CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Participation in the American Geophysical Union Spring 2001 Meeting 20.01402.158

DATE/PLACE: May 30–June 2, 2001/Boston, Massachusetts

AUTHOR: John L. Russell

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PERSONS PRESENT: The author and approximately 2800 meeting registrants.

BACKGROUND AND PURPOSE OF TRIP:

The major purpose of this trip was recruitment of candidates for the Center for Nuclear Waste Regulatory Analyses (CNWRA) open job positions in the geosciences and related engineering disciplines. Poster sessions and exhibits at the meeting were examined to obtain technical and programmatic information relevant to the CNWRA support of the U.S. Nuclear Regulatory Commission (NRC) high-level nuclear waste (HLW) regulatory programs. This information will be used by the author in his activities for the NRC contracts and it was transmitted to appropriate CNWRA employees for their use.

SUMMARY OF ACTIVITIES:

During this trip, the author used the services of the AGU Job Center to post seven open job positions of the CNWRA and to display information on Southwest Research Institute and the CNWRA. The Job Center maintained a communication system to allow transfer of messages between employers and persons seeking employment. Approximately 2800 individuals registered at the AGU meeting of which only 45 filed resumes at the Job Center. All of these resumes were reviewed by the author and best qualified individuals were interviewed. The CNWRA employment opportunities were discussed with the interviewees and their interests and qualifications assessed. Dr. Russell also participated in the American Geophysical Union (AGU) meeting session on "Where are the jobs? Career Choices for Students in the Geosciences" where he gave an invited presentation entitled, "Employment of Geoscientists in the Private Sector." The presentation abstract and viewgraphs are attached. Attendees were primarily geosciences graduate students and university advisors. This session was followed by a reception ("mixer") allowing informal interactions with individuals seeking employment and with university counselors. Most of the Dr. Russell's time at the meeting (2.5 days) was consumed by recruitment activities.

Information obtained from exhibitors was primarily related to imagery and other data available from the National Aeronautics and Space Administration (NASA) and tools for processing the data. The author obtained literature and compact disks containing information on the Earth Observing System Data and Information System (EOSDIS) data available through the Distributed Active Archive Center (DAAG) Alliance organizations such as the NASA Langley Atmospheric Sciences Data Center, the Goddard Space

Flight Center, and the Jet Propulsion Laboratory. Available data includes satellite-acquired data of land, atmospheric, and oceanic conditions.

Selected poster presentations were also examined. One of particular interest to the author was entitled, "2-D Numerical Simulation of Eruption Clouds: Effects of Turbulent Mixing Between Eruption Cloud and Air" (Poster V41A-10) by Yujiro Suzaki and others of the University of Tokyo. The poster was supported by running simulations using a portable computer. Eruption clouds in the immediate vicinity (within 10 kilometers) of the volcanic vent could be modeled, but not more extensive ash fall dispersal. The model could be varied to simulate primarily ascending eruption clouds to collapsing clouds resulting in nuee ardente phenomena. A copy of this poster presentation abstract is attached. One of the meeting themes was "Science for Decision Making". Meeting presentations directed toward this theme were not particularly useful or enlightening with regard to issues being addressed by the CNWRA and the NRC.

The author participated in numerous informal meetings with meeting participants. These meetings were valuable sources of information on advances and trends in the earth sciences and engineering and provided important background for performing technical, programmatic, and management activities.

CONCLUSIONS:

My overall impressions and conclusions regarding recruitment of geoscientists and engineers in associated disciplines are as follows.

- A very small number of individuals at the AGU meeting were seriously pursuing employment as witnessed by the low number of individuals (45) that took advantage of the AGU Job Center. Immigration/naturalization issues would need to be addressed to employ over one-half of the persons submitting resumes.

- Academic advisors in the United States geoscience Ph.D.-producing programs have increasingly less industry experience due to retirements and graduates are commonly discouraged from obtaining employment in private industry and government, but instead advisors promote postdoctoral fellowships and academic teaching/research positions.

- Funding for fellowships is sufficiently high to support a large number of recent Ph.D. graduates. The average age of a Ph.D. geoscientist entering the job market is 30 years old.

