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2009-2010 PROJECTS

SE ALASKA - EXHUMATION OF THE COAST MOUNTAINS BATHOLITH DURING THE GREENHOUSE TO ICEHOUSE TRANSITION IN SOUTHEAST ALASKA: A MULTIDISCIPLINARY STUDY OF THE PALEOGENE KOOTZNAHOO FM.

Faculty: Cameron Davidson (Carleton College), Karl Wirth (Macalester College), Tim White (Penn State University)

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WISCONSIN - THE GEOLOGY AND ECOHYDROLOGY OF SPRINGS IN THE DRIFTLESS AREA OF SOUTHWEST WISCONSIN.

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Students: Adam Curry, Allison Goldberg, Lauren Idleman, Allan Lerner, Max Siegrist, Clare Tochilin

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**Keck Geology Consortium: Projects 2009-2010
Short Contributions – SE ALASKA**

**EXHUMATION OF THE COAST MOUNTAINS BATHOLITH DURING THE
GREENHOUSE TO ICEHOUSE TRANSITION IN SOUTHEAST ALASKA: A
MULTIDISCIPLINARY STUDY OF THE PALEOGENE KOOTZNAHOO
FORMATION**

CAMERON DAVIDSON, Carleton College

KARL R. WIRTH, Macalester College

TIM WHITE, Pennsylvania State University

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LEONARD ANCUTA: Union College

Research Advisor: John Garver

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NATHAN S. EVENSON: Carleton College

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SAMANTHA FALCON: West Virginia University

Research Advisor: Dr. Helen Lang

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ALEXANDER BRIAN GONZALEZ: Amherst College
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TIFFANY HENDERSON: Trinity University
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CONOR P. MCNALLY: The Pennsylvania State University
Research Advisor: Tim White

**USING STABLE AND CLUMPED ISOTOPE GEOCHEMISTRY TO
RECONSTRUCT PALEOCLIMATE AND PALEOHYDROLOGY IN THE
KOOTZNAHOO FORMATION, SE ALASKA**

JULIA NAVE: The Colorado College
Research Advisor: Henry Fricke

**PALEOMAGNETIC STUDY OF THE PALEOGENE KOOTZNAHOO
FORMATION, SOUTHEAST ALASKA**

MARIA PRINCEN: Macalester College
Research Advisor: Karl Wirth

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INTERPRETATION OF THE KOOTZNAHOO FORMATION USING STRATIGRAPHY AND PALYNOLOGY

SAMANTHA FALCON

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Research Advisor: Dr. Helen Lang

ABSTRACT

The interpretation of the Kootznahoo Formation requires a multidisciplinary investigation. The use of sedimentary stratigraphy and the study of palynology are two ways that one can use multiple methods to create stronger evidence for any interpretations made.

Glass pollen mounts were created from five palynological samples that were taken from layers composed of fine, shaley silts. Once in the lab, optical analysis of the pollen and spores are conducted in order to gain a better understanding of the depositional environment. The result of the analysis supports earlier ideas presented by people such as Millers and others (1959), who suggest that the Kootznahoo Formation was deposited in fluvial environments in the Admiralty Trough, an elongate depression about 320 km long and 50 km wide (Dickinson et al, 1990). The preservation of the pollen and spores that were encountered is poor but this can be attributed to tectonic activity and volcanism; both of which actively occurred before and after the deposition of the Kootznahoo Formation. The field area focused on in this paper is a recently named and measured area known as Hamilton Point South.

INTRODUCTION

The Kootznahoo Formation is a lower Tertiary non-marine clastic unit that crops out in southeastern Alaska. It consists mostly of nonmarine poorly sorted arkosic and lithic sandstone, conglomerate, and lesser amounts of shale and coal (Dickinson et al, 1990). This formation crops out on multiple islands which are easily accessible from our field station located in Kake, Alaska. The islands on which the

Kootznahoo Formation crops out are in the Zarembo-Kuiu Islands region (Brew and others, 1984) and on Admiralty Island (Lathram and others, 1965). Age of the Kootznahoo Formation is reported to be Eocene to Paleocene in the Zarembo-Kuiu Islands region and Micocene to Eocene on Admiralty Island (Brew and others, 1984).

