

Application for a 2009 GSA Research Grant

Name: Kjos, A. R.

Project Title: Characterization of the Tortugas basement mélange, Baja California Sur, Mexico: Spatial, Geochemical, Geochronological and Petrographic analysis

Project Supervisor: Kimbrough

Academic Info (Department Address): SDSU – Dept. of Geological Sciences

Clearly state the problem(s) to be addressed, the hypothesis or hypotheses to be tested, and the overall objectives of your proposed project. (1,000 character limit):

This project will determine the composition and structure of a ~10 km-long serpentinite matrix ophiolitic mélange exposed along the Late Miocene-early Pliocene Bahia Tortugas Fault in the northern Vizcaino Peninsula, Baja California Sur. Reconnaissance mapping & sampling in June 2008 revealed granitoid, pyroxenite, basalt, amphibolite, micro-gabbro and harzburgite blocks hosted in a talc serpentinite matrix. Zircon U-Pb analysis of plagiogranite blocks at two localities yield ages of ~189 & 193 Ma. Ophiolite complexes of Late Triassic and Middle Jurassic age are well-known from the Vizcaino (Kimbrough & Moore, 2003), but results here provide the first indication of Early Jurassic ophiolite. Detailed mapping and petrologic study of the mélange will fill a major gap in Vizcaino geologic history and provide a basis for comparison and correlation to potential equivalents in the western Sierra Nevada foothills of California and the Guerrero terrane of mainland Mexico.

Discuss the previous work on your problem(s) that (1) places the project in a disciplinary and, if appropriate, regional context and (2) documents the importance of your project. (2,500 character limit):

South of the California Coast Ranges, the Vizcaino Peninsula of west-central Baja California provides the best view of Mesozoic forearc basement along the outboard edge of the southwest Cordillera. These rocks have been interpreted in two fundamentally different ways: (1) they represent the southern along-strike equivalent to California-Oregon ophiolite-arc-forearc assemblages (e.g. Jones et. al, 1976; Hopson et al., 1992; Saleeby, 1982), (2) they represent part of the exotic Guerrero terrane that was accreted to the North American margin in Early Cretaceous time (Dickinson & Lawton, 2001). The Cedros Island ophiolite in the Vizcaino region correlates to the Coast Range ophiolite of California and Oregon (Kimbrough & Moore, 2003), while the closest potential matches of the Bahia Tortugas Fault mélange are the Late Triassic to Early Jurassic Rattlesnake Creek serpentinite matrix ophiolite mélange in the Klamaths

(Wright & Wyld 1994; Shervais et. al, 2005), and the Early Jurassic (196–200 Ma) Penon Blanco ankaramitic volcanic assemblage in the western Sierra foothills (Saleeby, 1982).

Robinson (1975) mapped the northern Vizcaino Peninsula and recognized the Tortugas mélangé but did not subdivide this unit or do any detailed work. Robinson (1975) and Hickey (1984) interpreted the mélangé as a local metamorphic basement to Mesozoic forearc deposits. Reconnaissance field mapping by Kjos (June 2008) shows that the ophiolitic mélangé is in contact with the Eugenia Formation along a detachment fault. The sub-vertical foliation and chaotic nature of the ophiolitic mélangé suggests emplacement of the melange as a result of transpressional forces across the Tortugas fault.

Concisely state how you plan to address your problem(s) and test your hypothesis or hypotheses (2,500 character limit):

Detailed field mapping at 1:5000 will characterize the distribution, size and composition of blocks in the serpentinite matrix mélangé and will be the focus of the proposed field program. High-resolution color imagery from Google maps and digital elevation models available from Mexico (INEGI) will provide the base map. Mapping will guide representative sampling of all block types present in the mélangé.

Laboratory analysis will start with thin-section analysis which will document the mineralogy, texture and metamorphic overprinting of mélangé blocks. Whole rock major and trace element analyses will be conducted on selected mélangé blocks by X-ray fluorescence spectroscopy (XRF). The focus of the XRF work will be on metavolcanic blocks in order to determine potential MORB versus arc affinities of the volcanic rocks. This is important to test the potential correlation of these rocks to the arc-related Penon Blanco volcanics of California. XRD work on the matrix serpentinites is to determine the degree of metamorphism of the matrix (ie, low temperature chrysotile vs higher temperature antigorite). Additional zircon U-Pb analysis will be conducted by laser ablation ICP-MS analysis at the University of Arizona. This will include work on micro-gabbro, metavolcanic, and granitoid rocks. The extent of this effort depends on sample return but 4 additional zircon samples are anticipated.