- Retirement of the "older generation" of geoscientists and moderate increase in petroleum industry employment appears to be creating demand for new employees with advanced degrees that is outpacing supply of qualified and interested individuals. The American Geological Institute information supports this impression.

- Demand and supply for geoscientists is cyclic with supply now slowly decreasing below demand.

- More than one-half of individuals with geosciences degrees are not performing geosciences work. An exception to these generalizations may be in the disciplines of hydrology and hydrogeology. Many students entered these disciplines as a result of recent demand and by

promotion of these programs by universities. The supply may now have increased sufficiently to exceed overall demand, although individuals with adequate background in a combination of field work, laboratory analyses, and computational modeling compose a very small component of all hydrologists. It is concluded that competition for qualified staff is likely to increase in the near future.

PROBLEMS ENCOUNTERED:

None

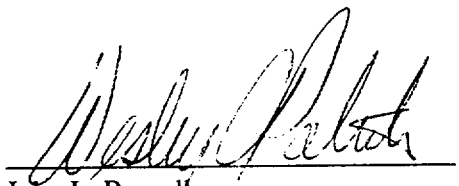
PENDING ACTIONS:

Resumes and completed interview review forms for four individuals have been transmitted to the CNWRA in San Antonio and should be reviewed by CNWRA management staff to determine whether sufficient interest exists to request full applications for Institute employment. The completed interview forms also suggest contacting the academic departments of several Fall 2001 prospective graduates to obtain additional information on the individuals, such as reasonableness of anticipated graduation dates. Four additional resumes were obtained from the AGU Job Center files, but the individuals were not available for interviews. These resumes, which were also transmitted to the CNWRA in San Antonio, should be reviewed to determine if Institute applications or more information should be requested.

RECOMMENDATIONS:

The CNWRA Participation in the future AGU Spring and Fall meetings can continue to provide important employee recruitment opportunities, enhancement of peer awareness of the CNWRA and its reputation, and acquisition of information beneficial to both the CNWRA and the NRC.

SIGNATURES:



John L. Russell
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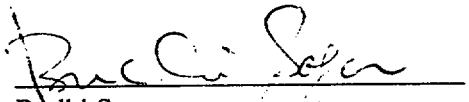

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6/14/2001
Date

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In this NSF-funded project we will adapt problem-based learning (PBL) and other inquiry-based approaches to create an integrated science and education methods curriculum ("science semester") for elementary teacher education majors. Our goal is to foster integrated understandings of science and pedagogy that future elementary teachers need to effectively use inquiry-based approaches in their classrooms. This project responds to calls to improve science education for all students by making preservice teachers' experiences in undergraduate science courses more consistent with reforms at the K-12 level.

The involved faculty teach three science courses (biology, earth science, physical science) and an elementary science education methods course that are degree requirements for elementary teacher education majors. Presently, students take the courses in variable sequences and at widely scattered times. Too many students fail to appreciate the value of science courses to their future careers as teachers, and when they reach the methods course in the junior year they often retain little of the science content studied earlier. These episodic encounters with science make it difficult for students to learn the content, and to translate their understandings of science into effective, inquiry-based teaching strategies.

To encourage integrated understandings of science concepts and pedagogy we will coordinate the science and methods courses in a junior-year science semester. Traditional subject matter boundaries will be crossed to stress shared themes that teachers must understand to teach standards-based elementary science. We will adapt exemplary approaches that support both learning science and learning how to teach science. Students will work collaboratively on multidisciplinary PBL activities that place science concepts in authentic contexts and build learning skills. "Lecture" meetings will be large group active learning sessions that help students understand difficult concepts, make connections between class activities, and launch and wrap-up PBL problems. Labs will include activities from elementary science kits as launching points for in-depth investigations that demonstrate the continuity of science concepts and pedagogies across age levels. In the methods course, students will critically explore the theory and practice of elementary science teaching, drawing on their shared experiences of inquiry learning in the science courses. Field placements in elementary classrooms will allow students to ground their studies of science and pedagogy in actual practice.

