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PI/PD Name: Mark S Ghiorso

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

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PI/PD Name: George W Bergantz

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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PI/PD Name: Wendy A Bohrson

Gender: ☐ Male ☒ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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PI/PD Name: Victor C Kress

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
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- ☒ White

Disability Status: (Select one or more)
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PI/PD Name: Frank J Spera

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
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- ☐ Other
- ☒ None

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COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 01-2

NSF 00-126

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

IIS - INFORMATION TECHNOLOGY RESEARC

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0105691

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				042803536	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

916001537

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYMS(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University of Washington

AWARDEE ORGANIZATION CODE (IF KNOWN)

0037986000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

University of Washington
3935 University Way NE
Seattle, WA. 981056613

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply)
(See GPG II.C For Definitions) ☐ FOR-PROFIT ORGANIZATION ☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS

TITLE OF PROPOSED PROJECT **ITR/IM Collaborative Group proposal for establishing an Internet server and for development of client/server software for computational geochemistry, petrology and fluid dynamics**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PREPROPOSAL NO., IF APPLICABLE
$ **2,446,746**	**60** months	**07/01/01**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.A)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.6)
☐ NATIONAL ENVIRONMENTAL POLICY ACT (GPG II.C.9)
☐ HISTORIC PLACES (GPG II.C.9)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.C.11)
☐ VERTEBRATE ANIMALS (GPG II.C.11) IACUC App. Date _____
☐ HUMAN SUBJECTS (GPG II.C.11)
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED _____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT
Department of Geological Sciences

PI/PD FAX NUMBER
206-543-3836

PI/PD POSTAL ADDRESS
Box 351310

Seattle, WA 98195
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Mark S Ghiorso**	**PH.D.**	**1980**	**206-685-2482**	**ghiorso@u.washington.edu**
CO-PI/PD **George W Bergantz**	**Ph.D.**	**1988**	**206-685-4972**	**bergantz@u.washington.edu**
CO-PI/PD **Wendy A Bohrson**	**Ph.D.**	**1993**	**509-963-2835**	**bohrson@geology.cwu.edu**
CO-PI/PD **Victor C Kress**	**Ph.D.**	**1991**	**206-616-8512**	**kress@u.washington.edu**
CO-PI/PD **Frank J Spera**	**Ph.D.**	**1977**	**805-893-4880**	**spera@magma.geol.ucsb.edu**

Received :11/27/2000

CERTIFICATION PAGE

Certification for Principal Investigators and Co-Principal Investigators:

I certify to the best of my knowledge that:

(1) the statements herein (excluding scientific hypotheses and scientific opinions) are true and complete, and
(2) the text and graphics herein as well as any accompanying publications or other documents, unless otherwise indicated, are the original work of the signatories or individuals working under their supervision. I agree to accept responsibility for the scientific conduct of the project and to provide the required progress reports if an award is made as a result of this proposal.

I understand that the willful provision of false information or concealing a material fact in this proposal or any other communication submitted to NSF is a criminal offense (U.S.Code, Title 18, Section 1001).

Name (Typed)	Signature	Social Security No.*	Date
PI/PD **Mark S Ghiorso**		***ON FASTLANE SUBMISSIONS* SSN's are confidential and are not displayed**	
Co-PI/PD **George W Bergantz**			
Co-PI/PD **Wendy A Bohrson**			
Co-PI/PD **Victor C Kress**			
Co-PI/PD **Frank J Spera**			

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 01-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuring award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflict which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Debarment Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure Form to Report Lobbying,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME/TITLE (TYPED) **Carol Zuiches/Director**		**11/27/00**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
206-543-4043	**gcsvcs@u.washington.edu**	**206-685-1732**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

Received :11/27/2000

Project Summary

We propose to provide the geoscience community access to a suite of state of the art computational resources in geochemical and fluid dynamical modeling. We envision delivery of these resources over the Internet utilizing a robust multi-level client/server software model. A range of client applications will be provided serving audiences with diverse backgrounds and levels of sophistication. Researchers will be furnished with client software templates that implement direct function calls to server modules in order to deliver materials and/or thermodynamic properties of Earth substances. This ability will allow users to write targeted client applications that model complex real systems without the need to develop and test supporting code. At an intermediate level, software clients will be made available to provide application user interfaces for more specific calculations such as phase diagram construction, energy minimization, delivery of thermodynamic properties of minerals and fluids, trace element modeling, water-rock interaction scenarios, petrologic modeling, and cooling and crystallization of magma bodies. Educators and students will be provided with a variety of tutorial-style clients designed to illustrate important processes at work in the natural world. These educational clients will access the same server functions used by the research applications, but will offer simpler, easier to use and less flexible interfaces designed to allow students to interactively explore specific process simulations. We foresee establishing an Internet resource center for computational geochemistry and fluid dynamics in the geosciences with the dual aim of educating the community in modeling techniques and empowering the researcher with tools previously accessible to only a small handful of specialists.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Brief Statement of Purpose

This is a group proposal for development of information technology infrastructure in the area of computational geochemistry (CG) and geological fluid dynamics (GFD). Our intent is twofold. First, to provide state-of-the-art, rigorously tested, and fault tolerant software tools in CG and GFD to users of all levels of sophistication, from researcher to student. Second, to utilize a client/server model to deliver these tools to users on the Internet, providing remote access to parallel computing server hardware and to algorithms optimized for performance in this environment, thereby equipping the geoscience modeling community with computational resources not generally available. Our goal is to empower both researcher and student by furnishing them with flexible tools to construct model simulations of geochemical and geodynamical systems without the need to formulate, code, validate and maintain software locally. We foresee our effort as allowing remote users to focus on the formulation of simulations with realistic constraints, freeing them from the necessity to artificially simplify models to accommodate local computing resources or their own lack of numerical expertise. This proposal is aimed directly at knowledge dissemination with the goal of elevating the level of sophistication of users who rely on geochemical and fluid dynamic models to simulate and understand environmental processes and other earth systems. Our goal is to create an infrastructure to facilitate rapid, accurate, efficient and user-friendly integration and testing of computational models among researchers, educators and students worldwide. It is hoped that this infrastructure will provide a model for similar efforts in other scientific disciplines.

Need

Computational geochemistry is that branch of the geosciences concerned with quantitative estimation of the outcomes and rates of chemical reactions that proceed in the natural world. Geological fluid dynamics quantifies transport and dynamical aspects of Earth systems focusing on the spatial redistribution of mass and heat as a system evolves toward thermodynamic and gravitational equilibrium. The marriage of the two fields of computational geochemistry and geological fluid dynamics represents today's cutting edge research in Earth systems simulation because the resulting coupling of the physical and chemical processes permits the historical evolution of the system to be modeled. Such modeling is of fundamental importance in the geosciences for two reasons. First, the physical conditions under which the process of interest operates are usually not accessible to direct observation or experimental verification. For example, critical aspects of the production of magma deep within the earth, its transport to the near surface, storage in shallow magma reservoirs, and subsequent eruption and solidification can neither be observed directly nor simulated experimentally. Second, the time scales over which Earth processes evolve are so much longer than human lifetimes that hypothesis testing must proceed by comparing field observations with results of forward modeling of hypothetical systems. A classic example would be modeling the evolution of the Earth's atmosphere over time, which would include contributions from volcanic degassing, chemical reaction associated with silicate weathering and intervening biologic mediation. Results of such a simulation may be compared to the current snapshot of atmosphere composition and

sparse data from the geologic record in order to validate the model, make inferences regarding processes that are not recorded in the rock record and make predictions regarding future evolution of the system.

