Linda C. Kah Non-Technical Project Summary 10 March 2002

REEF EVOLUTION AND BASIN DEVELOPMENT, DISMAL LAKES AND PARRY BAY GROUPS

Today's magnificent tropical reefs show distinct growth patterns depending on the position of the reef relative to sea level, which controls the amount of sunlight that reaches the reef surface. Reefs that occur in deep water grow rapidly upward toward the ocean surface, where sunlight is more available, and in reefs that occur in shallow water spread outward. Over the lifetime of a reef, sea level changes are recorded in these growth patterns. By examining these growth patterns in ancient reefs, we can begin to understand the relationships between environmental and biological processes in the Earth's geologic past.

The Dismal Lakes Group (Coppermine region) and Parry Bay Group (Kent Peninsula) contain some of the Earth's oldest fossil reefs. These structures are ~1.3 billion years old and are similar in size to the Great Barrier Reef in Australia. However, these ancient structures were built entirely from photosynthetic bacteria, rather than corals with hard skeletons. In order to understand how single-cell organisms could construct such massive reefs, we are trying to reconstruct reef growth and compare it to that of other reefs of similar age.

Over 45 days, we will travel to four localities by float plane, set up mobile camps (4-person, 2-3 tents), and will follow standard low-impact backpacking practices (pack in, pack out). Our research will consist of measuring thickness of rock strata, photographing and mapping reef structures, and removing small (3x5x7 cm) rock samples from surface outcrops. These samples will be examined in the lab to determine how the reefs were cemented into rock. In commitment to both education and northern regions, I am designing a computer CD for local community schools that will show what these ancient geological formations, and similar ones elsewhere in the world, can teach us about the Earth's ancient past.

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A. PROJECT BACKGROUND AND SUMMARY

Today's magnificent tropical reefs show distinct growth patterns depending on the position of the reef relative to sea level, which controls the amount of sunlight that reaches the reef surface. Reefs that occur in deep water grow rapidly upward toward the ocean surface, where sunlight is more available, and in reefs that occur in shallow water spread outward. Over the lifetime of a reef, sea level changes are recorded in these growth patterns. By examining these growth patterns in ancient reefs, we can begin to understand the relationships between environmental and biological processes in the Earth's geologic past.

The Dismal Lakes Group (Coppermine region) and Parry Bay Formation (Kent Peninsula) contain some of the Earth's oldest fossil reefs. These structures are ~1.3 billion years old and are similar in size to the Great Barrier Reef in Australia. However, these ancient structures were built entirely from photosynthetic bacteria, rather than corals with hard skeletons. Ultimately, we believe that reef growth processes, prior to the evolution of skeletonizing organisms, were largely controlled by a series of complex interactions among evolving bacterial populations, the changing physical conditions that affected bacterial growth and decomposition, and long-term changes in the chemistry of ocean systems that affected the early lithification of microbial structures. Reconstruction of environments of reef growth, reef growth patterns, and environments of reef lithification will aid in our understanding and interpretation of these complex biogeochemical processes.

B. METHODOLOGY

The proposed research will consist of measuring numerous stratigraphic sections through the Sulky and Greenhorn formations of the Dismal Lakes Group, and the Parry Bay Formation of Elu Basin. Reef structures and surrounding strata will be carefully measured and described, leading to interpretations of ancient environmental conditions. Surfaces within the reef that suggest changing reef development as a result of fluctuating sea level will be mapped in detail, allowing reconstruction of reef profiles during specific time intervals. Field localities have been specifically chosen to allow observation of reef growth in both shallow-water and deeper-water environments within the basin.

Small (3x5x7 cm) rock samples will be collected by hand from surface outcrops. Collected samples will be examined returned to the University of Tennessee where they will be analysed in the laboratory, both under the microscope and in terms of their geochemical composition. Textural information gained from petrographic analysis will permit interpretation of the timing of lithification relative to bacterial growth and decomposition. Geochemical data (C and O isotopes, trace elements) will permit us to interpret the chemistry of marine waters in which reefs grew and were lithified. We will hopefully be able to relate specific geochemical signatures (related to environment of deposition) to time intervals of reef growth, thereby permitting interpretation of the relationship between biological reef construction and marine lithification processes. Combined with data from geologic successions of different age, this information will help us understand how both environmental and biological processes have changed through Earth history.

