TO: RESEARCH EQUIPMENT SUPPORT FUNDS
Vice President's Office

Research Equipment Fund Application	**Department** Bioengineering **College** Engineering **Date Submitted** 12/1/95
Application Deadline Dates **1 December**	**RES Funds Requested** $ 30,000 **Funds From Other Sources** $ 60,000 **Total Project Costs** $ 90,000

Brief statement describing the proposed grant. Justification of the grant in terms of anticipated benefits to the Department, College, and University.

Title of Request: Trace Element Analysis Facility (TEAF) (1)

Principal Investigator: Joseph D. Andrade

Campus Address: 2480 M.E.B.

Phone: 1 - 4379 **Department #:** 1 - 8528 **Mail Code:** 06409

Kenneth Horch, Associate Chair
(Print name) DEPARTMENT CHAIR

David Pershing
(Print Name) DEAN

(Signature)

(Signature)

Dean's Comments:

This form should be completed and attached as a cover page to a full statement justifying the request for funds. Supporting information may be submitted as an appendix. **Please submit the original application and two (2) copies to Larry DeVries, 2220 MEB by 12:00 noon.**

Research Equipment Support Proposal

Trace Element Analysis Facility: TEAF
J.D. Andrade, P.I.
581-4379

I. Summary:

University research equipment matching support is requested for the establishment of a Trace Element Analysis Facility (TEAF) based on an inductively coupled plasma (ICP) mass spectrometer (MS). ICP-MS is *the* state of the art trace element analytical technique, enabling 90% of the Periodic Table to be analyzed over a 5 order magnitude of range to the sub-part per billion level.

The University has no such facility. The limited elemental analysis facilities we do have are generally only suitable for a dozen or so elements and are not suitable for many of the research and teaching needs on campus. In addition, commercial laboratory analysis is generally too expensive, inconvenient, or simply inappropriate due to a lack of expertise and skill, as well as very inconvenient. The establishment of a TEAF facility on this campus would greatly enhance the University's competitiveness and would contribute significantly to both graduate and undergraduate teaching and research activities.

It will require approximately $90,000 to acquire the instrument, establish the facility, and provide the first year of operation, at which point the facility will be self supporting. $30,000 in University matching funds are requested. ARUP will provide the instrument, valued on the used equipment market at $30,000, and the remaining $30,000 will be solicited from local companies who have research, analytical, and other interests in such a facility. The University's $30,000 commitment would, of course, be contingent on the successful raising of these other funds. However, the University pledge at this time is essential to that successful fundraising effort.

The facility will be based on a Perkin Elmer ELAN 500 ICP MS. The instrument will be housed in 2473 M.E.B., together with the existing Hewlett Packard 5950B X-Ray Photoelectron Spectrometer. Space is now available in that lab as a result of the movement of some of the equipment previously housed there to the new Bio-Polymers Research Building. The manager of the existing XPS laboratory, Mr. Paul Dryden, would assume maintenance and management duties for the new TEAF facility. The faculty director/supervisor would be J.D. Andrade. Funds budgeted include a full maintenance contract with the Perkin Elmer Corporation, as well as the cost of consumables, as well as a student operator for the first full year.

It is anticipated that the instrument would be available in early 1996, and would be installed and operational by the beginning of Spring Quarter, 1996, conditional on the additional funds being secured.

II. Capabilities:

The ELAN 500 ICP MS provides semi-quantitative and quantitative elemental analysis, with isotopic analysis specificity and detection, metal and semi-conductor speciation, detection of more than 90% of all the elements in the Periodic Table, rapid multi-element coverage, low-detection limits for most elements between 0.1 and 10 PPB, high sample through put, and a wide dynamic range of 5 orders of magnitude.

Routine ICP MS laboratory applications include:

• analysis of trace elements in drinking water, ground water, surface water, waste water, and various effluents.

• clinical and biological samples, including rapid analysis of trace elements in body fluids (blood, serum, urine, milk, tears), and other appropriate analytical samples, including hair, saliva, and sweat.

• geochemical applications include determination of precious metals, refractory, transition, and rare earth elements in geological and mining samples.

• semi-conductor applications include monitoring the purity of raw materials and processed chemicals used in semi-conductor manufacturing.

• nuclear and energy applications include low detection limits for actinide and lanthanide elements, and precise isotope rations.

• petroleum and petro-chemical applications include analysis of complex, organic, and oil-based samples.

