



State of California
 Commission on Teacher Credentialing
 Certification Division
 1900 Capitol Avenue
 Sacramento, CA 95811-4213

Email: credentials@ctc.ca.gov
 Website: www.ctc.ca.gov

RECOMMENDATION FOR A PERSON OF EMINENCE

The governing board of the Santa Rosa City Schools

school district, by resolution adopted on _____, in accordance with
Date

California Education Code, Section 44262, recommends the issuance of a credential based on eminence to
Adrienne Larocque, PhD

Candidate's Name

in the subject of Chemistry

Eminence was determined on the basis of: advanced degrees (MSc and PhD) with specialization in
geochemistry; distinguished employment (prestigious postdoctoral fellowship at Los Alamos
National Lab and University of Manitoba); landmark research contributions to her field; renowned
authorship in international journals; high level of expertise in a variety of chemical analytical methods;
letters from eminent scientists acknowledging Dr. Larocque's ability beyond the norm; opinions of
representatives of international organizations of her extraordinary ability worthy of distinction; receipt
of international Hawley Medal, evidence of significant contributions; evidence of successful science
instruction at the secondary and post-secondary level, including undergraduate and graduate
courses in Geochemistry.

The above named applicant will be employed in this school district to serve as a
Science teacher at the secondary level.
Teacher (include subject), Administrator, Other *Elementary or Secondary*

Signature of District Superintendent: _____

Date: _____ Telephone Number: _____

Email Address: _____

The individual is recognized as eminent beyond the boundaries of his or her community, has demonstrably advanced his or her field, and has been acknowledged by his or her peers beyond the norm for others in the specific endeavor.

1. The following affirmations of eminence are attached:
Renowned authorship in international journals and special publications; letters from eminent scientists attesting to Dr. Larocque's high level of expertise, extraordinary ability worthy of distinction, and significant contributions; international award for research; research grants; requests to review manuscripts submitted to journals and grant proposals submitted to granting agencies; international invited presentations; early promotion to Associate Professor

2. The following documentation of achievement (advanced degrees, distinguished employment, publications, other) are attached:
MSc and PhD transcripts; Prestigious postdoctoral fellowship at Los Alamos National Lab; promotion to Associate Professor at University of Manitoba; numerous publications in international journals documenting research substantially contributing to her field; awarded the Hawley Medal by the Mineralogical Association of Canada for excellence in research;

3. Please provide an explanation of the individual's effectiveness as a teacher:
In addition to highly successful teaching at the university level in Canada and at Santa Rosa Junior College, Dr. Larocque has been teaching Earth Science to high school freshmen at 2 schools in Santa Rosa. Letters from parents, students, and teaching colleagues and observations and evaluations by different administrators attest to her ability to engage, inspire, and challenge her students.

4. Attached are the following miscellaneous items the district feels support eminence:
See the attached explanation of Dr. Larocque's contributions to geochemical research and teaching. Included in the document are: graduate transcripts; letters of support from eminent scientists and former university students; citation for Hawley Medal; student evaluations; numerous publications in refereed, international journals; description of landmark contributions to her field.

5. Attached is a letter from the applicant describing his or her accomplishments that support a claim of eminence.



SANTA ROSA HIGH SCHOOL

A CALIFORNIA DISTINGUISHED AND GOLD RIBBON SCHOOL

Celebrating over 144 years of academic excellence to our community!

Brad Coscarelli
Principal

Allie Greene
Vice Principal

Forrest Harper
Assistant Principal

Karolina Gage
Assistant Principal

Anton Negri
Assistant Principal

January 30, 2018

To Whom It May Concern:

Dr. Adrienne Larocque joined the Science Department at Santa Rosa High School in August 2017 to teach Earth Science to freshmen students. We hired Dr. Larocque because of her successful track record in teaching a diverse group of students here in our district and at international schools overseas. In addition, she has experience teaching at the post-secondary level here at Santa Rosa Junior College and at the undergraduate and graduate level at the University of Manitoba. As such, Dr. Larocque understands the skill sets that students will need to be successful in college. Because of her background working as a research scientist for both the Canadian and US governments and receiving financial support from industry, Dr. Larocque has a wealth of real-world work experience that she shares with students.

In a short time, Dr. Larocque has established productive collaborative relationships with other faculty members at SRHS. She currently is organizing an impressive collection of rocks and minerals that she brought with her to make the collection accessible and easy to use for other Earth Science teachers. Those teachers routinely seek her out to sharpen their skills in delivering Earth Science content.

In addition to her teaching duties, Dr. Larocque was recruited by the Sonoma County Office of Education to be a Teacher Leader in SCOE's 21st Century Teacher Leader Cohort. The cohort members work with teachers at all levels throughout the county to help them prepare to implement the Next Generation Science Standards. During her graduate studies and research activities in Earth Science, Dr. Larocque specialized in Geochemistry. We are excited at the prospect of having her teach Chemistry at Santa Rosa High, as she will bring high-level theoretical knowledge as well as a wealth of practical expertise to the classroom.

Brad Coscarelli
Principal
Santa Rosa High School

Jason Lea
Assistant Superintendent, Human Resources
Santa Rosa City Schools

February 2, 2018

California Commission on Teacher Credentialing

1900 Capitol Ave.

Sacramento, CA 95811

Re: Application for an Eminence Teaching Credential in Chemistry

I have a BSc in Earth Sciences, MSc in Geology, and PhD in Geological Sciences. I am an Earth Scientist, but the area of specialization for my research was in Geochemistry (see attached documentation for details). Defined by Goldschmidt (1954), geochemistry is “the study of the distribution and amounts of the chemical elements in minerals, ores, rocks, soils, water, and the atmosphere, and the study of the circulation of the elements in nature, on the basis of the properties of their atoms and ions... A major concern of geochemistry is the synoptic evaluation of the abundances of the elements in the Earth’s crust and in major classes of rocks and minerals.” [1]

Throughout my research career, I studied chemical interactions between various Earth materials. I am expert in the quantitative chemical analysis of solids (e.g., rocks, minerals, soils, ore samples), liquids (e.g., lake and river waters, acid-mine drainage), and gases (e.g., condensed magmatic volatile phases) using a wide variety of techniques. I was a pioneer in the use of secondary ion mass spectrometry (SIMS) for the analysis of geological materials. Not only did I develop methods that pushed existing analytical methods (specifically, lowering detection limits), I also produced standards and developed new techniques for the analysis of materials that had never been done before.

In addition to my extensive practical experience and research using chemical analytical methods, I developed and taught undergraduate and graduate courses in Geochemistry at the University of Manitoba. In that role, I shared with students both the theoretical principles and the practical methods and applications of analytical techniques such as scanning-electron microscopy, electron-probe microanalysis, X-ray fluorescence analysis, atomic-absorption spectroscopy, and SIMS. I also taught experienced geologists about SIMS analysis through short courses sponsored

by professional societies. In addition to my skills as an analyst, I have broad experience in field and sampling methods. This expertise is crucial to providing context and ensuring reliable and meaningful chemical data to help understand geochemical processes on Earth.

