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SENT VIA DEPARTMENT

UCSD: 2009-4538  
Date: May 4, 2009

Eileen Maher  
Environmental Services Department  
Port of San Diego  
3165 Pacific Highway  
San Diego, CA 92101

On behalf of the Regents of the University of California, University of California, San Diego, the following proposal is presented for your consideration:

- 1. Project Title:** "Studies of Ship Emission and Their Impact on San Diego's Air Quality"
- 2. Principal Investigator(s):** Drs. Mark Thiemens and Gerardo Dominguez
- 3. Project Description:** "We propose to quantify the impact of ship emissions on San Diego's air quality using recently discovered and published isotopic techniques that distinguish between sulfate particles emitted by ships and those emitted by land-based diesel engines (i.e. diesel trucks, etc.)."
- 4. Project Manager's Contact Information:** Dr. Gerardo Dominguez  
UC San Diego  
La Jolla, CA 92093-0356  
[gdominguez@ucsd.edu](mailto:gdominguez@ucsd.edu), 858-534-6053
- 5. Grant Funding Request:** \$345,864
- 6. Total Cost of Proposal (including matching funds/in-kind services):** \$428,701
- 7. Timeline of Project:** 9/1/09 – 8/31/12
- 8. Benefit to San Diego Bay:** "A direct assessment of the contribution of ships as well as a direct assessment of improvements to air quality resulting from changes in the type of fuel consumed by ships."
- 9. Source of Matching Funds:** University of California, San Diego

Attached to this letter please find our documented proof of non-profit (501(c)(3)) status. Should an award be granted for this proposal, we reserve the right to negotiate the terms of the award to ensure compliance with University policy.

Additional program information may be obtained from the Principal Investigator. Inquiries concerning the contractual or budgetary aspects should be directed to the undersigned at (858) 822-5180.

Your consideration of this proposal is appreciated. Please reference the legal name of our institution as **THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, UNIVERSITY OF CALIFORNIA, SAN DIEGO** on any subsequent award/subcontract document.

Sincerely,

A handwritten signature in black ink, appearing to read 'CLP', with a long horizontal flourish extending to the right.

Clarice Lin Park  
Contract and Grant Officer

Internal Revenue Service

Department of the Treasury

District  
Director

450 Golden Gate Ave.  
San Francisco, Calif. 94102

The Regents of the University  
of California  
c/o The Office of the General  
Counsel  
590 University Hall  
2200 University Avenue  
Berkeley, CA 94720

Person to Contact:  
Desk Officer  
Telephone Number:  
(415) 556-5353  
Refer Reply to:  
EP/EO:l  
Date:

8 SEP 1982



Re: Request for Confirmation of Exempt  
Status under Section 501(c)(3) of  
the Internal Revenue Code of 1954.

Dear Regents:

This is in reference to your letter of July 13, 1982 requesting confirmation of the exempt status of The Regents of the University of California under section 501(c)(3) of the Internal Revenue Code of 1954.

In our letter of September 14, 1939, Code II:R:T:l CQ, it was held that you were entitled to exemption under the provisions of section 101(6) of the Revenue Act of 1939.

A determination or ruling letter issued to an organization granting exemption under the Internal Revenue Code of 1954 or under a prior or subsequent Revenue Act remains in effect until exempt status has been terminated, revoked or modified.

Our records indicate that you are the regularly constituted state university of the State of California originally created by a state legislature act of 1868; that you are engaged in educational activities; that your income is derived from investments, endowments, tuition, and miscellaneous sources; and that your income is used in furtherance of your educational activities.

In addition, it appears from our records (including the information submitted with your letter of July 13, 1982), that there has been no change in your organization's exempt status. Accordingly, our letter of September 14, 1939 is still in effect. This letter does not constitute a no change examination letter.

Because section 501(c)(3) of the Internal Revenue Code of 1954 was derived from and continues, without substantive change, the language of section 101(6) of the Revenue Act of 1939 ("1939 Code") and because our letter of September 14, 1939 is still in effect, it appears that you and your constituent units are entitled to exemption as an organization described in section 501(c)(3) of the 1954 Code.

