SECOND I.R. and H. KAPLAN WORKSHOP

Global Pollution:
From Background to Contemporary Levels

MARCH 23-25, 2008
MITZPE RAMON
Introduction

On behalf of the Institute of Earth Sciences we are pleased to welcome you to the second Kaplan Workshop. This series of exciting workshops in environmental geochemistry was made possible by a generous donation from Ian R. and Helen Kaplan. The present workshop covers various aspects of global pollution bringing together some of the leading figures in their fields. We hope that its intimate size and pristine location will generate the right atmosphere for free exchange of ideas and initiation of future collaborations. In addition it should allow Israeli students and scientists to present their own research and be exposed to some of the new directions in tracing the fate of pollutants on a global scale.

As noted in the introduction to the first workshop booklet, Ian has been a teacher, a colleague and a friend of our institute for many years. Ian’s first encounter with the Department of Geology at the Hebrew University (later to become part of the Institute of Earth Sciences) was during his stay in Jerusalem in 1962-1965 as a Jacob Ziskind Visiting Scholar and Guest Lecturer at the Department of Microbial Chemistry. It was at this time that students and faculty in Jerusalem were first exposed to the then emerging science of Biogeochemistry by one of its early leaders. The continuing contacts of IRK with Israeli science were primarily via his training a sequence of graduate students and post-docs from Israel in various aspects of low-temperature geochemistry. The Israeli graduates of the “Kaplan Group” on the fifth floor of Slichter Hall at UCLA returned to several Israeli universities, the Geological Survey and Industry. Ian’s ties with the HU have never ceased. He was always there for many of us, generous with mentoring and sound scientific advice. It goes without saying that these are but a small part of his achievements as a scientist and mentor. His contributions are many. His students are spread around the US and the world.

We would like to warmly thank the contributions of our invited speakers, who all made huge efforts to join us and share with us their knowledge. We also thank the poster contributors, showing the high quality science of Israel.

We thank you all!
Program

SECOND KAPLAN WORKSHOP:
GLOBAL POLLUTION:
FROM BACKGROUND TO
CONTEMPORARY LEVELS

MARCH 23-25, 2008, MITZPE RAMON

Sunday, March 23rd

Field excursion – Yoav Avni, The Geological Survey of Israel

08:00 – Leaving Jerusalem to the Dead Sea.
09:00 – 12:00 – Traveling along the Dead Sea and visiting the Massada museum
12:00 - 12:30 – Lunch in Massada.
12:30 – 14:00 – Traveling from Massada to the Negev Highlands
14:00 – 15:30 – Visiting the Avedat archeological site
16:00 – 16:45 – Arriving at Mizpe Ramon + checking in

Session 1: Atmospheric Aerosols

16:45 – 17:45 James J. Schauer, University of Wisconsin-Madison - Source Apportionment of Carbonaceous Aerosols using Molecular Markers


18:45 – 20:00 – Dinner

20:00 – 21:00 Daniel Rosenfeld, the Hebrew University – The Role of Aerosols in Global Earth Energy Budgets: The Big Questions That Make Climate Predictions so Uncertain

21:00 – 23:00 – Round table discussion, posters, drinks and snacks

Monday, March 24th
7:00 – 8:30 – Breakfast

**Session 2: Sulfur**

8:30 – 9:30 **Mike Hoffmann**, Caltech – Heterogeneous Chemistry of Sulfur in the Atmosphere

9:30 – 10:30 **Prasad Kasibhatla**, Duke University – A Global View of Anthropogenic Impacts on Atmospheric Sulfate

10:30 – 11:00 – coffee break

**Session 3: Nitrogen**

11:00 – 12:00 **Joel Savarino**, LGGE/CNRS - Toward a New Marker of the Atmospheric Chemistry/Climate Relationship: Tracing the Ozone Isotopic Anomaly Transferred to Other Atmospheric Constituents

12:00 – 13:00 **Bernhard Wehrli**, EAWAG/ETH - Old and New Sinks in the Global Nitrogen Cycle

13:00 – 14:00 Lunch

**Session 4: Carbon**

14:00 – 15:00 **Jonathan Erez**, The Hebrew University - Biomineralization and dissolution of CaCO₃ in the Oceans: A Negative Feedback Mechanism to Atmospheric CO₂ Increase