In 2015, I began teaching Earth Science to high school freshmen in Santa Rosa. Since then, I've done considerable professional development to prepare for and to assist other teachers to prepare for the implementation of the Next Generation Science Standards (NGSS). One possible model for implementation involves splitting up Earth and Space Science content and distributing it among Biology, Chemistry, and Physics. Under this model, Chemistry content is to be delivered as Chemistry in the Earth System [2]. Not only do I have the expertise to teach my students about Chemistry at the highest level, I also can provide the Earth Science context. Even if a more traditional progression (incorporating stand-alone Chemistry courses) is adopted by Santa Rosa City Schools, I want to use my extensive practical and theoretical knowledge to serve the students in my district by teaching classes in Chemistry.

In the attached document, you will find evidence supporting my claim of eminence in the field of Chemistry as well as my accomplishments teaching students at secondary and post-secondary levels. I hope that the Commission will look favorably upon my application for an Eminence Teaching Credential for Chemistry.

Yours truly,



Adrienne Larocque, PhD

Sources of Information

[1] Goldschmidt, V.M., 1954, *Geochemistry*. Oxford University Press, 730 p.

[2] <https://ngss.sdcoe.net/Chemistry-In-The-Earth-System>

SUMMARY OF DOCUMENTATION ESTABLISHING EMINENCE

The table below summarizes evidence included in this application establishing Dr. Larocque's eminence. Documents pertaining to each item can be found in the appendices at the end of the application.

- A. Evidence of recognition beyond the boundaries of her community
- B. Evidence that she demonstrably advanced her field
- C. Evidence that she is acknowledged by her peers beyond the norm for others in the specific endeavor

Evidentiary Materials Presented by Dr. Adrienne Larocque	A	B	C
Advanced Degrees:			
Transcripts for MSc and PhD, formal evaluation of PhD			√
Distinguished Employment:			
Director's postdoctoral fellow at Los Alamos National Laboratory	√	√	√
Assistant/Associate Professor at University of Manitoba	√	√	√
Research Substantially Contributing to the Field			
Documentation of <i>unequivocal evidence</i> for the chemical fixation of zinc by vermiculite formed by weathering of biotite		√	
<i>Development of new methods</i> for sampling and chemical analysis of clay minerals in altered seafloor rocks from the Galapagos Rift		√	
Documentation of <i>unequivocal evidence</i> that gold in the Moberly deposit was syngenetic, contrary to previous theories		√	
Demonstration that metamorphic recrystallization resulted in the release of sulfide-bound "invisible" gold, <i>identifying an actual mechanism for its mobilization</i> into metamorphic fluids that subsequently deposited gold in shear zones		√	
<i>Proof of a mechanism</i> by which refractory (unrecoverable) gold could be upgraded to form easily-recoverable gold; this has <i>critical implications</i> for the economics of mining and the formation of shear-hosted gold deposits in greenstone belts		√	

<i>Improvements in methodology</i> for quantification of gold and silver in sulfide minerals resulting in lower detection limits		√	
Development of techniques, applied research, and communication of results that <i>paved the way</i> for the use of SIMS, and techniques like laser-ablation ICP mass spectrometry, in geochemical studies		√	
Ion implantation of gold into iron-oxide minerals to create analytical standards for SIMS work (this <i>had never been attempted</i> by other workers)		√	
Analysis of oxide phases in volcanic rocks that <i>established the importance</i> of iron-oxide phenocrysts and degassed iron-sulfur-oxygen liquids in sequestering gold in magmas (<i>previously unrecognized/unanticipated</i>)		√	
Documentation of base and precious metal phases in vesicles, <i>not previously reported in terrestrial volcanic rocks</i>		√	
First <i>unequivocal</i> evidence of <i>direct magmatic contributions</i> of metals to ore-forming fluids in magmatic-hydrothermal systems		√	
<i>First ever documentation</i> of quenched immiscible sulfide-oxide melts in igneous rocks		√	
<i>Development of model</i> for degassing of immiscible sulfide-oxide melts in silicate magmas and <i>identification of implications</i> for (a) formation of magmatic-hydrothermal ore deposits, and (b) excess sulfur degassing		√	
<i>Identification and reporting to Philippine authorities</i> of potential lahar threat at Mt. Pinatubo Crater Lake		√	
Renowned Authorship – Refereed Publications in International Journals:			
Gold distribution in the Mobern VMS deposit, Noranda, Quebec: A preliminary evaluation of the role of metamorphic remobilization <i>Economic Geology</i> , v. 88, 1993	√	√	√
Ion-microprobe analysis of pyrite, chalcopyrite and pyrrhotite from the Mobern VMS deposit in Northwestern Quebec: Evidence for metamorphic remobilization of gold <i>Canadian Mineralogist</i> , v. 33, 1995	√	√	√
Calibration of the ion microprobe for the determination of silver in pyrite and chalcopyrite from the Mobern VMS deposit, Rouyn-Noranda, Quebec <i>Canadian Mineralogist</i> , v. 33, 1995	√	√	√

Effects of greenschist-facies metamorphism and deformation on the Moberly massive sulfide deposit, Quebec, Canada <i>Mineralium Deposita</i> , v. 30, 1995	√	√	√
Evidence for hydrothermal reworking of gold in sulfide deposits of the TAG hydrothermal field, Mid-Atlantic Ridge <i>Canadian Mineralogist</i> , v. 33, co-author, 1995	√	√	√
Redistribution of Pb and other volatile trace metals during eruption, devitrification, and vapour-phase crystallization of the Bandelier Tuff, New Mexico <i>Journal of Volcanology and Geothermal Research</i> , v. 73, co-author, 1996	√	√	√
A comparative mineralogical and geochemical study of sulfide mine-tailings at two sites in New Mexico, USA <i>Environmental Geology (special issue)</i> , v. 33, co-author, 1998	√	√	√
Ion-microprobe quantification of precious metals in sulfide minerals <i>SEG Reviews in Economic Geology</i> , v. 7, 1998	√	√	√
Regional metamorphic remobilization: upgrading and formation of ore deposits <i>SEG Reviews in Economic Geology</i> , v.11, co-author, 1999	√	√	√
Evidence for open-system behavior in immiscible Fe-S-O liquids in silicate magmas: Implications for contributions of metals and sulfur to ore-forming fluids <i>Canadian Mineralogist</i> , v. 38, 2000	√	√	√
Ion-microprobe analysis of FeTi oxides: Optimization for the determination of invisible gold <i>Economic Geology</i> , v. 97, 2002	√	√	√
The Crater Lake and Hydrothermal System of Mount Pinatubo, Philippines: Evolution in the Decade after Eruption <i>Bulletin of Volcanology</i> , v. 66, co-author, 2004	√	√	√
A high-sulfidation epithermal Au assemblage in pumice from Volcan Popocatepetl, Mexico <i>Journal of Volcanology and Geothermal Research</i> , v. 170, 2008	√	√	√
Indications of High Level of Expertise:			
Letter from Dr. Jennifer Jackman, senior research scientist (physicist), SIMS expert, recently retired from her position as Director General of the Materials Technology Laboratory at the Canada Centre for Mineral and Energy Technology (CANMET)		√	√
Requests from other scientists to collaborate or advise on their research	√	√	√