Donors may deduct contributions to you as provided in section 170 of the Internal Revenue Code of 1954 (formerly section 23(O) of the Internal

3.

The Regents of the University of California

Revenue Code of 1938). Bequests, legacies, devises, transfers, or gifts to you or for your use are deductible for Federal estate and gift tax purposes as provided in the applicable provisions of sections 2055, 2106, and 2522 of the Internal Revenue Code of 1954.

You are not required to file Form 990, Return of Organization Exempt from Income Tax, because you are a State institution, the income of which is excluded from gross income under section 115(a) of the Internal Revenue Code of 1954.

You are not required to file Federal income tax returns unless you are subject to the tax on unrelated business income under section 511 of the Code. If you are subject to this tax, you must file an income tax return on Form 990-T. This office has not been asked to consider and therefore, in this letter, we are not determining whether any of your present or proposed activities are unrelated trade or business as defined in section 513 of the Internal Revenue Code of 1954.

Because this letter could help resolve any questions about your exempt status, you should keep it in your permanent records.

If you have any questions, please contact the person whose name and telephone are shown in the heading of this letter.

Sincerely,

*Michael Sarni*

District Director

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## I. Introduction

### **Background and Motivation**

Maritime vessels, from cargo container ships to cruise vessels, are one of the largest unregulated sources of air pollution today, although the impact of their emissions are receiving increased scrutiny by local, regional, and international agencies [1]. These emissions, which include both gaseous and solid particles (aerosols), impact the air quality and human health of communities surrounding Ports.

A recent study focusing on the public health and economic impact associated with ship emissions, estimated that ship emissions are responsible for nearly 60,000 deaths worldwide. Most of these deaths are concentrated in communities surrounding major Ports, which experience elevated levels of PM<sub>2.5</sub>, that is the concentration of airborne solid particles smaller than 2.5 microns in size. The study cited above, like all other assessments of the impact of maritime vessel traffic, are based on modeling the chemistry and diffusion of ship plumes in the atmosphere combined with toxicological models that estimate the relationship between PM<sub>2.5</sub> levels and cardiopulmonary and lung cancer mortalities [2].

Despite the potential impact of ship emissions on local communities, direct assessments of their impact on local air quality in areas surrounding major Ports have not been done. There exists a handful of observational studies focusing on the chemical components within ship plumes [3, 4]. These studies have found that ships are potentially significant sources of toxic trace metals such as Vanadium (V), Nickel (Ni), Zinc (Zn), and Lead (Pb). We have recently published the results of a two week long study that directly quantified the impact of ship primary sulfate in the San Diego area [5]. Here we propose to extend the time-period encompassed by these measurements so that the temporal variation of ship emissions and their impact can be quantified. In addition, given recent regulations by the state of California, the work we propose will also directly quantify the expected improvements in air quality resulting from these regulations.

### **A Novel Isotopic “Fingerprint” of Ship Particulate Sulfate**

Sulfate ( $\text{SO}_4^{-2}$ ) found in the atmosphere has two distinct classifications: primary and secondary. Primary sulfate refers to sulfate that is fully oxidized ( $\text{SO}_4^{-2}$ ) at the point of emission. There are both natural and man-made contributors (volcanoes, diesel engines and ship emissions, biomass burning), but man-made contributions are by far dominant in the environment [6]. Secondary sulfate refers to sulfate derived from the oxidation (via the addition of oxygen atoms) of natural and gaseous sulfur emissions (e.g  $\text{SO}_2$ ) to  $\text{SO}_4^{-2}$  by various oxidants found in the atmosphere (e.g. ozone, OH,  $\text{H}_2\text{O}_2$ )[7].