Advances in both computational geochemistry and geological fluid dynamics have been nothing less than revolutionary over the past decade. Knowledge of the physical properties and thermodynamics of Earth materials has matured to the point where phase equilibria in complex chemical systems can be calculated accurately over a wide range of pressure and temperature conditions. In recent years, researchers have made remarkable progress in advancing our understanding the kinetics of reactions between minerals and fluids, the theory of nucleation and crystal growth, and the formulation of constitutive relations for multi-phase materials. These advances have been accompanied by equally significant breakthroughs in numerical procedures and algorithmic design, motivated by the widespread accessibility of increasingly powerful computer hardware.

This confluence of theoretical advances in computational geochemistry and geological fluid dynamics places the geosciences at the brink of a revolution in the study of the chemistry and physics of the Earth. For the first time in history we have the tools to construct models that realistically simulate many-dimensional Earth systems in much of their true complexity. The downside to this rapid evolution of theory and computational ability is that the majority of geoscientists who might benefit from the work do not have access to the necessary tools and expertise to take full advantage of these advances. Geoscience researchers and students alike lack computational resources for model development and execution, or lack the time and experience required to formulate, code and debug software to implement model simulations for research and study of Earth systems. There is an overwhelming need for access to high quality, well-tested software modules and for software tools that may be used to integrate these modules to construct realistic simulations. Additionally, the computational hardware for many problems in geological fluid dynamics is simply not universally available. This proposal is aimed at addressing both of these needs.

Objectives and Scope

Our objective is to provide the geoscience community with a suite of state of the art computational resources in geochemical and fluid dynamical modeling. We envision delivery of these resources over the Internet utilizing a robust object-oriented multi-level client/server software model. We have the dual aim of educating the community in modeling techniques and empowering the researcher with tools previously accessible to only a small handful of specialists. Client applications will be designed to access the server at three levels of sophistication.

- **Function/Object Level:** Researchers will be provided with client software templates that implement direct remote procedure function calls to server modules in order to deliver physical and/or thermodynamic properties of Earth materials. This ability will allow sophisticated users to write client applications targeted at specific geologic problems without the need to develop and test complicated supporting code.

- **Research Application Level:** Software clients will be made available to provide application user interfaces for more generic calculations such as phase diagram construction, energy minimization and the calculation of heterogeneous and homogeneous phase equilibria, delivery of thermodynamic properties of minerals and fluids, trace element modeling, water-rock interaction, petrologic modeling, and cooling and crystallization of magma bodies.
- **Educational Application Level:** Students and educators will be provided with easy to use tutorial-level educational applications designed to allow users to interactively explore a variety of complex natural processes. These educational clients will often resemble research-level tools, but will be configured to maximize ease of use, clarity and illustrative value.

All levels of clients will interact with software that we will design/port to function on a multi-processor, -node server platform. This platform will consist of a server/slave cluster and a Beowulf parallel-computing cluster. Code for this server compute engine will be placed in the public domain and will be designed to be object oriented, fast, portable, and optimized to a parallel-computing environment. All server code will be verified against test suites.

Function/Object Level

Server compute modules (i.e. function libraries) will be written to strict and publicly known specifications so that they can be accessed by remote procedure calls over the Internet by user written clients. We envision these modules returning fundamental properties of phases and/or collections of phases in response to specific user requests and boundary constraints. For example, a user might invoke procedures for a specified solution composition at known temperature and pressure and retrieve thermodynamic state functions, or density, or species distribution results, or cation order-disorder estimates, or the elastic tensor of the material, or the viscosity of the solution. Alternatively, remote procedure calls for collections of phases might return equilibrium phase assemblages (phase diagrams by free energy minimization), bulk thermodynamic properties, bulk modulus and sound speed, viscosity, or permeability. A user client making extensive use of the server for phase property calculations in the context of some complex fluid dynamical simulation will require extensive network bandwidth to keep in step with demand. By locating the server cluster at the University of Washington, we take full advantage of bandwidth gains associated with the University's active participation in the Internet2 effort.

Research Application Level

Web based clients with a graphical user interface (GUI) will be developed for the intermediate level user to provide a simple interface to server modules and to specify boundary conditions for more complex scenarios involving process simulation and time/spatial evolution of the system. These clients will transparently invoke remote server calls to reduce client coding. Flexibility in specification of boundary conditions will make these simulators useful for research purposes. A sophisticated client GUI and reliance on anticipated processing power of client machines means that much of the problem definition, book keeping and analysis of results can be offloaded to the client machine, freeing the server for the most computationally intensive tasks. This server/client model is feasible because users typically have desktop computers that are more than adequate to run a GUI

and to process results obtained from the server locally. One of us (Ghiorso) has developed a prototype application along these lines (MELTS, http://melts.geology.washington.edu) that has proved to be an effective tool in petrological research and education. In addition to phase equilibrium calculators like MELTS, we envision clients that simulate diffusion processes, nucleation and crystal growth, trace element and energy constrained petrologic modeling, water-rock interaction simulations, and conductive/convective cooling in multiphase systems subject to specified boundary conditions.

Educational Application Level

Education oriented Web based GUI clients will be constructed with specific pedagogical objectives. These clients will allow a restricted set of adjustable parameters to be manipulated in order to allow interactive exploration of outcomes without compromising the reality of the simulation. They will provide a simplified and more structured window to what is available to the researcher in the field. Examples include clients that deliver phase diagrams, single/multi-phase convection/flow, double diffusive convection, simulated cooling of lava lakes, equilibrium versus fractional crystallization and melting, adiabatic melting of the Earth's mantle, trace element evolution of model systems, Eh-pH diagrams, aqueous activity diagrams and aqueous solution species distribution calculations.

To our knowledge resources comparable to those proposed here are not available to the geoscience community. On-line web-calculators and thermochemical database tools are available (e.g. Facility for the Analysis of Chemical Thermodynamics, //www.crct.polymtl.ca/fact/fact.htm; NIST Chemistry Webbook, //webbook.nist.gov/, MELTS, //melts.geology.washington.edu/), but the scope of the material and the audience for which it is intended is limited. Our proposed client/server software/hardware Internet platform will deliver unique resources in computational geochemistry and geological fluid dynamics to the geoscience community. This will enable a broader group of researchers to have access to state-of-the-art computational tools and will promote an increased sophistication in model development and simulation of geoscience related issues of societal concern.

Personnel and Educational Impact

The facility will be housed in the Department of Earth and Space Sciences at the University of Washington, and will be under the direction of Professors Ghiorso (PI), Bergantz, Kress, Spera (UCSB) and Bohrson (CWU). Ghiorso is a leading authority in the fields of geological thermodynamics and computational geochemistry. He has pioneered the use of computational phase equilibrium models in petrology and the distribution of these tools to the Internet community via the client/server model. Bergantz is recognized as an expert in the computation of multiphase flow and crystallization in systems of highly variable viscosity. He is an innovator in the use of Beowulf-type, parallel-computing architectures in the solution of problems in computational fluid dynamics (CFD). Kress is a research faculty member with extensive experience in the collection of experimental data on physical property measurements of materials at high temperature. He is an expert on multicomponent diffusion and has extensive experience with the construction of thermodynamic models of highly complex systems. Kress will be in charge of the day-to-day operations of the facility and will supervise the staff and student employees working with the group. Spera is a pioneer in the application of CFD to geological problems, especially in convecting systems with highly variable viscosity. He has worked on computational models of eruption dynamics, molecular dynamics simulations of the properties of materials and has extensive experience in supercomputing applications of CFD. Bohrson is an authority on the development and use of trace element and

thermodynamic modeling to the interpretation of igneous rocks. Her extensive experience in the use of model simulations in petrology/geochemistry will be invaluable to the development of client applications.

The scope of the software development project proposed here requires a dedicated staff person with demonstrated expertise in client/server software development, server configuration, parallel-computing architecture, security issues and numerical methods. Timely progress and platform stability preclude giving primary responsibility to a graduate student assistant and the effort involved is beyond that of the participant faculty--their time being better spent defining the scientific direction of the project. For these reasons we have budgeted a staff person who will be responsible for software design, development, and documentation and who will oversee hardware purchase and configuration.