Invitations to give short courses about SIMS to other professionals	√	√	√
Invited presentations at national and international meetings	√	√	√
Invited presentations and guest lectures	√	√	√
Requests for reviews of manuscripts from national and international journals	√		√
Requests for reviews of proposals from national and international granting agencies	√		√
Letters Recognizing Expertise:			
Letter from Dr. James Franklin, former Chief Scientist of the Geological Survey of Canada		√	√
Letter from Dr. John Thompson, holder of a prestigious research chair at Cornell University	√	√	√
Letter from Dr. Paul Spry, internationally-recognized mineralogist and Professor of Economic Geology at Iowa State University	√	√	√
Letters from Dr. Jeff Keith, former research colleague, professor of Geology who is now Associate Academic Vice President at Brigham Young University	√	√	√
Opinion of Representatives of National/International Organizations of Extraordinary Ability Worthy of Distinction			
Letter from Dr. Fraser Goff, senior scientist (retired) from Los Alamos National Lab	√	√	√
Letter from Dr. Nigel Cook, Past-President of the International Association on the genesis of Ore Deposits (IAGOD), and current Chairman (2014-2018) of the International Mineralogical Association's Commission on Ore Mineralogy	√	√	√
Letter from Dr. Paul Spry, Chair of the Working Group on Ores and Metamorphism, part of the International Association on the Genesis of Ore Deposits (IAGOD)	√	√	√
Letter from Dr. John Thompson, Past President of the Society of Economic Geologists	√	√	√
Letter from Dr. Pat Rasmussen, senior research scientist at Health Canada	√	√	√

National/International Awards:			
Received Hawley Medal of the Mineralogical Association of Canada	√	√	√
Nomination for Young Scientist Award of the Mineralogical Association of Canada	√	√	√
Evidence of Significant Contribution:			
Letter from Dr. John Thompson, holder of a prestigious research chair at Cornell University	√	√	√
Letter from Dr. Nigel Cook, Past-President of IAGOD, current Chairman (2014-2018) of the IMA's Commission on Ore Mineralogy	√	√	√
Letter from Dr. Mark Hannington, formerly a research scientist at the Geological Survey of Canada and currently the holder of a prestigious research chair in Economic Geology endowed by Goldcorp at the University of Ottawa	√	√	√
Letter from Dr. Paul Spry, Associate Editor for 4 different scientific journals	√	√	√
Evidence of Successful Science Education (secondary and post-secondary):			
Article co-authored with Ms. Anna Van Dordrecht and published in <i>California Classroom Science</i>	√	√	
Letters from parents of secondary students at Maria Carrillo High School		√	
Letters and notes from secondary students at Maria Carrillo High School		√	
Letters and notes from secondary students at Santa Rosa High School		√	
Letters from fellow teachers at Maria Carrillo High School		√	√
Positive evaluations from administrators at Maria Carrillo High School		√	√
Invitation to join SRCS Equity Steering Committee		√	√
Recruitment by SCOE to be a Teacher Leader to instruct teachers in implementation of NGSS	√	√	√

Comments and ranking by students at Santa Rosa Junior College		√	
Letters from former undergraduate and graduate students at University of Manitoba		√	
Promotion to Associate Professor at University of Manitoba (teaching criteria)		√	√
Extraordinary Success in Science:			
<p>Research Funding Received and Renewed</p> <ul style="list-style-type: none"> • NSERC Operating Grant 2000-2005: \$24,000/yr; Mineral-Fluid Partitioning of Metals in Magmatic, Hydrothermal, and Weathering Environments 1996-2000: \$25,000/yr; Mineral-Fluid Partitioning of Ore Metals in Melts and Aqueous Fluids • NSERC Equipment Grant 1996-1997: \$53,123 and \$42,000 • Industry Source Grants 1997-2001: \$165,700; CAMIRO \$136,300; NSERC • University of Manitoba Grants 1996: \$3,500; Geological Contributions to Mercury Content of Lake Waters 1994-1995: \$75,000; Start-Up Grant 	√	√	√
Promotion to Associate Professor at University of Manitoba (application was considered an early one)		√	√
Additional Evidence of National/International Recognition of Eminence:			
Requests for reviews of manuscripts from national and international journals	√		√
Requests for reviews of proposals from national and international granting agencies	√		√
Renewal of NSERC Operating Grant at full level when Dr. Larocque was on half-time appointment	√	√	√
Recruitment by NSERC to serve on Committee on Research Partnerships	√		√
Invited presentations at universities and in short courses/symposia	√	√	√

**APPLICATION FOR EMINENCE CREDENTIAL IN CHEMISTRY
FOR DR. ADRIENNE LAROCQUE**

A) Evidence of Advancement of Field

1. Advanced degrees

Dr. Adrienne Larocque obtained her BSc in Earth Sciences from the Ottawa - Carleton Geoscience Center in Ottawa, Canada [1, 2]. For graduate studies, she attended the University of Western Ontario, where she obtained her MSc in Geology [1, 3], and Queen's University, where she was awarded a PhD in Geological Sciences [1, 4]. These latter schools are two of the most respected institutions in Canada for Earth Sciences. Both schools were also ranked in the top 200 universities worldwide in 2013 [5]. The Academic Credentials Report for Dr. Larocque's degree confirms that she has US equivalence of a BSc in Geology, MSc in Geology and PhD in Geological Sciences, with a GPA of 3.8 (A) at the graduate level [6].

During her undergraduate study, Dr. Larocque took courses in inorganic chemistry, physical chemistry, and geochemistry [1]. For her Master's degree, Dr. Larocque took courses in geochemistry and did research on the geochemistry of trace metals in weathered glacial sediments in Ontario [2]. For her PhD thesis, Dr. Larocque worked on the geochemical remobilization of gold in an Archean volcanogenic massive sulfide deposit [3].

2. Distinguished employment

In 1993, Dr. Larocque was awarded a prestigious Director's Postdoctoral Fellowship [7, 8] at Los Alamos National Lab (administered by the University of California for the US Department of Energy). For that position, she was chosen above scientists in many different scientific fields. While working in the Geo-engineering Group of the Earth and Environmental Sciences Division, Dr. Larocque carried out research in a number of environmental disciplines. Her studies included work on the geochemistry and mineralogy of mine tailings and the chemical characterization of vitrified natural materials. She also was involved in research programs studying the chemical partitioning and redistribution of trace elements in volcanic rocks and soils using proton-induced X-ray emission (PIXE) [9, 10].

In 1994, Dr. Larocque took up a faculty position at the University of Manitoba, one of the top institutions for mineralogical research worldwide [11]. In addition to carrying out research there, she developed and taught new courses for undergraduate and graduate students [12]. She also supervised undergraduate and graduate theses and was on advisory committees for students in several other departments [13]. Dr.

Larocque served on a number of hiring and promotional committees at the University [14]. In 2001, she was promoted from Assistant to Associate Professor [15].