C. PROJECT LOGISTICS AND ENVIRONMENTAL IMPACT OF FIELD ACTIVITIES

We will be examining the Dismal Lakes and Parry Bay Groups over a period of ~ 45 days, travelling to four different localities by float plane (Air Tindi charter). In these localities, we will have a small (4 person, 2-3 tents), mobile camp. Our research will entail linear foot-traverses through stratigraphic units, making detailed measurements during the traverses. We expect to complete two traverses, through ~300-500 m of section, at each locality. Our preliminary schedule is as follows:

- June 25, 2002 – September Lake locality (67° 06' N; 115° 45' W)
- July 5, 2002 – Dismal Lake locality (67° 25' N; 117° 03' W)
- July 16, 2002 – Bebensee Lake locality (67° 29' N; 118° 32' W)
- July 26, 2002 – Parry Bay locality (67° 50' N; 107° 30' W)
- August 6, 2002 – Return to Yellowknife

Our small field party (4 person, 2-3 tents) aims for as little environmental impact as possible. We are all experienced campers and will be following standard low-impact backpacking practices (pack in, pack out). To this end, there will be no construction of structures or trails, and no clearing or excavation of the region. Collection of rock samples from surface exposures will be done by hand with rock hammers; there will be no drills or water/air pressurized machinery.

Environmental contaminants in the camp regions will also be minimal. Food packaging waste will be burned in a discrete fire pit, compacted, and packed out. Personal eliminations (sewage and grey water) will be buried in regions at least 100 meters from primary water sources. Camp fuel will consist of two or three 4L canisters of white gas for cooking, and will be stored within plastic storage compartments to eliminate possibilities of spill contamination. Upon camp breakdown, any rocks used to anchor tents and equipment tarps will be scattered in the region. We will choose camp localities to have the least impact possible on the tundra terrain.

To our knowledge, the primary wildlife in the region that might be affected by our field activities are that of nesting birds. These are regions within migration routes of barren-ground caribou, but migration typically occurs through the area prior to our proposed activities. Raptors (peregrine falcons, gyrfalcons, and rough-legged hawks) nest throughout the region in the high cliffs. We will remain aware of their presence, and avoid regions of observed nests. Sandhill crane, waterfowl (yellow-billed, red-throated, and pacific loons; tundra swan; white-fronted, snow, Ross', brant and Canada goose; pintail, canvasback, and oldsquaw ducks; eiders and mergansers), shorebirds (a variety of pipers, plovers and phaleropes), and some small songbirds (buntings and longspurs) also nest throughout the northern lands. Most of these are not recorded in abundance in our proposed field regions and we will do our best to avoid regions where wildlife is observed. Most of these nesting areas will be in water-rich low-land areas, that will be easily avoided by our work in the rocky outcrops.

D. REPOSITORY FOR SAMPLES AND DATA

Under my supervision, much of this project will be undertaken by a Ph.D. student (Patrick Schuneman) from the University of Tennessee and an undergraduate student (Bryn McInnish) from the State University of West Georgia. In the short term, samples will be reposited at both of these institutions, but will be transferred to the University of Tennessee for permanent storage. Over the 3 years following field research, stratigraphic data will be compiled and petrographic and geochemical data will be collected. Data and interpretations will then be published in a series of peer-reviewed scientific publications. This information and data will be considered the intellectual property of the researchers, both at the University of Tennessee and at the State University of West Georgia. However, as non-profit, educational institutions, all data will remain accessible to the public, upon request.

E. REPORTING OF DATA

As a university professor and researcher, I am required to make the primary reporting of this data as peer-reviewed scientific publications and as presentations at scientific conferences. However, I have worked in the far north before – having spent time during 1993, 1994, and 1997 as a graduate student on northern Baffin and Bylot Islands, and during 1998 as a postgraduate worker in the Dismal Lakes region. Since my first summer in the north, I have felt a great kinship and respect for both the land and the communities. As an educator, I believe that I can best show my respect for members of the northern communities through educational means. I have been thinking for several years that I would like to design a computer CD for local community schools that will explore some of these ancient geological formations (and similar ones elsewhere in the world) and what they can teach us about the Earth's ancient past. Now that I am employed as a university faculty member, I am now in the position to bring these ideas to completion. In the next 8 months, both before and after my projected field season, I plan to contact teachers in various community schools regarding their input to a geologic education module. Then, working with interested students at the University of Tennessee and State University of West Georgia, I hope to be able to provide communities with a final product by June 2003.