These efforts will characterize the nature, origin and geochemical character of the Tortugas ophiolitic mélangé. The results will then be used to evaluate regional implications and alternative models of the Vizcaino Mesozoic basement assemblages.

Duration of investigation (dates): late March - early April 2009

Budget: LIST IN ORDER OF PRIORITY AND JUSTIFY IN DETAIL, for example, funding of chemical and isotopic analysis, equipment, technicians and expendable laboratory supplies is necessary for consideration. Grants are made for one year only.

- Field Expenses (\$952)
 - 1600 mi (round-trip) @ \$0.32 per mile = \$512
 - Insurance = \$290
 - \$ 5 per diem for 15days x 2 = \$150
- Analytical Costs (\$1200)
 - An estimated 20 XRF samples = \$400
 - U-Pb zircon dating @ = \$400
 - Thin-sections; 20 @ \$15/each = \$300

Budget justification (1,200 character limit):

Budget costs cover major and essential expenses for field and lab work focusing on transportation and primary analytical costs. Fieldwork will consist of one trip over a 15-day period in late March and early April. Transportation costs cover the majority of the budget due to the remoteness of the field area and additional insurance requirements for all vehicles entering Mexico. Round-trip access to the field area will total an average 1600-mile round-trip drive from San Diego to the tip of the Vizcaino Peninsula. Due to the remoteness of the area and steep terrain, a field assistant is required due to safety concerns. Per diem food costs are estimates for a geologist and field assistant. These field costs associated with producing a detailed strip map of the ophiolitic mélange and also requires geochemical, petrographic and U-Pb zircon analysis to allow for regional comparison. Initial fieldwork has been done on this project and the additional funds will allow for its completion.

Amount and nature of other available funds, facilities, materials, etc. (1,200 character limit):

San Diego State University (SDSU) will offset the cost of laboratory and analytical costs for X-Ray Fluorescence Spectroscopy for major and minor element geochemistry and for costs associated with separation and mounting associated with zircon analysis. Kjos will use his own 4 wheel drive vehicle to conduct this field work. Additional support in the form of technical assistance, mapping and office supplies will be provided through SDSU. There are no other funds currently available to support this project.

Other grants that (a) have supported this project, (b) are currently supporting this project, and (c) are being applied for. This list should include funds available to or applied for by the thesis supervisor, if these can support the proposed work:

none

If you have received a previous GSA graduate student research grant, please copy and paste your progress report form below. Click here for [Progress Report Form \(Word Format – copy attached to end of document\)](#). (4,000 character limit):

n/a

Abbreviated resume. List education, major positions held, and significant accomplishments. Provide information relevant to your qualifications to undertake proposed research. List up to 5 of your publications and presentations (2,500 character limit):

Education: Bachelor of Science Degree, Geology (comprehensive): University of Wisconsin Eau Claire, 2007

Major Positions and Accomplishments:

Regional Geologic Mapper & Project Geologist, Archer, Cathro & Associates (1984) Limited, Yukon, June-August 2007, July-August 2008

Field Assistant to Geological Survey of Canada (GSC) and UWEC Faculty, British Columbia, June-August 2004, July-August 2005, and June-August 2006

Geologic Mapper USGS EDMAP Project, Montana, May-July 2005 and May-June 2006

Research Assistant, University of Wisconsin, Eau Claire, 2004-2006

University of Wisconsin Eau Claire (UWEC) Teaching Assistantships: Geological Field School, Boulder, Montana, June 2006; Geological Field School, Kingston, New Mexico, January 2006; Earth History, Fall 2005; Sedimentology and Stratigraphy, Spring 2005; Introduction to Geology, Fall 2004

San Diego State University Teaching Assistantships: Dynamics of Earth Lab, Fall 2007 and Spring 2008; Mineralogy, Fall 2007; Earth History, Fall 2008; Sed. Strat., Spring 2009

UWEC Geology Department Award for Excellence, 2007

Publications:

Kjos A.R., MacLaurin, C.I., Kohel, C.A., Nawikas, J.M., Stoltz, J.M., Mahoney, J.B., and Ihinger, P.D., 2006, Reassessment of the Belt Supergroup: a stratigraphic analysis for the Devil's Fence Anticlinorium, Southwest Montana [an EDMAP project]; Geological Society of America Abstracts with Programs, vol. 37, no. 7, p. 500.

