זו באה לחקור את מקור המליחות של מי התהום באקויפר אבן החול הנובית (קורנוב) ואקויפר חבורת יהודה וזאת ע"י בדיקת ההרכב הכימי והאיזוטופי (חמצן, מימן, בורון וסטרנוציום) של מי התהום. האנליזות הכימיות והאיזוטופיות המוצגות בעבודה מתבססות על 43 קידוחים מאזור הנגב והערבה.

מגמתם של סדקים רב שכבתיים בכיוון NE כדרך אפשרית לתנועת מי תהום מרמת חובב לבאר שבע

ווזנסנסקי , ו.

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון בנגב, ת.ד. 653 באר שבע 84105

ככל הנראה, תנועת מי התהום מרמת חובב לכיוון באר שבע בתוך אקוויפר עבדת הנה בעלת אופי של זיגזג, בעיקר לאורכם של סדקים רב שיכבתיים בכיוון NE (45^0-55^0).

נפילתו של אגם הסמרה ועלייתו של אגם הלשון: המעבר בין התקופה הבין-קרחונית האחרונה לתקופה הקרחונית האחרונה בבקע ים המלח

וולדמן, נ.[1] שטיין, מ.[1] סטרינסקי, א.[1]

1. המכון למדעי כדור הארץ, האוניברסיטה העברית, ירושלים 91904
2. המכון הגיאולוגי, מלכי ישראל 30, ירושלים 95501

מספר אגמים התקיימו בתקופת הפלייסטוקן בבקע ים המלח, התפתחותם משקפת את השינויים האקלימיים ולימנולוגיים שחלו באזור.
במחקר הנוכחי נחקר נפילתו של אגם הסמרה, אשר התרחש לפני כ- 70 אלף שנה. נבדקו המאפיינים המורפולוגיים והסדימנטולוגיים של ארוע זה וכן המשמעות הלימנולוגית ופלאואקלימית.

קצב השקעת גבס בתערובות מי הים האדום ומי ים המלח – תוצאות ראשוניות

גנאור, י., אביטל א., טלבי ר.

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן-גוריון, באר-שבע, 84105

בניסויי מעבדה נבדק קצב ההשקעה של גבס מתערובת של מי ים ומי ים המלח. תוצאות ראשוניות מראות שקצב ההשקעה פרופורציונלי לכמות הגבס. בניסוי שנערך בלא נוכחות גרעיני התגבשות של גבס, נוצרו גרעיני התגבשות של גבס בתוך פחות מיממה. לאחר מכן, קינטיקת ההשקעה היתה זהה לזו שבניסויים בהם הוספו גרעיני גיבוש.

פאזות טקטוניות מזוזואיות ופוטנציאל הנפט של אגן דרום מזרח הים התיכון: תוצאות מסקרים סייסמים ימיים חדשים

גרדוש, מ.[1] דרוקמן, י.,[2] ברונר, א.,[1] רזניקוב, מ.,[1] בוכבינדר, ב.,[3] שגיא, י.[1]

1. המכון הגיאופיסי לישראל, רחוב הבעש"ט 6 , לוד 71100.
2. משרד התשתיות הלאומיות, רחוב יפו 216, ירושלים 91130.
3. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501

סקרים סייסמים רגיונלים שבוצעו לאחרונה מראים פרטים חדשים על המבנה העמוק של דרום מזרח הים התיכון. זוהו מערכות מבני מתיחה ולחיצה אשר נוצרו במהלך הפאזות הטקטוניות הראשיות שעצבו את האגן במשך המזוזואיקון. הנתונים מצביעים על הפוטנציאל הקיים לחיפושי נפט באזור.

פענוח של רעידות במשולש AFAR בשנים 1960-2000

הופשטטר, ר.,[1] בייט, מ.[2]

1. מכון גיאופיזי לישראל, ת.ד. 182, לוד 71100
2. מכון גיאולוגי לישראל, רח' מלכי ישראל 30, ירושלים 95501

אנו מציגים מחקר של רעידות אדמה אשר התרחשו במזרח אפריקה בשנים 1960-2000, יחד עם פתרונות של מיכניזם של 125 ר"א וניתוח סייסמוטקטוני שלהן.

מורפולוגיה של הקרקעית בצפון מערב הכינרת

גולדשטיין, ט.[1] טיבור, ג.[1] בן אברהם, צ.[1] חרות, ב.[2] נישרי, א.[3] צוריאלי, א.[1]

1. אוניברסיטת תל אביב החוג לגאופיסיקה ומדעים פלנטריים
2. חקר ימים ואגמים לישראל, המכון הלאומי לאוקיאנוגרפיה, חיפה
3. המעבדה לחקר הכינרת, חקר ימים ואגמים לישראל

הקרקעית בצפון מערב הכנרת מאופיינת באזורים של שחרור גז מקומי ושחרור דפוזי נרחב יותר. בורות גדולים (קוטר 30-1 מטר, עומק 8-0.3 מטר) מאפיינים בעיקר את אזורי השברים. מכניזם אפשרי ליצירת הבורות שיבחן בבדיקות גאוכימיות הוא זרימה של מים מלוחים באזורי השבירה, באופן שקיימת התאמה בין גודל הבור למשך ועוצמת הזרימה.

התאמה בין גיאולוגית פני השטח לתגובת האתר לאורך מישור החוף של ישראל

גורשטיין, מ.[1] זסלבסקי, י.[1] בגין, ב.[2] קלמנוביץ', מ.[1] שפירא, א.[1]

1. אגף הסיסמולוגיה, המכון הגיאופיסי לישראל, ת.ד. 182, לוד, ישראל 71100
2. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501

במישור החוף בין אשקלון לחיפה ערכנו מדידות רעש רקע ב-190 נקודות מדידה בתנאי מסלע שונים. תוצאות המחקר מראות שבקירוב ראשון קיימת התאמה בין גיאולוגית פני השטח לבין התכונות העיקריות של פונקצית תגובת האתר (תדר תהודה והגברה) בכל נקודת מדידה., אך לצורך תרחישי רעידות אדמה מפורטים יש לבצע מדידות נוספות באתרים הנחקרים.

נופים קדומים בהולוקן בחוף הכרמל הצפוני, ישראל

גלילי, א.[1], וינשטיין-עברון, מ.[2], צביאלי, ד.[3], רונן, א.[2]

1. היחידה לארכיאולוגיה ימית, רשות העתיקות.
2. מכון זינמן לארכיאולוגיה, אוניברסיטת חיפה.
3. החוג לגיאוגרפיה, אוניברסיטת חיפה.

בראשית ההולוקן ניקז קניון נחל אורן נחלים בין מהר"ל ומגדים. נחלים בין מתלה ואחוזה נוקזו בקניון שחז רכס השקוע כיום בים. ב PPNC החוף מצפון לעתלית סלעי ומפורץ ובדרום ישר וחולי. כשמולאה המרז במשקעים שונה דגם הניקוז, נחלים גלשו מעל רכס הכורכר המזרחי וזרמו הישר לים. ב PN צפונה לעתל החוף חולי וישר ומולו סדרת איים.