Isotopes<sup>1</sup> have a long history of providing unique insights into the sources and transformations of elements in geological and environmental settings [8]. Isotopic measurements of the relative ratios of oxygen isotopes from atmospheric samples ( $^{16}\text{O}$ ,  $^{17}\text{O}$ , and  $^{18}\text{O}$ ), recently pioneered at the UCSD Stable Isotopes Laboratory, have led to new insights into atmospheric chemical processes (sources, transport, and transformation), and the sources of secondary sulfate in the atmosphere[9, 10]. Our most recent work, using triple isotope measurements of oxygen isotopes from direct samples of primary sulfate from a container ship coupled with collections of aerosols samples at the Scripps Pier, revealed that ship primary sulfate has a unique isotopic signature. This signature makes primary sulfate from ships distinguishable from land-based diesel emissions [11] and atmospheric processes that produce sulfate from  $\text{SO}_2$ . This signature was found only in sulfate found as submicron particles (< 1 micrometer size) particles in La Jolla, the same size range of primary sulfate emissions that have been reported. Using this signature of primary sulfate, we have made the first determinations of the amount of sulfate found in coastal San Diego that originated as primary ship sulfate. Surprisingly, **we have found that up to 44% of the total sulfate found at the Scripps Pier is attributable to primary sulfate emissions from ships** [5] and our more recent work using meteorological back-trajectory calculations indicate that the amount of ship primary sulfate is highest when the air flows over the Port of San Diego and towards our sampling site at the Scripps Pier (Dominguez et al., in prep).

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<sup>1</sup> An isotope of an element is an atom that has the same number of protons, but a different number of neutrons. Oxygen, for example, has three stable isotopes  $^{16}\text{O}$ ,  $^{17}\text{O}$ , and  $^{18}\text{O}$  with 8 protons and 8, 9, and 10 neutrons respectively.

This proposal seeks the funds to apply triple-oxygen isotopic measurements on a larger set of samples and combine these with trace metal quantitative analysis. Scope of Proposed Work:The work we propose will, for the first time, directly assess the temporal and geographic impact of ship particulate sulfate and trace metals associated with these emissions in the Port of San Diego and surrounding communities. This proposed research is of great importance to other communities surrounding ports and directly addresses the issue of air quality. As such, the proposed research extends “beyond compliance and mitigation”. The completion of the proposed research should help the Port of San Diego and the City of San Diego to determine the future impact of expected increases in cruise and cargo ship traffic.

Regarding the Applicants:The facilities and personnel at the UCSD Stable Isotopes Laboratory are uniquely qualified to implement the proposed research program. The lab has state of the art facilities to conduct the isotopic measurements described here, including a MAT 251 and 253 Isotope ratio mass spectrometers. The Principal Investigator of this project, Prof. Mark Thiemens, has a long record of significant contributions in atmospheric chemistry, cosmochemistry, and chemistry through the use of isotope ratio mass spectrometry. Dr. Gerardo Dominguez, a former Henry and Camille Dreyfus Postdoctoral Fellow in Environmental Chemistry, has made significant contributions in atmospheric chemistry, specifically in the use of isotopes and photochemical modeling to interpret measurements of isotopic measurements of aerosol nitrate and sulfate in the environment. The overall progress and direction of the research will be supervised jointly by Prof. Thiemens and Dr. Dominguez.

## II. Project Narrative

As part of an exploratory research grant, partially funded by the California Air Resources Board (CARB), we have collected and archived over two years worth (~3 day averages) of size-segregated aerosols. Only a small portion of these (<40 ) samples were processed and analyzed for their triple-oxygen isotopes as part of the work reported in Dominguez et al. (2008). The sample analysis techniques used to determine the triple oxygen isotopic composition of aerosol sulfate were developed at the UCSD laboratory and their applications are well documented in the scientific literature[8]. As a major portion of our research project, we propose to make use of this archive to apply the isotope technique to determine the variation of 1) total sulfate and 2) non-sea-salt sulfate as a function of aerosol size and c) the amount of ship primary sulfate and trace-metal concentrations of aerosols at the Scripps Pier (La Jolla) in a statistically significant (~50) number of (already) collected aerosol samples. Fifty more samples will be collected and analyzed AFTER the newest ship fuel regulations become active in June of 2009. This work will be completed throughout years 1-3 of the proposal period.