Kjos, A.R., MacLaurin, Catherine I., Mahoney, J.B., Hooper, R.L., Snyder, Lori D., Haggart, J. W., and Woodsworth, 2006, G. J., Geologic Evolution and Economic Mineralization Potential of the Whitesail Lake map area, west-central British Columbia; 7th Annual UW-System Symposium for Undergraduate Research and Creative Activity—Poster Session, Menomonie, WI.

Kjos, A.R., Suzanne Reed, Lori D. Snyder, J. Brian Mahoney, R. G. Anderson, Vicki McNicoll, and Simpson, Kirstie, 2006, Stratigraphy of John Peaks, Iskut River area, Northwestern British Columbia: Illuminating the Geologic History and Mineral Potential; 7th Annual UW-System Symposium for Undergraduate Research and Creative Activity—Poster Session, Menomonie, WI.

Nawikas, J.M., Kohel, C.A., Stoltz, John M., MacLaurin, Catherine I., Kjos, Adam R., Mahoney, J.B., Ihinger, P. D., 2005, Structural and Magmatic Evolution of the Helena Salient: New Geologic Mapping in the Devils Fence Anticlinorium; Geological Society of America Abstracts with Programs, Vol. 37, No. 7, p. 76.

***References cited in proposal (2,500 character limit):**

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- Hickey, J., 1984, Stratigraphy and composition of a Jura-Cretaceous volcanic arc apron, Punta Eugenia, Baja California Sur, Mexico, in Frizzell, V.A., Jr., ed., *Geology of the Baja California peninsula: Field Trip Guidebook*. Pacific Section, SEPM Pacific Section, v. 39, p. 149-160.
- Hopson, C.A., et. al, 1992, California Coast Range Ophiolite; Jurassic tectonic history: *AAPG Bulletin*, v. 76, no. 3, p. 422.
- Jones, D.L., et. al, 1976, The four Jurassic belts of northern California and their significance to the geology of the southern California borderland, in Howell, D.G., ed., *Aspects of the geologic history of the California continental borderland: AAPG Pacific Section Miscellaneous Publication 24*, p. 343-362.
- Kimbrough, D.L., 1982, Structure, petrology and geochronology of Mesozoic paleoceanic basement terranes on Cedros Island and the Vizcaíno Peninsula [Ph.D. thesis], UC Santa Barbara, 395 p.
- Kimbrough, D. L., and Moore, T. E., 2003, Ophiolite and volcanic arc assemblages on the Vizcaino Peninsula and Cedros Island, Baja California Sur, Mexico: Mesozoic forearc lithosphere of the Cordilleran magmatic arc, in Johnson, S.E., Paterson, S.R., Fletcher, J.M., Girty, G.H., Kimbrough, D.L., and Martin-Barajas, A., eds., *Tectonic evolution of northwestern Mexico and the southwestern USA: GSA Special Paper 374*, p. 43–71.
- Moore, T.E., 1977, Structure and petrology of the Sierra de San Andres Ophiolite, Vizcaíno peninsula, Baja California Sur, Mexico [M.Sc. thesis]: San Diego, San Diego State University, 83 p.
- Robinson, J.W., 1975, Reconnaissance geology of the northern Vizcaíno peninsula, Baja California Sur, Mexico [M.S. thesis]: San Diego, San Diego State University, 114 p.
- Saleeby, J., 1982, Polygenetic ophiolite belt of the California Sierra Nevada: Geochronological and tectonostratigraphic development: *Journal of Geophysical Research*, v. 87, p. 1803-1824.
- Shervais, J. W. et. al, 2005, Radioisotopic and biostratigraphic age relations in the Coast Range Ophiolite, northern California: Implications for the tectonic evolution of the Western Cordillera: *GSA Bulletin*, v. 117, p. 633–653.
- Wright, J. E., & Wyld, S. J., 1994, The Rattlesnake Creek terrane, Klamath Mountains, California: An early Mesozoic volcanic arc and its basement of tectonically disrupted oceanic crust: *GSA Bulletin*, v. 106, p. 1033-1056.