Reports *from Albert and Alice Weeks Postdoctoral Fellows*

David Fowle

November, 1999 was an exciting time in my young research career as I not only completed my PhD. in geochemistry from the University of Notre Dame, but I also began my stay here in the Department of Geology and Geophysics as an Albert and Alice Weeks Postdoctoral Fellow. My doctoral research at ND focused primarily on the interactions between aqueous metal ions (Ca, Cu, Cr, Cd, Pb, UO_2^{2+}) and bacterial cell walls. The ultimate goal of this work was to develop a thermodynamic dataset to describe these reactions in low temperature geologic settings. As I was nearing the completion of my dissertation research I began to consider postdoctoral research collaborations in the field of geomicrobiology and it was immediately evident to me the that **Dr. Jill Banfield** was a leader of this emerging and dynamic geoscience field. The Alice and Albert Weeks Postdoctoral Fellowship has provided the means to begin this collaboration and I was quite honored when I learned I had been granted the fellowship. I am very thankful for this opportunity.

My research project at Wisconsin has evolved into the study of the formation and properties of nanocrystalline iron oxide(hydroxides) minerals with the geomicrobiology group's recent connections to the Tennyson Mine in southwestern Wisconsin. Scuba divers from Diversions Scuba in Madison provided videotaped footage of their diving trip into this MVT type Pb mine that was abandoned and flooded in the 1960's. Figures 1 and 2 are still images captured from this video and depict the thick beds of biological material covering the floor of the mine. TEM (Transmission Electron Microscopy) and optical microscopy images (Figures 3 and 4) of the biological material indicate the presence of two common iron oxidizing bacteria *Gallionella* and *Leptothrix* (identified by their distinct cell morphologies) in sample. The stalks and sheaths of these bacteria were completely coated in nanocrystalline iron oxide material (Banfield et al., 2000) (Figures 3 and 4).

Due to the small particle size (and therefore large surface area exposed to the fluid phase) the biogenic nanocrystalline minerals will have unique geochemical interactions between their surface and the surrounding aqueous environment. In order to quantify how decreasing the particle size of iron oxyhydroxides affects the adsorption of metal cations and organic molecules I am synthesizing these nanocrystalline iron oxyhydroxide particles in the laboratory. After characterizing this material I will study its surface chemistry in series of controlled adsorption studies as a function of pH, ionic strength, and metal ion/ organic molecule concentration. Further studies of the nanocrystalline goethite may include an oxygen isotope study in collaboration with **Dr. John Valley** to confirm the hypothesis that the aggregation of nanocrystalline mineral particles is an important crystallization mechanism. The results of this work will improve our understanding of the importance of biogenic iron oxides on the mass distribution of aqueous metal cations and dissolved organic carbon in the environment as well the role microorganisms have in the formation of iron oxide mineral phases.