A second portion of the research will focus on improving our understanding of the primary particulate emissions from ships using a combination of advanced analytical techniques. As part of this proposal, during year 1 we will:

a) determine the ratio of primary sulfate to trace metals in direct samples (on hand) of ship emissions using ICP-MS<sup>2</sup> and

b) determine the elemental makeup of individual primary sulfate-rich particles to identify the elemental composition (aside from Sulfur(S) and Oxygen(O)) of metals directly associated with ship primary sulfate. These measurements will be done using the instruments available at a UCSD User Facility (CalIT, <http://nano3.calit2.net/equipment/>). These measurements will provide us with ground truth assessments of the relationship between ship primary sulfate and toxic trace metal concentrations in atmospheric aerosols. This type of study has never been done at any major port and thus the Port of San Diego will be a leader in this regard. The results of the work will be published in a premier journal as our laboratory has done in the past.

A third phase of our proposed research will involve the use of back-trajectory analysis to better understand how our measurements at the Scripps Pier relate to the rest of the city of San Diego. This work will be developed throughout the project period (years 1-3) by both Dr. Dominguez and the Ph.D. student. This work will produce exposure maps for residents in San Diego County and will quantify the effects of the newest regulations on these exposures

A detailed description of the sample collection and analysis techniques that will be used in this project are given below.

### ***Aerosol Sample Collection***

A 5-stage cascade laminar flow impactor is used to collect size-segregated aerosol samples on glass-fiber filter paper at the Scripps Pier in La Jolla, CA. These samples are archived in freezers at the Stable Isotopes Laboratory at UCSD until they are prepared for chemical and isotopic analysis. For the proposed research, we will

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<sup>2</sup> Inductively Coupled Plasma Mass Spectrometry

measure the chemical and isotopic composition of aerosol sulfate for ~ a 1 year span (~100 samples) to determine the spatial and temporal variation of ship primary content in San Diego's air.

To determine their water soluble chemical composition, these filters will be:

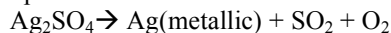
- hydrated with Millipore water (up to 30 mL) and sonicated for 1 hour using standard laboratory equipment.
- after sonication, the wet filter papers are placed in a 50 mL syringe and plunged dry. The water with soluble aerosol components are collected in a separate centrifuge tube. The filter paper is rinsed with an additional 10 mL of millipore water and squeezed dry. Additional water is added until the level of the liquid reaches 50 mL.
- Finally, cation (Na<sup>+</sup>, Ca<sup>++</sup>, Mg<sup>++</sup>, K<sup>+</sup>, and NH<sub>4</sub><sup>+</sup>) and anion (Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, and SO<sub>4</sub><sup>-2</sup>) concentrations in these samples are measured using a Dionex Ion Chromatograph using 1 mL of the 50 mL sample volume and standard calibration techniques.

### **Sample preparation for Isotopic Analysis**

The UCSD Stable Isotopes Laboratory has developed a combustion technique that consumes about 6 micromoles of sulfate per isotopic measurement. This requirements is not strict, but is generally targeted to achieve analytical precisions of (0.01 %) in the measurements of isotopic compositions using isotope ratio mass spectroscopy (IRMS) of the O<sub>2</sub> produced from the pyrolysis of AgNO<sub>3</sub> or Ag<sub>2</sub>SO<sub>4</sub>. The ion chromatographic determinations of the ionic concentrations of NO<sub>3</sub><sup>-</sup> and SO<sub>4</sub><sup>-2</sup> determined in each of the 5 stages (See section above) are used to prepare representative aliquots of the coarse (stages 1-3) and fine (stages 4,5) water soluble aerosols. This binning of fine and coarse aerosols is done primarily to satisfy the sample size requirement for analytical precision using IRMS.

Once an aliquot is prepared, organics removal is achieved through the use of *Polyvinylpyrrolidone* (PVP), C18 resin (Alltech), and silica gel and this procedure is repeated until clear Ag<sub>2</sub>SO<sub>4</sub> crystals are obtained.

Combustion of Ag<sub>2</sub>SO<sub>4</sub> can be represented as:



The oxygen produced from combustion is separated from SO<sub>2</sub> using double cold traps and a gas chromatograph. Detailed descriptions of this analytical method are found in Reference [12].