15:00 – 16:00 **Kon-Kee Liu**, National Central University, Taiwan - The role of continental margins in the global carbon cycle

16:00 – 18:30 - Rest, swim, enjoy facilities of Isrotel Mizpe Ramon

18:30 – 19:30 – Dinner

19:30 – 22:00 – Adama dance show

**Tuesday, March 25th**

7:00 – 8:30 – Breakfast + checkout

**Session 5: Heavy Metals**

8:30 – 9:30 **Ed Boyle**, MIT - Evolution of the North American Anthropogenic Lead Transient for the Past 200 Years
9:30 – 10:30 Martin Goldhaber, USGS - From Continents to Atoms; Environmental Geochemistry at all Scales

10:30 – 11:00 – coffee break

11:00 – 12:00 Stephan Kraemer, University of Vienna - Heavy Meals: Mechanisms of High Affinity Iron Acquisition in Iron-Limited Ecosystems

12:00 – 13:00 Ian Kaplan and Alan Matthews - Round table discussion on the past achievements and future of environmental geochemistry

13:00 – 14:00 Lunch

14:00 – 18:00 Guided tour to the Ramon "Crater" – Gideon Baer, The Geological Survey of Israel

18:00-20:30 travelling back to Jerusalem
Invited Speakers

Abstracts

Environmental Geochemistry

K 2008

Workshops
Due to the importance of carbonaceous aerosols on the climate forcing and human health effects, there is great interest in better understanding the origin of both organic carbon (OC) and black carbon (BC) in the atmosphere. In the past two decades, significant progress has been made in the development of analytical and data analysis tools to measure particle-phase organics compounds, often called molecular markers, in the atmosphere and in the emission from air pollution sources to identify and quantify sources of carbonaceous aerosols. The knowledge of molecular markers for primary emissions from air pollution sources is reasonably well developed, and in recent years, progress has been made in the development of analytical and data analysis tools for the use of secondary organic aerosol molecular markers. Molecular markers for primary and secondary organic aerosols have been used for semi-quantitative assessments, and have been used in quantitative statistical based source apportionment model including chemical tracer models and multi-variant models. These techniques have been used to study carbonaceous aerosols in many regions including the United States, Mexico, China, Hong Kong, Korea, the Maldives Islands, Nepal, and Pakistan; and are now being used in several studies in the Middle East and Europe. The application of these molecular marker tools have been added to studies addressing climate forcing, trans-boundary pollution, urban air pollution, human health effects, and air pollution control technology development. Background will be provided on molecular markers and examples of the use of these tools will be presented.
Organic Aerosols in our Atmosphere: Sources, Properties, and Impacts

Spyros Pandis
Department of Chemical Engineering, University of Patras, Greece

Airborne particles pose serious health risks and have a controlling influence on Earth’s climate. Organic aerosol (OA) is a major component of fine-particle mass throughout the atmosphere and is often the most important component in polluted urban areas. OA comprises primary OA (particle mass directly emitted from sources such as motor vehicles and forest fires) and secondary OA (particle mass formed in the atmosphere from oxidation of gas-phase precursors). Despite their importance, the relative contribution of primary and secondary OA to the overall OA budget, their sources, their chemical transformations in the atmosphere, and the physical properties remain controversial. The current state-of-knowledge will be reviewed focusing on some of the most controversial issues and on issues related to air quality and health. Our recent efforts, combining laboratory and field measurements with chemical transport modeling, will be discussed to close some of the major knowledge gaps.
The Role of Aerosols in Global Earth Energy Budgets: The Big Questions that Make Climate Predictions so Uncertain

Daniel Rosenfeld
Institute of Earth Sciences, the Hebrew University of Jerusalem, Israel

Aerosols cool the climate system by reflecting solar radiation back to space directly and through their cloud mediated effects of increasing clouds reflectance and area coverage. The realized warming so far is due to the difference between the greenhouse gases (GHG) induced warming and aerosol induced cooling. Because the aerosols mask part of the GHG warming, the climate sensitivity to increase in GHG is greater if the aerosols have been cooling the climate system more strongly.

