

H. Raymond Bingham Faculty Collaboration and Research Fund
Pre-proposal

Colin Inglefield, Department of Physics
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“Dynamics of Arctic Geochemical and Microbial Processes Altered by Global Warming.
Changes to mineral surfaces exposed to retreating glacier’s climate environment between 1 and 3
years - Investigations by Atomic Force Microscopy”

We propose the next phase of an existing collaborative research effort between the departments of physics and geosciences at WSU and the University of Mining and Metallurgy, Krakow, Poland. Last year we were awarded H. Raymond Bingham Faculty Collaboration and Research Fund to study the effects of arctic environments on mineral surfaces. We have completed the study proposed in last year’s proposal and results are being at two international conferences this year (Anna Plonka et al, 2008, Sara Summers et al, 2008). Three Weber State University students coauthored these presentations.

Prior to receiving the Fund last year, we have had an extensive library of images of calcite. The same type of calcite specimens were buried on Spitsbergen, Norway, in 2005, by our collaborators (Dr. Maciej Manecki, The University of Science and Technology, Krakow, Poland), on an arctic Spitsbergen research expedition financed by the European Community Research Grant. Study areas are the foreland of the Werenskiold glacier, continuously retreating by several meters a year (Figure 1). Chemical weathering associated with glaciers may affect several geochemical cycles, including the global carbon cycle and as a result have negative feedback on the global climate. Two samples of calcite (calcite 1 and calcite 2) were recovered after one year in 2006. Results of our AFM investigation, conducted this year from the Fund, show significant changes observed on a calcite samples located respectively about 2500 meters (sample calcite 1) and 100 m (sample calcite 2) from the glacier front as compared to a control sample calcite 0, that has never been exposed to glacier environment. Since this type of research is very new, all researchers involved in this project are very excited that the first set of results allowed us to observe and measure quantitatively changes occurring on mineral surfaces. Compared to the control sample calcite 0, which displays sharp edges and smooth surfaces (Figure 2), both field-treated samples calcite 1 and calcite 2 display several different features, including rounded edges and irregular surfaces (Figure 2). The observations suggest that both samples calcite 1 and 2 undergo intensive and rapid chemical weathering when exposed to glacial meltwaters. Several types of analyses have been applied to various regions and lines on the calcite surface (Figure 3).

We would like to pursue this avenue further and our existing collaboration with Dr. Manecki puts us in an excellent position to make a contribution in this area. The next set of mineral samples buried in 2005, after being exposed to arctic environment for three years, was recovered this last summer in the most recent arctic expedition. These samples will be sent to us in October this year. We plan to use Atomic Force Microscopy to compare these samples with our previously studied samples calcite 0, calcite 1, and calcite 2. After obtaining very exciting results in the last year’s study, we are looking with great enthusiasm to be able to research the changing rate of geochemical processes at nanoscales after additional two years in the arctic environment.

We were able to accelerate our research due to additional funding from the Beishline Fellowship that allowed to have one additional student working with us on Atomic Force Microscope. The H. Raymond Bingham Faculty Collaboration and Research Fund remains our primary source for the equipment, travel and faculty summer stipend expenses as these are not allowed to be paid from the Beishline Fellowship.

Budget Estimate

We anticipate using the funds to cover summer salary for the two faculty members. The microscope itself uses scanning probes which must be replaced regularly.

Note: a student is paid by the Beishline scholarship for a period of 12 months to work on this project (\$ 12,000 scholarship).

<u>Item</u>	<u>Cost</u>
2 Month Summer Faculty Stipends	\$ 12, 394 (including WSU indirect cost of 22%)
Scanning probes	\$2900 (10 boxes x \$290)
Travel cost for collaborating researchers and presenting the results	\$3000
Total	\$18,294

- (1) Sara Summers, Marek Matyjasik, Colin Inglefield, Maciej Manecki, Anna Plonka, Chad Paget, Corey Park. AFM Observations of Weathering and Microbiological Alterations on the Surface of Calcite Buried in Arctic Soil (Spitsbergen). A presentation to be presented at Annual Meeting of American Geophysical Union, December 11-16, 2008, San Francisco.
- (2) Anna Plonka, Maciej Manecki, Sara Summers, Marek Matyjasik, Colin Inglefield. Alterations on the surface of apatite and calcite buried in arctic soil (Spitsbergen): an AFM and SEM study. Abstract published in Second Central European Mineralogical Conference, Szklarska Poreba, Poland, September 11-14, 2008.



Figure 1: Spitsbergen glacier (left) and one of the sample location (right)

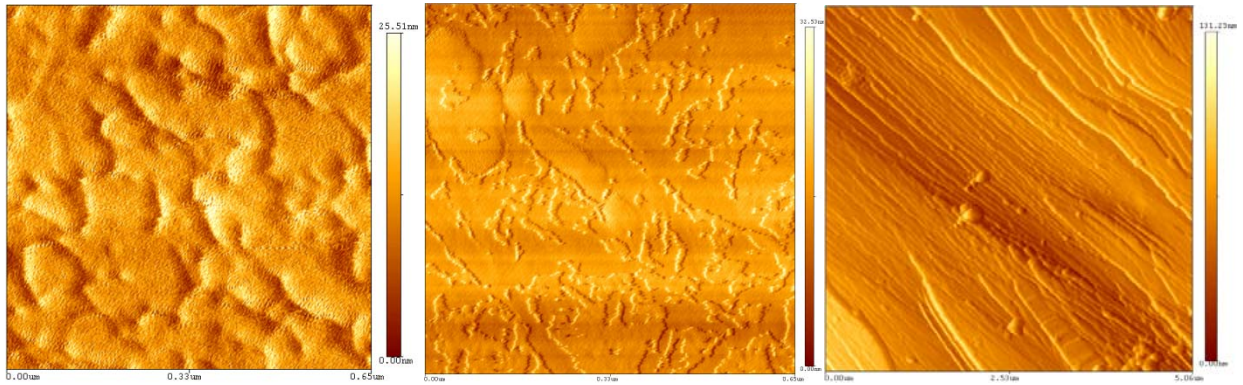


Figure 2: Examples of representative images of calcite surfaces observed in Atomic Force Microscopy: calcite surface exposed for 1 year at a distance of 100 m from the glacier's front (calcite 2, left image), at a distance of 100 m from the glacier's front (calcite 1, middle image), a calcite surface that has never been exposed to arctic environment (calcite 0, right image).