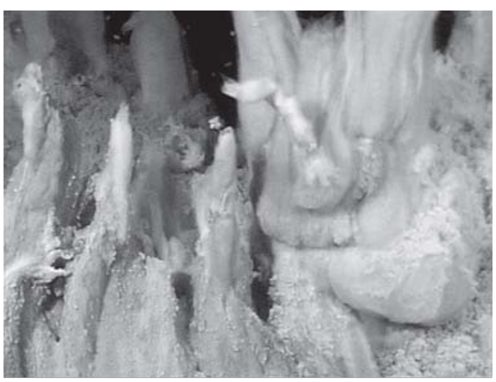


Figure 1

Figure 2

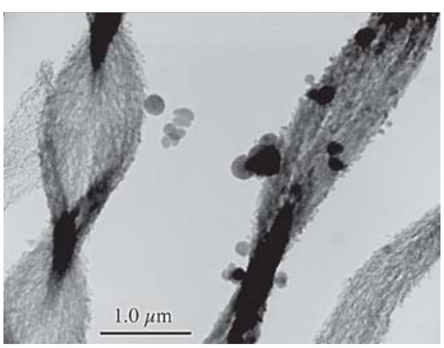


Figure 3

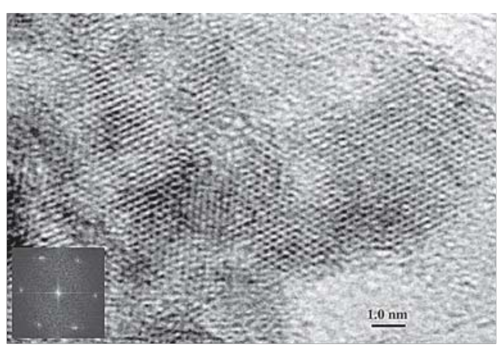
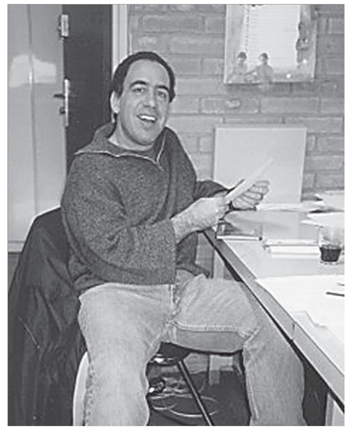


Figure 4

Yaron Katzir



Yaron Katzir, left and his family, (l to r) sons Tevel, 2, Geva, 5; daughter Aviv, 6, and his wife Zohar.

I’d like to thank the Weeks post-doctoral committee for awarding me the fellowship and giving me the opportunity to pursue the proposed research in this excellent department. I’m grateful for the soft landing in Madison made possible by the good will and attention of the staff, faculty and students of the department. You really made us feel welcomed!

Let me introduce the characters involved: Yaron Katzir (the new Weeks post-doc), my wife **Zohar** and our three kids: **Aviv** (6 years old girl), **Geva** (5, boy) and **Tevel** (2, boy). In Israel we live in Kibbutz Nir Eliyahu where Zohar works as the teacher and attendant of a big group of youngsters (2-3 years old).

A year ago I submitted my thesis titled *The origin, mode of emplacement and metamorphism of ultrabasic rocks in high P/T orogenic belts: The Alpine Orogen in the Aegean Sea* at the Hebrew University of Jerusalem. I was guided by **Prof. Alan Matthews**, **Prof. Zvi Garfunkel** and **Dr. Dov Avigad**. The thesis concerns the mechanisms by which mantle-derived rocks are incorporated into the burial-exhumation cycle of surface-derived rocks. I believe I was able to show the large variability and complexity of these processes, i.e. scenarios for tectonic emplacement of mantle rocks into the crust are numerous and exciting! There is much more to it than the classical models of ophiolite emplacement or mélange flow in subduction zones. I approached the subject using the classical tools of ‘hard-rock’ geologist: field-work, metamorphic petrology and thermodynamics, structural geology and geochemistry (both whole-rock and stable isotope).

Last year was spent in Paris (forget Paris...) where I was hosted for a post-doctoral study by **Mathilde Cannat** at Université Pierre et Marie Curie. I extended my interests to include also divergent plate-boundaries and looked into the intriguing question of denudation of abyssal peridotites. We worked on brecciated serpentinites dredged at the SW Indian Ridge, trying to shed light on their exhumation history: Is there a petrological and micro-structural evidence for the existence of low-angle oceanic detachments (mega-mullions) in slow-spreading ridges? Does serpentinization have a major role in accommodating and localizing deformation in the mid-oceanic lithosphere?

Back to the dry solid land—I’ve come to Madison to work with **John Valley** on metamorphic core-complexes, relating the famous Cordilleran ones (Ruby Mountains, Nevada) to their Mediterranean counterparts (Naxos, Greece). Having been recognized on the late 70s as structures representative of major processes of orogenic collapse: extension, high-temperature metamorphism and crustal anatexis, the core-complexes attracted lots of attention and research. Nevertheless there are still numerous open questions regarding their thermal and structural evolution and the counter-relations between them, and we wish to address several of these questions using the new techniques (laser-fluorination line), methods and attitudes developed in the stable isotope laboratory here.