In academic settings, the decision to award promotion is based on a candidate's research, teaching and service contributions. Dr. Larocque's application for promotion from Assistant to Associate Professor was considered an early one because of her maternity leave and partial leave of absence. Nonetheless, her contributions in research, teaching and service led to her being promoted to Associate Professor in 2001.

3. Research Substantially Contributing to the Field

Dr. Larocque's MSc research provided *unequivocal evidence* for the chemical fixation of zinc by vermiculite formed by weathering of biotite (Larocque, 1989; 9). Previously, chemical siting of trace elements in clay-sized fractions of soils and sediments was usually inferred from sequential chemical extractions, results of which can be difficult to interpret with confidence. Dr. Larocque's work identified the fractions of soil and sediment samples that are most effective in geochemical exploration programs. Furthermore, her research has important implications for methods of immobilizing heavy metals that have been released into the environment [Larocque and Nesbitt 1989; Larocque *et al.* 1993; 9, 10].

During her summer employment in the Mineral Resources Division (MRD) of the Geological Survey, Dr. Larocque wrote a paper about clay-mineral speciation and chemical composition of altered seafloor rocks from the Galapagos Rift [Larocque *et al.* 1989; 9]. The study required careful sampling of fine-scale zones defined by different mineral assemblages for chemical analysis. It also involved complicated X-ray diffraction procedures to identify the species of clay minerals present. This type of detailed work *had not been done before*, and her data were used in several publications by senior scientists.

Although Dr. Larocque changed research areas from her MSc to her PhD, she quickly made significant contributions to her new field by making *several important discoveries*. For example, the origin of gold in shear zone-hosted veins has long been a subject of debate. Dr. Larocque's research on an ancient gold-rich massive sulfide deposit had several significant outcomes. First, she *established unequivocally* that gold in the deposit was syngenetic (i.e., it formed at the same time as the massive sulfide body), contrary to previous theories [Larocque *et al.* 1995a,b; 9]. Second, she clearly demonstrated that metamorphic recrystallization resulted in the release of sulfide-bound "invisible" gold, *identifying an actual mechanism for its chemical mobilization* into metamorphic fluids that subsequently deposited gold in shear zones [Larocque *et al.* 1993; 9]. The second finding is *significant* because Dr. Larocque proved a mechanism by which refractory (unrecoverable) gold could be upgraded to form easily-recoverable gold; this has *critical implications* for the chemistry of extraction, the economics of mining, and the formation of shear-hosted gold deposits in greenstone belts [Larocque and Hodgson 1994; 10].

These *landmark findings* would not have been possible without the use of secondary-ion mass spectrometry (SIMS). Though still a graduate student working in a new field, it was Dr. Larocque's initiative to SIMS to solve the problem of the chemical residence sites and fate of sulfide-hosted gold (Larocque, 1993; 9). When Dr. Larocque began this work, SIMS had been used mainly by physicists and materials scientists and was just starting to be used for mineralogical problems related to precious metal recoveries in mineral processing. No one had actually used the technique to resolve questions of the genesis of ore deposits. Furthermore, her research on massive sulfide deposits, and later, other types of mineralization, required lower levels of detection than had previously been achieved. While Dr. Larocque did not develop the specific methodology for chemical quantification of gold and silver in sulfide minerals, she definitely pushed its limits [Larocque *et al.* 1995a,b; 9]. Her technique development and applied research paved the way for the use of SIMS, and techniques like laser-ablation ICP mass spectrometry, in geochemical studies.

At Los Alamos National Lab (LANL), Dr. Larocque was invited to participate in several research projects *because of her expertise* in those areas. Dr. Fraser Goff sought her input into work on degassing and deposition of gold at a volcano in Columbia [Goff *et al.* 1994; 9]. Dr. Donald Hickmott invited her collaboration on several studies. One project involved proton-induced X-ray emission (PIXE) analysis to quantify chemical abundances of trace elements in sulfides and other minerals [Hickmott *et al.* 2003; 9; Stimac *et al.* 1996; 9]. Another study looked at the chemical redistribution of lead in the Bandelier Tuff via eruptive and post-eruptive processes [Stimac *et al.* 1996; 9]. At LANL, Dr. Larocque succeeded in implanting gold into iron-oxide minerals to create analytical standards for SIMS work [Hickmott *et al.* 1995; 9]. This *had never been attempted* by other workers, and in itself *was a breakthrough*. Iron oxides had previously been unrecognized as an important chemical sink for gold in igneous rocks; however, Dr. Larocque's subsequent analyses of oxide phases in volcanic rocks was important in establishing the importance of iron-oxide phenocrysts and degassed iron-sulfur-oxygen liquids in sequestering gold in magmas [Larocque *et al.* 2000; Larocque *et al.* 2002; 9]. This phenomenon had been *previously unanticipated, not to mention unproven* [Larocque *et al.* 2002; 9].

In 1994, Dr. Larocque left Los Alamos to take up a faculty position at the University of Manitoba. There, she explored new areas of research, including geochemistry of magmatic and magmatic-hydrothermal ore deposits. Her first work in economic geology was on seafloor hydrothermal deposits. It was her interest in gold-rich massive-sulfide deposits that led her to work on the geochemistry of other gold-bearing systems. Dr. Larocque was invited to study magmatic-hydrothermal ore minerals from the Bingham Canyon porphyry-copper deposit in Utah by Dr. Marco Einaudi and his student at Stanford [Redmond *et al.* 2000;

10]. Dr. Einaudi is world-renowned for his work on the origin and environmental impacts of mineral deposits. Dr. Larocque also worked on chemical characterization of magmatic sulfides in volcanic rocks around the Bingham Canyon deposit with Dr. Jeffrey Keith and his students at Brigham Young University [Stavast *et al.* 2006; 9].

In 1995-1996, Dr. Larocque and colleague Dr. James Stimac collected samples of pyroclastic rocks from Popocatepetl Volcano in Mexico, including recent ejecta (pumice) from an ongoing eruption. These samples were exciting because the vesicles contained tiny crystals of ore minerals. While some seafloor lava samples had been observed with sulfide minerals in vesicles, such occurrences *never been reported in subaerial rocks*. Even more sensational was the discovery that some of the ore minerals were compounds containing gold, silver, and tellurium, and that the assemblage was similar to those seen in epithermal gold deposits. This study was *revolutionary* because isotopic evidence indicates that epithermal ore-forming fluids contain a high proportion of meteoric fluids (such as groundwater) and many workers assumed that the sources of precious metals deposited by these fluids were also located near-surface. Dr. Larocque's research *established unambiguously and for the first time* that precious metals in high-level magmatic-hydrothermal ore deposits can be sourced directly from a silicate magma [Larocque *et al.* 2008; 9]. Dr. Larocque's work is important for understanding the genesis of deposits like the McLaughlin mine, the largest gold discovery of the 20th century in California.