### **Isotopic Analysis and Quantification**

For all of the isotopic data that we report, we make use of the standard delta notation. All of the isotopic data reported will be determined using isotope ratio mass-spectrometry (IRMS). Thus, the oxygen isotopic data we will produce will be determined from the following expression:

$$\delta^x\text{O} = \left[ \frac{\left( \frac{{}^x\text{O}}{{}^{16}\text{O}} \right)_{\text{sample}}}{\left( \frac{{}^x\text{O}}{{}^{16}\text{O}} \right)_{\text{standard}}} - 1 \right] \times 1000$$

where x=17 and 18 for the isotopic ratios of <sup>17</sup>O and <sup>18</sup>O respectively. All of our numbers are reported with respect to the Standard Mean Oceanic Water (SMOW) standard and are expressed in parts per thousand or per mil (‰).

Excess <sup>17</sup>O, for a given sample are quantified and expressed as:

$$\Delta^{17}\text{O} \cong \delta^{17}\text{O} - 0.52\delta^{18}\text{O}$$

When the isotopic composition of an oxygen-bearing compound is such that  $\Delta^{17}\text{O} = 0$  ‰, its composition is termed “mass-dependent”. It is this property that forms the fundamental basis for the forensic analysis.

### **Back-trajectory Computations**

In our previous work for the California Air Resources Board, we developed new analytical techniques to relate the variable air quality found in San Diego to the origins of air masses using the National Oceanic and Atmospheric Administration's (NOAA) HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) model back-trajectory program run on a Unix machine in our laboratory. Using the outputs of this program and additional programming in Matlab, we have developed methods of quantifying the relative influence of oceanic air (which have low non-sea-salt sulfate concentrations) and local sources, such as the Port of San Diego or even the Port of

Los Angeles. Outputs of the HYSPLIT program and processed through our Matlab algorithms are shown in Figure 1 below.

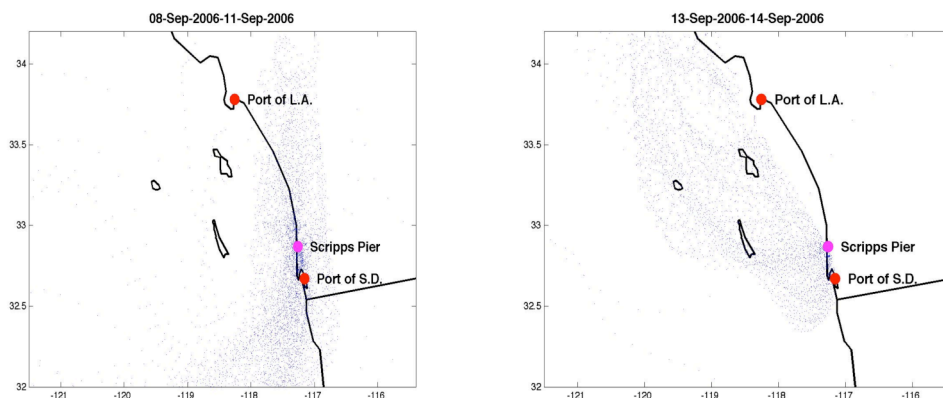


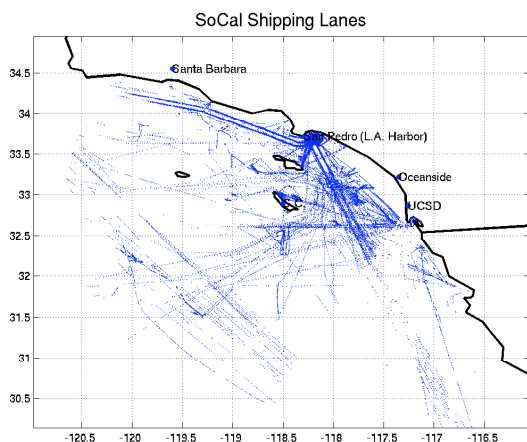
Figure 1. Back-trajectory calculations using HYSPLIT and Matlab showing the location of air (blue dots) prior to passage over the Scripps Pier during the time intervals shown above each plot. Note that for the days on the left hand plot, Port of San Diego influence was strong compared to the day on the right, where the back-trajectory points originate off of the ocean and away from Los Angeles as well. Our isotopic measurements revealed that during the sampling period shown on the left, ship primary sulfate accounted for as much as 26% ( $\sim 1.8 \mu\text{g m}^{-3}$ ) of all airborne sulfate at the Scripps Pier compared to the day on the right, during which ship primary sulfate accounted for less than 13% ( $\sim 0.77 \mu\text{g m}^{-3}$ ) of all non-sea salt sulfate.