Clouds regulate to a great extent the global albedo and hence serve as an effective thermostat for the globe. The cloud mediated effects of the aerosols are at least as large as the direct radiative effects, but their magnitude is very poorly known. Recent insights to the mechanism by which aerosols change the cloud cover of marine stratocumulus clouds from nearly cloud free to fully covered will be presented. This mechanism is a response of the cloud precipitation to the aerosols, and consequent chain of feedbacks.

On the other end of the spectrum of cloud types, aerosols affect deep tropical convective clouds over land in two ways: moderate amounts of aerosols prevent early rainout of the cloud water, so that the water ascends to heights where it can freeze, release extra latent heat of freezing, and so invigorate the cloud system and make it more extensive. When aerosols become very thick, such as in heavy smoke from forest fires or Asian air pollution, the solar energy intercepted by the aerosols is prevented from reaching the surface and energize the formation of the convective clouds.

These very complicated large sensitivities to aerosols provide us with a still widening range of uncertainty on aerosol induced impact on Earth energy and hydrological budgets. This implies similarly growing uncertainties about climate predictions. Respectively, understanding and quantifying these effects receives increasing attention in the climate research.
Heterogeneous Chemistry of Sulfur in the Atmosphere

Michael R. Hoffmann
Environmental Science & Engineering, Caltech, USA

The development of comprehensive understanding of the chemistry of sulfur compounds in the atmosphere has been evolving for more than 100 years. It is clear that both homogeneous gas-phase and heterogeneous condensed-phase reactions contribute to the conversion of primary sulfur gases such as H₂S, SO₂, OCS, and (CH₃)₂S to H₂SO₄ and other intermediate redox-state compounds. In this presentation, I will review some of the key factors that control the oxidation of the reduced sulfur compounds in clouds and haze aerosol. The role of critical oxidants such as H₂O₂, O₃, O₂, H₂SO₅, .OH, and NO₃ will be addressed. The relative roles of in situ free radical reactions and heterogeneous photochemistry in sulfur compound oxidation will be addressed.

Current research on heterogeneous sulfur chemistry occurring on marine aerosols will be discussed. Emphasis will be placed on reactions at droplet interfaces, where selective enrichment of certain anions takes place. Furthermore, the ultimate fate of perfluorinated sulfur compounds such as perfluoroctane sulfonate in the atmosphere will be discussed.

The rapid oxidation of sulfite and/or iodide in the interfacial layers of aqueous microdroplets during brief exposure to O₃(g) is investigated by electrospray mass spectrometry. The oxidation of S(IV) in aqueous microdroplets of HSO₃⁻/SO₃²⁻, which proceeds at a rate, -d[HSO₃⁻]/dt ≈ [S(IV)][O₃(g)], appears to be a surface-specific reaction. In the case of I⁻, diffusion from the droplets core significantly competes with its oxidation at the interface. I⁻ is enriched over HSO₃⁻ in the interfacial layers of equimolar (Na₂SO₃ + NaI) microdroplets, and inhibits its oxidation in a process mediated by a persistent, metastable intermediate, ISO₃⁻ (m/z = 207). In addition, ISO₃⁻ and IS₂O₃⁻ (m/z = 239) form within 1 msec of exposure to O₃. The simultaneous detection of the anionic reactants and their reaction products, S₂O₆²⁻, HSO₄⁻, IO₃⁻, and I₃⁻, as a function of experimental conditions provides evidence of enhanced interfacial reaction kinetics.
A Global View of Anthropogenic Impacts on Atmospheric Sulfate

Prasad Kasibhatla
Nicholas School of the Environment, Duke University, USA

Sulfate aerosols play an important role in regulating the earth’s climate, owing to their direct and indirect radiative effects. In this talk, I will review progress in our understanding of the factors that shape the spatiotemporal distribution of sulfate aerosols on a global scale. In this review, I will (i) identify existing global-scale emission inventories of atmospheric sulfate precursors; (ii) characterize the development of global atmospheric sulfur models over the last three decades; (iii) assess the capabilities of current global models to simulate observed characteristics of the atmospheric sulfur cycle; (iv) elucidate the insights gained with regards to anthropogenic impacts on the global sulfate aerosol distribution; and (v) identify persistent gaps in our knowledge related to the global distribution of atmospheric sulfate.
Toward a New Marker of the Atmospheric Chemistry/Climate Relationship:
Tracing the Ozone Isotopic Anomaly Transferred to Other Atmospheric
Constituents