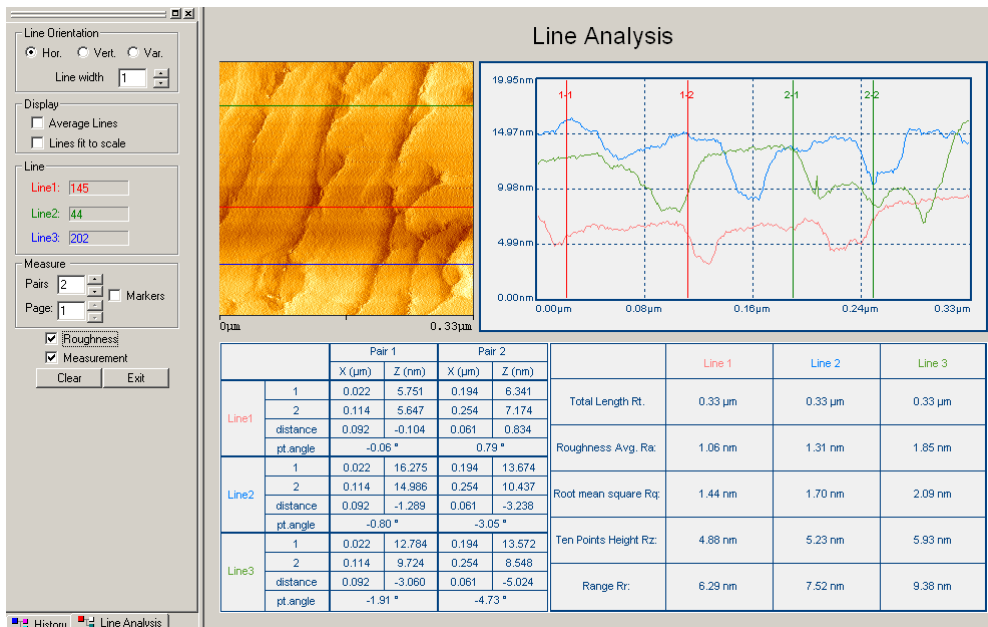


Figure 3: Examples of parameters calculated for Atomic Force Microscopy images.



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Krakow, September 30, 2008

I am writing this letter to support the proposal from Drs. Inglefield and Matyjasik, "Dynamics of Arctic Geochemical and Microbial Processes Altered by Global Warming. Changes to mineral surfaces exposed to retreating glacier's climate environment between 1 and 3 years - Investigations by Atomic Force Microscopy".

Drs. Inglefield and Matyjasik, together with Weber State University students, have collaborated with myself and my research group over the past three years, including the last year thanks to Your Fund, on studying of dynamics of Arctic geochemical cycles using Atomic Force Microscopy. Our arctic annual expeditions to Spitsbergen are being funded from a combination of research grants from European Union and Polish Science Foundation in the amount of \$80,000 over a period of four years from 2007 to 2010. These expeditions, combined with our research efforts from previous expeditions in 2005 and 2006, allowed us to plant samples of minerals at various distances from retreating Spitsbergen glaciers (first expedition took place in 2005), and to recover these samples of minerals in 2006. This year we are moving to the next phase of this exciting research. This last Summer, we recovered the next set of minerals from Spitsbergen. These samples will be shipped to Weber State University in October this year. Analysis of these samples will take approximately 1.5 year. From our preliminary observations using Scanning Electron Microscope we concluded that these samples collected from Spitsbergen after three years show even more changing affects of retreating glaciers on geochemical processes alternating mineral surfaces.

Thanks to your H. Raymond Bingham Research Fund award last year, Drs. Inglefield and Matyjasik, together with their students, were able to significantly intensify their research on mineral samples sent from Spitsbergen. These samples need to be analyzed in a relatively short period of time so that other geochemical and biological processes would not modify mineral surfaces after the samples had been recovered from Spitsbergen. Only additional research funding would allow them to commit sufficient amount of time for this research and to cover the cost of Atomic Force Microscope tips. Because of very intense pace of their and my group's research we were able to obtain extremely interesting and exciting results from the samples recovered in 2006. These results are already presented in two international conferences and we plan to present the next set of results at the European Geological Society meeting in Vienna in 2009. In short they show how minerals planted at various distances from the retreating glacier are altered in different ways, showing how geochemical activity affects carbon cycle, thus accelerating global warming.

It would be very beneficial to the success of this important project, partly funded on our end as described above in my letter, if you could assist Drs. Inglefield and Matyjasik with your H. Bingham Faculty Collaboration and Research Fund for the next year to allow them compare mineral surfaces of the samples recovered from arctic environment after three years with those that have been exposed to the same arctic environment only for one year. I will be very happy to answer or discussed with you any questions. I would like to add that our research group greatly values collaboration with Weber State University students.

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