The work shown in Figure 1 is part of a second major publication that is currently being prepared. Here, we apply back-trajectory calculations with the Scripps Pier as the “end point” and follow where the air had been. Similar back-trajectory analysis using other “end points” or receptor sites, corresponding to the locations (Chula Vista, Downtown, etc.) will be made and the results from the Scripps Pier will be used to “calibrate” the exposure at these other sites.

### Trace Metal Quantification using ICP-MS

Samples showing both low and high Port of San Diego influence that were selected for oxygen isotopic analysis will also be used to quantify the abundance of trace metals. To do these measurements, aqueous samples in the same form as those used for our isotopic analysis, will be sent to a quantitative analysis service such as that offered by Caltest Analytical Laboratory. This analytical laboratory uses the EPA 200.8 (ICPMS) protocol to determine trace metal abundances.

### Ship Traffic Monitoring



Ship traffic, both offshore and docked at the Port of San Diego will be tracked using an Automated Identification System (AIS) radio burst antenna that is networked and has been logging ship traffic continuously using a computer server at UCSD. A map of intercepted ship transmissions during the month of September (2006) is shown in Figure 2, revealing the locations of major ship traffic corridors in Southern California and ships in the Port of San Diego.

Figure 2: Location of individual ships as logged by the UCSD Ship Tracking Facility.

### Benefits to the Bay

It is expected that the proposed research will lead to more informed policy making concerning Port activities such as: 1) idling of large cargo and cruise ships while in Port and 2) where is future growth in Port ship traffic expected to have the most severe impact and by how much 3) What is the contribution by ships to the total trace metal budget of the area. Answering these questions is a complex activity that goes “beyond the compliance and mitigation” mandate of the Port of San Diego’s announcement and presents the Port of San Diego with an opportunity to fund research that will be the first of its kind and that may serve as a model for studies of ship emission and their impact in communities surrounding major Ports throughout the world.

The proposed project involves the collection and chemical analysis of the chemical and isotopic composition of aerosol particles as a function of size. The proposals PIs have executed similar projects during the last five years.

### III. Qualifying Experience

#### Similar Projects

Title: South Pole Atmospheric Nitrate Isotopic Analysis (SPANIA)  
Agency: National Science Foundation Total Award: 338,324  
Start Date: 5/01/2002 End Date: 4/30/2005  
Contact: Julie Palais, Program Manager, ANT Antarctic Sciences Division, OPP Office of Polar Programs  
Telephone #: (703) 292-8033

Title: Multiple-isotope Analysis of Nitrate and Sulfate in the West Antarctic Ice Sheet Divide Ice Core  
Agency: National Science Foundation Total Award: \$ 192,000  
Start Date: 7/1/2006 End Date: in progress  
Contact: Julie M. Palais  
Telephone #: (703) 292-8033

Title: The Use of Multi-Isotope Ratio Measurements as a New and Unique Technique to resolve  $\text{NO}_x$  Transformation  
Agency: California Air Resources Board Total Award: \$75,000  
Start Date: 07/01/04 Ending Date: 01/31/06  
Contact: Dongmin Luo, Staff Air Pollution Specialist - Research Division California Air Resources Board  
Telephone #: (916) 324-8496

#### References Cited

1. Ribeiro, K., et al., *Transport and its infrastructure*, in *Contribution of Working Group III Fourth Assessment Report of the Intergovernmental Panel on Climate Change* B. Metz, et al., Editors. 2007, Cambridge University Press.
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9. Alexander, B., et al., *Sulfate formation in sea-salt aerosols: Constraints from oxygen isotopes*. Journal of Geophysical Research (Atmospheres), 2005. 110(D9): p. D10307.