III. Existing Expertise and Capabilities:

J.D. Andrade has been working on a collaborative project with Dr. Owen Ash at ARUP, Inc., in the University of Utah Research Park, using their existing Perkin Elmer ELAN 500 and 5,000 ICP MS systems. Mr. Y.S. Hsiung, a graduate student in Materials Science and Engineering, working under Andrade's supervision, has developed a sophisticated multi-element protocol for the analysis of trace elements in urine, hair, and tears.

The tear project is partially supported by the Center for Biopolymers at Interfaces and will be the basis of a major NIH grant application early next year for the study of metalloproteins in tears.

The hair project involves a study for the Gateway Center Project to develop a personal Periodic Table exhibit/activity using rapid human hair sampling and analysis. A major proposal in support of this project will be submitted to the National Science Foundation early next year.

In addition, J. Andrade now has a planning grant from the Centers of Excellence program for a Center for Novel Applications of Fibers (CNAF). A full grant will be submitted in February to the Centers of Excellence competition, funding to be requested at about the level of about $150,000/year for three years. One of the research projects in that grant includes trace metal analysis of synthetic and natural fibers, as part of a major project involving the development of smart fibers for chemical sensing applications

IV. Budget:

First full year of operation, estimated March 1996 through February 1997.

Equipment: Used Perkin Elmer ELAN 500, available from ARUP, Inc.,:	$30,000*
Annual Service Contract:	$20,000
Operating Consumables:	$15,000
Graduate Student Operator:	$15,000
Moving & Installation Costs:	$5,000
Lab Director/Engineer (part time): Paul Dryden:	$5,000
First Year Total Budget:	$90,000

* Original acquisition cost of this instrument, upgrades, and modifications are approximately $200,000.

V. Sources of Funds:

ARUP, Inc. is considering making a full donation of the instrument to the University of Utah, assuming the value on the used equipment market is not in excess of $30,000. The University of Utah contribution is requested at $30,000. Local industries and/or foundations will provide $30,000. These funds may come in smaller donations from a group of industries, probably including Geneva, Kennecott, and Micron.

The $90,000 budget, based on a 1-1-1 match, would provide the instrument, its installation, and it's full servicing and operation for a 12 month period. At the conclusion of that period, approximately, March, 1997, the facility will be self-supporting.

VI. Sources of Ongoing Funds:

The 15 industrial members of the Center for Biopolymers at Interfaces, which have made extensive use of surface analytical facilities on campus, have often indicated their interest in trace bulk elemental analysis capabilities. They have had to be turned away because the appropriate facilities were not available.

CNAF is expected to require about $10,000/year in elemental analysis services. Other on campus projects on a fee for service basis would provide an additional $10,000.

The Gateway Center and it's Personal Periodic Table exhibit, would raise and make available another $10,000 per year for 3 to 5 years towards the development of that exhibit.

We anticipate that public agencies and services would be interested in developing joint projects utilizing the facilities -- annual estimate, $10,000. We are confident that a number of environmental groups, probably through student initiated and originated undergraduate and high school projects would also make extensive use of the facility at another cost of $10,000.

We are fully aware that the University must not compete with private laboratories in providing analytical services. The services provided would be for joint collaborative research and would involve students and their education as much as possible. Samples and projects would only be accepted if they contribute to the educational and research mission and activities of the University.

Assuming an annual operating cost of $60,000, about $5,000/month, corresponds to an hourly instrument charge of about $50. This instrument, with the appropriate preparation of sample, can run literally dozens of samples/hour, making the analysis relatively inexpensive for the University's projects and activities.

VI. Urgency:

This is a unique opportunity for the University of Utah to rapidly develop and establish a state of the art elemental analysis facility which will rapidly and dramatically impact research and education programs throughout the campus. We are fortunate in that space is available and identified, that a faculty director/supervisor is in place with the requisite experience and interest to manage such a facility, that an existing staff engineer is available and can be assigned part time to maintaining and managing the facility, and that a highly trained student operator is available and can train the appropriate users of the facility and provide sample analysis for those who wish such services.

In order to raise the funds to make this facility a reality, it is important that the University commit funds as soon as possible, thereby matching the expected ARUP commitment and enabling the third $30,000 component to be raised from local sources as quickly as possible.

For further information contact J.D. Andrade, Departments of Bioengineering and Materials Science, 581-4379.

FP8a

OPTIMIZATION OF ICP-MS FOR QUANTITATIVE MULTI-ELEMENT ANALYSIS OF BIOLOGICAL SPECIMENS.

