THE UNIVERSITY OF NEVADA, RENO
UNDERGRADUATE RESEARCH GRANT APPLICATION

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COLLEGE Arts & Science

MAJOR Physics **YEAR** Junior

EXPECTED GRADUATION DATE May 2005 **PHONE NO.** 775-250-1760

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TITLE OF PROPOSED PROJECT Exploration of Rock Samples Using Resonant Ultrasound Spectroscopy

FACULTY MENTOR(S) Dr. Katherine McCall

DEPARTMENT(S) Physics

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ENCLOSE WITH THIS APPLICATION FORM:

- **PROJECT DESCRIPTION, BUDGET, COPY OF YOUR TRANSCRIPTS, including a list of courses taken during Fall 2003, and SUPPORT LETTER(S). SEE THE ENCLOSED ANNOUNCMENT FOR DETAILS.**

Electronic submission is highly encouraged. Submit via email as an attached file in PDF or Word format to the address shown below. Alternatively send one copy of the proposal to:

Dr. M. Saiidi, Director, Undergraduate Research Programs
Office of Vice President for Research (403), RH 201
University of Nevada, Reno
Reno, NV 89557
Email: *ugresearch@unr.edu*

APPLICATIONS MUST BE RECEIVED BY 5:00 PM ON MONDAY, OCTOBER 20, 2003.

Exploration of Rock Samples Using Resonant Ultrasound Spectroscopy

Ken Williamson
Department of Physics

Introduction:

You don't have to know anything about a rock to fit it in your sling and zap Goliath. However you *do* have to understand a great deal if you mean to assess the behavior of a rock as part of a transportation system (a bridge for example), as a participant in a seismic event (an earthquake), or as a medium employed by an artist (as in Michelangelo's David). Study of the elastic properties of rocks and similar materials can be effectively conducted with Resonant Ultrasound Spectroscopy (RUS). RUS is a fast, accurate, non-invasive experimental technique for characterizing the elastic state of a material and monitoring changes in that elastic state. An empirical equation of state for a material can be determine by changing the conditions on a sample and monitoring its reaction using RUS. This understanding can be used to predict future change, e.g. to anticipate structural failure in a bridge or to choose a protocol for cleaning a statue without damaging it. The project described here will employ RUS measurements on a suite of sandstones to determine the elastic signature of their response to carefully controlled changes in temperature at fixed relative humidity.

Objectives:

I propose to employ a RUS measurement system to study the evolution of the elastic state of three sandstones (Berea, Fontainebleau, and Meule) under conditions of fixed relative humidity and careful control of temperature. Previous measurements show that the response of the rock is highly dependent on how fast temperature is changed. I will compare this rate dependence across samples with similar constituents but varying amounts of clay. The primary constituent in all three sandstones is quartz. The clay composition varies from 15% by weight (Meule) to less than 1% by weight (Fontainebleau). The objective is to begin to understand the origin and cause of the strong rate dependence of rock elasticity on temperature. In particular, I wish to quantify the importance of clay content, and indirectly to assess the impact of water content.

Research plans:

Measurements will be made on thermally isolated parallelepipeds of three sandstone samples, a single crystal of quartz, and a fused quartz sample at temperatures ranging from forty to sixty degrees centigrade. The quartz samples will act as controls on the experiment. The fused quartz sample will contain no water or clay, but provide a polycrystalline standard. The single crystal acts as a control on disorder, as well as eliminating dependence on water or clay. The samples will be connected to two piezoelectric transducers; one will act as a signal source and the other as a detector. Data will be taken as a function of temperature and time to empirically map the equation of state of the samples. Various simple phenomenological models will be developed to try to fit and describe the data. These models may then be used to predict the results of further measurements.

Time Table:

- November 2003: Cut the sandstone samples (2 of each type of sandstone), acquire quartz crystals, and attach piezoelectric transducers.
- December 2003 – March 2004: Data acquisition. Previous experience implies that up to a month of measurement time will be required for each sandstone sample.
- April 2004 – May 2004: Data analysis and report.

Dissemination of Results:

These results will be presented at the 2004 Fall meeting of the American Geophysical Union. They will be reported in my senior thesis and will be incorporated into a peer – reviewed manuscript to be submitted to the Journal of Geophysical Research.

Qualifications:

I am a third year Physics major with a 3.08 Cumulative GPA (3.15 in major credits). I began working as a research assistant for Dr. Katherine McCall in the Rock Physics Group in September 2003. Under the guidance of Dr. McCall and graduate student TJ Ulrich, I have learned how to use the RUS apparatus and analyze the data. The research I propose is a response to questions raised by Ulrich's dissertation research.

Budget:

To anticipate sample failure, two of each type of sample will be prepared: two of each of the three types of sandstone, two single crystals of quartz, and two fused quartz (poly-crystalline) samples.

Item	Quantity	Price per Unit	Total
Piezoelectric Transducers	18	$ 35.00	$ 630.00
Single Quartz Crystals	1	$ 250.00	$ 250.00
Fused Quartz Crystals	1	$ 100.00	$ 100.00
Request			$980.00

I request $980 as an Undergraduate Research Award. Dr. McCall has committed to using indirect cost recovery funds to cover the remaining costs.