ED52B CC: 205 Friday 1515h

Where are the Jobs? Career Choices for Students in the Geosciences

Presiding: A C Staudt, Harvard Univ.; J Giesler, AGU

ED52B-01 1515h INVITED

Earth and Space Science PhD Employment Trends

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A recent report by the American Geophysical Union and the American Geological Institute, "Earth and Space Science PhDs, Class of 1999" looked at employment trends of recent graduates. Demographically, our graduates are, as a population, older than those who graduated in any other physical science. While almost one-third of graduates are employed in a different subfield than that of their degree, more than 80% of Earth and space science PhDs secure initial employment in the geosciences. Graduates are finding employment in less than 6 months and the unemployment rate has dropped significantly below that of two years ago. The PhD classes of 1996, 1997, and 1998 had 50% of their graduates taking postdoctoral appointments. In 1999, this declined to only 38% postdocs with an increase in permanent employment in both the education and government sectors. Perception of the job market is improving as well. Respondents are considerably happier than they were in 1996.

ED52B-02 1530h INVITED

The Consulting Universe: Not One-Size-Fits-All

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As doctoral students approach graduation, they often consider opportunities to apply their analytical skills in consulting companies. This path can provide intellectual challenges and opportunities for creative thinking, and may be more attainable, secure and lucrative than an academic or research career. While there are some common threads which characterize the fabric of consulting, there are many kinds of consulting firms with varying implications for subject matter, work atmosphere and lifestyle.

I present categories which may be used to distinguish among consulting firms, and to help graduating students determine which firms and positions they would find appropriate and appealing. I address issues of lifestyle choices, remuneration and incentive packages, and industry trends which affect the consulting work environment. Using my own experience as an example, I discuss how to identify commercially-relevant skills and present them to firms which may be unused to hiring highly-skilled candidates with non-traditional backgrounds.

URL: http://www.tca-us.com

ED52B-03 1545h

Career Opportunities for Geoscientists in the Petroleum Service Sector: A Perspective from an Industrial Research Lab

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The petroleum service sector provides client oil and gas companies with the measurements and services necessary to find and extract hydrocarbons from subsurface reservoirs. These services encompass a range of geophysical and petrophysical measurements ranging from the well bore to seismic scale. As the easily extracted oil and gas reserves are being depleted, new technologies allow geoscientists to tap reservoirs that were previously economically unattractive. Much of the industrial research that leads to these new technologies stems not from the oil companies themselves, but from the oilfield service companies. Schlumberger has traditionally been a leader of developing new technology for hydrocarbon exploitation, exemplified by its strong commitment to supporting research and development through the ups and downs in the oil industry. As a recent hire in a petroleum industry research lab, I will provide the perspective of a fairly recent graduate on careers in the petroleum industry. Specific attention will be given to significant industry trends that will shape the careers of petroleum geoscientists in the future and the skills and attitudes necessary to be successful.

ED52B-04 1600h

Postdoctoral Opportunities and Career Options

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Following the completion of a Ph.D. degree, in the sciences a postdoctoral appointment has traditionally been a key step in career development to expand the student's background and broaden their perspective. The postdoctoral appointment often is almost a requirement to obtain some positions in academia and government laboratories. In addition, postdoctoral positions in industry are becoming more common and offer an opportunity to explore a field without making a long-term commitment.

We describe the nature of a postdoctoral appointment and discuss the advantages and disadvantages of the recent Ph.D. taking a postdoctoral position. We comment on the role such positions play in university, government and the corporate research.

Finally, we describe some of the national postdoctoral opportunities that exist including large programs offered by the National Research Council through Federal laboratories including those of NASA, NOAA, EPA, and the Department of Defense. Exciting new interdisciplinary opportunities such as fellowships at the NASA Astrobiology Institute are summarized, as are international opportunities such as the von Humboldt fellowships in Germany.

URL: http://nationalacademies.org/

ED52B-05 1615h INVITED

Future Careers in Geoscience

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A new generation of Geoscientists are abandoning the traditional pathways of oil exploration and academic research to pursue careers in public policy, international affairs, business, education and diplomacy. They are using their backgrounds in Geoscience to address challenging, multi-disciplinary problems of societal concern. To prepare for such careers, students are developing a broad understanding of science and a basic literacy in economics, international affairs, and policy-making.