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11. Lee, C.C.-W., et al., *Sulfur (32S, 33S, 34S, 36S) and oxygen (16O,17O,18O) isotopic ratios of primary sulfate produced from combustion processes*. Tellus B, 2002. 54(3): p. 193-200.
12. Savarino, J., et al., *Sulfur and oxygen isotope analysis of sulfate at micromole levels using a pyrolysis technique in a continuous flow system*. Anal Chem, 2001. 73(18): p. 4457-62.

#### IV. Objectives of Grant Proposal

We will measure the triple-oxygen isotopic composition of 100 aerosol samples and provide direct measurements of the impact of ships on air quality in San Diego. We will target assessment of this impact to quantify the improvement in air quality resulting from the enforcement of low-sulfur fuel requirements recently mandated by the California Air Resources Board.

#### V. Cost Proposal

We request funds to pay for supplies (\$7500) and the acquisition of new equipment to automate (\$75,000) the otherwise labor intensive isotopic measurements proposed. We also request funds to pay for the tuition and salary of the Ph.D. student for three years. In addition, we request funds for to partially support a staff scientist (Terri Jackson) to help with instrumentation that will be used for the proposed study. Funds for partial support (20%) of Dr. Dominguez's (Co-PI/Project Manager) time are requested. This time will be used in the preparation of progress reports, data analysis, and training of the graduate student. Professor Thiemens will also work with Dr. Dominguez and the Ph.D. student in the analysis and writing of required reports and publications. Total salary support for the proposed funding period equals \$144,153. Fringe benefits equal \$16,998.

Fully burdened hourly rates for personell:

Personell	Fully Burdened Hourly Rate
Project Manager&Co-PI/Dr. Dominguez	\$40.05
Staff Scientist	\$28.97
Ph.D. Student (include Tuition Remission)	\$42.32
Co-PI/Mark Thiemens	\$114.93

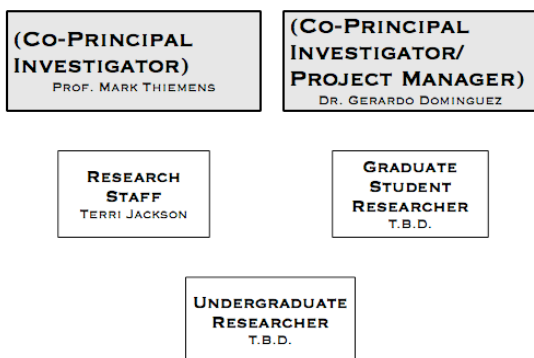
In addition to salary support, we have budgeted funds (\$12,240) to present results of the proposed research at one major research conference (AGU San Francisco, California) for each of the years. The requested funds will cover the costs for one of the Co-Is and the graduate student travel.

We budget \$750.00 to cover the sample preparation costs of doing elemental characterization of primary particulates, in particular, sulfate rich particles from direct ship stack samples that we already have on hand. These funds are for ~10 hours of instrument and sample preparation time at the CalIT user facilities at UCSD(<http://nano3.calit2.net/rates/>).

The overhead rate for the proposed project is 15%.

#### In kind services

We propose match the direct costs (315,586) at a **26% level**. We propose to donate Prof. Mark Thiemens' time (32,245\$), 100 aerosol filter samples required for the analysis (\$4,500), as well as the depreciation of laboratory equipment that will be used for the analysis of samples. Matching funds in the form of cash (**\$10,092**) have been committed by UCSD to make up the remainder of the 26% matching requirement.



#### VI. Personnel

Figure 3. Organizational chart. Co-PIs will direct overall project. Project management will be done by Dr. Dominguez and sample handling and analysis will be executed by a Ph.D. student (T.B.D.). Additional help may be obtained (Undergraduate Researcher).

