KECK GEOLOGY CONSORTIUM

PROCEEDINGS OF THE TWENTY-FOURTH ANNUAL KECK RESEARCH SYMPOSIUM IN GEOLOGY

April 2011
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Dr. Robert J. Varga, Editor
Director, Keck Geology Consortium
Pomona College

Dr. Holli Frey
Symposium Convenor
Union College

Carol Morgan
Keck Geology Consortium Administrative Assistant

Diane Kadyk
Symposium Proceedings Layout & Design
Department of Earth & Environment
Franklin & Marshall College

Keck Geology Consortium
Geology Department, Pomona College
185 E. 6th St., Claremont, CA 91711
(909) 607-0651, keckgeology@pomona.edu, keckgeology.org

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Editor and Keck Director
Pomona College

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2010-2011 PROJECTS

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Faculty: *CHRISTINE SIDDOWAY, MEGAN ANDERSON*, Colorado College, *ERIC ERSLEV*, University of Wyoming
Students: *MOLLY CHAMBERLIN*, Texas A&M University, *ELIZABETH DALLEY*, Oberlin College, JOHN *SPENCE HORNBUCKLE III*, Washington and Lee University, *BRYAN MCATEE*, Lafayette College, *DAVID OAKLEY*, Williams College, *DREW C. THAYER*, Colorado College, *CHAD TREXLER*, Whitman College, *TRIANA N. UFRET*, University of Puerto Rico, *BRENNAN YOUNG*, Utah State University.

EXPLORING THE PROTEROZOIC BIG SKY OROGENY IN SOUTHWEST MONTANA
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Students: *JESSE DAVENPORT*, College of Wooster, *KRISTINA DOYLE*, Amherst College, *B. PARKER HAYNES*, University of North Carolina - Chapel Hill, *DANIELLE LERNER*, Mount Holyoke College, *CALEB O. LUCY*, Williams College, *ALIANORA WALKER*, Smith College.

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Faculty: *DAVID P. DETHIER*, Williams College, *WILL OUIMET*. University of Connecticut
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Students: *HANNAH BOURNE*, Wesleyan University, *JONATHAN GRIFFITH*, Union College, *JACQUELINE KUTVIRT*, Macalester College, *EMMA LOCATELLI*, Macalester College, *SARAH MATTESON*, Bryn Mawr College, *PERRY ODDO*, Franklin and Marshall College, *CLARK BRUNSON SIMCOE*, Washington and Lee University.

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Students: *BRIANA BERKOWITZ*, Beloit College, *DAENA CHARLES*, Union College, *MELLISSA CROSS*, Colgate University, *JOHN MICHAELS*, North Carolina State University, *ERDENEBAYAR TSAGAANNARAN*, Mongolian University of Science and Technology, *BATTOGTOH DAMDINSUREN*, Mongolian University of Science and Technology, *DANIEL ROTHBERG*, Colorado College, *ESUGEI GANBOLD*, *ARANZAL ERDENE*, Mongolian University of Science and Technology, *AFSHAN SHAIKH*, Georgia Institute of Technology, *KRISTIN TADDEI*, Franklin and Marshall College, *GABRIELLE VANCE*, Whitman College, *ANDREW ZUZA*, Cornell University.

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Students: *MARY BADAME*, Oberlin College, *MEGAN D'ERRICO*, Trinity University, *STANLEY HENSLEY*, California State University, Bakersfield, *JULIA HOLLAND*, Trinity University, *JESSLYN STARNES*, Denison University, *JULIANNE M. WALLAN*, Colgate University.

EOCENE TECTONIC EVOLUTION OF THE TETONS-ABSAROKA RANGES, WYOMING
Faculty: *JOHN CRADDOCK*, Macalester College, *DAVE MALONE*, Illinois State University
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Short Contributions— Big Sky Orogen

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Project Faculty: TEKLA A. HARMS, JOHN T. CHENEY, Amherst College, JOHN BRADY, Smith College

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ALIANORA WALKER, Smith College
Research Advisor: H. Robert Burger

Keck Geology Consortium
Pomona College
185 E. 6th St., Claremont, CA 91711
Keckgeology.org

GEOCHRONOLOGY OF PRECAMBRIAN META-GABBRO IN THE HENRYS LAKE MOUNTAINS, SOUTHWEST MONTANA AND IDAHO

B. PARKER HAYNES, University of North Carolina - Chapel Hill
Research Advisor: Drew S. Coleman

INTRODUCTION

O'Neill and Christiansen (2004) mapped the geology of Henrys Lake Mountains and surrounding areas including the southern end of the Madison range and the Gravelly range. They found the study area, Henrys Lake Mountains, southwest Montana and Idaho, to contain several meta-plutonic bodies consisting of Precambrian tonalite, diorite, and amphibolite.