פרוס תנועת מומסים לאורך מישור סידוק בסלע קירטון

ברנשטין, ע.,[1,2] אדר, א.,[1,2] יקירביץ', א.,[1,2] נתיב, ר.[3]

1. המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן-גוריון בנגב, ת.ד. 653, באר-שבע 84105
2. המכון למדעים וטכנולוגיות של מים במכונים לחקר המדבר ע"ש יעקב בלאושטיין, אוניברסיטת בן גוריון בנגב, קריית שדה בוקר 84990
3. מרכז סיגרם למדעי הקרקע והמים, האוניברסיטה העברית בירושלים, ת.ד. 12 רחובות, 76100

שני ניסויי עוקבים בוצעו בין מספר קידוחים לצורך אפיון תנועת מומסים לאורך שני מישורי סידוק ברמת חובב. ניסוי עוקבים אחד נערך בתנאי זרימה יציבים בזמן וניסוי העוקבים השני בתנאי זרימה משתנים בזמן. ניתוח תוצאות הניסוי נעשה על ידי שימוש בשני מודלים שונים של הסעה.

מבנה תת הקרקע והגברה סייסמית

גבירצמן, ז.,[1] זסלבסקי, י.[2]

נמצאה התאמה בין מבנה תת הקרקע באזור השפלה לערכי ההגברה שנמדדו בשיטת נקמורה. הכללה ראשונית המתייחסת לכל הסלעים המכסים את חבורת יהודה כחבילה אחת מצביעה על חוקיות בערכי התדר. חלוקת הכיסוי הנ"ל ל- 4 יחידות משנה משפרת מאוד את יכולת התחזית, אם כי חיזוי העוצמה עדיין בעייתי.

אפיון מליחות מי תהום בתת-אקויפרים השונים של אקויפר החוף בעזרת שיטת ה-TDEM

גולדמן, מ.,[1] כפרי, א.,[2] גנדלר, מ.[1]

1. המכון הגיאופיסי לישראל, רחוב הבעש"ט 6, לוד, 71100
2. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501

השימוש בשיטת ה-TDEM הצליח לאתר אזורים עם גופי מים מתוקים ומליחים בתת האקויפרים העמוקים של אקויפר החוף, לעתים קרובות מתחת לחדירות מי ים בתת האקויפרים העליונים.

מעוות אינטרסייסמי לאורך חלקו הדרומי של בקע ים המלח: מדידה באינטרפרומטריה של רדאר (InSAR)

בר, ג.[1] פינצי, י.[1,2] רכס, ז.[2]

1. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים 95501
2. המכון למדעי כדור הארץ, האוניברסיטה העברית, ירושלים 91904

תנועות אנכיות בקצב שבין 5 מ״מ בשנה ו – 85 מ״מ בשנה נמדדו לאורך בקע ים המלח הדרומי באמצעות אינטרפרומטריה של רדאר. בשלושה מקרים לפחות ניתן ליחס תנועות אלה לאירועי זחילה באזורי הדירוג בין ההעתקים הראשיים. התרוממות נצפתה באזורי דירוג ימני, ושקיעה התרחשה באזורי דירוג שמאלי. תצפיות אלה מצביעות על האפשרות שבעשור האחרון פני השטח לאורך הקטעים העיקריים של בקע ים המלח הדרומי נעולים, וזחילה מתבצעת בעיקר באזורי הדירוג.

סטרטיגרפית רצפים בפלייסטוקן המאוחר – תצפיות שדה ומודל

ברטוב, י.[1] אנזל, י.[1] שטיין, מ.[2]

1. **המחלקה למדעי כדור הארץ, האוניברסיטה העברית, ירושלים, גבעת רם 91904.**
2. המכון הגיאולוגי, רח׳ מלכי ישראל 30, 95501 ירושלים

השימוש בסטרטיגרפית רצפים ובעקומת מפלסי אגם הלשון מאפשרת הצבת מגבלות כמותיות במודל נ המשחזר את החתך הסטרטיגרפי בדלתאות ים המלח מתקופת הפלייסטוקן המאוחר. הגדרת המשתנים הנ על המילוי הסדימנטרי באגן מלמדת על ההיסטוריה האקלימית והטקטונית של האגן בתקופה זו.

מחקר בעיות סטרטיגרפיות וסטרוקטורליות בעקבות מפוי הנגב, 1948-2003

ברטוב, י.

המכון הגיאולוגי, מלכי ישראל 30, ירושלים 95501

עבודתם של יעקב בן תור ועקיבא פרומן במסגרת ״מפוי הנגב״ מהווה את ראשיתו של המחקר הגיאולוגי הסיסטמטי , אשר המשיכה עבודות חלוציות, והיוותה יסוד למחקרי תלמידיהם. הנושאים העיקריים שהועלו על ידם היו נושאים סטרטיגרפיים וסטרוקטורליים, אשר נגעו להתפתחות הקשת הסורית, העתקי הרוחב והבקע. ההתענינות בנושאים אלה התפתחה והתרחבה עם הכנסתן של שיטות מחקר חדישות בתחומים רבים.

תגובת מערכת הידרוגרפית ל-Thrusting בצפון הרי טיין-שאן, קירגיסטאן

באומן, ד.,[1] קורז'נקוב, א.,[2] פורת, נ.,[3] קזסני, ב.[4]

1. אוניברסיטת בן-גוריון בנגב, באר שבע 84105
2. המכון הסייסמולוגי, בישקק, קירגיסטאן
3. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים95501
4.המכון למדעי האדמה, אוניברסיטת פוטסדם, גרמניה

מערכת הידרוגרפית, שניזונה מרצועת הרים גבוהה, הצליחה לבתר קמט צעיר מ-ka 167 אשר התרומם דרך בחדה בניצב למערכת הניקוז. בהמשך תהליך ההתחתרות ותוך יצירת העמקים הרצנטיים שגילם המינימלי ka 21 , הופסקה הזנת הבחדה שהפכה למישטח אלובילי פוסילי. הנחלים הקדמנים, חוצי הקמר לשעבר, הפכו underfit .

ניטור שפיעת ראדון באתר גבנונים, דרום מכתש רמון

בלוג, ב., שטייניץ, ג., גזית-יערי, נ., מליק, א.

המכון הגיאולוגי, ירושלים

ניטור ראדון ברזולוציית זמן גבוהה מתבצע מאז 1996 באינטרוזיה של הגבנונים, בעומק 1.2 ו-90 מטר. מופעים אחדים של רמות ראדון ניכרים – שינויים יומיים (בעומק רדוד בלבד), רב-יומיים (רדוד ועמוק) וספייקים קצרים (רק בעומק). התופעות אינן קשורות ישירות עם שינויים אטמוספריים והנחת העבודה היא שהן מייצגות תהליכים בתת-הקרקע, ככל הנראה גיאודינמיים.

סקר גיאופיסי בהפרדה גבוהה באדמות הכבול בעמק החולה

בן-גיא, י.,[1] ליטאור, מ.א.,[2] שטיבלמן, ו.[1]

המכון הגיאופיסי לישראל, ת.ד. 182 לוד 71100
המחלקה לביוטכנולוגיה ומדעי הסביבה, מכללה אקדמית תל-חי, גליל עליון

סקרים סייסמיים שנעשו בעבר באדמות הכבול בחולה הראו כי הדמיית החתך הרדוד הינה בעייתית. מטרת המחקר הנוכחי היא לבחון שיטות להדמיית החתך הרדוד לצורך זיהוי נתיבי זרימה כגון תעלות עתיקות, סדקים ושברים. התוצאות מראות כי ניתן לאתר תעלות עתיקות וכי המהירויות הסייסמיות הינן נמוכות מאד, דבר המאפיין חתך בתת-רוויה.