Chiung-Sheng Hsiung, Joseph D. Andrade, Department of Materials Science & Engineering, University of Utah, Salt Lake City, UT 84112, and K. Owen Ash, ARUP, Chipeta Way, Salt Lake City, UT 84108

The simultaneous determination of elements in biological specimens is increasingly crucial to the operation of a clinical chemistry laboratory. To accomplish this goal demands a versatile and reliable technique. Since the first launch of commercial ICP-MS instrumentation in 1984, this hybrid technique has emerged as a promising method of rapid multi-element analysis with superior detection limits. Yet, in a number of applications of biological specimens, the quadrupole-type ICP-MS suffers both spectroscopic and non-spectroscopic interferences. There are a number of strategies for reducing interferences and enhancing signals. Addition of an organic solvent to the analyzed samples is an easy, low-cost, and effective method.

Using a Perkin-Elmer Sciex Elan 5000 ICP-MS, equipped with pneumatic nebulizer, platinum sampler and skimmer cones, and argon plasma, we evaluated the feasibility of ethanol chemical modification using a systematic optimization procedure. Moreover, we also investigated the direct multi-element analysis of biological samples while varying two instrument parameters, nebulizer flow rate and rf power.

Maximum optimum signals, for a wide range of elements, were a function of atomic mass. The higher the mass of the element, the lower the rf power for maximum intensity. At a particular power, the optimum nebulizer flow rate for each element shifted regularly as the atomic mass changed. However, the power patterns and the nebulizer flow-rate patterns permitted an optimization of ICP-MS parameters for simultaneous analysis of multiple elements.

The power patterns, comparing optimum signals and interferences at different powers (1.0 kW-1.4 kW), suggested that the medium power range may be the better candidate for multi-element analysis. By analyzing the patterns of signals at a range of varied nebulizer flows, the nebulizer flow rate can be optimized using a multiple element standard covering wide atomic mass. We confirmed that ethanol chemical modification increased the optimized power and decreased the optimized nebulizer flow rate. The ICP-MS parameters should be optimized individually under ethanol conditions other than those optimized for non-ethanol samples. Otherwise, the effects of ethanol chemical modification may be obscured due to improper instrument operating parameters. Analyses of analytes with low ionization efficiency or heavy interferences were improved by ethanol due to signal enhancements and reduction of polyatomic overlap and matrix effects. These investigations provide further support for simultaneous multi-element analysis of biological specimens by ICP-MS.

Dcct

ARUP® Laboratories

500 Chipeta Way • Salt Lake City, Utah 84108 • (801) 583-2787 • (800) 242-2787 • Fax (801) 583-2712

January 25, 1996

Joseph D. Andrade, Ph.D.
Bioengineering Department
College of Engineering
University of Utah
2480 MEB
Salt Lake City, UT 84112

Dear Dr. Andrade:

I was pleased to learn that your request for funding to establish the *T*race *E*lement *A*nalysis *F*acility at the University of Utah has been favorably received and partially funded. The purpose of this letter is to confirm the agreement of ARUP to donate the Perkin-Elmer Elan 500 ICP Mass Spec to this effort. I understand this analyzer will be located at 2473 MEB and use for research. The current fair market value of this equipment ,which was purchased in 1989 for approximately $250,000, is $30,000. We are pleased to support the research relating to trace elements and look forward to the advances that will be forthcoming.

As we discussed, the instrument needs to be moved as soon as possible because of the renovations taking place at ARUP .

Sincerely,

K. Owen Ash, Ph.D.
Executive Vice President/COO
Medical Director, Trace Elements Laboratory

KOA:cv

cc: John M. Matsen, M.D.
Carl R. Kjeldsberg, M.D.
ARUP Executive Committee
Ron Schmitt
Harold Crockett

February 5, 1996

TEAF

(1)

Dr. K. Owen Ash
ARUP Laboratories
500 Chipeta Way
Salt Lake City, Utah 84108

Dear Owen:

Thank you so much for your letter of January 25, 1996 informing me that ARUP Labs is donating the ELAN 500 ICP Mass Spec system. This generous equipment donation will enable us to establish the trace element analysis facility and to provide enhanced trace element capability for the University of Utah. It will also enable us to significantly enhance and accelerate our own efforts dealing with trace element studies and non-invasively derived biological tissues and materials.

I know that you are desirous of having the instrument moved as soon as possible. I have asked Mr. Y-H Hsiung and Mr. Paul Dryden to work as rapidly as they can, ~~together with the Perkin Elmer people, and with the University moving people~~ to facilitate the move as quickly as possible.

Thanks again.

Sincerely,

J.D. Andrade, Ph.D.
Professor

cc: P. Dryden
R. Koehn, V.P.
D. Pershing, Dean

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