The field site of Hamilton Point South (Fig. !A,B) is within the Keku strait area and is stratigraphically above Hamilton Point and below Dakaneek Point North. Figure 2 (Davidson et al, this volume) is a map of the area around Kake, Alaska and shows where each of the previous areas mentioned are in relation to one another geographically.

This paper's purpose is to focus on how the study of stratigraphy coupled with the study of palynology can help recreate the depositional environment of the Kootznahoo Formation during the Paleocene to Eocene.



Figure 2. Photos of the Kootznahoo Formation at Hamilton Point South. A- Zoomed out view containing main exposure from photo A with people for scale, B- Close up view of main exposure near bottom of measured section, C- Site where Sample 09SF030 was collected from Facies D with chisel for scale.

Schematic Sketch Displaying the Stratigraphy of the Kootznehoo Formation at Hamilton Point South

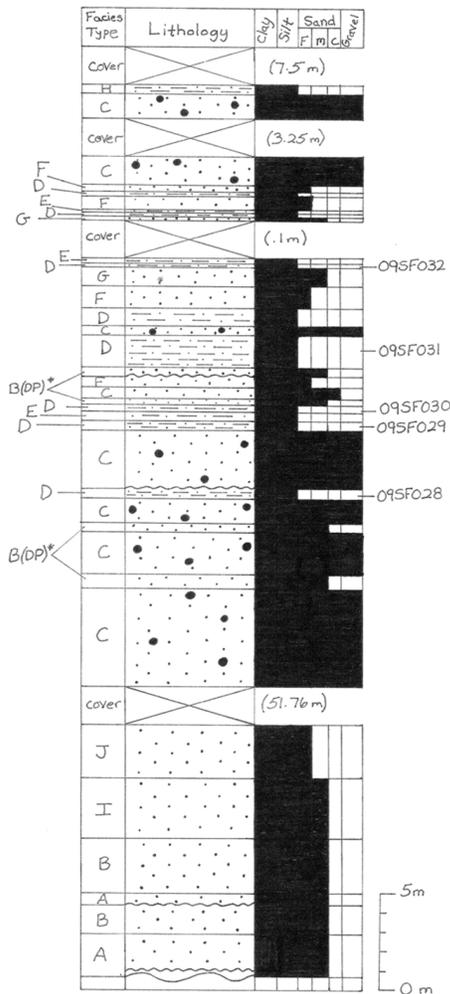


Figure 2. Changes in rock composition are categorized by individual descriptions for each facies type. The types of facies seen at Hamilton Point South are: Facies A: white-tan-yellowish medium Ss with low angle trough cross laminations, Facies B: Tan-yellow medium Ss with moqui marbles (cm), vertical burrows, CaCO_3 concretions, occasional pebbles, and prominent shale chip weathering porosity, Facies B(DP)*: Dark grey-brown medium Ss with cross laminations and calcite cement, Facies C: Medium grey-olive green coarse Ss; pebbly with sparse cobbles, HCL reactive, load casts, cross laminations (m), and undulatory top surface, Facies D: Medium olive grey shaly silt, Facies E: Medium olive grey shaly silt with concretionary organic rich layers, Facies F: Medium-olive brown very fine Ss with chaotic cross laminations, Facies G: Medium brown colored fine-medium Ss with low angle trough cross bedding and concretions, Facies H: Olive green silty shales with sheen and strong, Facies I: Tan-brown-olive colored fine-medium Ss with massive bedding, steep cross beds, and CaCO_3 cement, and Facies J: Light brown/grey fine Ss with massive bedding and flaggy (sheety Ss, looks like shale) at base

METHODS

Fieldwork

In the field, we measured and described the lithology of the exposed outcrops in which the Kootznehoo Formation was present. Measurements were taken using a 1.5 meter long Jacob's staff and Brunton compass. The lithologies of the layers found within the measured section were recorded as facies types. Each change of facies type is measured for its bedding thickness within the overall section and referred to again if it reappears later in the section. Figure 2 is a schematic sketch showing the measured stratigraphy that was compiled from notes and measurements taken in the field. Table 1 was created to be viewed along with Figure 2 and shows more detailed information about each individual layer.