בורות ים המלח – סימפטום לשחרור אקוות כורנוב?

ארזי, א. א.

יועץ גיאוטכני, רחוב קריניצי 80, רמת גן 52601

המודל המסביר את בורות ים המלח כתוצאה של תהליכים באקווה האלוביאלית הרדודה מתקשה להסביר פרמטרים עיקריים של התפתחות התופעה במרחב ובזמן. להסברתם, מוצע מודל חלופי לפיו נסיגת האגם הגיעה לרמה קריטית שבה התגברה באופן חד הנביעה מאקוות כורנוב דרך שברי האגן העמוק וגרמה המסת חללים בגופי מלח בטווח עומקים רחב.

השפעת פעילות מיקרוביאלית על פירוק 2,4,6 טריברומופנול ועל התכונות ההידראוליות של קרטון סדוק

ארנון, ש.[1,2] אדר, א.[1,2] רונן, ז.[2] יקירביץ, א.[2] נתיב, ר.[3]

1. המחלקה להידרולוגיה ומיקרוביולוגיה של הסביבה, המכון למדעים וטכנולוגיות של מים שבמכונים לחקר המדבר בשדה בוקר, אוניברסיטת בן-גוריון בנגב.
2. המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן-גוריון בנגב.
3. המחלקה לקרקע ומים, הפקולטה לחקלאות ברחובות, האוניברסיטה העברית בירושלים.

שימוש בחיידקים כחלק מאסטרטגיה של שיקום אקויפרים קירטונים סדוקים המזוהמים בתרכובות אורגניות. בחינה של הגורמים המשפיעים על פירוק מזהמים אורגנים ע"י חיידקים במהלך זרימה בסדקים בסלע קרטוני, והשפעת הפעילות המיקרוביאלית על התכונות ההידראוליות של קרטון סדוק.

Thrusting לרגלי חזית הרים בצפון הרי טיין-שאן, קירגיסטאן

באומן, ד.[1] קורז'נקוב, א.[2] פורת, נ.[3] קזסני, ב.[4]

1. אוניברסיטת בן-גוריון בנגב, באר שבע 84105
2. המכון הסייסמולוגי, בישקק, קירגיסטאן
3. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים,95501
4.המכון למדעי האדמה, אוניברסיטת פוטסדם, גרמניה

על בסיס חתכים גיאולוגים ומיפוי בתעלות שוחזר קמט (thrust-generated front anticline) שהתרומם דרך בחדה וחצה אותה לשניים. התנועה צעירה ל 167 ka לפני ההוה , שהוא גיל סדימנט הגג של הבחדה. הקמט מבטא תנועה במגמה לסגירת אגנים תוצאת collision tectonics.

השפעת מדיניות התפעול של מערכת המים הארצית על מגמת ההמלחה באקויפר החוף

אסולין, ש.[1] שביט, א.[2]

1. המכון למדעי הקרקע, המים והסביבה, מנהל המחקר החקלאי, בית דגן
2. הפקולטה להנדסה אזרחית וסביבתית הטכניון, חיפה

במערכת המים הארצית, אקויפר החוף הנו מאגר הויסות הרב-שנתי העיקרי וכתוצאה מכך הוא בעל חשיבות אסטרטגית. כיום, קיימת מגמה ברורה של עליה במליחות המים באקויפר החוף. העבודה בוחנת בעזרת חישובי מאזן כוללים ובעזרת פתרון נומרי דו ממדי מקורב את הקשר בין מדיניות התפעול בכלל, ומדיניות השאיבה וההחדרה בפרט, על קצב ההמלחה באקויפר.

פיענוח של אנומליות מגנטיות – תרומה להבנת מבנה אגן הכינרת

אפלבאום, ל.[1] בן-אברהם, צ.[1] כץ, י.[2] מרקו, ש.[1]

1. חוג לגיאופיזיקה ומדעים פלנטריים, אוניברסיטת תל אביב
2. המוזיאון הזואולוגי, אוניברסיטת תל אביב

ניתוח של השדה המגנטי שנמדד על פני הכינרת משפר את הבנת מבנה האגן. שילוב של פולריות נורמלית והפוכה של בזלות מתקופת הפליוקן מכתיב את אופי האנומליות.

פיתוח גישה רב-שיטתית לאינטרפראטציה של נתונים גאופיזיים באתרי המחקרים הארכיאולוגיים

אפלבאום, ל.[1] יעקובוב, י.[2] אפלבאום, מ.[3]

1. החוג לגיאופיזיקה ולמדעים פלנטריים, אוניברסיטת תל-אביב, רמת-אביב 69978, תל-אביב
2. החוג למתמטיקה, אוניברסיטת תל-אביב, רמת-אביב 69978, תל-אביב
3. היחידה למתמטיקה, המכללה האקדמית להנדסה בנגב, באר-שבע 84100

שדות גאופיזיים פוטנציאליים (שיטות מגנטיות, התנגדות חשמלית, פוטנציאל עצמי, גרביטציוניות, טמפרטורות) משמשים לעיתים קרובות לגילוי וזיהוי של אובייקטים ארכיאולוגיים. אינטרפרטציה כמותית של שדות אלה מתבצעת בדרך כלל על בסיס בניית המודל יחיד שיתאר את האובייקט של החקירה. על סמך תאוריה מתמטית של תיכנון הניסוי אנו משערים כי שימוש במספר מודלים שונים לחקירתו של אובייקט מסוים עשוייה להגדיל במידה רבה את הדיוק ואת הביטחון בגילוי של האובייקט הנחקר.

תהליכי המלחה וזיהום של מי תהום מתחת שדות חקלאיים בסביבה ארידית, דוגמא מהערבה התיכונה

אורן, א.,[1,2] יחיאלי, י.,[1] דודי, א.[2,3]

1. המכון הגיאולוגי, רחוב מלכי ישראל 30, ירושלים, 95501.
2. המחלקה לגיאוגרפיה ופיתוח סביבתי, אוניברסיטת בן גוריון בנגב, באר שבע.
3. הקריה למחקר גרעיני נגב, ת. ד. 9001, באר שבע.

מטרת המחקר הינה להבין את תהליכי ההמלחה והזיהום של מי התהום בסביבה ארידית כתוצאה מפעילות חקלאית. במהלך המחקר נעשה שימוש בנתונים פיסיים, כימיים ואיזוטופיים לצורך תאור המערכת ההידרוגיאולוגית ובחינת מגמות ההעשרה של מים ומלחים לאקוויפר. השקיה ודישון אינטנסיביים משפיעים באופן ניכר על כמות ואיכות מי המילוי החוזר של האקוויפר. תהליכי ההמלחה העיקריים הם: 1. המלחה כתוצאה מסחרור מלחים הנמצאים במי ההשקיה עצמם ו- 2. תרומה של מלחים מעודפי דשנים.

מיפוי מגנטי מפורט של אתרים ארכיאולוגיים בישראל

איטקיס, ס., חסין, ב., פיינשטיין, ש.

המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן גוריון בנגב, 84105, באר שבע

שיפור ניכר בדיוק המדידות המגנטומטריות בעשרות השנים האחרונות מאפשר למפות אובייקטים ארכיאולוגיים קטנים יחסית עם הבדלים קטנים בתכונות מגנטיות ביחס לסביבתם. המטרה העיקרית של המחקר הנוכחי היא אופטימיזציה של סקר מגנטי מפורט ופיתוח שיטה למיפוי אלמנטים ארכיאולוגיים בסביבות גיאולוגיות-גיאופיסיות מורכבות ומגוון רחב של סוגי אתרים.

זיהום החתך הרווי והבלתי רווי של אקויפר החוף במרכיבים אורגנים נדיפים

אלחנני, ש.,[1] רונן, ד.,[2] גרבר, א.[3]

1. אגף איכות מים, נציבות המים, ת.ד.20365, תל-אביב 61203
2. אגף איכות מים, נציבות המים, ת.ד.20365, תל-אביב 61203 והמחלקה להידרולוגיה ומיקרוביולוגיה סביבתית, אוניברסיטת בו גוריון בנגב
3. המכון למדעי הקרקע, המים והסביבה, מכון וולקני, ת.ד. 6, בית-דגן 50250

בעבודה להערכת היקף זיהום מי התהום באזור גוש דן נמצא זיהום רחב היקף במרכיבים אורגנים נדיפים (VOC's) שחלחלו לאקויפר, ממקורות זיהום תעשייתים בפני השטח . פלומת הזיהום משתרעת על פני שטח של כ- 200 קמ״ר. רכוזים גבוהים במיוחד של טריכלוראתילן נדגמו הן באזור הלא-רווי כפאזה גזית (עד 124,000 מיקרוגרם לליטר אויר) והן באזור הרווי (250,000 מקרוגרם לליטר מים) בשטח התעשיה הצבאית.

ההיסטוריה הגיאולוגית של מדף היבשת הרדוד בקוורטר העליון על פי קידוחים ימיים באזור אשקלון, ישראל

אביטל, א.,[1,2] אלמוגי-לבין, א.,[2] בנימיני, ח.[1]

1. המחלקה למדעי הגיאולוגיה והסביבה, אוניברסיטת בן-גוריון בנגב, ת.ד. 653, באר-שבע, 84105.
2. המכון הגיאולוגי, מלכי ישראל 30, ירושלים 95501

ההסטוריה הגיאלוגית של מדף היבשת הרדוד ב 330,000~ השנים האחרונות שוחזרה על סמך ניתוח סדימנטולוגי ומיקרופאליאונטולוגי מפורט בשילוב של מגוון שיטות תיארוך מתקדמות בשני גלעינים ימיים ארוכים באזור אשקלון. זוהו היחידות העיקריות של החתך עם דגש על יחסי ים-יבשה ושוחזרו התנאים הסביבתיים והפליאואקלימיים של תקופה זו.

המעבר מתקופה פלוביאלית לתקופה בין-פלוביאלית בהר הנגב כפי שמשתקף בארועי השקעה והתחתרות במשך 50,000 השנים האחרונות

אבני, י.,[1,2] פורת, נ.,[1] פלכט, י.,[2] שנקמן, ו.[2]

1. המכון הגיאולוגי, מלכי ישראל 30, ירושלים 95501
2. מרכז מדע רמון, ת.ד. 194, מצפה רמון 80600

מופו ותוארכו בשיטת הלומיניסנסיה יחידות אלוביאליות וקולוביאליות בשני אגני ניקוז בהר הנגב – האחד טבעי והשני הכולל חוות נגר חקלאית קדומה. נמצא כי פאזה עיקרית של סדימנטציה אלוביאלית דקת גרגר התרחשה בהר הנגב בין 20-60 אלף שנה. מאז סוף הפלייסטוקן ובמשך ההולוקן מצוי האזור במשטר ארוזיבי מתמשך שהביא לחתירת הערוצים במספר שלבים. בניית חוות הנגר הביאה להשקעה של חומרי סחף דקי גרגר מאחורי מחסומי אבן. להשקעה זו שהתרחשה לפני 1400-1800 שנה אין משמעות אקלימית.

סמנים איזוטופיים באקוויטרד קרטוני סדוק

אדר, א.[1] נתיב, ר.[2]

1. אוניברסיטה בן גוריון בנגב
2. המחלקה למדעי הקרקע והמים, האוניברסיטה העברית, רחובות

טריטיום והיחסים האיזוטופיים של חמצן, מימן, גפרית שמשו לזיהוי מקורות מזהמים של מי התהום באקוויטרד הקרטוני, במקרים בהם היו מספר מקורות זיהום אפשריים וההרכב הכימי של מי התהום לא יכול היה לתרום לזיהוי.

מערכת זרימה בין אקוויפרית ברמת הגולן – גיר ובזלות מעקב בעזרת עפרות נדירות וייטריום (REY) ופענוח קווים סיסמיים
שולמן, ח., מלר, פ., רוזנטל, א., פלכסר, ע., גוטמן, י. 32

הגיאומורפולוגיה של רכס הרי נפתלי
שטובר זיסו, נ., גרינבאום, נ., ענבר, מ., פלכסר, ע.[1] 32

המשכו הימי של מבנה הכרמל ותפקידו במערך הטקטוני של אגן
שטנר, א., בן-אברהם, צ., האובשר, כ. 32

מבנה תת-הקרקע של החוף הצפון-מערבי של ים המלח – מחקר גיאופיסי
שטרית, מ., פיינשטיין, ש., אייל, י., ברונר, א., שמיר, ג. 33

מנגנון חדש להיווצרות פנוקריסטים של פירוקסן בסלעים וולקניים בסיסיים במכתש רמון
שימשילשוילי, א., יהודלביץ, ז. 33

המבנה הפעיל של צפון שקע ים המלח (בקעת יריחו-פצאל)
שמיר, ג., ברונר, א., אייל, י 33

שקע ים המלח: אזור גזירה פעיל של גבול לוחות
שמיר, ג 34

השטפון הגדול ביותר אי פעם (8-9/9/2002) בנהר הגרדון (צרפת) – האמנם?
שפר, נ., אנזל, י., גרודק, ת., ולדמן, נ., בניטו, ח. 34

דולומיטים של פלטפורמות: עדות לשחזור תנאים אקלימיים ואוקיאנוגרפיים
שש, א. 34

מדידות קצב התרוממות הר סדום בעזרת מדידות שדה
פארי, ש., בן-אברהם, צ., זבקר, ה., פרומקין, ע., שטיינברג, ג. 24

איכות מסת סלע קירטונית כמדד מכתיב עלות מנהרת תעבורה
פולישוק, צ. 24

תעלות של מניפת הנילוס בים העמוק שמול ישראל
פולקמן, י 25

זיהוי מקורות ומנגנוני המלחה לאורך נהר הירדן התחתון
פרבר, א., ונגוש, א., שביט, א., הולצמן, ר., סגל, מ., גבריאלי, א., בולן, ט., מאייר, ב. 25

זרימה קרסטית עמוקה וטרנסוורסלית באקוויפר ירקון-תנינים
פרומקין, ע., גבירצמן, ח. 25

תוכנת עיבוד מדידות שיטתיות לחישוב תכונות דינמיות של מבנים
פרלמן,נ., זסלבסקי,י. 26

תופעות מעוות סינסדימנטריות בקנומן-טורון של אזור אדמית, צפון-מערב הגליל
פרנק, ר., בנימיני, ח., אייל, י. 26