Joël Savarino
Laboratoire de Glaciologie et Geophysique de l'Environnement, CNRS, France

Our understanding of the climate fluctuation is hindered by our lack of knowledge about
the climate-atmospheric chemistry interactions. The main reason is that reactive atmospheric
compounds that drive the reactivity of the atmosphere are not well recorded in climatic archives.
The discovery of a chemical origin of the so-called mass independent fractionation in stable
isotopes twenty years ago opened a new direction in probing this relationship. Indeed, ozone, one
of the most reactive species in the atmosphere possesses a unique isotopic composition that it
transfers during oxidation reactions. Oxygen bearing species formed through the chemical attack
of ozone integrate this fingerprint.

Nitrate is a model molecule to probe how ozone attacks its precursors, the nitrogen
oxides. We will see through different situations taken from the lab to polar field experiments that
indeed the oxygen isotopic composition of nitrate is strongly coupled to oxidant species and
therefore carries in it a fingerprint of the chemical state of the atmosphere at the moment of its
formation. Since nitrate is ubiquitous in ice cores, oxygen isotopic anomalies open a new path to
reconstruct the chemical state of the atmosphere back in time.
Old and New Sinks in the Global Nitrogen Cycle

Bernhard Wehrli
Limnological Research Center, EAWAG / ETH, Switzerland

Reactive nitrogen in the form of ammonia, nitrate and organic N is a limiting factor for food production. Anthropogenic nitrogen fixation via the Haber-Bosch process and the emission of NOx from fossil fuel combustion add about 160 teragrams of reactive nitrogen per year to the global N cycle [1]. This is more than biological N fixation on land or in marine systems. Human activities seem to have doubled the nitrogen turnover rates on the continents, with severe consequences for terrestrial and aquatic productivity, atmospheric chemistry and other geochemical cycles [2]. While the increasing release of reactive nitrogen can be estimated with some confidence the accumulation, transformation and elimination of nitrogen compounds in terrestrial and aquatic environments is very difficult to quantify because (i) the portfolio of “old” microbial transformations needs to be updated as new processes are discovered and (ii) the global distribution of different reaction zones such as wetlands, lakes, agricultural areas is also constantly changing.

New pathways for the microbial transformation of reactive nitrogen into N2 have been discovered recently. The anammox process (anaerobic ammonium oxidation) was first detected in wastewater treatment plants where ammonium is oxidized by nitrite to form N2. In the meantime, there is growing evidence for a widespread occurrence at oxic-anoxic interfaces in marine systems and recently the process has also been discovered in a freshwater lake [3]. Such studies indicate that several, parallel processes release N2 back to the atmosphere. Global nitrogen budgets need to include improved estimates for these “new” sinks. In addition, longer water residence times and contact times with suboxic and anoxic zones are accelerating the removal of reactive nitrogen along the aquatic continuum from land to ocean. Damming of rivers, artificial ponds in agriculture and an underestimated number of small lakes are all contributing to nitrogen removal [4]. Improved estimates of old and “new” sinks for reactive nitrogen require an up-to-date process-level understanding and realistic global estimates for the relevant reaction zones.
Biomineralization and Dissolution of CaCO₃ in the Oceans: A Negative Feedback Mechanism to Atmospheric CO₂ Increase

Jonathan Erez, Kenneth Schneider, Jacob Silverman, Alon Braun, Shmuel Bentov, Mor Grinstein, and Boaz Lazar
Institute of Earth Sciences, the Hebrew University of Jerusalem, Israel

Biomineralization of CaCO₃ and its dissolution are major processes in the global carbon cycle. Coccolithophores, foraminifera, pteropods and corals are the main groups that control the CaCO₃ cycle in the oceans. These organisms are abundant in the surface ocean where their biomineralization is often associated with algal photosynthesis. Increase in atmospheric CO₂ lowers the pH of the surface ocean and consequently the CO₃²⁻ ion concentration is decreasing. This dramatically lowers the biomineralization rate of the main calcifying groups in the ocean. In parallel, CaCO₃ dissolution in shallow environments that exchange CO₂ with the atmosphere is increasing. Both processes work to elevate the alkalinity of the surface ocean and thus provide an important negative feedback to atmospheric CO₂ increase. Evidence from coral reef environments as well as open sea (e.g. the Gulf of Aqaba (Eilat) suggest that the CaCO₃ cycle is already responding to ocean acidification. Community metabolism studies in coral reefs and shallow tropical banks show that net calcification rates are a strong function of Ω and allow future prediction that most coral reefs will be dissolving when atmospheric CO₂ levels will double.