Realizing the importance of metal degassing from magmas in the formation of hydrothermal ore deposits, Dr. Larocque sought to understand the chemical processes that governed how and where it happened. She studied suites of volcanic rocks from around the world, including samples from Clear Lake, California. Doing research on rocks with different chemical compositions from a variety of geological settings was crucial to understanding the controls on degassing. While studying magmatic sulfides and some unusual oxides first noticed by her research colleagues, Dr. Larocque made a *truly groundbreaking discovery* – the strange oxides actually formed by degassing of immiscible sulfide-oxide liquids that might otherwise crystallize to form sulfide minerals. Thorough investigation of a suite of rocks from all over the world revealed that evidence of degassing is widespread, although it *had previously been unrecognized* [Larocque *et al.* 2000; 9]. This finding has *noteworthy* economic and environmental implications. Removal of sulfur and metals from a melt to a magmatic-hydrothermal fluid can result in the formation of porphyry copper or epithermal deposits. This research explains why such deposits can be associated with intrusive rocks that are metal-poor, improving geochemical exploration models for intrusion-related deposits. The results also *explain the enigma* of excessive sulfur degassing, where a much larger volume of sulfur may be emitted by a volcano than would be expected in light of the volume of subsequently erupted lava. Dr.

Larocque and her colleagues were **recognized for this significant work** by being awarded the Hawley Medal of the Mineralogical Association of Canada (see below).

While already known for her work on the genesis of ore deposits, Dr. Larocque extended her research into the area of environmental geochemistry of ore deposits. She initiated a research program on mineralogy and geochemistry of mine tailings (Larocque *et al.*, 1995; 10] and the chemistry of acid mine drainage. In 1996, she organized and co-chaired a symposium entitled *Trace Metals in the Environment: From Mobilization to Remediation* with Dr. Pat Rasmussen of Health Canada [16]. From 1996 to 1998, she served as a guest editor of a special issue of *Environmental Geology* arising from the symposium [9].

While on maternity leave in the Philippines, Dr. Larocque became involved in work on the chemistry of the crater lake at Mt. Pinatubo. She and Dr. James Stimac climbed the volcano to collect water samples, analysis of which yielded information about the flux of magmatic gas into the lake [Stimac et al. 2004; 9]. This type of work had been done at other crater lakes to monitor volcanoes for signs of imminent eruption. However, during sampling of the lake, a potentially hazardous rise in lake level (that could result in catastrophic draining of the lake and the generation of mudflows down-slope) was noticed and reported to Philippine authorities [Stimac *et al.* 2002; 9].

4. Renowned Authorship

To share the results of her geochemical research, Dr. Larocque gave 52 oral and poster presentations at international meetings over the years [10]. This exposure of her findings led to new collaborations with other scientists worldwide. She published 21 papers in **international** science journals and special publications, and wrote articles that appeared in non-refereed media [9]. Many of the papers that Dr. Larocque published were invited contributions to thematic issues of respected journals or short course publications [e.g., Larocque et al. 1995a,b; Larocque and Cabri 1998; Larocque et al 2005; 9]. Publication of her research in leading international science journals in itself is **evidence of advancement of her field** and **acknowledgment by peers** of eminence as the review process is quite rigorous.

Dr. Larocque published various aspects of her research in *Economic Geology*, the leading journal in the geosciences applied to mineral deposits [17]. It is distributed by the Society of Economic Geologists, an international geological society [18]. According to Dr. John Thompson, Past President of the Society of Economic Geologists, “Several of her papers are in *Economic Geology*, an **international journal** produced by the Society of Economic Geologists (SEG). This society originated in the United States and still has its administrative home in Littleton, Colorado. Since its early days over one hundred years ago, it has grown to a **global society** of over 7000 fellows and members, less than 50% of whom are based in

North America. Economic Geology is **the preeminent journal** for science related to the complex earth processes that move and concentrate metals and other commodities that are vital for the modern world.” [19; emphasis added].

Mineralium Deposita is another international journal for geology, mineralogy and geochemistry of mineral deposits in which Dr. Larocque published results of her research [9]; its governing organization, the Society for Geology Applied to Mineral Deposits, boast members from over 50 countries [20]. Her work also appeared in the *Bulletin of Volcanology*, the official journal of the International Association of Volcanology and Chemistry of the Earth’s Interior (IAVCEI) [21]. She contributed many papers, including several **invited** ones, to *Canadian Mineralogist*, the journal of the Mineralogical Association of Canada [22]; contributors to *Canadian Mineralogist* hail from around the world.

The field of economic geology moves quickly, with the discovery of new deposits and the application of increasing numbers of analytical techniques such as those pioneered by Dr. Larocque. As such, relatively few textbooks are published in the field because of these rapid advances. Volumes such as *Reviews in Economic Geology* [23], also published by the SEG, are **much more widely used** because they provide up-to-date theoretical and practical information due to their quick production schedule. These sorts of reviews are often used in place of textbooks in academic settings. In addition to publishing in the **top journals in her field**, Dr. Larocque was enlisted to contribute chapters to two different *SEG Reviews in Economic Geology* [Larocque *et al.* 1998, Marshall *et al.* 1999; 9] organized by different groups of scientists.

Dr. Mark Hannington was formerly a research scientist at the Geological Survey of Canada and is currently the holder of a prominent research chair in Economic Geology endowed by Goldcorp at the University of Ottawa. Dr. Hannington said that Dr. Larocque has “**acclaimed published works** in the areas of geology, mineralogy, and geochemistry... She has more than 20 peer-reviewed publications in the **top international journals** of the science, including multiple publications in two of the **most widely read and cited international scientific journals** in her field... It is common practice in the Earth sciences for researchers to publish in only a few journals close to their interests. Dr. Larocque has published in at least 10 different research journals in widely varying fields from environmental geology, to volcanology to mineralogy; **only the most accomplished researchers** are able to publish their research across a spectrum of journals with such wide audiences.” [24; emphasis added].

5. Indications of High Level of Expertise

Dr. Larocque was trained in SIMS analysis by Dr. Jennifer Jackman, then a senior research scientist (physicist), SIMS expert, and recently retired from her position as Director General of the Materials Technology Laboratory at the Canada Centre for Mineral and Energy Technology (CANMET), a Canadian government department. CANMET would be comparable to national labs in the US that do research into Materials Science such as Lawrence Berkeley, Oak Ridge, Sandia, Los Alamos, Brookhaven, or Argonne. Dr. Larocque quickly became adept at the work. According to Dr. Jackman, “[SIMS is] a particularly sensitive but difficult technique (since it requires advanced understanding of ion-solid interactions, ionizing processes and mass spectrometry)... Dr. Larocque worked on geological samples which is the *most difficult class of materials* to analyze by SIMS. She was able to *master this technique* and produce *original, advanced research* despite the fact that her own formal training was in a very different field. My own expertise is in the analysis of metallurgical samples, which present entirely different problems, therefore Dr. Larocque, even as a PhD student, was required to *resolve many difficult challenges through her own initiative*. She was able to *develop and advance novel methodologies* for analyzing geological materials by SIMS, making her *one of only a few researchers in Canada able to utilize this tool effectively* for geological research. Her research increased our knowledge and understanding of the mobilization of elements in geological formations... [She] was *recognized for her scientific contributions* in the field.” [25; emphasis added].