Training of graduate and undergraduate students is an integral part of this proposal. Students will assist in development and coding of client applications, maintenance of databases, web-based documentation, and routine software maintenance of the server and Beowulf compute cluster. This experience will greatly enhance their education at the University of Washington.

A program designed to integrate advanced high school students with strong interest and potential in science into research environments at the UW forms an central part of the "Space Grant" program, an educational effort directed at K-16 students within the Department of Earth and Space Sciences administered by Dr. Janice DeCosmo with funding from NASA. We intend to take advantage of the Space Grant infrastructure to engage high school students into our efforts when inclination and interest permits. This should provide the student with a unique educational opportunity and support stated outreach goals encouraged by the University and NSF.

Equipment

Permanent equipment is requested in support of this proposal. Specific items and a tentative purchase schedule are indicated in the budget justification section. Hardware includes development platforms for key personnel, server and server/slave clusters for parallel asynchronous computing, and an 8-node/16-processor Beowulf cluster that will provide a compute engine for CFD calculations. Equipment will be housed at the University of Washington where space and 100 MB network access is available.

Research Schedule

As a tentative research schedule we foresee focussing efforts in years one and two on development of server software architecture and interaction protocol, including specification and documentation of remote procedure calls and development of the server/slave cluster computational model. Concurrently, conversion of existing software tools will be undertaken to integrate these seamlessly into the new client/server architecture. We also envision developing in years one and two new clients for phase equilibrium and fluid dynamical calculations and we will probably emphasize initially a suite of simple applications aimed at the educational component of the effort. In years three through five the effort will continue through the development of more sophisticated research-level clients and in the specification of more elaborate remote procedure modules as demand increases for these capabilities. Concurrently, a Beowulf cluster will be assembled and put online during this period and non-proprietary code will be designed and tested for this platform. Research-level software clients will be constructed to use this Beowulf cluster as a CFD compute engine. Documentation of the client/server protocols, user guides and tutorials for use of the software clients will be developed in parallel with these efforts.

Supporting Individuals/Institutions

Dr. Gregory Valentine, of the Los Alamos National Laboratory, who leads an effort in the use of CFD in prediction of volcanic phenomena, has expressed strong interest in this proposal and the possibility for future collaboration.

BIOGRAPHICAL SKETCH

Provide the following information for the senior personnel on the project. Begin with the Principal Investigator/Project Director.
DO NOT EXCEED 2 PAGES PER PERSON

A. Vitae, listing professional and academic essentials and mailing address.
B. List up to 5 publications most closely related to the proposed project and up to 5 other significant publications, including those being printed. Patents, copyrights, or software systems developed may be substituted for publications. Do not include additional lists of publications, invited lectures, etc. Only the list of up to 10 will be used in merit review.
C List of persons, other than those cited in the publication list, who have collaborated on a project or a book, article, report or paper within the last 48 months, including collaborators on this proposal. If there are no other collaborators, please indicate that fact.
D. Names of graduate and post-graduate advisors and advisees.
The information in C. and D. is used to help identify potential conflicts or bias in the selection of reviewers.

A. **Mark S. Ghiorso** (prepared November 5, 2000)

Department of Geological Sciences, BOX 351310, University of Washington
Seattle, WA 98195-1310
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EMAIL: ghiorso@u.washington.edu

Birth date: October 21, 1954
Birth place: San Francisco, California

Education:

A.B.	1976	University of California, Berkeley
M.A.	1978	University of California, Berkeley
Ph.D.	1980	University of California, Berkeley

Positions held:

1980-1985	Assistant Professor, Geological Sciences, University of Washington
1985-1988	Associate Professor, Geological Sciences, University of Washington
1988-present	Professor, Geological Sciences, University of Washington
1990-present	Associate editor, *American Journal of Science*
1990-1993	Associate editor, *American Mineralogist*
1991-present	Associate editor, *Geochimica et Cosmochimica Acta*
1994-1999	Chairman, Geological Sciences, University of Washington

Awards:

1984	Presidential Young Investigator Award, National Science Foundation
1987	Intern Assoc of Mathematical Geologists Best Paper Award for 1983
1993	Elected Fellow of the Mineralogical Society of America
1996-1997	Distinguished Lecturer, Mineralogical Society of America
1997	Elected Fellow of the Geological Society of America
1999	Elected Fellow of the American Geophysical Union

National Committees

1988-1991	Mineralogical Society of America representative to the Joint Technical Program Committee of the Geological Society of America
1988	Representative to the National Science Foundation advisory panel on Presidential Young Investigator Awards
1992-1995	Joint Technical Program Committee (JTPC) for Annual Meetings, Geological Society of America. 1994 Chair for Seattle meeting.
1994	Mineralogical Society of America ad hoc committee on the *American Mineralogist*
1994-1995	Mineralogical Society of America Committee on Committees
1995-1997	Mineralogical Society of America Short Course Committee (1996-7, Chair)
1997-present	Councilor, Mineralogical Society of America
1998	Mineralogical Society of America, Roebling Committee (Chair)
1999	Mineralogical Society of America, MSA Award Committee (Chair)

B. Publications

5 pertinent publications to research proposal

Ghiorso MS (1985) Chemical mass transfer in magmatic processes. I. Thermodynamic relations and numerical algorithms. *Contrib Mineral Petrol* **90**:107-120

Ghiorso MS, Kelemen PB (1987) Evaluating reaction stoichiometry in magmatic systems evolving under generalized thermodynamic constraints: Examples comparing isothermal and isenthalpic assimilation, *in*, Mysen BO, ed., Magmatic Processes: Physicochemical Principles, Geochemical Society, *Special Publication* **1**: 319-336

Ghiorso MS (1994) Algorithms for the estimation of phase stability in heterogeneous thermodynamic systems. *Geochimica et Cosmochimica Acta* **58**, 5489-5501

Ghiorso MS, Sack RO (1995) Chemical Mass Transfer in Magmatic Processes IV. A revised and internally consistent thermodynamic model for the interpolation and extrapolation of liquid-solid equilibria in magmatic systems at elevated temperatures and pressures. *Contrib Mineral Petrology* **119**, 197-212

Asimow PD, Ghiorso MS (1998) Algorithmic Modifications Extending MELTS to Calculate Subsolidus Phase Relations. *American Mineralogist* **83**, 1127-1131

Ebel DS, Ghiorso MS, Sack RO, Grossman L (2000) Gibbs energy minimization in gas + liquid + solid systems. *J Computational Chemistry* **21** 247-256

5 other significant publications:

Asimow PD, Hirschmann MM, Ghiorso MS, O'Hara MJ, Stolper EM (1995) The effect of pressure-induced solid-solid phase transitions on decompression melting of the mantle. *Geochimica et Cosmochimica Acta* **59**, 4489-4506

Ghiorso MS (1997) Thermodynamic analyses of the effect of magnetic ordering on miscibility gaps in the Fe-Ti cubic and rhombohedral oxide minerals and the Fe-Ti oxide geothermometer. *Physics and Chem Minerals* **25**, 28-38

Hirschmann MM, Ghiorso MS, Wasylenki LE, Asimow PD, Stolper EM (1998) Calculation of peridotite partial melting from thermodynamic models of minerals and melts. I. Methods and comparison to experiments. *J Petrology* **39**, 1091-1115

Hirschmann MM, Ghiorso MS, Stolper EM (1999) Calculation of Peridotite Partial Melting from Thermodynamic Models of Minerals and Melts. II. Isobaric variations in melts near the solidus and owing to variable source composition. *J Petrology* **40**, 297-313

Hirschmann MM, Asimow PD, Ghiorso MS, Stolper EM (1999) Calculation Of Peridotite Partial Melting From Thermodynamic Models Of Minerals And Melts. III. Controls on isobaric melt production and the effect of water on melt production *J Petrology* **40**, 831-851