קצה המדף של ישראל בקנומן המאוחר
פרנק, ר., בנימיני, ח., אייל, י. 26

הערכה ומיפוי של סכנות טבע בחוף המערבי של ים המלח תוך שימוש בG.I.S
ציון, כ., בן אברהם, צ., ווסט בלוך, ה., טיבור, ג. 27

יציבות חללים תת קרקעיים בסלע משוכב וסדוק – פתרונות ספרתיים באמצעות מודל הדפורמציה הבלתי רציפה
צסרסקי, מ., חצור, י. ח. 27

חתרורים – האזור המגוון
קולחני, י. 27

מקור החתך הקלסטי מגיל פליאוזואיקון תחתון בדרום ישראל וירדן: תארוך צירקון דטריטי בעזרת מכשיר ה SHRIMP-RG
קולחנר, ק., אביגד, ד., וויסברוד, ט., מקוויליאמס, מ., וודן, ג. 28

אפיון הידראולי של האקוויטרד הקרטוני ברמת חובב ע"י תצפיות בסדקים בסקלות שונות
קורצמן, ד., נתיב, ר., אדר, א. 28

התנהגות מחזורית ארוכת-טווח של רעידות אדמה מרקורד פלאו-סייסמי ממשקעי מערות
קייגן, א., עגנון, א., בר-מטיוס, מ., אילון, א. 28

תמלחות ממעמקי המעטפת
קליין בן-דוד, ע., יזרעאלי, א.ש., נבון, ע. 29

פיתוח מודלים חד-ממדיים להערכת הסיכון הסיסמי על בסיס מדידות של רעש הרקע: משור החוף של ישראל
קלמנוביץ', מ., גורשטיין, מ., זסלבסקי, י. 29

הרכב מי התהום מתחת לאזורים המושקים במי קולחין ומים שפירים באקויפר החוף
קס, ע., גבריאלי, א., יחיאלי, י., ונגוש, א., סטרינסקי, א. 29

פרקציונציה איזוטופית של חמצן בין קלציט לקורונדום במט-באוקסיטים מנקסוס: לקראת כיול התרמומטר
קציר, י., ואלי, ג.ו., ספיקוזה, מ.ג'. 30

שימוש באיזוטופים של חנקן וחמצן לזיהוי מקורות ותהליכי זיהום חנקות באקוויפר החוף של ישראל
רוזד, ד., ונגוש, א., מאהייר, ב. 30

מבנה תת הקרקע של עמק ההולה עפ" פענוח מידע גרבימטרי
ריבקוב, מ., פלישר, ל., טן ברינק, א. 30

מבנה הליתוספירה באזור הלבנט ודרום - מערב הים התיכון והאיזון האיזוסטטי החל מתקופת הפליוקן
שגב, ע., ריבקוב, מ., ליחובסקי, ו., הופשטטר, א., טיבור, ג., בן- אברהם, צ. 31

הדפורמציה של שולי אגן ים המלח ומשמעותה הטקטונית
שגיא, א., רכס, ז 31

על "משחק המחבואים" בין הגורמים הגיאולוגיים וזרימת מי התהום באזור פצאל יריחו
שולמן, ח., פלכסר, ע., גוטמן, ., ילין-דרור ע., רוזנטל, א., אנקר, י. 31

יזרסקי, מ. 15

השפעת שינויי מפלס של בסיס הניקוז על מערכות מי תהום שבסביבתו – דוגמא מים המלח
יחיאלי, י., ליחובסקי, ו., כפרי, א. 16

תמלחות בבקע ים המלח: מקורן והיחסים ההדדיים ביניהן
כץ, א. 16

מודל נומרי של היווצרות רצועות דחיסה בסלע סדימנטרי בעל נקבוביות גבוהה
כצמן, ר., אהרונוב, ע., שר, ח. 16

שימוש בממ"ג (GIS) להערכת סיכוני רעידות אדמה בתחום העיר ירושלים
כרובי, א., סלמון, ע., כץ, ע. 17

מרבצי הפוספט בישראל כבסיס לתעשית הזרחן- בעיות ומגמות לעתיד
לוי, י. 17

מחקר מקיף של אזור יריחו – צפון אגן ים המלח
לזר, מ., בן-אברהם, צ., שולמן, ח., רשף, מ. 18

מפת הרגישות של אקוויפר החוף הדרומי לשאיבה (ניתוח ראשוני)
ליבשיץ, י., ליבשיץ, י., בן-אברהם, צ. 18

נטור כלוריניות ורדון במי תהום באזור עינות צוקים, ים המלח
לנג, ב., כפרי, א. 18

מערכת סדקים פתוחים בחוף ים המלח למרגלות מצוק העתקים וקשר אפשרי לרעידת האדמה של 1927
מוצן, צ. 19

מבנתור ועד לארץ המכתשים
מזור, ע. 19

שילוב סביבתי של כריית הפוספטים בפיתוח הנגב
מזור, ע. 19

שפיעת ראדון בשולי הערבה הדרומית – תוצאות ראשונות של ניטור ברזולוציית זמן גבוהה
מליק, א., גזית-יערי, נ., שטייניץ, ג. 20

הדמיה ברזולוציה גבוהה של מערכות שבירה והשקעה בראש מפרץ אילת
מקובסקי, י., בן אברהם, צ., עגנון, א., שקד, י., שמש, א., גולן, א., גדעון, א. 20

העתק של רעידת האדמה ב-18 בינואר 749 נחשף בטבריה
מרקו, ש., הרטל, מ., חזן, נ., לב, ל., שטיין, מ. 20

האם שמורת החולה מהווה קולט או מקור לזרחן וחנקן העלולים להגיע לכנרת?
מרקל, ד., ואורון, ט. 21

גאולוגיה ופילולוגיה, מלים ערביות שנכנסו לשימוש בגאולוגיה של ארץ-ישראל
נצר, מ. 21

בן-תור ופוספוריטים
נתן, י. 21

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סגל, י., מרקו, ש., שוואן, א., ברבה, ח. 22

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מ 1950 ועד 1954 ניהל את מחלקת המחצבים של המכון הגיאולוגי, וב1955 נתמנה להיות מנהלו. בן תור ניהל את המכון בין השנים 1955-1966 ושאף לבנותו בצלמו ובדמותו: מוסד המשלב מחקר מדעי לשמו, עם עשייה יום יומית בגיאולוגיה יישומית. בשנות ניהולו יסד מחלקות מחקר אשר נועדו לתת מענה לצורכי המשק והתעשייה. באותו זמן התמיד גם בעבודת ההוראה באוניברסיטה, ודאג להביא את תלמידיו מן האוניברסיטה ולשלבם בפעילותו במכון. כך קמו מחלקות לגיאולוגיה ימית, לכימיה אנליטית ולפליאונטולוגיה, אשר רוב עובדיהן היו תלמידיו של בן תור, ואשר לקחו חלק במאמץ המתמשך שתחילתו במיפוי הנגב. שאיפתו לקדם את תלמידיו לא הושפעה מחשש לתחרות, וגאוותו על הישגיהם הייתה רבה גם בחלוף השנים.