Dr. Larocque became widely recognized for her analytical abilities even before graduating from Queen’s University. Dr. Louis Cabri, then a senior research scientist in materials science at CANMET and recipient of numerous awards [26], was external supervisor for Dr. Larocque’s PhD research. In 1993, while still a graduate student, she was invited along with Dr. Cabri to give a short course at the Mineral Deposits Research Unit at the University of British Columbia because of her expertise in SIMS analysis [16, 19]. Dr. John Thompson, head of MDRU at that time, said “The course involved several professionals and established experts in microbeam analytical techniques but Dr. Larocque was the most passionate and effective speaker and teacher.” [16]. In 1996, Dr. Larocque was invited, alone, to present applications of SIMS as part of a short course sponsored by US Society of Economic Geologists [16; 23]. This invitation from organizers Drs. Michael McKibben (UC Riverside) and Pat Shanks (US Geological Survey) indicate the *recognition of Dr. Larocque’s expertise* at an early stage in her scientific career.

Because of her expertise with SIMS, Dr. Larocque was recruited to do research on seafloor mineralization with Dr. Mark Hannington [Hannington *et al.* 1995; 9]. According to him, “In a short time after her Ph.D., Dr. Larocque achieved a *remarkable level of distinction* for her work, *far beyond her immediate peers*...

Dr. Larocque quickly made *significant, internationally recognized* advances in each of the diverse fields in which she has worked... A hallmark of Dr. Larocque's research was *mastering and significantly advancing* the use of sophisticated instrumental approaches to analysis of geological materials, including then state-of-the art SIMS ion probe techniques (CANMET and Los Alamos)... The quality of her research is evidenced by the fact that so many leaders in these fields, from Canada, the U.S. and overseas, have chosen to work with Dr. Larocque and co-author papers with her." [24; emphasis added].

Reviewing manuscripts submitted to science journals is an important part of the peer review process. Journal editors solicit reviews from *known experts in the field*. Between 1994 and 2002, professional journals solicited reviews for more than 14 manuscripts from Dr. Larocque [27, 28]. Between 1999 and 2003, she reviewed 4 grant proposals submitted to national granting agencies in the US (National Science Foundation) and Canada (NSERC) [27]. According to Dr. Mark Hannington, who served as editor of *Economic Geology* from 2001 to 2008, "Dr. Larocque is also acknowledged by her peers to be an *expert evaluator of her field*, serving as a scientific reviewer for journals and a reviewer of grant applications for NSF and NSERC." [24].

B) Evidence of Acknowledgement by Peers as beyond the Norm

1. Letters Recognizing Expertise

Dr. Larocque is acknowledged by her peers to be knowledgeable or expert in the fields of sediment geochemistry, ore mineral identification and characterization, clay-mineral identification and analysis, mineralogy and geochemistry of hydrothermal and magmatic-segregation ore deposits, metals in magmas, exploration geochemistry, environmental geochemistry and secondary-ion mass spectrometry.

Dr. Jay Hodgson was Dr. Larocque's doctoral thesis supervisor at Queen's University. Dr. Hodgson has an international reputation in mineral-deposits research and retired from Queen's to become Chief Geologist for Barrick Gold Corporation before becoming an independent consultant. He said "During her doctoral studies, Adrienne also became expert in secondary ion mass spectrometry (SIMS). She has no fear of high-tech instruments and quickly and efficiently gets right on with using them for her work. Personally, I think this is an extremely important attribute in a researcher, since too much current research is controlled by the familiarity of the researcher with certain types of data and data gathering techniques. Geologists who know how to deal with fluid inclusions try to solve all problems with fluid inclusion studies, and isotope geologists do the same with isotope studies. With Adrienne, research is controlled by the problems that she needs to

solve, not the techniques that she is familiar with, *because* she is *so quick and competent* at learning new techniques.” [29; emphasis added].

During their first year in the PhD degree program, students at Queen’s are required to pass comprehensive exams to establish that they have an advanced knowledge of their subject area. Dr. Larocque easily passed her comprehensive exams, in spite of having made a significant change in her area of research after completing her MSc. According to Dr. James Franklin, former Chief Scientist of the Geological Survey of Canada and external referee for Dr. Larocque’s doctoral defense, “Her doctoral work was in a completely different field, related to understanding the genetic processes attendant on the formation of major mineral deposits. This required a totally different *specialized knowledge* base. Dr. Larocque demonstrated her ability to learn an entirely new field of geoscience at an *advanced level* in a very short time period. Her doctoral work stands today as preeminent in understanding the processes of gold enrichment in mineral deposits. This work has had wide-ranging economic benefits to the exploration and mining industry” [30; emphasis added].

Dr. John Thompson stated “In terms of her science, Dr. Larocque has *demonstrated unusual breadth*. She has tackled a range of problems requiring different research approaches and analytical techniques, and *has consistently excelled*. This is *beyond the norm* in a world that tends to value specialization above flexibility... Microbeam techniques were developing rapidly through the nineties and Dr. Larocque was *one of the leaders* both in the technological development and applications to problems related to geoscience and the environment.” [19; emphasis added].

Dr. Paul Spry is an internationally-recognized mineralogist and Professor of Economic Geology at Iowa State University. According to him, “Her work on the mobilization of precious metals during metamorphism is *exceptional*... In addition to being an economic geologist and low-temperature geochemist, Adrienne is also a *world-class mineralogist*. She has *considerable expertise* on the characterization of minerals with complicated analytical instrumentation such as SIMS... This prompted me to seek her advice about using SIMS analysis for my own research.” [31; emphasis added].

Dr. Jeff Keith is a professor of Geology who is now Associate Academic Vice President at Brigham Young University. He said “I have known Adrienne for most of her career and have watched with admiration both the unselfish service she has given to those around her and the professional recognition that she has developed and maintained. She has *distinguished herself* broadly during these years... In my current position as Associate Academic Vice President, I see many portfolios of faculty work and applications for university awards – some by very distinguished faculty members. In comparison, Dr. Larocque has *distinguished herself* on a similar level.” [32]. Dr. Keith and Dr. Marco Einaudi, both of whom enlisted

Dr. Larocque's input into research on different aspects of magmatic and hydrothermal mineralization at Bingham Canyon, "concur that her work is excellent; there are very *few people that have the expertise with SIMS analysis* and the specific background with Au analysis to do the type of work that she does... Adrienne's work is at the *forefront* of the field... I am impressed that her knowledge of topics in environmental geology and volcanology as well as geochemistry, economic geology, and microanalysis are *substantial and much better than most of her colleagues* at a comparable stage." [33; emphasis added].

2. Opinion of Representatives of National/International Organizations of Extraordinary Ability Worthy of Distinction

In 1993, Dr. Larocque was awarded a prestigious Director's postdoctoral fellowship at Los Alamos National Lab. For this, she was chosen above scientists from inside and outside of the US who hold PhDs in numerous fields other than her own. While at LANL, she worked with several researchers including Dr. Fraser Goff, a respected senior scientist (now retired) and adjunct professor at two schools in New Mexico. Dr. Goff said that each candidate who is awarded a Director's postdoc "*walks on water*"... the laboratory accepts the *best possible candidates* from the USA and many different countries. Clearly, the *competition is incredibly intense*, made more so for any candidate who is not in the disciplines of physics, nuclear chemistry/physics, math, and computer science. Successful candidates in earth science (geology, geochemistry, petrology, geophysics, etc.) are *rare... her candidate package was exceptionally strong to receive this remarkable award*... LANL wants the *very best*... it would be difficult for me to imagine another person *more qualified* to receive such a credential. Her achievements in a single discipline in earth science would easily qualify her. The fact that she has attained wide recognition in diverse fields is *extraordinary*." [34; emphasis added].