C) Collaborators

Paul D. Asimow, Mike Baker, Darby Dyar, Bernard W. Evans, Cinzia Farnetani, Ron Frost, Timothy Grove, Marc M. Hirschmann, Gary Jacobs, Victor Kress, Rebecca Lange, Don Lindsley, Mike Naney, Bruce K. Nelson, Mike O'Hara, Peter M. Reiners, Mark Richards, Richard Sack, Edward Stolper, Hexiong Yang

D) Thesis Advisors

Ian Carmichael, George Brimhall, Ken Pitzer, Alan Searcy

E) Advises (PhD)

Dave Frank, Ellen Gitlin, Marc Hirschmann, Peter Kelemen, Jim Wells

George W. Bergantz

Abbreviated Curriculum Vitae for ITR Proposal

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Education: Ph.D. in Earth and Planetary Sciences, July, 1988
The Johns Hopkins University

M.S. in Geophysical Sciences, May, 1985
Georgia Institute of Technology

B.Sc. (Cum Laude) in Geological Engineering, May, 1983
Mackay School of Mines, University of Nevada, Reno

Academic and Professional Experience:

Professor — Dept. of Geological Sciences, University of Washington, on faculty from 9/88 to present.

Associate Editor:
Journal of Petrology
Journal of Volcanology and Geothermal Research

Publications related to proposed Penrose meeting:

Bergantz, G.W., 2000, On the dynamics of magma mixing by reintrusion: Implications for pluton assembly processes, Journal of Structural Geology, v. 22, p. 1297-1309.

Bergantz, G.W. and Ni, J., 1999, A numerical study of crystal sedimentation in basaltic magma chambers, Int. J. Multiphase Flow, v. 25, p. 307-320.

Barboza, S. and Bergantz, G.W., 1998, Rheological transitions and the progress of melting of crustal rocks, Earth and Planetary Science Letters, v. 158, p. 19-29.

Barboza, S. and Bergantz, G.W., 1997, Melt productivity and rheology: complementary influences on the progress of melting, Numerical Heat Transfer A, v. 31, p. 375-392

Barboza, S. and Bergantz, G.W., 1996, Dynamic model of dehydration melting motivated by a natural analogue: applications to the Ivrea-Verbano zone, nothern Italy, Trans. Roy. Soc. Edinburgh: Earth Sciences, v. 87, p. 23-31.

Bergantz, G.W. and Dawes, R., 1994, Aspects of magma generation and ascent in continental lithosphere, in, Magmatic Systems, M. Ryan ed., pp. 291-317.

Bergantz, G.W., 1992, Conjugate solidification and melting in multicomponent open and closed systems, Int. J. Heat Mass Transfer, v. 35, p. 533-543.

Other Related Publications:

Barboza, S., Bergantz, G.W. and Brown, M., 1999, Basaltic magmatism and regional metamorphism in the Ivrea Zone: a smoking gun or a red herring? Geology, v. 27 p. 447-450.

Bergantz, G.W., 1991, Elements in the physical and chemical characterization of plutons, Rev. Mineralogy, v. 25, p.13-42.

Bergantz, G.W., 1995, Changing paradigms and techniques for the evaluation of magmatic processes, J. Geophys. Res., v. 100, p. 17,603-17,613.

Graduate Students Supervised by Bergantz

Marilyn DeRosa, M.S. 1991, Juliet McKenna, M.S. 1994, Ralph Dawes, Ph.D. 1994, Steve Macias, M.S., 1996, Scott Barboza, M.S., 1996. Ph.D. 1999.

Scientific Collaborators

Dr. M. Murphy, Prof. J. Ni, Dr. J. Quick, Prof. M. Brown, Prof. S. Sinigoi, Prof. J. Davidson, Dr. K. Knesel, Prof. S. Paterson

Wendy A. Bohrson
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Central Washington University
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A. PROFESSIONAL PREPARATION

Stanford University, Geology and Biology, B. Sc., 1984
University of California, Los Angeles, Geology, Ph.D., 1993
University of California, Santa Barbara, Postdoctoral Fellowships, 1993-1998

B. APPOINTMENTS

July, 2000, Director of Undergraduate Research and the Symposium for Undergraduate Research and Creative Expression (May, 2001), Central Washington University
December, 1998 Assistant Professor, Department of Geological Sciences, Central Washington University
1996-1998 National Science Foundation Postdoctoral Fellow, University of California, Santa Barbara
1993-1995 University of California Presidential Postdoctoral Fellow, University of California, Santa Barbara
1994-1999 Researcher, Institute of Crustal Studies, University of California, Santa Barbara
1989-1993 Research Assistant and Teaching assistant, UCLA
1983-1989 Geologist, U.S. Geological Survey, Menlo Park, CA

C. PUBLICATIONS

([1] most closely related; [2] other significant publications)

[1]Spera FJ and Bohrson WA, (in press), Energy-Constrained Open-System Magmatic Processes I: General Model and Energy-Constrained Assimilation and Fractional Crystallization (EC-AFC) Formulation, J. of Petrology.

[1]Bohrson WA and Spera FJ, (in press), Energy-Constrained Open-System Magmatic Processes II: Application of EC-AFC Model to Magmatic Systems, J. of Petrology.

[1]Bohrson WA and Spera FJ, (in press), Geochemical Consequences of Incorporating Energetic Constraints into a Quantitative Model of Assimilation-Fractional Crystallization, Geological Society of America Meeting.

[1]Bohrson WA and Spera FJ, (1999), New Insight Into the Geochemical Consequences of Assimilation-Fractional Crystallization: Energy Constrained Assimilation-Fractional Crystallization (ECAFC), EOS, Transactions, American Geophysical Union.

[1]Spera FJ and Bohrson WA, (1999), A Next-Generation Model for Computing the Geochemical Evolution of Magma Undergoing Concurrent Recharge, Wallrock Partial Melt Assimilation, and Fractional Crystallization With Self-Consistent Energy Conservation (EC-RAFC), EOS, Transactions, American Geophysical Union.

[2]Evans CK, Spera FJ, Bohrson WA, (1999), Magma Storage and Ascent Dynamics of Historic Alkali Basalt eruptions from Mount Etna, Italy: Inferences from Crystal Size Distribution and Correlation with Composition and Eruptive Volume, EOS, Transactions, AGU.

[2]Bohrson WA, Reid MR, 1998, Genesis of evolved ocean island magmas by deep and shallow level basement recycling, Socorro Island, Mexico: Constraints from Th and other isotope signatures. Journal of Petrology 39:995-1008.

[2]Gans PB, Bohrson WA, 1998, Suppression of volcanism during rapid extension in the Basin and Range Province, United States. Science 279:66-68.

[2]Bohrson WA, Reid MR, 1997, Genesis of silicic peralkaline volcanic rocks in an ocean island setting by crustal melting and open-system process: Socorro Island, Mexico. Journal of Petrology 38: 1137-1166.

[2]Bohrson WA, Reid MR, Grunder AL, Heizler MT, Harrison TM, and Lee J, 1996, Prolonged history of silicic peralkaline volcanism in the Eastern Pacific Ocean. J. Geophys. Res. 101:11457-11474.