ED52B-06 1630h

Employment of Geoscientists in the Private Sector

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In the private sector, major employers of geoscientists engage in diverse activities ranging from resource exploration and extraction, assessment of geologic hazards, and determination of environmental impacts. These firms actively recruit, from the breadth of geoscience disciplines, technically qualified individuals with the ability to make pragmatic decisions in the context of multidisciplinary teams that commonly include non-scientists. Moreover, they expect applicants to communicate effectively verbally and in writing, as well as demonstrate skills and experience in integrating field investigations, conducting laboratory studies, and accomplishing computer modeling. These applicants should be capable of simultaneously working in multiple projects which are rapidly evolving. Successful recruiting and employment requires interactions between the job applicant and potential employer conducted with honesty and integrity. Resumes and associated transmittal letters should be directed to specific employers based on the applicant's review of information on the firm from the Internet and other sources. "Shotgun" or blanket approaches are seldom productive. Participation in pertinent professional societies, internships, and summer employment can provide valuable experiences and opportunities for networking with potential employers.

ED52B-07 1645h INVITED

Career Preparation: An Often Omitted Element of the Advisor-Graduate Student Relationship

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Most graduate research advisors care about the education of their graduate students. However, they often define "graduate education" so narrowly that it consists only of solving a research problem. This narrow definition is consistent with their principal goal as geoscientists, to understand the Earth better, and with the reward system typical of research universities, with its emphasis on research. As a result, most advisors usually well prepare students to be researchers in research universities. Research, however, is only part of a faculty member's duties. Commonly omitted is mentoring in the teaching and service duties of a faculty member. Students interested in teaching, in positions in other academic institutions, or in careers outside of academia may be perceived as questioning the advisors' career values and may not be encouraged in these interests.

Graduate students should take an active role in their education. In addition to seeking information on career preparation from the campus career center and teaching center and from books, newsmagazines, newspapers, and seminars, students should also seek mentors who have demonstrated an interest in what the student is interested in: teaching and service, as well as research, or in careers outside academia. These mentors may be the students' committee members, other faculty members, or other professional geoscientists. With a broad base of information and some personal decisions, students will have a rationale for exploring careers.

The questions students ask can now be more specific: How do they gain the requisite breadth in knowledge and the beneficial skills, beyond the depth of the research experience, and how do they gain opportunities to practice these skills? In short, how can they experience, and preferably practice, what professional geoscientists do in particular careers? If necessary, graduate students can work together to answer these questions by inviting experts to offer workshops in the

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inferred beneath Hawaii and the ocean ridges. We have attempted to model this process by studying the entrainment, transport, and deposition of particles in a vertical stack of sills (Plexiglas tanks) connected by resistive conduits (check valves), over-pressured from the base, and open at the top. The system is about two meters in height with water and oil as fluids and particles with Reynolds numbers that closely approximate actual crystals. Particles of a range of sizes are placed in the lower input pipe and carried by the fluid. The base state is a sustained over-pressure that permits a steady effusive flux throughout the system. To establish this state, the conduit resistance (check valve tension) must be overcome. As the critical moment of flow is approached, the system exudes a high-pitched vibration emanating from the check valves which may be akin to the well-known harmonic tremor of active volcanic systems. We also employ a time-series of over-pressure pulses, designed to mimic eruptive episodes of volcanism as estimated by Simkin (An. Rev. EPS, 1993). We observe many aspects of the process described above: particle deposition on sill floors forming beds around the conduits, cumulate piles disrupted by flux associated with over-pressure pulses, and flushing of choked conduits. The largest particle concentrations are in the basal sill and particle concentration decreases upward in the system. The magnitude and frequency of over-pressure pulses controls the ability of the system to erupt particles. Cumulate deposition is restricted to the conduit areas in each sill unless the flow is made to spread throughout the sill by horizontally separating the inflow and outflow conduits. Spreading flows, which form laterally graded cumulates, are also achieved by simulating outward lateral propagation of the sill via side-wall taps. The overall dynamic behavior of the system as understood so far suggests that the time history of the cumulate eruptive flux, as measured by crystal size, abundance, and composition, may carry enough information to critically evaluate the deep plumbing and dynamics of many magmatic-volcanic systems.