Dr. Nigel Cook is Past-President of the International Association on the genesis of Ore Deposits (IAGOD), and current Chairman (2014-2018) of the International Mineralogical Association's Commission on Ore Mineralogy. He stated "As a matter of routine, my PhD students are asked to read and understand the significance of Adrienne's academic output. Adrienne is *very well regarded* in the ore geology research community and by her peers at large as a *skilled researcher* and *highly efficient communicator*... Her research, providing *unequivocal evidence* for metamorphic remobilization of gold and the development of new methodologies for the quantification of gold in sulphides, represents a 'unique or significant discovery or authorship in the field of geology' and is *recognised as such by her peers nationally and internationally*." [35; emphasis added].

Dr. Paul Spry is Chair of the Working Group on Ores and Metamorphism, part of the International Association on the Genesis of Ore Deposits (IAGOD). Dr. Larocque's research on metamorphic remobilization prompted Dr. Spry to seek her input into an important review paper on metamorphosed ore deposits [Marshall *et al.* 1999; 36]. According to Dr. Spry, "In the late 1990s, I was asked to put together a prestigious volume for the Society of Economic Geologists (the world's leading society on the study of ore deposits) entitled 'Metamorphosed and Metamorphogenic Ore Deposits.' This volume appeared as a 'Reviews in Economic Geology' and was co-organized and edited by me, Brian Marshall and Frank Vokes. I asked Adrienne to co-author a paper with my two co-editors, who were regarded as *the two leading researchers* on the discipline of 'metamorphosed ore deposits' at the time. This speaks volumes to her *outstanding reputation* in this field at such a young age." [31]. Drs. Marshall and Vokes subsequently sought Dr. Larocque's input into presentations about metamorphosed ore deposits that were given at international meetings [Marshall *et al.* 1998; Marshall *et al.* 1999; 9; emphasis added].

Dr. John Thompson, Past-President of the Society of Economic Geologists, stated "Dr. Larocque has a publication and professional record that demonstrates *world class expertise*, a breadth of geoscience topics, publications in high caliber journals representing different specialties, and *international credentials* based on work in different parts of the globe... As a past President of SEG, I can confirm that Dr. Larocque is *recognized widely within the society*... I have considerable respect for Dr. Larocque as a scientist and educator. Aside from her scientific credentials and *papers of global significance*, she is an exceptional communicator." [19; emphasis added].

Although she had established an international reputation for her work on ore deposits, Dr. Larocque was also widely known for her work in environmental geochemistry. In 1997, she was drafted by the Metals in the Environment (MITE) Research Network, a unique interdisciplinary initiative that brought together dozens of researchers from across Canada [37]. Research within the network was divided into 3 domains of focus regarding metals in the environment: 1) sources, 2) transportation and transformation, and 3) impacts on ecosystems; Dr. Larocque was recruited to be the leader of the Sources Domain. Dr. Pat Rasmussen is a senior research scientist at Health Canada who was in part responsible for Dr. Larocque being drafted by MITE. Dr. Rasmussen stated "The fact that Dr. Larocque was chosen as leader for the Sources Domain at such an early stage in her career is evidence of *recognition on a national scale of her expertise* in environmental geochemistry. In her role as Domain leader, she was responsible for coordinating research scientists and engineers (many of whom were much more established investigators) from a variety of disciplines studying both natural and anthropogenic sources of hazardous metals in the environment. *Only someone with her extraordinary breadth of knowledge could have done this*

successfully... Adrienne is *widely respected by her academic and government colleagues for excellence in research.*” [38; emphasis added].

3. National/International Award

Perhaps the most exciting evidence of recognition of Dr. Larocque’s scholarly achievements came in 2001 when she and her colleagues were awarded the prestigious Hawley Medal by the Mineralogical Association of Canada. The Hawley Medal is awarded to the authors of the *best paper* to appear in *Canadian Mineralogist* in the previous year. In his citation for the Hawley Medal, then-President of the MAC Brian Fryer stated “The paper is extremely well illustrated, meticulously organized, and clearly written... a clear exposition of the criteria that can be used to determine the origin of sulfides in volcanic rocks.” [39]. Recent recipients of the Hawley Medal include researchers from Europe, the US, and Canada who have worked on mineralogical and geochemical problems all over the world [40]. It is truly an *international* honor. Just 3 years before Dr. Larocque and her colleagues won the Hawley Medal, it was awarded to Dr. Frank Hawthorne, the most highly-cited author worldwide in geosciences between 1996 and 2007 [41].

The following year, Dr. Larocque was nominated for the Young Scientist Award of the Mineralogical Association of Canada, given to a young scientist who has made a significant *international* research contribution in a promising start to a scientific career [42].

4. Evidence of Significant Contribution

Dr. John Thompson holds a prestigious research chair at Cornell University. According to Dr. Thompson, “Dr. Larocque has also managed to produce *landmark contributions*... The publication on sulfide immiscibility (Larocque et al., 2000) is a *highly regarded and frequently used* paper that was recognized by a *prestigious award* – the Hawley Medal. The more recent paper on significant mineral assemblages found in pumice Popocatepetl Volcano (Larocque et al. 2008) is *equally important*. In addition, her early papers on the use of the SIMS microbeam analytical technique were *highly significant*...” [19; emphasis added].

Dr. Nigel Cook of the IMA’s Commission on Ore Mineralogy stated “Adrienne has made a number of *extremely valuable* contributions to Earth Science and her published work remains highly regarded by those of us working in the field. Her research, showing the connection between concentrations of gold in common sulphides and ore-forming processes was *fundamental at the time, remains fully valid, and is widely applied today*. Without her high-quality contribution, carried out at a time when accurate analysis was nowhere as easy as it is today, many of the models for trace element behaviour in sulphide systems

would not be possible. The *implications which her work had for the economic viability of gold resources are profound.*” [35; emphasis added].

According to Dr. Mark Hannington, “Dr. Larocque quickly made *significant, internationally recognized advances* in each of the diverse fields in which she has worked... Dr. Larocque’s research using these tools contributed directly to *fundamental advances* in our understanding of the distribution trace metals in the crust and in the environment in general, including in lakes, streams, weathered rocks, mine tailings, volcanic systems and ore deposits... Dr. Larocque’s work on the mineralogical siting of platinum group elements in ores and rocks is a *singular achievement* that captured the attention of the international mining industry and presented rare opportunities to combine industry-funded and government-funded research on a topic of critical importance to the Canadian economy. She was rewarded for these achievements by successfully obtaining highly competitive research funding from the Natural Sciences and Engineering Research Council (NSERC, or Canada’s equivalent of NSF) while professor at the University of Manitoba.” [24; emphasis added].