D. SYNERGISTIC ACTIVITIES

Director of Undergraduate Research and the Symposium for Undergraduate Research and Creative Expression (May, 2001), Central Washington University (2000-present)

Integrating Analytical Geochemistry into the Geology Curriculum at CWU: Development of a geochemistry laboratory for undergraduate research and integration of active-learning techniques at CWU (2000-2003)

Collaborative Development of Geochemical Computer Code Modeling Open-System Processes in Magma Chambers, available as a teaching tool for undergraduate and graduate classes and research

Community activity–public lectures, presentations to K-12 classes, participation in "Expanding Your Horizons" (1994-present)

Co-Convener, GSA Penrose conference, Evolution of ocean island volcanoes, Galapagos (June 4-12, 1998)

E. COLLABORATORS AND OTHER AFFILIATIONS

i) *collaborators:* J. Arrington (CWU), G. Bergantz (UW) D. Clague (MBARI), J. Davidson (UCLA), A. Davis (MBARI), P. Gans (UCSB), C. Gazis (CWU), D. Geist (U. of Idaho), M. Ghiorso (UW), D. Graham (Oregon State U), K. Harpp (Colgate U), V. Kress (UW), J. Hinthorne (CWU), F. Spera (UCSB), J. Wolff (WSU)

ii) *graduate and postdoctoral advisors:* Ph.D. advisor: Mary Reid (UCLA), post-doctoral advisor: Frank Spera (UCSB)

iii) *graduate students:* Sarah Fowler (CWU); William Strand (CWU)

BIOGRAPHICAL SKETCH

Provide the following inromation for the senior personnel on the project. Begin with the Principal Investigator/Project Director (PI/PD)

DO NOT EXCEED 2 PAGES PER PERSON

A. Vitae, listing professional and academic essentials and mailing addresses.
B. List up to 5 publications most closely related to the proposed project and up to 5 other significant publications, including those being printed. Patents, copyrights or software systems developed may be substituted for publications. Do hot include additional lists of publications, invited lectures, etc. Only the list of up to 10 will be used in merit review.
C. A list of persons, other than those cited in the publication list, who have collaborated on a project or a book, article, report or paper within the last 48 months, including collaborators on this proposal. If there are no other collaborators, please indicate so.
D. A list of the names of graduate students with whom this individual has had an association as thesis advisor and postdoctoral scholars sponsored by thiws individual over the past five years, with a summary of the total numbers of graduate students advised and postdoctoral scholars sponsored.
E. The names of the individual's own graduate and postdoctoral advisors.

The information in C, D, and E is used to help identify potential conflicts or bias in the selection of reviewers.

A) Victor C. Kress II (prepared November. 15, 2000)

Department of Geological Sciences Box 35130, University of Washington, Seattle, Washington 98195-1310
(206) 616-8512 Fax (shared): (206) 543-3836
Email: kress@u.washington.edu

Birth Place: San Francisco, California

Education:

B.S.	1981	University of California, Santa Cruz
M.S.	1986	State University of New York, Stony Brook
Ph.D.	1990	University of California, Berkeley

Positions held:

9/96-	Research Assistant Professor, Geological Sciences, Univ. of Washington.
8/94-8/96	Postdoctoral Researcher, Geophysical Laboratory, Washington, DC.
8/95-8/96	Adjunct Professor, George Mason University.
5/90-8/94	Postdoctoral Researcher, Geological Sciences, University of Washington.
9/85-5/90	Research Assistant, University of California, Berkeley.
1/86-6/86	Teaching Assistant, University of California, Berkeley, California.
6/84-9/85	Research Assistant**,** SUNY, Stony Brook, New York.
9/83-6/84	Teaching Assistant, SUNY, Stony Brook, New York.
3/82-9/83	Field Geologist/Petrologist, Los Alamos National Laboratories.

Professional Societies: Mineralogical Society of America, Geochemical Society, American Geophysical Union.

Community Service;

Scientific Mentor for the Montgomery Blair High School Science Magnet Program

Manuscript reviewer for *Nature*, *Geochimica et Cosmochimica Acta*, *American Mineralogist*, *Earth and Planetary Science Letters*, *Contributions to Mineralogy and Petrology* and the *Journal of Geophysical Research*.

Proposal reviewer for the National Science Foundation.

B) Five publications pertinent to research proposal:

Kress V.C. (2000) Thermochemistry of sulfide liquids. II. associated solution model for liquids in the system O-S-Fe. *Contributions to Mineralogy and Petrology*, **139**:316-325.

Kress V.C. (1997) Thermochemistry of sulfide liquids I: The system Fe-S-O at 1 bar. *Contributions to Mineralogy and Petrology*, **127**, 176-186.

Kress VC and Carmichael ISE (1991) The compressibility of silicate liquids containing Fe_2O_3 and the effect of composition, temperature, oxygen fugacity and pressure on their redox states. *Contributions to Mineralogy and Petrology*, **108**, 82-92.

Kress VC and Ghiorso MS (1994) Multicomponent diffusion in basaltic melts. *Geochimica et Cosmochimica Acta*, **59**, 313-324.

Kress VC and Ghiorso MS (1993) Multicomponent diffusion in MgO-Al_2O_3-SiO_2 and CaO-MgO-Al_2O_3-SiO_2 melts. *Geochimica et Cosmochimica Acta*, **57**, 4453-4466.

Five other significant publications

Kress V.C. (1997) Magma mixing as a source for Pinatubo sulfur. *Nature*, **389**, 591-593.

Kress VC, Williams Q and Carmichael ISE (1989) When is a silicate melt not a liquid? *Geochimica et Cosmochimica Acta*, **53**, 1683-1692.

Kress VC and Carmichael ISE (1989) The lime-iron-silicate melt system: Redox and volume systematics. *Geochimica et Cosmochimica Acta*, **53**, 2883-2892.

Kress VC, Williams Q and Carmichael ISE (1988) Ultrasonic investigation of melts in the system Na_2O-Al_2O_3-SiO_2. *Geochimica et Cosmochimica Acta*, **52**, 283-293.

Kress VC and Carmichael ISE (1988) Stoichiometry of the iron oxidation reaction in silicate melts. *American Mineralogist*, **73**, 1267-1274.

C) Collaborators: Ian S.E. Carmichael, Rebecca Lange, Ivan C. Getting, Mark S. Ghiorso, Bjorn O. Mysen, Frank J. Spera, Hartmut A. Spetzler, Alain F. Trial, Hexiong Yang, George Bergantz, Chris Newhall, Bernard Evans.

D) Graduate or post-doctoral advises: Brad Wakoff, Jeffrey B. Whitter, Nathan Chutas.

E) Graduate and post-doctoral advisors: Ian S.E. Carmichael, Mark S. Ghiorso, Bjorn O. Mysen

FRANK J. SPERA

University of California
Institute for Crustal Studies
Santa Barbara, CA 93106
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Education: B.A., Geology, Franklin and Marshall College, Magna Cum Laude, 1972
M.A., Geology, University of California, Berkeley, 1974
Ph.D., Geology, University of California, Berkeley, 1977

Experience:

1977-85	Member, Geophysical Fluid Dynamics Laboratory (GFDL), Princeton University, Forrestal Campus.
1977-82	Assistant Professor of Geology, Department of Geological and Geophysical Sciences, Princeton University.
1981-82	Visiting Assistant Professor of Geology, University of California at Los Angeles 9/1/81-12/15/81.
1981-82	Visiting Research Geophysicist, institute of' Geophysics and Planetary Physics, UCLA 9/1/81 - 1/21/82.
1982-85	Associate Professor of Geology, Department of Geological and Geophysical Sciences, Princeton University.
1983-85	Adjunct Professor of Volcanology, Institute for Mineralogy and Petrology, University of Rome, Rome, Italy.
1982-88	Associate Editor, Geology.
1982-89	Associate Professor of Geology, Department of Geological Sciences, UCSB.
1986-90	Associate Editor, American Mineralogist.
1983-1987	Associate Editor, Journal of Geophysical Research
1983-1988	Associate Editor, Journal of Geophysical Research
1987 -	Professor of Geological Sciences Department of Geological Sciences, UCSB
1987 -	Member, Institute for Crustal Studies, University of California, Santa Barbara.
1996-	Associate Editor, Journal of Geophysical Research

FIVE RELATED PUBLICATIONS

Simulations of crustal anatexis: Implications for the growth and differentiation of continental crust. F.Raia, F. Spera, Journal of Geophysical Research -, vol.102 pp. 22629-22648, 1997.