Detailed physiological studies on the effects carbonate chemistry on corals and foraminifera show that both groups decrease their calcification when the CO₃²⁻ is decreasing (regardless of whether this is caused by a drop in pH or in total inorganic carbon at constant pH). Photosynthesis of the symbiotic algae on the other hand is hardly affected by changes in the carbonate chemistry. The sensitivity of corals and foraminifera to small changes in carbonate chemistry can be readily explained by the fact that both groups are utilizing seawater as their direct source of Ca²⁺ and CO₃²⁻ for calcification. In foraminifera we show (using confocal laser microscopy) that this is mediated by vacuolization of seawater and direct channeling of the seawater vacuoles to the site of biomineralization. In corals we can demonstrate that fluorescent
seawater arrives to the calicoblastic space where they serve for biomineralization. The mechanism responsible for this process is yet unknown, but may be associated with paracellular pathways, or by other gaps in the coral tissue that exposes the porous skeleton to seawater. In both groups the main modification that the organisms exert on seawater in order to precipitate CaCO₃ is an elevation of roughly 1 pH unit relative to ambient levels. In addition foraminifera posses an inorganic carbon concentrating mechanism in their seawater vacuoles that can be demonstrated using $^{14}$C tracer experiments, fluorescent pH probes and pH and CO$_3^{2-}$ microelectrodes. Ocean acidification is interfering with these biologic mechanisms by increasing the buffering capacity of the seawater to the required changes exerted by the organisms. Lower calcification rates (and increased CaCO₃ dissolution) provide negative feedbacks to atmospheric CO$_2$ increase. Rough estimate of the CO$_2$ sink that may be operating here is not larger than 0.5 GT carbon per year (for the next hundred years). On the other hand the future existence of whole ecosystems like corals reefs and possibly other biogenic CaCO₃ banks is endangered.
The Role of Continental Margins in the Global Carbon Cycle

Kon-Kee Liu
Institute of Hydrological and Oceanic Sciences, National Central University, Taiwan

In the past decade, there has been a shift of the paradigm concerning the role of continental margins in the global carbon cycle. The conventional wisdom has it that continental margins are sources of CO2 to the atmosphere due to the river loadings of carbon discharged to the coastal ocean or the upwelling of CO2 laden subsurface water from offshore. However, observations in recent years suggest the contrary, that continental margins are an important part of the CO2 sequestration machinery in the ocean with an estimated strength of 0.3 Gt C/yr, representing ca 19% of the net global ocean uptake of atmospheric CO2. It has been postulated that a combination of physical and biological pumps are responsible for the CO2 uptake, but the details are still not thoroughly understood. This renders prediction of future changes difficult, if not impossible. Although the coastal ocean is more productive than the open ocean in general, it is not necessarily a more efficient biological pump. The carbon uptake either by biological fixation or by dissolution in seawater over the shelf may be released back to the atmosphere, when the organic matter gets mineralized or the shelf water warms up. These processes neutralize the continental shelf pump, unless there is a net transfer of carbon from the shelf to the ocean interior or the carbon gets buried in sediments. The high productivity in the coastal ocean is driven by the relatively rich nutrient supply, mainly from the ocean interior. It has been recently demonstrated and gradually appreciated that the coastal ocean is a more efficient processor for nutrient utilization and carbon transformation-transportation that enhance the net uptake of atmospheric CO2. Several important features of the coastal ocean contribute to the enhanced efficiency. These include intensified stratification due to warming and fresh water input in summer, rapid de-stratification and cooling in winter, repletion of trace metals for phytoplankton growth, benthic nutrient recycling and sediment-enhanced carbon transport and preservation. To understand the interplay between physical and the biogeochemical processes in continental margins, one must go beyond the 1-D approach often adopted in ocean
biogeochemical studies. Although 2-D schematic diagrams are often used to depict coastal ocean processes, it would greatly accelerate the understanding, if a fully 3-D approach can be adopted in these studies.
Evolution of the North American Anthropogenic Lead Transient for the Past 200 Years