Samples were collected during the measuring process from layers that were composed of very fine shales to silts. The selection of a fine grained sample will provide a greater chance of pollen and spores being present in abundance. Samples collected outside of this parameter will result in poor palynological samples once in the lab. Environments that are anoxic, receive low energy levels, and undergoes little to no reworking or deformation of its sediments produce high quality palynological samples. At the field site of Hamilton Point South, five palynological samples were collected from the Kootznehoo Formation with no specific interval spacing (Fig. 2). All five samples were chosen from what is referred to as Facies D. Facies D has been described as being a medium olive/grey shaly silt; a perfect specimen type to be taken back to the lab for maceration of the sample. Figure 1C is a photograph that was taken after Sample 09SF030 was collected from within Facies D.

Lab work

To be able to view and analyze the types of pollen and spores, the collected samples must be processed. There are four main stages of Palynological Sample-Processing (Traverse, 1988), they are: I.) Initial Processes, II.) Demineralization, III.) Maceration,

Numerical and Textural Data for the schematic sketch of the Kootznahoo Formation at Hamilton Point South			
Total Section Length (m)	Facies Type	Facies Thickness (m)	Comments
168.51	Covered	69.2	Ends at beginning of gabbros
99.31	H	.3	
99.01	C	1.2	
97.81	Covered	7.5	
90.31	C	1.6	Contact deformation w/red-brown concretions (cover upper surface)
88.71	F	.3	
88.41	D	.2	
88.21	F	.8	Deformation around concretions
87.41	E	.1	
87.31	D	.15	
87.16	G	.1	Ripple laminations
87.06	Covered	.1	
86.96	E	.1	
86.86	D	.2	Sample 09SF032
86.66	G	1.1	
85.56	F	1.2	
84.36	D	.95	Partially covered
83.41	C	.4	Concretions
83.01	D	1.7	Partially covered, Sample 09SF031
81.31	B(DP)*	.5	Erosive base, cheerio/ashtray concretions, and undulatory top
80.81	F	.6	
80.21	C	.5	No pebbles
79.71	B(DP)*	.4	Top w/meter scale lenses of Facies E
79.31	D	.3	Sample 09SF030
79.01	E	.5	
78.51	D	.5	Ripple laminations, Sample 09SF029
78.01	C	3.0	Erosive base
75.01	D	.4	Sample 09SF028
74.61	C	1.3	Lenses of Facies B(DP)* and concretionary
73.31	B(DP)*	.5	
72.81	C	2.2	Lenses of Facies B(DP)*
70.61	B(DP)*	.8	
69.81	C	5.05	Upper 2 m contains lenses (.5-3m long) of Facies B(DP)* w/an erosive base
64.76	Covered	51.76	
13.0	J	2.7	
10.3	I	3.2	
7.1	B	2.8	Prominant low angle trough cross laminations (6 m in diameter, units=20 cm thick) and mid layer = bed of shale chips
4.3	A	.5	Shale clasts (throughout base) and an erosive base
3.8	B	1.6	Lense (10 cm thick, 1.2 m diameter): white-medium brown-light grey fine, iron-rich sand. Contains oxidized pyrite (jaracite), 2 mm thick vitrain band, and has knobby weathering.
2.2	A	2.2	Cret. clasts (cm-m) near base above unconformity with 1.5 m of erosional topography on unconformity. CaCO3 concretions present in upper meter (40-126 cm in diameter)

and IV.) Final Process. Each of the four stages is broken up into sub-stages. The Initial Processes include cleaning, disaggregation, and weighing of the sample. The Demineralization stage involves the removal of carbonates, the removal of silicates, and the removal of any remaining inorganics using a Heavy Liquid Separation process. Maceration begins with oxidation and is followed by the removal of oxidation products by way of either an alkali/organic solvent-treatment or by bleaching. The Final Process completes the sample processing by staining the sample before doing the final cleaning. These four stages produce the organic residue that is viewed and studied at the microscopic level (Brown, 2008).

