

# THE ANNUAL FIVE-COLLEGE GEOLOGY FACULTY SYMPOSIUM

THURSDAY, SEPTEMBER 27TH

AT 4:30 PM

CLEVELAND L1  
(MOUNT HOLYOKE COLLEGE)



RECEPTION TO FOLLOW IN THE KENDADE ATRIUM

*Proudly hosted by the Department of Geology and Geography  
Mount Holyoke College*

## SCHEDULE OF TALKS

ANNUAL FIVE-COLLEGE GEOLOGY FACULTY SYMPOSIUM  
SEPTEMBER 27, 2007  
CLEVELAND L1

4:30 PM

SARA PRUSS, SMITH COLLEGE

“CAMBRO-ORDOVICIAN CARBONATES IN SKELETON-POOR SEAS”

4:45 PM

TEKLA HARMS, AMHERST COLLEGE

“THE KLINKIT FAULT AND THE KLINKIT BATHOLITH OF NORTHERN BRITISH COLUMBIA: MELT AND DISPLACEMENT”

5:00 PM

STEVE DUNN, MOUNT HOLYOKE COLLEGE

“CONVERSION OF ORGANIC MATTER TO GRAPHITE DURING METAMORPHISM”

5:15 PM

STEVE ROOF, HAMPSHIRE COLLEGE

“WATCHING THE SNOW MELT: SPRINGTIME IN THE ARCTIC”

5:30 PM

RAY BRADLEY, UMASS (FEATURED JOHN B. REID SPEAKER)

“THE PROBLEM OF VENICE”

## **Cambro-Ordovician Carbonates in Skeleton-Poor Seas**

**Sara Pruss**

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The evolution of mineralized skeletons near the Proterozoic-Cambrian boundary set the stage for a major shift in the processes and patterns of carbonate deposition in the world's oceans. Quantitative analysis of petrofabrics in the Middle to Upper Cambrian Port au Port Group, western Newfoundland indicates, however, that despite the multi-clade radiation of carbonate skeletons earlier in the Cambrian Period, the skeletal sink for carbonate did not develop fully until Ordovician time. Carbonate facies in the Port au Port Group consist of oolites, flat-pebble conglomerates, microbial buildups, and micrite -- much like Neoproterozoic ramps and platforms. Skeletons make up only a small proportion of carbonate observed in outcrop. To complement field observations, a petrographic study was conducted to quantify the carbonate components preserved in thin section. Common facies were analyzed to determine if the apparent contribution of carbonate skeletons to total carbonate was influenced by the size of fossil material. Both field and thin section studies show that carbonate fossil material comprises only a small proportion of the carbonate that accumulated during later Cambrian time. A few individual beds contain relatively abundant fossil material (18.5% of points counted). Mean abundance of skeletal material in the Cambrian carbonates examined, however, is  $4\pm 6\%$ , with a median and mode value of 0. These field and thin section observations from Newfoundland were complimented with a literature compilation of carbonate sections across Laurentia. The literature compilation showed that, at least on Laurentia, a skeletal sink for carbonate was not established until the Middle Ordovician.

# **The Klinkit Fault and the Klinkit Batholith of Northern British Columbia: Melt and Displacement**

**Tekla Harms**

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Quaternary fill in the broad valley of the Jennings River in northernmost British Columbia obscures the contact relationship between Mesozoic volcanic rocks of Quesnellia terrane (QN) to the south and Paleozoic greenschist to amphibolite facies metasedimentary and meta-igneous rocks of Yukon-Tanana terrane (YT) to the north. Nevertheless, it has been presumed that a thrust fault, the Klinkit fault (KF), underlies the Jennings River and places QN over YT. While initially QN may have been accreted to and thrust over YT, or built unconformably on a basement of YT, new fabric analysis demonstrates the present contact in this area is a sinistral strike slip fault.

The late Early Cretaceous, biotite-monzogranitic Klinkit batholith (KB) intrudes the southern margin of YT rocks adjacent to the Jennings River. In some places there is no fabric in the batholith; elsewhere two generations of fabric occur: 1) a restricted, moderately NW-dipping foliation with NW-plunging lineation, which is locally overprinted by 2) a dominant, near-vertical WNW-striking foliation with a subhorizontal lineation. The later fabric can occur either as a primary magmatic alignment of biotite and elongated quartz grains or be protomylonitic with grain size reduction of quartz and feldspar in discrete C-folia and aligned biotite in S-folia. The S and C fabrics indicate a sinistral sense of displacement across the batholith.

Because the WNW-trending KB lineation is parallel to the linear Jennings River valley, the KB fabric is interpreted to reflect displacement on the KF. Because there are both magmatic and mylonitic fabrics in the KB that are aligned, and because the lineation is also parallel to the long axis of the elliptical KB, the intrusion is considered early synkinematic, and sinistral offset on the KF can thereby be dated as mid-Cretaceous. This coincides with the earliest phase of dextral displacement on a well-documented network of NW-trending faults to the east and west of the KF. These seemingly antithetic displacements can be reconciled if, together, the sinistral Klinkit and dextral Kutcho-Cassiar faults accommodated modest northward escape of an intervening wedge-shaped block of YT as the allochthonous Intermontane terranes converged with ancestral North America in the culminating phase of Cordilleran orogenesis.