Edward A. Boyle
Department of Earth, Atmospheric and Planetary Sciences, MIT, USA

Detectable lead (Pb) emissions from the United States into the western North Atlantic began in ~1840 A.D. with exploitation of isotopically-distinct Upper Mississippi Valley (UMV) ores that were nearly the sole source of Pb in the U.S. at the time. Rising Pb concentrations and the isotopic signature of this source are clearly seen in laminated anoxic estuary sediments (Rhode Island) and annually-banded coral records in the ocean (Bermuda). Environmental Pb concentrations continued to rise through the US industrial revolution, although the isotopic signature shifted as UMV ores were replaced by other mining districts. Industrial Pb emissions reached a plateau in the 1920’s until Pb emissions were augmented by Pb gas utilization in the 1950’s peaking in the 1970’s; Pb isotopic signatures shifted as dominant mining districts shifted. These changes are again documented both in Rhode Island sediments and Bermuda coral. From the late 1970’s through the 1990’s Pb concentrations decreased as Pb gas was phased out, with the Pb isotopic signals of the Rhode Island sediments remaining constant at typical “U.S. Pb” values while the Bermuda coral isotope ratios shifted to values intermediate between U.S. and European Pb. This decrease is documented in the Rhode Island sediments, Bermuda corals, and seawater samples collected between 1983 and 2005. The shifting emissions changed the Pb concentrations and isotope ratios of North Atlantic surface waters throughout the North Atlantic, and in regions where surface water was subducted into the interior, these concentration and isotope signatures have been carried along the pathways of deep ocean circulation.
Geochemists need to be acutely aware of the issue of scale in their research. Many of our newest and most powerful chemical and isotopic techniques can provide detailed insight into processes operating on small volumes of rock or sediment. Yet an individual sample may only characterize a miniscule portion of a process that involves enormous volumes of the earth’s crust. I will give two examples of how processes operating over very large geographic areas manifest themselves at the regional, local, grain, and sub grain scale. The first concerns coal in the Appalachian basin, which lies along nearly the entire extent of the eastern U.S. Locally, arsenic and mercury are enriched by one to two orders of magnitude above that typical for most coal in the basin. I will show that these elemental enrichments result from widespread interaction of coal with hydrothermal fluids mobilized into the basin by metamorphic processes occurring during the late Paleozoic Alleghanian orogeny. The impact of this event on coal chemistry and mineralogy at basin, sub basin, bed and grain levels will be described, as will the environmental impacts of mining and combustion of this arsenic and mercury enriched coal at the same range of scales. The second example concerns the geochemistry of chromium in the Great Valley of California in the western U.S. Chromium, which is highly toxic in its soluble +6-oxidation state, occurs locally in ground water of the northern Great Valley. I will describe how this enrichment arises from the complex evolution of the geochemical landscape of the northern Great Valley controlled by geology, weathering, and transport of alluvial materials, geomorphology and biogeochemical processes.
Iron is an essential nutrient for most known organisms. It is abundant in the earth crust but its low bioavailability is potentially limiting primary productivity in large terrestrial and marine ecosystems. This has long been recognized as an important factor shaping terrestrial ecosystems and a problem in agriculture. However, iron limitation of primary productivity in marine systems has received much attention in recent years in the context of marine ecology and global carbon cycling.