OPTICAL MICROSCOPY AND THE SCANNING ELECTRON MICROSCOPE (SEM)

There are multiple methods in which to view pollen on the microscopic level. The way the five palynological samples were prepared was meant for use with an optical microscope. In using an optical method, pollen was visibly present but at only a 200x optical magnification. This allowed a general view of overall morphological features, but did not illuminate the fine, external aspects that are easily seen at a much higher magnification.

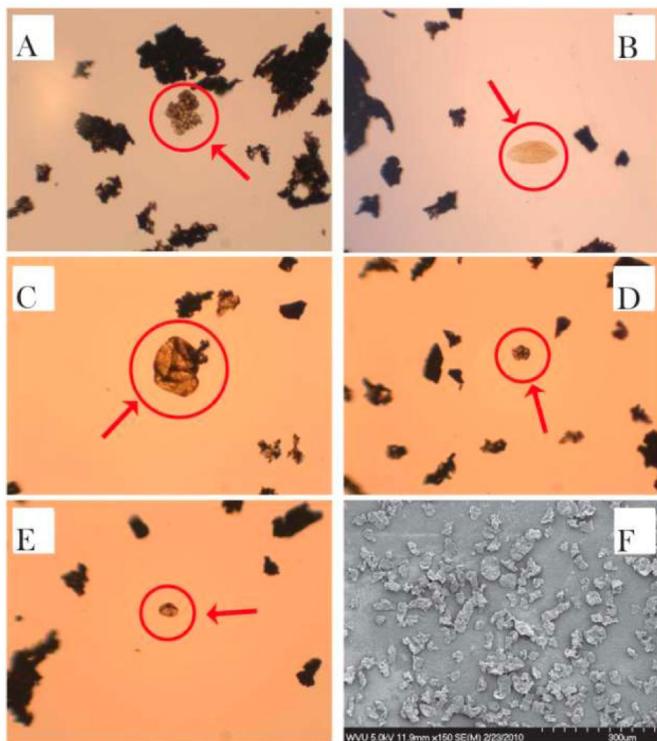


Figure 3. Images taken using the optical microscope (image A-E) and images taken with the scanning electron microscope (SEM) (image F). Arrows are used to indicate specific pollen or spore that is being discussed; all noted measurements were made of the individual pollen or spores (not the entire photo). A) Sample 09SF028 – 10-15 μm , B) Sample 09SF029 – 15 μm long, 7 μm wide, C) Sample 09SF030 – 18 μm long, 15 μm wide, D) Sample 09SF031 – 5 μm , E) Sample 09SF032 – 6 μm long, 4 μm wide, and F) Sample 09SF033 - scale included in photo.

Scanning electron microscopy (SEM) provides a three-dimensional appearing view of the surface of palynomorphs (Traverse, 1988). Figure 3A shows an SEM image taken of the leftover residual organics. Sample 09SF033 was used as a test run but was not collected from Hamilton Point South. None of the pollen grains or spores were recognizable in any way, shape, or form. This is due to the manner in which they were processed.

MORPHOLOGY AND NOMENCLATURE

The study of palynology requires an understanding that nomenclature should not be confused with classification (Norem, 1958). Using nomenclature as an identification system requires a skilled eye and knowledge of the topic. Instead, a morphologi-

cal classification scheme is used to acquire a basic interpretation of the fossil pollen and spores present in the samples.

Norem's (1958) morphological based classification system is presented as three main keys. The main key divides microfossils into groups according to the type and number of apertures, or prominent appendages. The next division of the groups from the first key is based upon surface sculpturing. The final key is the least diagnostic and separates the groups further on basis of shape.