V41A-08 0830h POSTER

Traces of pyroclastic flows and lahars detected with satellite synthetic aperture radars

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Rapid detection of traces of pyroclastic flow and lahar is important for disaster prevention and mitigation in a volcanic area. For this purpose, we developed some methods by using the L-band synthetic aperture radar (SAR) on JERS-1 satellite. The following three methods were tested and evaluated against actual volcanic events in Mt. Unzen 1991-1995 eruption in Japan: a) Back-scatter analysis, b) coherence analysis, and c) SAR interferometry. The method b) with coherence analysis showed the highest capability of detection of pyroclastic flows and lahars in the following two manners: Case 1) A pair of SAR images taken both before and after the event gives particularly low coherence over the trace of the flows. Case 2) A pair of SAR images taken just after the event gives particularly high coherence over the trace of the flows than other slopes. The change of land surface status realizes the Case 1 with low coherence, whereas the bare surface of the sediments contributes to the Case 2 with high coherence.

V41A-09 0830h POSTER

Petrology of the 1995/2000 Magma of Copahue, Argentina

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Phreatomagmatic eruptions of Copahue in July/August,1995 and July/August 2000 produced mixed juvenile clasts, silica-rich debris from the hydrothermal system, and magmatic scoria with 88 percent SiO2. These high-SiO2 clasts carry an as yet unidentified (crystobalite?), euhedral silica phase in great abundance, which is riddled with tan, primary melt inclusions. The mixed clasts have bands of mafic material with small euhedral olivine, clinopyroxene, and plagioclase that are mixed with an intermediate magma with coarser, resorbed phenocrysts of olivine, plagioclase, clino- and ortho- pyroxene, and rare occurrences of the silica phase. These ejecta are intimate mixtures of a relatively felsic magma similar to Pleistocene Copahue lavas and a mafic basaltic andesite, with minor contributions of a magma contaminated with silica-rich hydrothermal wallrock material. Two-pyroxene geothermometry indicates crystallization temperatures of 1020 - 1045 C. Glass inclusions (59-63 percent SiO2) in plagioclase and olivine crystals yield very low volatile contents in the melt (0.4-1.5 percent H2O). The 1995/2000 magmas resided at shallow level and degassed into the active volcano-hydrothermal system which discharges acid fluids into the Copahue crater lake and hot springs. More mafic magma intruded this shallow batch and the mixture rose into the hydrothermal system and assimilated siliceous wall rock. A Ti-diffusion profile in a magnetite crystal suggests that the period between magma mixing and eruption was on the order of 4-10 weeks, and the temperature difference between resident and intruding magma was about 50-60 oC.

V41A-10 0830h POSTER

2-D Numerical Simulation of Eruption Clouds : Effects of Turbulent Mixing between Eruption Cloud and Air

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Mixing of eruption cloud and air is one of the most important processes for eruption cloud dynamics. The critical condition of eruption types (eruption column or pyroclastic flow) depends on efficiency of mixing of eruption cloud and the ambient air. However, in most of the previous models (e.g., Sparks,1986; Woods, 1988), the rate of mixing between cloud and air is taken into account by introducing empirical parameters such as entrainment coefficient or turbulent diffusion coefficient. We developed a numerical model of 2-D (axisymmetrical) eruption columns in order to simulate the turbulent mixing between eruption column and air.

We calculated the motion of an eruption column from a circular vent on the flat surface of the earth. Supposing that relative velocity of gas and ash particles is sufficiently small, we can treat eruption cloud as a single gas. Equation of state (EOS) for the mixture of the magmatic component (i.e. volcanic gas plus pyroclasts) and air can be expressed by EOS for an ideal gas, because volume fraction of the gas phase is very large. The density change as a function of mixing ratio between air and the magmatic component has a strong non-linear feature, because the density of the mixture drastically decreases as entrained air expands by heating. This non-linear feature can be reproduced by changing the gas constant and the ratio of specific heat in EOS for ideal gases; the molecular weight increases and the ratio of specific heat approaches 1 as the magmatic component increases. It is assumed that the dynamics of eruption column follows the Euler equation, so that no viscous effect except for the numerical viscosity is taken into account. Roe scheme (a general TVD scheme for compressible flow) is used in order to simulate the generation of shock waves inside and around the eruption column.