Microorganisms and certain plant species (grasses) have developed high affinity iron acquisition systems involving the exudation of iron specific ligands, the so-called siderophores. In this presentation, I will give an overview of the geochemical of iron cycling in the presence of siderophores and then focus on mechanisms, including ligand controlled dissolution and photoreductive dissolution. These mechanisms will be discussed from a surface geochemical standpoint and links between surface speciation and reactivity will be drawn based on spectroscopic information and observations of reaction kinetics.
Posters

Environmental Geochemistry

K 2008

Workshops
Posters

Bernstein, Anat; Ronen, Zeev; Adar, Eilon; Lowag, Harad; Stichler, Willibald; Meckenstock, Rainer U. Compound Specific δ15N Analysis to Quantify RDX Biodegradation in the Israeli Costal Aquifer

Gal, Assaf; Reznik, Itay; Ganor, Jiwchar; Gavrieli, Ittai. Gypsum Saturation Degrees in Mixtures of Dead Sea Brines and Seawater

Harlavan, Yehudit; Almogi-Labin, Ahuva; Herut, Barak. Natural and Anthropogenic Pb in marine sediments offshore Israel.

Herut, Barak; Halicz, Ludwik; Hyams, Orit; Almogi-Labin, Ahuva. Tracking dissolved trace metals in seawater using living Amphistegina lobifera (benthic foraminifera) tests from Haifa Bay, Israel

Klein Kedem, Nir; Saragosti, Eldad; Shaked, Yeala. Linking iron, hydrogen peroxide and superoxide photochemistry in the Gulf of Aqaba.

Magal, Einat; Arbel, Yuval; Caspi, Sarit; Katz, Yoram; Glazman, Hilel; Greenbaum, Noam; Yechieli, Yoseph. Tracer test in En Ziv

Rosenberg, Yoav; Oren, Yoram; Volkman, Ygal; Vengosh, Avner; Ganor, Jiwchar. The Fate of Radium in the Concentrate of a Desalinization Plant in Israel

Segal-Rosenheimer, Michal; Dubowski, Yael. Atmospheric Aging of Semi-volatile Pesticides: Real Time Monitoring of Cypermethrin Photo-oxidation Using FTIR.

Sela, Michal; Sivan, Orit; Eckert, Werner. The redox coupling between carbon, sulfur and iron in Lake Kinneret sediments"

Shaked, Yeala. Iron redox dynamics in the surface waters of the Gulf of Aqaba.

Sivan, Orit; Yechieli, Yoseph; Kafri, Uri. The inter-relationship between coastal sub-aquifers and the Mediterranean Sea
## Contact List