ב1967, בעת שהיה בשיא פריחתו האקדמית ועמד בראש המחלקה לגיאולוגיה של האוניברסיטה העברית, נקרא בן תור לעמוד בראש פרויקט יישומי חדש: האוניברסיטה העברית ומשרד הביטחון העמידוהו בראש מפעל מיפוי סיני, אשר כלל לבד מן המיפוי הגיאולוגי, גם סקרים בוטניים וזואולוגיים. תלמידיו הרבים, שהשתתפו עמו בעבודה זו, עמדו משתאים לנוכח מרץ הנעורים, החריצות וההתלהבות שגילה במשך שנים, עת התמיד באורח חיים של שבועיים בסיני-שבוע בבית, כשהוא מקפיד גם על מילוי חובות ההוראה שלו. מפעלו זה הניב פירות רבים, ובתוכם מפה גיאולוגית חדשה של חצי האי סיני, דוחות מחקר, ספרים ופרסומים מדעיים רבים. בכל תחומי עבודתו דחף בן תור את תלמידיו להשתלב בעבודות הענק שביצע, ועודדם לפתח את הענפים השונים-גם באלה בהם תרם בעצמו, ובין באחרים שאת חשיבותם הכיר.

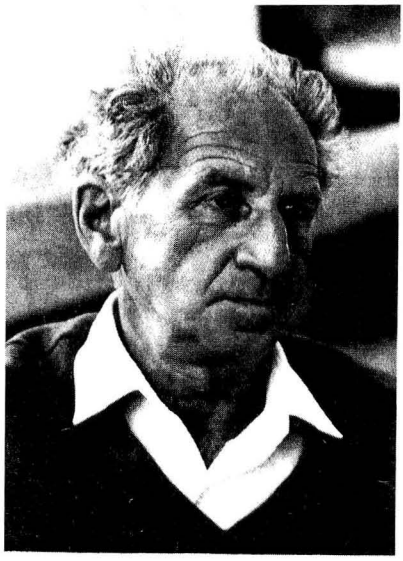
שני המוסדות אותם ניהל, המכון הגיאולוגי והמחלקה לגיאולוגיה באוניברסיטה העברית, והמחלקה לגיאולוגיה באוניברסיטת בן גוריון אשר הוקמה ביוזמתו, פועלים עד היום ברוח חזונו ובדפוסי העבודה אותם הטמיע.

תחום פעילות נוסף בו פעל בן תור היה בחברה הגיאולוגית הישראלית. הוא היה בין מייסדי החברה ב1954, ולאחר ששימש כנשיאה, המשיך בפעילותו כחבר כבוד. כשם שראה את עצמו כתלמיד הנצחי של מוריו הדגולים באירופה של ראשית המאה, כך כפר בקיומו של המושג "מורה לשעבר" ובפעילותו בחברה הגיאולוגית הרבה להעניק לתלמידיו מן השנים שעברו מידיעותיו ומניסיונו המתחדשים, והיה עסוק בהקניית ידע זה בהרצאות וסיורים שערך בעיקר בשנות הפעילות בסיני.

אין כמעט תחום בגיאולוגיה בישראל שליעקב בן תור אין בו תרומה משמעותית גם היום: תלמידיו, ותלמידי תלמידיו, הפעילים בענפים השונים של הגיאולוגיה בארץ, נושאים עמם את מורשתו של יעקב בן תור, וימשיכו להנחילה לדורות הבאים אחריהם.

יוסי ברטוב

פרופ' יעקב (קורט) בן תור (1910- 2002)



פרופ' יעקב בן תור, האיש אשר הטביע את חותמו על המחקר והמעשה הגיאולוגי בישראל מראשיתם, נפטר ב29.10.2002 בארה"ב.

בן תור עלה ארצה מגרמניה ב1933 לאחר לימודי משפטים ופיסיקה. הוא הצטרף אל פרופ' י.ל. פיקרד באוניברסיטה העברית בירושלים, למחלקה לגיאולוגיה בחיתוליה. שניהם ראו את עצמם כ"מדענים מגווייסים", אשר לצד מחקריהם המדעיים הם חייבים בשרות למפעל הציוני. מחקרו הגדול על הגיאולוגיה של הגליל התחתון המזרחי שהושלם ב1946 היה דוגמא לשילוב בו התמיד בן-תור כל חייו: הצורך המעשי לאתר מים לצד המחקר המדעי לשמו.

פיקרד גייס את בן תור לעבודה יישומית בנושאי מים, ודחפו להשלמת השכלתו הגיאולוגית באירופה: בציריך אצל פרופ' ניגלי, ואחכ' בגרנובל ובקלרמון-פרה בצרפת, שם החל בעבודה רחבת היקף על הסלעים הוולקניים של מסיב סנטראל. תלאות תחילת מלחמת העולם מנעו ממנו את השלמתה המלאה של עבודה זו, אשר נועדה להיות עבודת דוקטור. לאחר שנעצר בחשד להיותו מרגל גרמני, שוחרר וחזר לארץ ישראל ב1940. כאן השלים עבודת דוקטור נוספת על הדולומיטים של קרית ענבים. ב- 1952 הוענק לו גם תואר הדוקטור (בהצטיינות יתרה) על עבודתו בצרפת. באוניברסיטה העברית החל בן תור את דרכו העצמאית, כשהוא מתגלה כמרצה וירטואוז, הסוחף עמו את כל תלמידיו, והקושר סביבו חבורה של תלמידים צעירים לגיאולוגיה, הנשבים בקסמו, ומצטרפים אליו לעבודותיו בשדה. התגבשה סביבו חבורה צעירה של אנשים, ההולכת אחריו באשר יילך, ומקבלת על עצמה מטלות עצמאיות המשתלבות בעבודתו.

פעילותו ב"הגנה" בעת מלחמת השחרור הביאה אותו להשתתפות בהקמה של חיל המדע של צהל, ביחידה שנקראה "חמד ג'," בפיקודו של ישראל דוסטרובסקי יב"ל. במסגרת זו, אליה הצטרף ב1949, ניהל בן תור, יחד עם חברו הקרוב עקיבא פרומן, את המפעל העצום של "מיפוי הנגב". בשנים 1949-1953 הם עסקו במיפוי הגיאולוגי של הנגב ובבדיקת מחצביו, ובתוכם מרבצי הפוספטים של אורון והנחושת של תמנע. נחקרו על ידו גם תופעות מינרלוגיות רבות אשר לא בשלו לצורך הפקה, אך הענין המדעי בהם היה גדול (לדוגמא- סלעי החתרורים באזור ערד, אשר בתוכם נמצא לראשונה בעולם מינרל אשר נקרא על שמו- בנתוריט). בו תור השתתף ביסוד כמה מחברות המחצבים בנגב, שאת פעילותן ליווה כחבר במועצות המנהלים שלהן. עבודתיו בנגב זיכו אותו, יחד עם פרומן, בפרס ישראל לשנת 1953.

דו"ח קרן הפרס ע"ש פרץ גרדר ז"ל ליום 31/12/2002

בהתאם להוראות ועדת הביקורת של החברה הגיאולוגית, אשר ניתנו לועד החברה וליו"ר הקרן מובא להלן מצב הקרן נכון ליום 31.12.02

א. השקעות בניירות ערך	**ערך נקוב**	**ערך בשקלים חדשים**
פיא חו"ל- קרן נאמנות	1,341.94	4,311.79
סגולה - קרו נאמנות	6,874.00	18,364.58
		סה"כ ניירות ערך 22,676.37

ב. השקעות בשקלים	**ערך בשקלים חדשים**
עו"ש 025002/21-330	883.54

1. בשנת 2002 טרם ניתן הפרס לחתנים.
2. הדוח הכספי נערך עפ"י מסמכי בנק לאומי בע"מ, סניף ככר ציון, ירושלים.
3. חלק מן הכסף לפרס מומן על ידי פידיון מקרן סגולה.