RESULTS

Each slide was viewed, described, and photographed in order to better understand the organic remains that were processed and mounted on glass slides. Also recall that all of the samples are derived from the same facies type of D. Figure 3B-F displays all of the sample images that were taken using a Leica microscope camera.

Sample 09SF028

Majority of organics are useless, black organic material. The only interesting form is shown in Figure 3A. Morphological classification is hard to use here due to an amorphous shape. This reflects the amount of distortion and disfigurement the original rock sample underwent after deposition.

Sample 09SF029

Figure 3B is one of the photos taken from this sample. Using Norem's (1958) key classification system, this example is described as being elaterate (with elaters). These are spores for pollen without appendages. To further classify, it may also be referred to as being Tenuate (with thin areas serving as apertures) and has a spheroidal shape. Magnification is too poor to observe any sculptural features.

Sample 09SF030

Figure 3C displays the first pollen resembling shape found amongst large amounts of useless organic

material. Norem (1958) would classify this as a spore or pollen grain with appendages. Further description indicates it being a vesicutrilete (wing-like bladders with apertures), saccate in shape, and has no surface sculpture to be seen at the magnification available.

Sample 09SF031

Sample yielded a good amount of only slightly deformed pollen (Fig. 3D). Norem (1958) once again would call this a vesicutrilete. This vesicutrilete also has a saccate shape without any definitive surface sculpture features.

Sample 09SF032

Mostly useless organic material with few spores; Figure 3E looks as if the spore underwent compression and/or some type of deformation. Norem (1958) would call this a spore for pollen without appendages. It only has one aperture making it a monoaperturate. The shape of this aperture defines it as a sulcate because of its elongate, straight or branched distal-polar aperture. Also, because the aperture has three branches, it is called a Tri(cholomo)sulcate. It also has a squished ellipsoidal shape without any notable surface sculpture features.

DISCUSSION

In using the methods of stratigraphy and palynology combined, one can help recreate a paleoclimate and gain a greater insight at what went on at the time of deposition for the Kootznahoo Formation. Most of the specimens encountered in practical palynology are not so well preserved (Traverse, 1988). My personal research and analysis of the sedimentary samples brought back from the Kootznahoo Formation around Kake, Alaska reiterates this statement. Both pollen and spores were encountered in all the samples I looked at from Hamilton Point South but none had a very definitive shapes or features.

Factors such as increased heat flow, pyrite precipitation after deposition (Table 1), and oxidation can

all hinder or completely prevent the preservation process (Traverse, 1988). The poor preservation of the once fully-formed pollen and spores leaves them as a part of the highly abundant organic material.

The stratigraphy of Hamilton Point South (Fig. 2) suggests this was a fluvial dominated area; this is supported in Figure 1A which shows the exposure is mainly sandstone in composition with clear preservation of cross bedding and lamination. Variation within the grain sizes portrays a transition from a fine (at the bottom) to coarser (near the center) grained material with interfingering layers of fine sands to silt (Fig. 2). There is also a thinning of layers as you move up in section closer to the finer grained sands and silts (Fig. 2).

CONCLUSION

This series of indicators provides evidence for the idea that the Kootznahoo Formation was indeed deposited in an intermontane basin (Lathram and others, 1965). The stratigraphy highlights this evidence by having intervals of a coarsening upward sequence; for example, the interval between the first and second covered interval (Fig. 2), which is indicative of an alluvial fan deposition. This helps illustrate that the base of the Kootznahoo Formation at Hamilton Point South was not deposited at the source but within close proximity to the source. This is supported by the occasional presence of pebbles within named Facies C. The sequence stretches from close to the source near the edges of the intermontane basin, inward towards the center of the basin where the finer sands and silts are eventually deposited.

Further research of other exposures of the Kootznahoo Formation would allow further investigation of this depositional theory and would provide the ability to make palynological correlations. Correlations would help determine an age constraint of the deposit and indicate any stratigraphic correlations with other surrounding exposures of the Kootznahoo Formation.

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