The results show that many vortexes are generated around the boundary between eruption cloud and air, which results in violent mixing. When the size of each mesh is less than 20 m, the overall structure inside the eruption column (e.g., the distributions of magmatic component, pressure etc.) does not depend on the mesh size. It is suggested that the global features of turbulent mixing can be successfully simulated by the present method if a fine mesh size (5 m) is applied. The results capture the essential feature of the eruption column dynamics; the eruption column becomes buoyant by mixing of high-temprature pyroclasts and air. Some typical features of the high-pressure and high-velocity jet such as complex shock waves near the vent are also simulated. Quantitative comparison with the results of the 1-D models is in progress.

Reference

R. S. J. Sparks, Bull.Volcanol.,48,3-15,1986.

A. W. Woods, Bull.Volcanol.,50,169-193,1988.

V41A-11 0830h POSTER

Testing Links Between Resonant Core Nutations and Mantle Plume Volcanism

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Rocks unusually rich in Mg erupt from particularly hot mantle sources, consistent with mantle plumes. We compile a record of the ages of high-Mg igneous rocks, including komatiites and picrites, spanning 3.8 billion years of Earth history. We produce a time-series from this record that presumably reflects mantle plume events. Spectral energies in this record are concentrated at periods of approximately 273 My and 34 My. These periods are analogous to the length of the cosmic year and the frequency of cometary and meteorite impacts, respectively. Therefore we infer that mantle plume volcanism responds to an exogenic process.

However, others have suggested that resonance between free core nutations and those forced by luni-solar torques drives mantle plumes (Williams 1994; Greff-Lefftz and Legros 1999). It is not possible at the present time to complete viable spectral analysis of a time-series of resonant core nutations, because the timing of resonant events are associated with a huge uncertainty (+/- 100 My or more). Admittedly, there is an interesting similarity between the numbers of predicted resonant events and the numbers of mantle plume events through Earth history. Further, this hypothesis is compatible with a lull in mantle plume volcanism between about 1750 and 1250 Ma, which may not be consistent with a cometary impact model. (Very few impact events have been found for this time period, but the record is still very sparse.) If we use the plume time-series to "tune" the record of resonant nutations, then we conclude that the Earth's deceleration rate has varied considerably through geologic time. Particularly significant solar torques may have been associated with mantle plume events for which there are no known cometary impacts. Further tests of this model require that the Earth's deceleration rate through time be better constained. Until this is accomplished, we continue to advocate an exogenic drive to mantle plume volcanism.

V41A-12 0830h POSTER

In-Situ Trace Element Analysis of Volcanic Glass by 213 nm Laser Ablation Microprobe-ICPMS: Calibration Strategies and Use of He as an Ablation Gas

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Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) is a useful tool for in-situ trace element analysis of solid samples on the micron scale. Recent development of the 213 nm (quintupled) Nd-YAG laser has significantly improved upon the more widely used 266 nm laser. We focus here on analysis of volcanic glasses with a Merchantek/New Wave 213 nm LA system, coupled with a VG/TJA PlasmaQuad ExCell ICP-MS. Pillow-rim volcanic glasses (e.g., mid-ocean ridge basalts) generally provide optimum conditions, due to the large size and homogeneity of glass chips. With 100μ spots, detection limits are < 100 ppb for most high mass elements and < 1 ppb for U, Th and Ta. Spot-to-spot precision is better than 3% RSD for Sc, V, Cr, Co, Cu, Zn, Sr, Y, Zr, Nb, Hf, REE, Ba and 5-10% for Ta, Th, Pb (at < 1ppm) and U (< 100 ppb). Accuracy is a greater challenge; typical procedures involve internal standardization to Ca and external standardization to NIST 612. We find errors in absolute abundance decrease from 5-20% to <3% by using both ^{43}Ca and ^{47}Ti as internal standards (optimized for each analyte), and USGS basalt glasses BHVO-2G, BIR-2G and BCR-2G as external standards (calibrations generally R > 0.999). With this technique, agreement with solution ICP-MS is generally within the laser precision.