בברכה
דב גינזבורג
יו"ר הקו

הרינו לאשר כי בדקנו את הדו"ח ומצאנו אותו מתאים למסמכים אשר הוצגו בפנינו.
ועדת הביקורת:

משה אייל איתמר פלאי

מאזן כספי החברה הגיאולוגית 2002

הכנסות

העברה משנת 2001			38,361.56
	עו"ש בבנק הפועלים	38,361.56	
דמי חבר והשתתפות בכנס			189,613.00
	דמי חבר 2001	3,525.00	
	דמי חבר והשתתפות בכנס 2002	183,388.00	
תרומות			14,000.00
	תרומות בעבור כנס החברה 2002	9,000.00	
	תרומה בעבור יום מדעי כדור הארץ בנגב	5,000.00	
שונות			
	רבית מפק"מ	92.71	
			92.71
	סך הכול		**239,367.27**

הוצאות

כנס			153,958.00
	מלון	96,743.00	
	ביטוח והסעות	10,435.00	
	הפקת חוברות	37,648.00	
	החזר עבור ביטולים	1,649.00	
	שונות	7,483.00	
יום מדעי כדור הארץ בנגב			1,600.00
	שונות	1,600.00	
עיתון מדעי האדמה			40,000.00
	עיתון מדעי האדמה	40,000.00	
אתר אינטרנט			22,276.00
	בניית אתר אינטרנט	12,970.00	
	תפעול אתר אינטרנט	9,306.00	
הוצאות תפעוליות			3,505.06
	עמלות בנק	295.06	
	רואה חשבון	2,340.00	
	הוצאות משרד	870.00	
	סך הכול		**221,339.06**
העברה לשנת 2003			18,028.21
	עו"ש בבנק הפועלים	18,028.21	
	חוב – דפי לייזר	-20,000.00	
	חוב - הפעלת אתר האינטרנט	-22,618.00	
סה"כ חובות מועברים		-42,618.00	
	סך הכול		**239,367.27**

ועדת ביקורת:

איתמר פלאי משה אי

בטאון מדעי כדור הארץ הישראלי

בימים הקרובים עומדת לצאת החוברת הכפולה לכבודם של פרופסור איתן שש ופרופסור אמיתי כץ שהן גם החוברות האחרונות לשנת 2002. עד למועד הכנס השנתי מתוכננת לראות אור גם החוברת הראשונה לשנת 2003. בנוסף, נמצאות בשלבים מתקדמים חוברות המוקדשות לנושאים: גיאוכרונולוגיה בעריכת ד"ר נעמי פורת, מחקרי הכנרת בעריכת פרופסור צבי בן אברהם, אגן החולה בעריכת ד"ר רמי ויינברגר וד"ר עמיחי סנה ורעידות אדמה בעריכת ד"ר שמואל מרקו וד"ר אבי שפירא. במקביל עובדים גם על חוברות נוספות במתכונת הרגילה.

שינוי תקנון החברה הגיאולוגית

בהתאם להצעה שהועלתה בכנס השנתי במעגן, גובשה בעזרת מספר חברים הצעה לשנוי תקנון החברה הגיאולוגית הישראלית שעומדת להצבעה ואישור האסיפה הכללית. הנוסח החדש של התקנון עבר כמה שלבים של הערות ותיקונים. הנוסח החדש מנסה לשמור ככל האפשר את דפוסי הפעולה כפי שהתגבשו בעת הקמת החברה ובמהלך השנים ולהתאימם לזמננו. הנוסח החדש מציע כי, בניגוד לנוהג הקיים, הנשיא שנבחר יכהן קודם כסגן הנשיא דבר שיאפשר לו להתוודע אל התפקיד ולהכשיר עצמו לפני שהאחריות העיקרית מועברת אליו. בנוסף, מוצעים שנויים לגבי הגדרת הקריטריונים בתקנוני הפרסים, הליך בחירתם של חברי הכבוד, הצגת המאזן לחברים ועוד. אנחנו מקווים שהצעת השינוי בתקנון תאושר ותתרום לשיפור פעולת החברה הגיאולוגית.

תודות לחברים שהשקיעו מזמנם בגיבוש הצעת השינוי בתקנון ולכל מי שטרח והעביר הערות והצעות.

שימור אתרים גיאולוגיים

הפעילות בנושא חשוב זה החלה לפני שנים רבות, אולם מסיבות שונות טרם בשלה לכדי הכרזת אתרים גיאולוגיים מוגנים. ביוזמתם של אלי שדות וניר אוריון ניסינו השנה לקדם את הפעילות בנושא, אך לצערנו לא הצלחנו להשלימה. יחד עם זה , נראה שעם קצת מאמץ ועזרה מצד חברי החברה הגיאולוגית ניתן בזמן קצר יחסית להשלים את עבודת ההכנה שתאפשר הגשת אתרים מומלצים להכרזה כאתרים מוגנים ואנחנו קוראים לועד שיבחר לפעול להשלמת המשימה ולחברי החברה הגיאולוגית לסייע בכך.

פעילות החברה לשנת תשס"ב - תשס"ג (2002-2003)

יום מדעי כדור הארץ בנגב

על מנת להגביר את המודעות ולחזק את מעמד מדעי כדור הארץ בציבור, ערכה החברה הגיאולוגית הישראלית, זו השנה השניה ברציפות, את יום "מדעי כדור הארץ". יום העיון נערך השנה ב- 1.12.2002 באוניברסיטת בן גוריון והושם בו דגש על שאלות הנוגעות לאיזור הנגב. האירוע זכה להצלחה רבה, לקחו בו חלק מעל 250 משתתפים והוא זכה לתהודה נרחבת בכלי התקשורת. ברצוננו להודות לחברי החברה שלקחו חלק ביום זה.

כנס חובבי גיאולוגיה וידיעת הארץ במצפה רמון

החברה הגיאולוגית הישראלית מקיימת השנה בפעם הראשונה מאז 1987 כנס חובבי גיאולוגיה וידיעת הארץ. הכנס ייערך במצפה רמון בתאריך 14-13 לאפריל 2003 ומטרתו לדון בהתפתחות הנוף והמכתשים, והקשר לאדם ולתיירות עתידית באזור הר הנגב. ד"ר יואב אבני לקח על עצמו את ריכוז הכנס מטעם החברה הגיאולוגית וחברו לארגונו המכון הגיאולוגי, המועצה המקומית מצפה רמון, מרכז מדע רמון, רשות הטבע והגנים, בית ספר שדה "הר הנגב", החברה להגנת הטבע, הסוכנות היהודית ועמותת התירות הר הנגב. תודתנו לכל אלו המסייעים בהדרכה וארגון הכנס.

אתר האינטרנט של החברה הגיאולוגית

עקב עלויות גבוהות מהצפוי הוחלט לצמצם השנה את הפעילות באתר האינטרנט של החברה הגיאולוגית למינימום. הצמצום פוגע באתר באופן משמעותי ויהיה צורך לדון בהמשך בדרכים להפעלתו בעלויות נמוכות יותר.