We’ll first turn our interest into fluid-flow, thought to have profound affect on heat and material advection in core-complexes as well as enhancing deformation within them. Our work-hypothesis is that at high metamorphic temperatures, the behavior of volatiles is closely linked to the formation and crystallization of silicate melts, which act as a temporary volatile reservoir. Major fluid-flow episode is thus not expected to occur in peak metamorphic temperatures and its effect won’t show in associated mineralogical assemblages. Volatiles will only be released as retrograde fluid when temperature have decreased and the melts crystallize. Such fluid flow potentially can initiate metamorphic hydration reactions in the surroundings and induce cooling. However in core complexes, which mostly consist of partially molten and migmatized leucogneiss derived from granitic and pelitic protoliths, isolating the signature of retrograde fluid-flow from those of the other complicated processes is impossible .We thus focus on 'foreigners'—exotic blocks and lenses of mantle-derived rock incorporated to Naxos crustal sequence prior to metamorphism. The original mineralogy, chemical composition and oxygen isotope composition of the ultrabasic rocks which are completely different from those of the felsic country-rocks turn them into ideal candidates for detecting retrograde volatile release in core complexes. By careful oxygen isotope analysis of minerals representing different generations of crystallization, deformation and metasomatism of the ultrabasics, we seek to understand the paths of fluid transport, the geochemical controls of the transport and the retrograde metamorphic effects.

Our next interest is to understand the geometry and distribution of the low-angle normal faults considered to cut through the collapsing mountain-belts. The extensional stresses superposed on the thickened orogenic crust might materialize in a series of detachments removing substantial portions of the upper crust and enabling the exhumation of intact sections of the lower crust. This extensional-style was suggested for several core complexes in the Basin and Range province. Alternatively core complexes might expose uniformly thinned sections of the lower crust as argued on Naxos. Our belief is that the style of extension can be determined by studying geothermal field gradients. Do temperatures decrease in a monotonous way going up-section in core complexes? Are there pronounced discontinuities in the thermal field-gradient in footwalls of core complexes? Are these discontinuities associated with lithological boundaries or mylonitic zones? The powerful tool for answering these questions will be stable-isotope thermometry, and probably the best place to do it will be the 3rd floor in Weeks Hall, where a world-leading stable isotope lab is housed. I'm looking forward to a fruitful collaborative research!

Jay Schneider

I am now in the middle of my second year as a Weeks Postdoctoral Fellow. My project, *The Origin and Diversification of Brackish-Water Cockles (Bivalvia: Cardiidae: Lymnocardiinae)*, concerns the evolutionary history of one of a very few groups of marine origin that was able to suvive and diversify in the low salinity basins of the Neogene of eastern Europe and southwestern Asia. These basins were cut off from the Tethys Seaway as Africa and the Near East moved northwards towards Eurasia. Due mostly to tectonic processes and lowering of global eustatic sealevel, this series of basins, called the Paratethys, almost completely disappeared by the Late Pliocene. The only remaining remanants of Paratethys are the Caspian and Aral lakes. The lymnocards, a group known from approximately 700 fossil species, is represented by only fifteen living species in the Caspian and Aral lakes, as well as the Black Sea and the lower reaches of its tributaries.

The results of my first year of research were presented at three meetings in 1999: 1) The combined meeting of the American Society of Naturalists, the Society for the Study of Evolution, and the Society of Systematic Biologists, held in Madison in June, 2) the symposium on the Evolution of the Bivalvia, held in Cambridge, England in September, and 3) the annual meeting of the Geological Society of America, held in Denver in October.

As I write this in early February, I plan to complete my data analysis over the next several weeks and plan to write papers during the remainder of my time at Madison. These papers will be co-authored by **Dr. Imre Magyar** and **Dr. Dana Geary**. Dr. Magyar is a Hungarian paleontologist who was a postdoctoral fellow here at UW just previous to my arrival. Dr. Dana Geary is a UW paleontologist who has worked extensively in central and eastern Europe, and has been faculty advisor to both Dr. Magyar and myself. Dr. Magyar, now employed by the MOL Hungarian Oil Company in Budapest, was able to make one visit to Madison last November and hopefully will be able to make one more visit during my postdoctoral fellowship. Not only will this facilitate writing papers together, but planning future research projects. Dr. Magyar and I would like to organize and arrange funding for an international multidisciplinary Paratethyan Paleontology Project. This project would bring together all sorts of paleontologists working on a variety of questions pertaining to the history of Paratethys. Our first major step will be taken at the 2001 European Malacological Congress (UNITAS), to be held in Vienna, Austria. We are hoping to have numerous paleo-malacologists (paleontologists who specialize in clams, snails, and their relatives) from across central and eastern Europe and southwestern Asia attend the meeting and organize the first stage of what will hopefully be a productive international research project.