# Conversion of Organic Matter to Graphite During Metamorphism

**Steve Dunn**

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Graphite is a remarkable mineral; fascinating in its physical properties, versatile in its uses, and interesting in its origin. The graphite atomic structure consists of sheets of very strongly bonded carbon atoms ( $sp^2$ -hybrid orbitals) with a hexagonal arrangement. The sheets are held together by extremely weak van der Waals forces. This disparity helps to explain how graphite can be used as a lubricant (slippery between the sheets) and also as a source of strength in lightweight composites for use in golf clubs, bicycles, tennis rackets, fishing rods, helmets, skateboards, surf boards, musical instruments, formula one race cars, and tiles on the space shuttle. Its high electrical and thermal conductivity make it useful for things such as motor brushes and heat sinks in laptop computers. Then there's pencil "lead!" Graphite is versatile.

At least two distinct processes can produce graphite. One is deposition from a fluid phase, for example, as seen in vein occurrences. Graphite veins are common in most high-grade metamorphic terranes. Vein graphite is always coarse, flaky, highly crystalline graphite. The most likely process that creates graphite veins involves mixing of  $CH_4$ -rich and  $CO_2$ -rich fluids producing  $H_2O$  + graphite. Cooling of C-O-H fluid mixtures and/or lowering its oxidation state should also cause graphite precipitation. The other way to produce graphite is by metamorphism of organic matter. Organic matter deposited along with other sediment undergoes chemical and structural changes in response to elevated temperatures and pressures during diagenesis and metamorphism, ultimately resulting in the creation of graphite. The transformation of carbonaceous matter to graphite, which is termed graphitization, proceeds as discontinuous, poorly-organized, aromatic layers of the original organic matter are converted into compositionally pure, well-ordered graphite with a layered atomic structure.

The process of graphitization has been studied using a number of different methods, including X-ray powder methods, differential thermal analysis, and transmission electron microscopy. But one of the most useful techniques is Raman spectroscopy, in which a laser light source impinges on the sample and inelastic scattering results in a spectrum of peaks that correspond to particular vibrational modes in the bonds of the atomic structure. Well crystallized graphite has a sharp peak called the G-peak (at  $1580\text{ cm}^{-1}$ ). Poorly crystalline carbonaceous material has a smaller G-peak and two prominent disorder peaks, called the D1- and D2-peaks (at  $1350\text{ cm}^{-1}$  and  $1620\text{ cm}^{-1}$ , respectively).

The ratio of the areas of these peaks ( $D1/(D1+D2+G)$ ) has been quantitatively correlated with metamorphic temperature by Beyssac et al. (2002, *Journal of Metamorphic Geology* 20, 859-871) for pelitic rocks over the range  $330$ - $650^\circ\text{C}$ . I have applied their methods to 37 marble samples from the Grenville Province, over the range  $450$  to  $735^\circ\text{C}$  and find that graphite in marble is consistently more structurally mature than graphite in pelitic rocks metamorphosed at the same temperature. Graphitization appears to be accelerated in marble relative to pelitic rocks, perhaps due different chemical or physical parameters, such as the role of a fluid phase, or higher oxygen fugacity, or different coarsening mechanisms. Precursor organic matter may also be a factor. Within sample variation is large and may result from variability in graphite orientation. With better understanding of the variability due to orientation, Raman spectroscopy may prove useful in recognizing within-sample heterogeneity and discriminating among organic precursors.

# Watching the Snow Melt: Springtime in the Arctic

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## Svalbard REU

High Latitude Climate Change  
Research Program

{NSF Award #0649006}



The Arctic is warming four times faster than lower latitudes and even greater rates of change and wholesale ecosystem migrations are predicted with the continuing decay of the Arctic Ocean pack ice . In light of these concerns and the importance of the polar regions in the global climate system , there is a growing need to understand how the Arctic climate system “works” and how it has changed in recent decades as well as over the last several thousand years. Since 2002, the Svalbard REU program has been studying a glacier-river-lake system in the Linné Valley, in which the layered sediments at the bottom of the lake provide a detailed record of climate changes over the past 9,000 years. However, our results have hinted that a majority of sediment is transported to the lake during the spring melt, when the snow melts off the landscape. During my sabbatical in spring 2007, I had the opportunity to spend time in the Linne Valley during the spring melt season to complement the work we have done during the past four summers.

After securing a competent field assistant, I spent a month in a remote trapper’s cabin making snow surveys, setting up instruments, and measuring baseline conditions during the month of May. By mid-May, we had everything ready for the spring melt as we observed the snow pack beginning to warm and melt. But unfortunately, temperatures dropped and everything froze up again and we had to leave before observing the spring melt directly. But the instruments we deployed captured the events of the spring melt and we later recovered an excellent series of photographs and sensor data revealing how the spring snowmelt occurred and the nature of its impact on the varve record in the lake. The snow melted off the landscape over a brief 4-day interval, but there were several pulses of sediment delivered to the lake. No single trigger appeared to initiate the snowmelt this year, just an accumulation of springtime warming. I will also discuss briefly how we undertake our modern process studies and describe the Svalbard REU program, which is seeking qualified undergraduate students interested in spending a summer studying Arctic climate change.

## **The Problem of Venice**

**Ray Bradley**

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Venice is sinking, sea-level is rising and that's not a good situation to be in. I will discuss the evidence for, and causes of, the subsidence, and of the sea-level rise, then outline some of the solutions that have been proposed to deal with the problem. In a very real sense, Venice is the "tip of the iceberg"; soon the problem of Venice will be at our shores too.