פרסי החברה הגיאולוגית

פרס החברה הגיאולוגית על שם פרופ' רפאל פרוינד ז"ל מוענק השנה לד"ר רם ויינברגר על תרומת מחקרו לקידום ההבנה בנושא התפתחות סדקים ומאמריו:

Joint Nucleation in layered rocks with non-uniform distribution of cavities, J. Structural Geology, 23: 1241-1254 (2001).

Evolution of polygonal patterns in stratified mud during desiccation: the role of flow distribution and layer boundaries, Geol. Soc. Am. Bull., 113: 20-31 (2001).

פרס החברה הגיאולוגית על שם דר' פרץ גרדר ז"ל מוענק השנה ל:

מר אנטון וקס על עבודת הגמר שלו לתואר שני "שינויי אקלים במא שישים אלף השנים האחרונות לפי משקעי מערה קרסטית על גבול המדבר, מעלה אפרים, מזרח השרון".

מר ניקולס ולדמן על עבודת הגמר שלו לתואר שני "הגיאולוגיה של תצורת סמרה בבקע ים המלח".

מדליית החברה הגיאולוגית על פעילות בתחום הגיאולוגיה למען החברה מוענקת השנה לפרופסור עקיבא פלכסר.

ברכות לזוכים ! ותודות לחברי ועדות הפרסים ולחברים שהמליצו על מועמדים .

החברה הגיאולוגית הישראלית מודה למוסדות הבאים על השתתפותם ותרומתם לפעילות החברה במהלך השנה ולכנס השנתי בעין בוקק.

משרד התשתיות הלאומיות
המשרד לאיכות הסביבה
מרכז ההסברה
המכון הגיאולוגי
המכון הגיאופיסי לישראל
רותם אמפרט נגב בע"מ (מפעלי ים המלח בע"מ)
"מכתשים" מפעלים כימיים בע"מ
Samedan, Mediterranean Sea
אוניברסיטת בן גוריון בנגב
האוניברסיטה העברית בירושלים
המועצה האזורית תמר
אלבטרוס צילומי אויר

ועד החברה הגיאולוגית הישראלית 2003-2002:

שמעון פיינשטיין – נשיא
אמוץ עגנון – סגן נשיא
אפרת פרבר – מזכירה
שי עזרא – גזבר
יאיר לוי – מרכז הפעולות
יואב אבני – רכז סיורים

דב גינזבורג – מנהל קרן ע"ש ד"ר פ. גרדר ז"ל

איתמר פלאי ומשה איל – ועדת ביקורת

החברה הגיאולוגית הישראלית מביעה תודות לשי שרתוק וענת ברנשטיין על עזרתם בהכנת הכנס ולחברים שהתנדבו לסייע בפעולות שונות של החברה במהלך השנה.

החברה הגיאולוגית הישראלית

הכנס השנתי, 2003

המכון הגיאולוגי
הספרייה
GEOLOGICAL SURVEY OF ISRAEL
THE LIBRARY

תקצירים

עריכה:
שמעון פיינשטיין
אמוץ עגנון
אפרת פרבר
שי עזרא
יואב אבני
יאיר לוי

עין בוקק

כ"א – כ"ג אדר ב' תשס"ג

27-25 מרץ 2003

תמונת שער: ים המלח

צלום: אלבטרוס צילום אויר

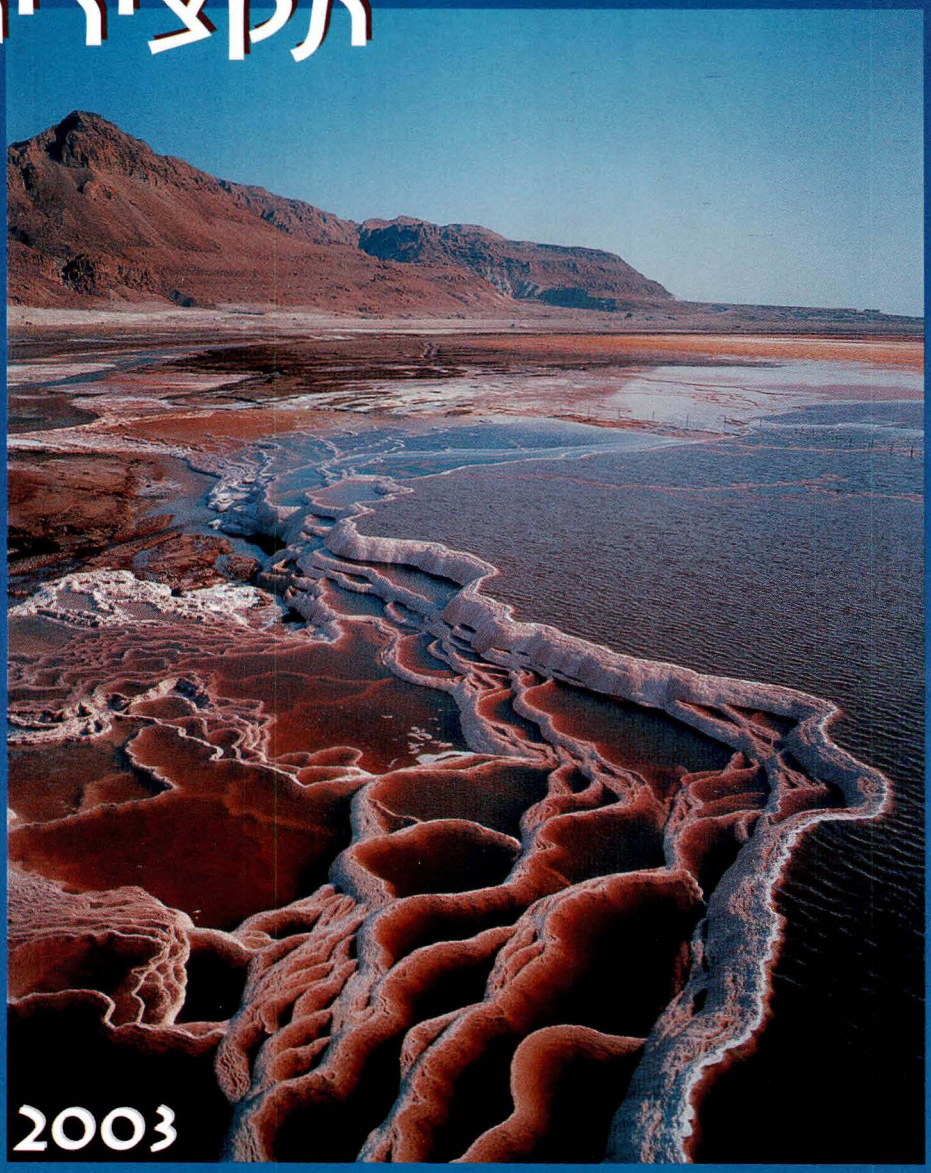
55(569.4)GEOL

החברה הגיאולוגית הישראלית
Israel Geological Society

2003
עין בוקק
כנס החברה הגיאולוגית

תקצירים

החברה הגיאולוגית הישראלית הכנס השנתי



עין בוקק

כ"א - כ"ג אדר ב' תשס"ג

27-25 מרץ 2003