Simulations of convection with crystallization in the system $KalSi_2O_6$-$CaMgSi_2O_6$: Implications for compositionally zoned magma bodies, F.J. Spera, C.M. Oldenburg, C. Christensen, M. Todesco, *American Mineralogist*, vol. 80 pp. 1188-1207, 1995.

The relationship between flow and permeability field in seafloor hydrothermal systems: N.D. Rosenberg, F.J. Spera, R.M. Haymon *Earth and Planetary Science Letters*, vol. 116 pp.135-153, 1993.

Chaotic Thermohaline convection in low-porosity hydrothermal systems. S.Schoofs, F. Spera, U. Hansen, *Earth and Planetary Science Letters*, vol. 174, pp. 213-229, 1999

Molecular Dynamics simulations of molten CaAl2Si2O8: Dependence of Structure and Properties on Pressure, D.Nevins, F.Spera, *American Mineralogist*, vol. 83, pp1220-1230, 1998

FIVE OTHER PUBLICATIONS

Mechanisms for the generation of compositional heterogeneities in magma chambers: A.F. Trial and F.J. Spera Geological Society of America Bulletin, vol. 102 pp. 353-367, 1990.

Dynamic mixing in magma bodies - theory, simulations, and implications: C.M. Oldenburg, F.J. Spera, D.A. Yuen, G. Sewell Journal of Geophysical Research - Solid Earth and Planets, vol. 94 pp. 9215-9236, 1989.

Simulations of magma withdrawal from compositionally zoned bodies: A.F. Trial, F.J. Spera, J. Greer, D.A. Yuen Journal of Geophysical Research - Solid Earth, vol. 97 pp. 6713-6733, 1992.

New high-temperature rotational rheometer for silicate melts, magmatic suspensions, and emulsions: D.J. Stein and F.J. Spera Review of Scientific Instruments, vol. 69 pp. 3398-3402, 1998.

Physical Properties of Magma, in *Encyclopedia of Volcanoes*, (ed) H. Siguurdson, Academic Press, 2000 ,pp171-189.

Former or Current Graduate and Undergraduate Students

Mark Feigenson	Andrea Borgia	Atillio Giacobbe	Tanya Furman
Steven Bergman	Brian Cousens	Mollie Thompson	Greg Valentine
Joy Crisp	Stacey Zeck	Julie Bryce	Dean Nevins
Stephen Clark	Dan Stein	Constance Balzer	Tracey Herrera
Nina Rosenberg	Curtis Oldenburg	Kirstin Kummer	Neil Morgan
Jennifer Benton	Cathy Broxterman	Alain Trial	

Post-Doctoral Students

David Graham, Micol Todesco, Elke Kaelicke, Alex Prousevitch, Federica Raia, Alain Trial, Daniel Stein, Wendy Bohrson, Stan Schoofs,

Scientific Collaborators (excluding PI's and students)

Dave Yuen, University of Minnesota
Rachel Haymon and Daniel Stein, University of California, Santa Barbara
David Graham, Oregon State University
Wendy Bohrson, Central Washington University

Graduate Thesis Advisor

Ian Carmichael, University of California, Berkeley

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Washington**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Mark S Ghiorso**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mark S Ghiorso - Professor**	**0.00**	**0.00**	**1.00**	$ **8,578**	$
2. **George Bergantz - Professor**	**0.00**	**0.00**	**1.00**	**6,618**	
3. **Wendy Bohrson - Asst Prof**	**0.00**	**0.00**	**0.00**	**0**	
4. **Victor C Kress - R Asst Prof**	**6.00**	**0.00**	**0.00**	**25,503**	
5. **Frank Spera - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	**6.00**	**0.00**	**2.00**	**40,699**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**12.00**	**0.00**	**0.00**	**100,000**	
3. (**3**) GRADUATE STUDENTS				**52,379**	
4. (**2**) UNDERGRADUATE STUDENTS				**9,000**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**202,078**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**39,369**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**241,447**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
1,Server Platform $ **3,000**					
2,Development Platforms **8,000**					
2,Slave nodes **6,000**					
TOTAL EQUIPMENT				**17,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**1,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**1,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**36,305**	
6. OTHER				**21,834**	
TOTAL OTHER DIRECT COSTS				**59,639**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**319,086**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Indirect Cost (Rate: 52.0000, Base: 280252)**					
TOTAL INDIRECT COSTS (F&A)				**145,731**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**464,817**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.D.7.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **464,817**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI / PD TYPED NAME & SIGNATURE*	DATE	FOR NSF USE ONLY
Mark S Ghiorso		INDIRECT COST RATE VERIFICATION
ORG. REP. TYPED NAME & SIGNATURE*	DATE	Date Checked / Date Of Rate Sheet / Initials - ORG

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Washington**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Mark S Ghiorso**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mark S Ghiorso - Professor**	**0.00**	**0.00**	**1.00**	$ **8,921**	$
2. **George Bergantz - Professor**	**0.00**	**0.00**	**1.00**	**6,882**	
3. **Wendy Bohrson - Asst Prof**	**0.00**	**0.00**	**0.00**	**0**	
4. **Victor C Kress - R Asst Prof**	**6.00**	**0.00**	**0.00**	**26,555**	
5. **Frank Spera - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	**6.00**	**0.00**	**2.00**	**42,358**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**12.00**	**0.00**	**0.00**	**104,000**	
3. (**3**) GRADUATE STUDENTS				**54,474**	
4. (**2**) UNDERGRADUATE STUDENTS				**9,360**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**210,192**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**40,951**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**251,143**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
1,Development Platforms $ **4,000**					
1,Server Platform **3,000**					
2,Slave nodes **6,000**					
TOTAL EQUIPMENT				**13,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**1,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**1,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**37,122**	
6. OTHER				**22,707**	
TOTAL OTHER DIRECT COSTS				**61,329**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**326,472**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Indirect Cost (Rate: 52.0000, Base: 266870)**					
TOTAL INDIRECT COSTS (F&A)				**138,772**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**465,244**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.D.7.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **465,244**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI / PD TYPED NAME & SIGNATURE*	DATE	FOR NSF USE ONLY
Mark S Ghiorso		INDIRECT COST RATE VERIFICATION
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SUMMARY PROPOSAL BUDGET YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Washington**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Mark S Ghiorso**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mark S Ghiorso - Professor**	**0.00**	**0.00**	**1.00**	$ **9,278**	$
2. **George Bergantz - Professor**	**0.00**	**0.00**	**1.00**	**7,158**	
3. **Wendy Bohrson - Asst Prof**	**0.00**	**0.00**	**0.00**	**0**	
4. **Victor C Kress - R Asst Prof**	**6.00**	**0.00**	**0.00**	**27,584**	
5. **Frank Spera - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	**6.00**	**0.00**	**2.00**	**44,020**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**12.00**	**0.00**	**0.00**	**108,160**	
3. (**3**) GRADUATE STUDENTS				**56,653**	
4. (**2**) UNDERGRADUATE STUDENTS				**9,734**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**218,567**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**42,581**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**261,148**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
1,Development Platforms $ **4,000**					
2,Slave nodes **6,000**					
4,Beowulf nodes **12,000**					
TOTAL EQUIPMENT				**22,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**1,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**1,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**37,965**	
6. OTHER				**23,615**	
TOTAL OTHER DIRECT COSTS				**63,080**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**347,228**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Indirect Cost (Rate: 52.0000, Base: 264117)**					
TOTAL INDIRECT COSTS (F&A)				**137,340**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**484,568**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.D.7.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **484,568**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI / PD TYPED NAME & SIGNATURE*: **Mark S Ghiorso** DATE