Volcanic glass shards from ash layers present a greater challenge due to their smaller size. Although LA spot sizes as small as 5μ are possible, data quality generally suffers below 50μ. In order to improve ablation characteristics at small spot sizes, we have explored the use of He instead of Ar as the ablation gas. As reported by others, He dramatically reduces the fall-out of ejecta on the sample surface. This leads to a 2- to 4- fold increase in the total ^{139}La signal over 60 sec. in our system for spots < 50μ in NIST 612, running ~0.5 l/min of 100% He into the sample cell. With time, however, the He signal decays and the Ar signal grows until they converge after 550-800 pulses into the sample. This behavior may result partly because less ejecta is produced as the pit deepens. Our initial

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EMPLOYMENT OF GEOSCIENTISTS IN THE PRIVATE SECTOR

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6/1/01

GEOSCIENCES IN THE PRIVATE SECTOR

- **EXPLORATION AND EXTRACTIVE INDUSTRIES**
  - PETROLEUM
  - MINERALS
  - CONSTRUCTION MATERIALS
- **ENVIRONMENTAL INDUSTRIES**
  - WATER RESOURCES
  - IDENTIFICATION AND CLEANUP OF CONTAMINATION
- **NATURAL HAZARDS**
  - FLOODING
  - MASS WASTING
  - SEISMIC
  - VOLCANIC

21ST CENTURY CHANGES

- ENVIRONMENTAL INDUSTRIES MOVING FROM INVESTIGATIONS TO REMEDIATION ("MOVING DIRT")
- OUTSOURCING BY
  - LARGE CORPORATIONS
  - FEDERAL GOVERNMENT
- URBAN GROWTH REQUIRING LAND USE PLANNING
- INCREASING DEMAND ON WATER SUPPLIES
- RENEWED INTEREST IN SITING WASTE DISPOSAL AND ENERGY PRODUCTION FACILITIES
- ADDITIONAL INTEREST IN ENERGY EXPLORATION AND PRODUCTION

EMPLOYEE ATTRIBUTES GENERALLY REQUIRED BY THE PRIVATE SECTOR

- TECHNICALLY COMPETENT
- ADVANCED GEOSCIENCE DEGREE
- EFFECTIVE COMMUNICATOR
- MULTIDISCIPLINARY TEAM PLAYER
- PRACTICAL/PRAGMATIC
- PROBLEM SOLVER
- INQUISITIVE
- FLEXIBLE
- CAPABLE OF MULTI-TASKING

CURRENT DEMAND FOR EXPERTISE

- EXPERTISE IS DESIRED IN CONDUCTING AND INTEGRATING:
  - FIELD INVESTIGATIONS
  - LABORATORY STUDIES AND ANALYSES
  - COMPUTER MODELING

PREPARING FOR EMPLOYMENT IN THE PRIVATE SECTOR

- ACADEMIC ACHIEVEMENT
- EXCELLENT VERBAL AND WRITTEN COMMUNICATION SKILLS
- EVIDENCE OF APPLICABLE AND INNOVATIVE INVESTIGATIVE SKILLS
- INTERNSHIPS
- SUMMER JOBS
- NETWORKING
  - LOCAL PROFESSIONAL SOCIETIES
  - NATIONAL PROFESSIONAL SOCIETIES

TO BE A SUCCESSFUL JOB APPLICANT

- PLAN YOUR APPROACH
- USE YOUR NETWORK
- OBTAIN BACKGROUND ON POTENTIAL EMPLOYERS
- TAILOR RESUMES AND TRANSMITTAL LETTERS
- PREPARE FOR INTERVIEWS
- BE HONEST
- FOLLOW UP

SUMMARY

- EMPLOYMENT OPPORTUNITIES EXIST IN PRIVATE INDUSTRY
- THE JOB MARKET IS CHANGING
- APPROPRIATE ACADEMIC QUALIFICATIONS ARE REQUIRED
- THE JOB SEARCH MUST BE WELL PLANNNED
- RECRUITER AND POTENTIAL EMPLOYEE MUST BE STRAIGHTFORWARD AND HONEST