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<tr>
<th>Name</th>
<th>E-mail</th>
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<tbody>
<tr>
<td>Aizenshtat Zeev</td>
<td><a href="mailto:zeev@vms.huji.ac.il">zeev@vms.huji.ac.il</a></td>
</tr>
<tr>
<td>Almogi-Labin Ahuva</td>
<td><a href="mailto:almogi@gsi.gov.il">almogi@gsi.gov.il</a></td>
</tr>
<tr>
<td>Asael Dan</td>
<td><a href="mailto:dan.asael@mail.huji.ac.il">dan.asael@mail.huji.ac.il</a></td>
</tr>
<tr>
<td>Avni Yavni</td>
<td><a href="mailto:yavni@gsi.gov.il">yavni@gsi.gov.il</a></td>
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<td>Ayalon Avner</td>
<td><a href="mailto:ayalon@gsi.gov.il">ayalon@gsi.gov.il</a></td>
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<tr>
<td>Bookman Revital</td>
<td><a href="mailto:rbookman@sci.haifa.ac.il">rbookman@sci.haifa.ac.il</a></td>
</tr>
<tr>
<td>Boyle Edward A.</td>
<td><a href="mailto:eaboyle@mit.edu">eaboyle@mit.edu</a></td>
</tr>
<tr>
<td>Dubowsky Yael</td>
<td><a href="mailto:yaeld@tx.technion.ac.il">yaeld@tx.technion.ac.il</a></td>
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<tr>
<td>Eliani Efrat</td>
<td><a href="mailto:elianief@bgu.ac.il">elianief@bgu.ac.il</a></td>
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<td>Erel Yigal</td>
<td><a href="mailto:yerel@vms.huji.ac.il">yerel@vms.huji.ac.il</a></td>
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<td>Erez Yonathan</td>
<td><a href="mailto:eresz@vms.huji.ac.il">eresz@vms.huji.ac.il</a></td>
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<td><a href="mailto:ganor@bgu.ac.il">ganor@bgu.ac.il</a></td>
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<td>Gavrieli Ittai</td>
<td><a href="mailto:ittai.gavrieli@gsi.gov.il">ittai.gavrieli@gsi.gov.il</a></td>
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<td><a href="mailto:y.harlan@gsi.gov.il">y.harlan@gsi.gov.il</a></td>
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<td><a href="mailto:caryn@vms.huji.ac.il">caryn@vms.huji.ac.il</a></td>
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<tr>
<td>Herut Barak</td>
<td><a href="mailto:barak@ocean.org.il">barak@ocean.org.il</a></td>
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<tr>
<td>Hoffmann Michael R.</td>
<td><a href="mailto:mrh@caltech.edu">mrh@caltech.edu</a></td>
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<tr>
<td>Kallai Zecharia</td>
<td><a href="mailto:Liza@vms.huji.ac.il">Liza@vms.huji.ac.il</a></td>
</tr>
<tr>
<td>Kallai Lisa</td>
<td><a href="mailto:Liza@vms.huji.ac.il">Liza@vms.huji.ac.il</a></td>
</tr>
<tr>
<td>Kaplan Ian</td>
<td><a href="mailto:kaplan@pacbell.net">kaplan@pacbell.net</a></td>
</tr>
<tr>
<td>Kaplan Helen</td>
<td><a href="mailto:kaplan@pacbell.net">kaplan@pacbell.net</a></td>
</tr>
<tr>
<td>Kasibhatla Prasad</td>
<td><a href="mailto:psk9@duke.edu">psk9@duke.edu</a></td>
</tr>
<tr>
<td>Kedem-Klein Nir</td>
<td>nir.kleinbedem&gt;Gmail.com</td>
</tr>
<tr>
<td>Kolodny Yeshu</td>
<td><a href="mailto:kolodny@vms.huji.ac.il">kolodny@vms.huji.ac.il</a></td>
</tr>
<tr>
<td>Kraemer Stephan</td>
<td><a href="mailto:stephan.kraemer@univie.ac.at">stephan.kraemer@univie.ac.at</a></td>
</tr>
<tr>
<td>Lazar Boaz</td>
<td><a href="mailto:boaz.lazar@huji.ac.il">boaz.lazar@huji.ac.il</a></td>
</tr>
<tr>
<td>Levenson Yael</td>
<td><a href="mailto:yaelevenson@gmail.com">yaelevenson@gmail.com</a></td>
</tr>
<tr>
<td>Lis Hagar</td>
<td><a href="mailto:hagarlis@gmail.com">hagarlis@gmail.com</a></td>
</tr>
</tbody>
</table>
Liu  Kon Kee  kkliu@cc.ncu.edu.tw
Luz  Boaz  boaz.luz@huji.ac.il
Magal  Einat  einat.magal@gsi.gov.il
Matthews  Alan  alan@vms.huji.ac.il
Nahum  Oz  oz.nahum@mail.huji.ac.il
Nishri  Aminadav  Nishri@ocean.org.il
Reznik  Itay  itayrez@bgu.ac.il
Ronen  Zeev  zeevrone@bgu.ac.il
Rosenberg  Yoav Oved  yoavoved@gmail.com
Rosenfeld  Daniel  daniel@vms.huji.ac.il
Rudich  Yinon  yinon.rudich@weizmann.ac.il
Savarino  Joel  jsavarino@lgge.obs.ujf-grenoble.fr
Schauer  James  jjschauer@wisc.edu
Sela  Michal  sela@bgu.ac.il
Shaked  Yeala  yshaked@vms.huji.ac.il
Sharf  Geula  geula@hadassah.ac.il
Shpund  Jacob  shpundk@gmail.com
Sivan  Orit  oritsi@bgu.ac.il
Spyros  Pandis  spyros@andrew.cmu.edu
Starinsky  Avraham  stari@vms.huji.ac.il
Taubner  Isabelle  itaubner@ifm-geomar.de
Teutsch  Nadya  teutsch@cc.huji.ac.il
Torfstein  Adi  adi.torf@mail.huji.ac.il
Wehrli  Bernhard  bernhard.wehrli@eawag.ch
Weinstein  Yishai  weinsty@mail.biu.ac.il
Yechieli  Yoseph  yechieli@gsi.gov.il

Thank you