**Mark H. Thiemens**

Department of Chemistry and Biochemistry  
University of California, San Diego (UCSD)  
9500 Gilman Drive  
La Jolla, CA 92093-0356

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**ACADEMIC PREPARATION**

University of Miami, Miami, FL	Chemistry	B.S.	1972
Old Dominion University, Norfolk, VA	Chemical Oceanography	M.S.	1974
Florida State University, Tallahassee, FL	Oceanography	Ph.D.	1977

**AWARDS & APPOINTMENTS**

- 2009 Goldschmidt Medal, The Geochemical Society  
2006 National Academy of Sciences, elected  
2002 American Academy of Arts and Sciences, elected  
1998 Ernest O. Lawrence Award, Dept. of Energy  
2000 – present Dean, Division of Physical Sciences, UCSD  
1996 – 1999 Chairman, Department of Chemistry and Biochemistry, UCSD  
1980 – present Professor, Department of Chemistry and Biochemistry, UCSD  
1996 – present Member, Center for Atmospheric Sciences, SIO, UCSD  
1980 – present Member, Center for Astrophysics and Space Sciences, UCSD

**PUBLICATIONS** (Selected)

- G. Dominguez, T. Jackson, L. Brothers, B. Nguyen, B. Barnett, M. Thiemens (2008), Discovery and measurement of an isotopically distinct source of sulfate in Earth's atmosphere, *Proceedings of the National Academy of Sciences*, **105**, 12769
- Baroni, M., Thiemens, M.H., Delmas, R.J., Savarino, J. (2007). Mass-independent sulfur isotopic compositions in stratospheric volcanic eruptions. *Science* 315, 84-86.
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- Farquhar, J., Bao, H. and Thiemens, M.H. Questions Regarding Precambrian Sulfur Isotope Fractionation. *Science*, **292**:1959 (2001).
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#### **Education**

U.C. Berkeley, Physics, Ph.D. 2005  
Thesis: *Fluorescent Aerogels for the Capture and Identification of Hypervelocity Extraterrestrial Particles*  
U.C. Berkeley, Physics, M.A. 2001  
U.C. Berkeley, Physics with Honors, B.A. 1998

#### **Appointments**

**NASA Stardust Preliminary Examination Team**, Cratering Subteam Member  
**U.C. President's Postdoctoral Fellow**, UCSD (2007-2009)  
Camille and Henry Dreyfus Foundation Environmental Chemistry Fellowship (2005-2007)  
Postdoctoral Researcher, U.C. Berkeley, Space Sciences Laboratory (2005)  
Graduate Student Researcher, U.C. Berkeley (1998-2005)  
Intern, Corning Inc. (Summer of 1999 and 2000)  
Graduate Student Instructor, U.C. Berkeley (Fall 1998, Spring 1999, Fall 2000)

#### **Awards**

U.C. President's Postdoctoral Fellowship (2007-2008)  
Dreyfus Foundation Postdoctoral Fellowship (2005-2007)  
National Physical Science Consortium Graduate Student Fellowship (1998-2004)  
NASA Graduate Student Research Fellowship (2001)  
Physics Undergraduate Research Scholar, U.C. Berkeley (1998)  
Chancellor's Scholar, U.C. Berkeley (1994-1998)  
Ronald E. McNair Scholar, U.C. Berkeley (1997-1998)  
Minority Summer Research Exchange Program-Fellow, Physics Dept., Stanford University, summer of 1996.

#### **Publications(select)**

**G. Dominguez**, T. Jackson, L. Brothers, B. Nguyen, B. Barnett, M. Thiemens, *Discovery and measurement of an isotopically distinct source of sulfate in Earth's atmosphere*, Proceedings of the National Academy of Sciences, 105, 12769 (2008)

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**Domínguez, G.**, Westphal, A. J., Phillips, M. L. F., Jones, S. M., *A Fluorescent Aerogel for Capture and Identification of Extraterrestrial Dust*, The Astrophysical Journal, v. 592, pgs. 631-635, July 2003.

**VII. Subconsultants**

N/A

**VIII. Non-Profit Status**

The University of California, San Diego is a non profit organization.

**IX. Applicant Disclosure**

N/A

**X. Agreement**

If selected by the Port of San Diego, and subject to consultation with University of California counsel, the applicant is willing to sign a reasonable indemnification statement and be subject to reasonable insurance requirements such as the ones listed in the RFP.

**XI. Conflict of Interest**

There is no conflict of interest to declare by the applicant.

**XII. Additional Information**