This project seeks to use U-Pb dating methods to obtain geochronological data from plutonic bodies in the study area. With the exception of a minimal study by Witkind (1974), this area of southwest Montana and Idaho has not been researched. Along with geochemical data of the study area, which Caleb Lucy of Williams College is interpreting as his portion of this Keck project, U-Pb geochronological data could help explain the geologic and tectonic history of the area.

DESCRIPTIONS

Hand specimens of all plutonic bodies reveal rocks ranging from light to intermediate color. Grain size ranges from 1-2 mm to 3-5 mm between fine and coarse-grained rocks. In hand sample, leucocratic rocks appear to be feldspar rich (50%) with amphibole (40%) present also. Intermediate colored rocks are more dominated by amphibole (50%), but still contain an abundance of feldspar (40%). O'Neill and Christiansen (2004) mapped leucocratic rocks as tonalite and intermediate colored rocks as diorite. However, a study by Lucy (2011) reveals that the meta-plutonic bodies mapped as tonalite and diorite in the study area are chemically indistinguishable. These rocks had an original intermediate to mafic character and are most accurately considered metagabbro and metadiorite (Lucy, 2011).

Due to surface weathering, it was difficult to find well-exposed outcrops for sample collection (Fig. 1).

Figure 1. One of the few well-exposed outcrops of tonalite. Lichen on the surface of the rocks made it difficult to recognize rock type.

Nevertheless, samples were collected based on several factors: color, grain size, visible alteration, and surface weathering. Leucocratic, coarse grained rocks with fresh surfaces and minimal alteration represented the best possibility to contain datable minerals.

METHODS

U-Pb zircon and titanite geochronology requires several processes and steps for completion. Five different samples were taken from five different tonalite and diorite bodies. Tonalites are similar to granite in composition, but contain 10% or less potassium feldspar. Samples 10-PH-2, 10-PH-13, 10-PH-14, 10-PH-17, 10-PH-20 were chosen for U-Pb dating based on potential for zircon abundance. These rocks were the most leucocratic, had the largest grain size and the freshest surface in their respective outcrops. Two of these five samples were chosen to prepare for dating. 10-PH-13 (Fig. 2) and 10-PH-20 were mapped as tonalite and diorite respectively and represented the highest probability for zircon abundance of the five samples.

Figure 2. A picture of sample 10-PH-13. Because Lucy (2011) determine this rock is a metagabbro, minerals identified in hand sample are not correct. However, greenish mafic minerals are amphibole and grayish felsic minerals are feldspar.

The geology department at the University of North Carolina provided facilities to crush samples 10-PH-13 and 10-PH-20 and run them through a disc-mill. The samples were then run through a water table to separate heavy minerals from light minerals. After drying overnight by heat lamps, the light minerals from both samples were placed in labeled containers. Heavy minerals from both samples were further separated using a hand magnet to eliminate magnetic minerals. 10-PH-13 was chosen to continue to prepare for dating because it had a more felsic nature than 10-PH-20. Heavy minerals from 10-PH-13 were run through a system of heavy liquids using Methylene Iodide (MEI).

In order to complete the heavy liquids process several steps were necessary. MEI was placed in a glass flask. The sample, which consisted of primarily heavy minerals, was funneled through the flask and into the MEI. After several minutes in the MEI, denser minerals sank to the bottom of the MEI, while less dense minerals stayed higher in the solution. The MEI was slowly released into a glass beaker drawing off all of the densest minerals without releasing the less dense minerals. After drying overnight, the remaining dense minerals were run through a Frantz magnetic separator, which further eliminated magnetic minerals from the sample.

After running approximately fifty grains though a scanning electron microscope (SEM), analysis showed that the grains contained elements Ca, Ti, Si, and O. This indicated that these grains are titanite. Analysis did not, however, show Zr present in the grains and thus the sample did not contain enough zircon to find an accurate date. Titanite was then used in place of zircon for the remainder of the project.