ORG. REP. TYPED NAME & SIGNATURE* DATE

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SUMMARY PROPOSAL BUDGET

YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Washington**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Mark S Ghiorso**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mark S Ghiorso - Professor**	**0.00**	**0.00**	**1.00**	$ **9,649**	$
2. **George Bergantz - Professor**	**0.00**	**0.00**	**1.00**	**7,444**	
3. **Wendy Bohrson - Asst Prof**	**0.00**	**0.00**	**0.00**	**0**	
4. **Victor C Kress - R Asst Prof**	**6.00**	**0.00**	**0.00**	**28,687**	
5. **Frank Spera - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	**6.00**	**0.00**	**2.00**	**45,780**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**12.00**	**0.00**	**0.00**	**112,486**	
3. (**3**) GRADUATE STUDENTS				**58,919**	
4. (**2**) UNDERGRADUATE STUDENTS				**10,124**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**227,309**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**44,285**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**271,594**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
1,Development Platforms $ **4,000**					
1,Server Platform **3,000**					
2,Slave nodes **6,000**					
4,Beowulf nodes **12,000**					
TOTAL EQUIPMENT				**25,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**1,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**1,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**40,662**	
6. OTHER				**24,560**	
TOTAL OTHER DIRECT COSTS				**66,722**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**364,316**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Indirect Cost (Rate: 52.0000, Base: 274094)**					
TOTAL INDIRECT COSTS (F&A)				**142,528**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**506,844**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.D.7.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **506,844**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI / PD TYPED NAME & SIGNATURE*: **Mark S Ghiorso** DATE

ORG. REP. TYPED NAME & SIGNATURE* DATE

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

SUMMARY PROPOSAL BUDGET

YEAR 5

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Washington**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Mark S Ghiorso**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mark S Ghiorso - Professor**	**0.00**	**0.00**	**1.00**	$ **10,035**	$
2. **George Bergantz - Professor**	**0.00**	**0.00**	**1.00**	**7,742**	
3. **Wendy Bohrson - Asst Prof**	**0.00**	**0.00**	**0.00**	**0**	
4. **Victor C Kress - R Asst Prof**	**6.00**	**0.00**	**0.00**	**29,834**	
5. **Frank Spera - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	**6.00**	**0.00**	**2.00**	**47,611**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**12.00**	**0.00**	**0.00**	**116,986**	
3. (**3**) GRADUATE STUDENTS				**61,276**	
4. (**2**) UNDERGRADUATE STUDENTS				**10,529**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**236,402**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**46,056**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**282,458**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
1,Development Platforms $ **4,000**					
1,Server Platform **3,000**					
2,Slave nodes **6,000**					
4,Beowulf nodes **12,000**					
TOTAL EQUIPMENT				**25,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**1,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**1,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**41,593**	
6. OTHER				**25,542**	
TOTAL OTHER DIRECT COSTS				**68,635**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**377,093**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Indirect Cost (Rate: 52.0000, Base: 284958)**					
TOTAL INDIRECT COSTS (F&A)				**148,178**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**525,271**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.D.7.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **525,271**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI / PD TYPED NAME & SIGNATURE*: **Mark S Ghiorso** DATE

ORG. REP. TYPED NAME & SIGNATURE* DATE

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Washington**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Mark S Ghiorso**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mark S Ghiorso - Professor**	**0.00**	**0.00**	**5.00**	$ **46,461**	$
2. **George Bergantz - Professor**	**0.00**	**0.00**	**5.00**	**35,844**	
3. **Wendy Bohrson - Asst Prof**	**0.00**	**0.00**	**0.00**	**0**	
4. **Victor C Kress - R Asst Prof**	**30.00**	**0.00**	**0.00**	**138,163**	
5. **Frank Spera - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	**30.00**	**0.00**	**10.00**	**220,468**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**5**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**60.00**	**0.00**	**0.00**	**541,632**	
3. (**15**) GRADUATE STUDENTS				**283,701**	
4. (**10**) UNDERGRADUATE STUDENTS				**48,747**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**1,094,548**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**213,242**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**1,307,790**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ **102,000**					
TOTAL EQUIPMENT				**102,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**5,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**5,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**2,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**193,647**	
6. OTHER				**118,258**	
TOTAL OTHER DIRECT COSTS				**319,405**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**1,734,195**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**712,551**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,446,746**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.D.7.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **2,446,746**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI / PD TYPED NAME & SIGNATURE*: **Mark S Ghiorso** DATE

ORG. REP. TYPED NAME & SIGNATURE* DATE

FOR NSF USE ONLY

INDIRECT COST RATE VERIFICATION

Date Checked	Date Of Rate Sheet	Initials - ORG

NSF Form 1030 (10/99) Supersedes all previous editions

C***SIGNATURES REQUIRED ONLY FOR REVISED BUDGET (GPG III.B)**

Budget Justification

Personnel

- Mark S. Ghiorso, PI, UW, 1 month summer salary/year, benefit rate: 21.80%. Responsible for overall project oversight and applications dealing with thermodynamic modeling of phase equilibria.
- George W. Bergantz, co-PI, UW, 1 month summer salary/year, benefit rate 21.80%. Bergantz and Spera are responsible for development of applications and algorithms dealing with fluid dynamical modeling.
- Wendy Bohrson, co-PI, Central Washington University (CWU), 1 month academic year salary/year. Bohrson holds a 9 month, 50% time appointment at CWU, and will be compensated for time devoted to this research project during her unpaid portion of the academic year. She will be responsible for development of applications dealing with petrological/geochemical modeling, especially trace elements and related methods. See detailed budget for CWU under subawards, below.
- Victor C. Kress, co-PI, UW, 6 months salary/year, benefit rate 21.80%. Responsible for day-to-day oversight of professional and student staff, coordination of software development activities, implementation strategies and most logistical issues dealing with this grant. Will also contribute substantially to applications dealing with thermodynamic modeling of phase equilibria. As a research faculty member, Kress receives no salary from the University of Washington and is responsible for generating his salary from external funding sources.
- Frank Spera, co-PI, University of California Santa Barbara (UCSB), 1 month summer salary/year. Bergantz and Spera are responsible for development of applications and algorithms dealing with fluid dynamical modeling. See detailed budget for UCSB under subawards, below.
- Three graduate student assistants, UW, level RAII @ $1,399/month, 50% time, 12 months, Note: tuition included as other direct costs. Current $1,732/academic quarter+$1,802/summer quarter, or $13,996/year, adjusted 4% annually for inflation. Responsible for routine software maintenance of computer hardware, including the Beowulf cluster. Involved with routine code development and application development for enduser research clients.
- Two undergraduate assistants, UW, hourly @ $9/hour, 500 hours/year, benefit rate 10.6%. Involved with database maintenance, routine code development and application development for enduser educational clients.

- Professional staff, software development, UW, salary estimated at ~ $100,000/year, benefit rate 24.2%. Responsible for all client/server software development and distribution and for oversight of software maintenance of the computer hardware.
- 4% inflation cost of living adjustment per year on salaries. Assumed start date of 7/1/01 assumes 4% cost of living adjustment to present salaries.

Equipment

Computer equipment necessary for development and production aspects of the project is included here. Development machines are intended for personnel and are to be used for program development and testing. Macintosh dual processor G4 systems running OS X are the model platform. Server machines are dual processor Pentium III/Power PC or equivalent boxes operating under Linux; slave units are hardware-identical to servers. The Beowulf cluster is envisioned as a grouping of SMP boxes (dual processor Intel or PowerPC G4) operating under Linux. Purchase strategy for computer hardware includes built in replacement and upgrades. Schedule for hardware purchase:

Year 1	Year 2	Year 3	Year 4	Year 5
2 D @ $4K	1 D @ $4K	1 D @ $4K	1 D @ $4K	1 D @ $4K
1 S @ $3K	1 S @ $3K		1 S @ $3K	1 S @ $3K
2 s @ $3K	2 s @ $3K	2 s @ $3K	2 s @ $3K	2 s @ $3K
		4 B @ $3K	4 B @ $3K	4 B @ $3K

Legend for table: D: development platform, S: server platform, s: slave machine for server, B: Beowulf node

Travel

Attendance at one national meeting/year ($500) for two senior personnel to report on progress and results.