During a process called "picking," the remaining grains were examined under a microscope in order to select grains for dating. Ethanol was used to allow the grains to float and then dental tools were used to pick the grains from the sample container. Four of these titanite grains were picked for analysis based on size and crystal habit. Typically, larger grains with more distinct crystal habit are more successful in dating.

These four titanite grains were dissolved in an oven for four days. The dissolution was then run through a process of columnar chemistry, which filtered and separated U and Pb isotopes from the dissolution. These Pb isotopes were run through a Thermal Ionizing Mass Spectrometer (TIMS). The TIMS measured the ratios of the radiogenic Pb isotopes to the non-radiogenic Pb isotopes, which gave a date on the titanite grains.

RESULTS

Analysis by SEM showed that the sample does not contain zircon. Typically, zircons are present in felsic rocks such as granite and absent in more mafic rocks such as gabbro. Because Lucy (2011) found that 10-PH-13 is a metagabbro, it is not surprising that these rocks do not contain zircon. However, these rocks do contain titanite, which can also be used for U-Pb dating. Therefore, the goal of the project changed to geochronological work on titanite in 10-PH-13.

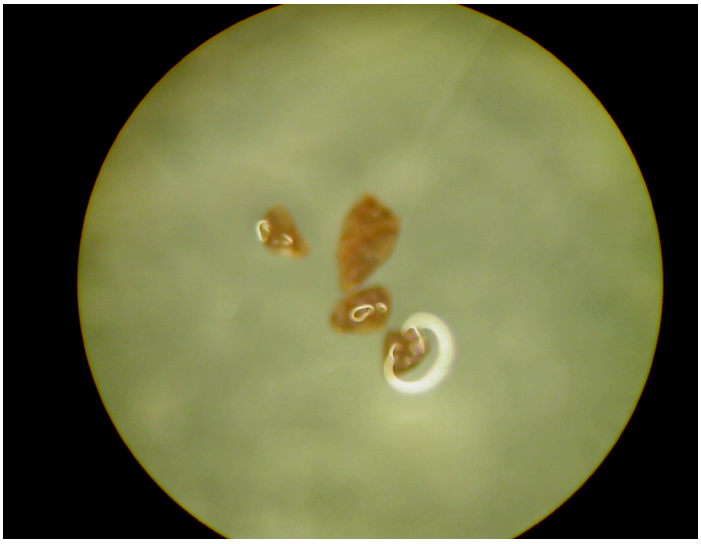

Figure 3. The four grains of titanite that were used to date 10-PH-13. These grains are brown and extremely altered, thus they do not exhibit normal titanite crystal habit, which is a prismatic wedge-shape.

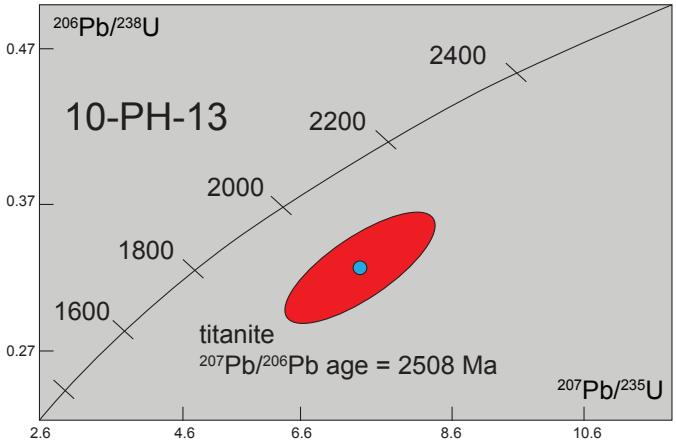

Figure 4. Conchordia plot of 206Pb/238U, 207Pb/235U system showing an age of 2508 Ma (blue dot) and error (red ellipse).

Geochronological data was only found for one of the four titanite grains. (Fig. 4) This grain yielded a $^{206}Pb/^{238}U$ age of ~1800 Ma and a $^{207}Pb/^{235}U$ age of ~2100 Ma. The data do not lie on Concordia, which can be attributed to Pb loss. However, when traced from the origin through the point where 206Pb/238U and $^{207}Pb/^{235}U$ equal to the line of conchordia, titanite $^{207}Pb/^{206}Pb$ age is 2508 Ma (with undetermined significant error).

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