Other Costs

- **Materials and Supplies**: Backup media, printing costs, software, other supplies directly related to grant activities
- **Publication costs**: Estimated page charges for publication of articles and reports resulting from work performed under this grant.
- **Subawards:**
  As outlined in NSF circular instructions for preparation of the pre-proposal, budgets for collaborative institutions are included here.

Budget for UCSB (Spera) is calculated as follows:

	Year 1	Year 2	Year 3	Year 4	Year 5	TOTALS
Salaries and Benefits						
Salaries: Frank J. Spera, 1 month/year, summer	$13,213	$13,477	$13,747	$15,236	$15,541	$71,214
Benefits: @3%	$396	$404	$412	$457	$466	$2,135
Total: Salaries and benefits:	$13,609	$13,881	$14,159	$15,693	$16,007	$73,349
Other Direct Costs:						
Supplies/Travel	$3,000	$3,000	$3,000	$3,000	$3,000	
Total Direct Costs:	$16,609	$16,881	$17,159	$18,693	$19,007	$88,349
Indirect Costs (@ 46%):	$7,640	$7,765	$7,893	$8,599	$8,743	$40,640
Total UCSB request:	$24,249	$24,646	$25,052	$27,292	$27,750	$128,989

Budget for CWU (Bohrson) is calculated as follows:

	Year 1	Year 2	Year 3	Year 4	Year 5	TOTALS
Salaries and Benefits						
Salaries: Wendy Bohrson, 1 month/year, academic	$5,276	$5,487	$5,706	$5,935	$6,172	$28,576
Benefits: @30%	$1,583	$1,646	$1,712	$1,781	$1,852	$8,573
Total: Salaries and benefits:	$6,859	$7,133	$7,418	$7,716	$8,024	$37,149
Other Direct Costs:						
Supplies/Travel	$1,000	$1,000	$1,000	$1,000	$1,000	$5,000
Total Direct Costs:	$7,859	$8,133	$8,418	$8,716	$9,024	$42,149
Indirect Costs (@ 53.4%):	$4,197	$4,343	$4,495	$4,654	$4,819	$22,508
Total UCSB request:	$12,056	$12,476	$12,913	$13,370	$13,843	$64,657

- **Other**: Graduate Operating fees associated with graduate students employed under this grant. Charging fees to the grant is required. Calculated costs are indicated above with salary information.

Indirect costs

Calculated as 52% of allowable direct cost. Equipment and Graduate Operating fees are direct costs that are excluded from the Allowable Direct Costs (base) at the UW. Subaward amounts are included in calculating UW direct costs up to a maximum of $25K/award for the life of the grant.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Ghiorso	Other agencies (including NSF) to which this proposal has been/will be submitted. None

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Collaborative Research: Partial Melting of the Shallow Mantle from Thermodynamic Modeling of Minerals and Melt

Source of Support: NSF (OCE- 9977416)

Total Award Amount: $149K Total Award Period Covered: 9/1/99-8/31/02

Location of Project: University of Washington

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 3 (total)

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Phase Equilibria of Sulfur and Chlorine Bearing Phases in Magmas

Source of Support: NSF (EAR- 9980518)

Total Award Amount: $150K Total Award Period Covered: 1/1/00-12/31/01

Location of Project: University of Washington

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 2 (total)

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

ITR/IM Collaborative Group Proposal for establishing an internet server and for development of client/server software for computational geochemistry, petrology and geological fluid dynamics [this proposal]

Source of Support: NSF (ITR/IM)

Total Award Amount: 2,351K Total Award Period Covered: 7/1/01-6/30/06

Location of Project: University of Washington/Central Washington University/UC Santa Barbara

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 5 (total)

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **George Bergantz**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Multiphase modeling of solidification and the dynamics of magma chambers**

Source of Support: **NSF**

Total Award Amount: $ **80,008** Total Award Period Covered: **07/01/98 - 06/30/01**

Location of Project: **University of Washington**

Person-Months Per Year Committed to the Project. Cal: **0.66** Acad: **0.00** Sumr: **0.66**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

Investigator: Wendy A. Bohrson

Support: **XX** Current __Pending __Submission Planned in Near Future __*Transfer of Support

Project/Proposal Title: Integrating an Inductively Coupled Plasma Mass Spectrometer into the Analytical Geochemistry Curriculum at Central Washington University

Source of Support: NSF-CCLI

Total Award Amount: $100,000 **Total Award Period Covered:** 07/01/99–06/30/01

Location of Project: Central Washington University

Person-Months Per Year Committed to Project: Cal:____ Acad: 1.00* Sumr:___

*no PI salary included in this grant

Support: **XX** Current __Pending __Submission Planned in Near Future __*Transfer of Support

Project/Proposal Title: Analytical Geochemistry Laboratory at Central Washington University

Source of Support: M. J. Murdock Charitable Trust

Total Award Amount: $373,000 **Total Award Period Covered:** 01/01/00-12/31/01

Location of Project: Central Washington University

Person-Months Per Year Committed to Project: Cal:____ Acad: 1.00* Sumr:___

*no PI salary included in this grant

Support: **XX** Current __Pending __Submission Planned in Near Future __*Transfer of Support

Project/Proposal Title: Relationship between Magma Recharge and Eruption Revealed Through In Situ Geochemical Fingerprinting and Crystal Size Distribution Analysis

Source of Support: NSF-EAR

Total Award Amount: $126,305 **Total Award Period Covered:** 07/01/00-06/30/02

Location of Project: Central Washington University

Person-Months Per Year Committed to Project: Cal: Acad: 2.00 Sumr: 1.00

Support: **XX** Current __Pending __Submission Planned in Near Future __*Transfer of Support

Project/Proposal Title: Collaborative Research: Energy-Constrained Geochemical Models for Open-System Magma Bodies with Anatexis, Replenishment, Magma Mixing and Fractional Crystallization

Source of Support: NSF-EAR

Total Award Amount: $89.931 **Total Award Period Covered:** 02/01/01-01/31/03

Location of Project: Central Washington University

Person-Months Per Year Committed to Project: Cal:____ Acad: 1.00 Sumr: 1.00

Support: __Current XX Pending __Submission Planned in Near Future __*Transfer of Support

Project/Proposal Title: this proposal

Source of Support: NSF-ITR/IM

Total Award Amount: $2091279 **Total Award Period Covered:** 02/01/01-01/31/03

Location of Project: University of Washington

Person-Months Per Year Committed to Project: Cal:____ Acad: 1.00 Sumr: ___

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. Use additional pages if necessary.

Laboratory:.

Clinical:

Animal:

Computer: General access computing is available on Macintosh platforms (6), 486-level PC machines (6), low end DEC alpha workstations (3), and Pentium-based workstations (6). The PI maintains a UNIX workstations (a 500 MHz Microway Alpha) which will be used to conduct some of the research indicated in this proposal.

Office: All required space is available.

Other: _____

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate, identify the location and pertinent capabilities of each.

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual/subaward arrangements with other organizations.
Secretarial services are available from the Department of Geological Sciences in support of the proposed research.

Supplementary Documentation

List of participating personnel and their affiliations

- George Bergantz, Professor, University of Washington
- Wendy Bohrson, Assistant Professor, Central Washington University
- Mark S. Ghiorso, Professor, University of Washington
- Victor C. Kress, Research Assistant Professor, University of Washington
- Frank Spera, Professor, University of California, Santa Barbara
- Gregory Valentine, Los Alamos National Laboratory