Dr. Paul Spry is Associate Editor for 4 different scientific journals. He said, “Dr. Larocque’s 2008 study on Volcan Popocatepetl in Mexico was *particularly notable* because it was the first paper that reported the presence of telluride minerals in vesicles that formed during an active volcanic eruption... Her work *resolved the long standing question* concerning whether the element tellurium was carried in the vapor or liquid phase. My recent *experimental studies verified what she discovered* in 2008, that tellurium is carried in the vapor phase under ore-forming conditions.” [29; emphasis added].

5. Evidence of Successful Science Education

Secondary Teaching

Since being awarded an Eminence Credential to teach Earth Science, Dr. Larocque has been teaching in the Santa Rosa City Schools District, first at Maria Carrillo High School and now at Santa Rosa High School. At both schools, “Dr. Addie” has developed strong relationships with students and parents, as evidenced by the following excerpts from notes and letters [42, 43]:

From Parents of Students at Maria Carrillo High School [42]:

Names have been redacted to protect student privacy, but original letters are available for viewing upon request.

“Dr. Larocque posted all of the slide shows, handouts, and assignments with due dates on the website Sophia.org. This was hugely helpful to [REDACTED], not only when he was absent... Dr. Larocque allowed

students to use their notes during tests which aided with test anxiety and encouraged them to take careful notes, a critical 9th grade skill... The tests were challenging and complex so while the students could use notes, higher level thinking skills and synthesis of information were required.”

“Dr. Addie and I had a few occasions to chat in person, and it was clear to me that she loves teaching and inspiring the students to explore the world around them. We need more teachers like her.”

“Dr. Addie taught my daughter a new way to engage in class boosting her self-confidence to speak up in class... she boosted my daughter’s confidence in the subject of science, but also in her ability to believe in herself! In fact, Dr. Addie recommended her for her only honors class, Honors Biology, in her sophomore year and she is doing amazing [sic] well.”

“Most importantly, Dr. Larocque was able to see the potential in [REDACTED] that other teachers often miss and connect with him on a personal level. Her confidence in him allowed him to gain confidence in himself... At the end of the school year, she recommended [REDACTED] for the Honors Biology class for the present school year. He is taking Honors Bio this year and it’s his favorite class. While it is challenging for him, the benefits of seeing himself as one of the ‘smart kids’ and pushing himself to taken concepts at a higher level have been really positive for him.”

“[REDACTED] took her class in his freshman year at Maria Carrillo High School in Santa Rosa, 2014-2015... That August he immediately began telling us about his Earth Science teacher and the course material with such enthusiasm & animation we felt relieved and lucky he'd started this leg of his schooling on such a strong foot... [REDACTED] soon packed along samples of his rock collection to school, from fossils and varying types of rocks to meteorites, because he had a receptive and supportive atmosphere to share in... We are pleased that [REDACTED] learned self-reliance and increased his self esteem by approaching his teachers and initiating a connection himself. Time is tight at school, yet he still stops in to see Dr. Addie and share news and tidbits he's excited about. It is illustrative of how her positive influence goes above and beyond to enrich his, and others', educational experience.”

“My daughter was terrified to start her freshman year in a large school the population of MCHS. Her first week of school all she could talk about was her science class and Dr. Addie. She never liked science before Dr. Addie. My daughter repeatedly said, ‘Dr. Addie explained everything so well I actually understand what she is trying to teach me.’”

“Her passion for science and teaching ensured my son was engaged and learning in class. Class expectations were well laid out, and challenging in such a way that my son surprised himself with how much he learned. She certainly laid a solid science foundation for him.”

“What you need to understand about [REDACTED] is that he is not the most ‘natural’ of students. He is one of those kids who seem to work twice as hard to get half the grade... What impressed me most about Dr. Addie was her desire to help her students. She regularly set up tutoring sessions and extra office hours in order to share her love of science with her students. Mostly, though, she seemed to actually CARE about these kids. She wanted them to LEARN, rather than merely pass requirements... As a result of her work, [REDACTED] shared with me that his favorite class last year was science – complete shock to me!”

“[REDACTED] has a hard time understanding and tolerating other kids. Addie recognized this with compassion, and allowed him to do some lab work alone, outside of class time, while still encouraging him to engage with other students in group work... I have never known anyone who has enriched his educational and social experiences as much as Addie did... I cannot begin to express how thankful as a parent I am to have run across a teacher like Dr. Addie.”

“[REDACTED] has an older sister who is presently at UCLA and is the type of student who will thrive no matter who is teaching the class. [REDACTED] is very different and the classroom teacher has always been critical to his success. We are grateful for his time with Dr. Larocque and feel she is an asset to the Science Department at Maria Carrillo High School.”

“As a parent I was equally as pleased with Dr. Addie’s communication skills through her timely e-mails home. She was the only teacher my daughter’s freshman year who took the time to communicate with me about what was going on in class, so that I was able to talk to my daughter about her studies.”

“Dr. Larocque made an effort to communicate with us regarding [REDACTED]’s progress and needs. She was timely and clear in her communications which is not always the case when students are in high school. I feel that many students continue to need the support of both their parents and teachers during this transitional year and communication is key.”

“I communicated with Dr. Addie regularly, making sure that [REDACTED] was keeping pace in the classroom. I was surprised at how quickly she would respond to my e-mails with her suggestions and concerns. In spite of having 100 students, she was aware of my son.”

“██████'s challenges come from working with his diagnosed ADD. Focusing and keeping organized are huge issues for him, regardless of subject... Dr. Addie's Sophia website enabled us & ██████ to see for ourselves what was current in class. Her timely and informative emails helped us to keep up on what ██████ should be planning for in Earth Science. The several times we emailed in return, she responded quickly.”

From Students at Maria Carrillo High School and Santa Rosa High School [43]:

“Thank you for helping me, pushing me on doing better in science, understanding me, and so much more!”

“I’m really happy that I have you as a teacher, friend someone to trust... You are one of the biggest motivations [sic] I have to be a strong woman and never give up. I may not get the best grade in your class but I have the best times and eventually learn a lot from it.”

“I’m so glad you’re my teacher this year. So far I hadn’t had a teacher I could trust enough to talk to until I met you. You’re so bubbly and welcoming and I can tell you care deeply about each and every one of your students. Not only that, it’s obvious you care very much about the subject you teach and as a teacher, that makes all the difference.”

“Thank you for being there when I have questions. Thank you for teaching with a passion and wanting everyone to be knowledgeable.”

“In the past, I never enjoyed science class because I was always lost and confused. Thank you for helping me not be lost and confused. Thank you for the great year and for being an amazing teacher... You really taught me so much, science and more.”

“I really appreciate and want to thank you for always helping me with my work and for helping me get back in track with your class but most of all for always being so nice and so lovely with me and for giving me the attention I need. Also for always answering my questions no matter what it is about.”

“Thank you so much for all that you do for me. You always go above and beyond to make sure we learn all the information in depth. You are one of the best teachers at Carrillo.”

“You’re my favorite teacher I’ve had in a long time!”

“Thank you for being such an amazing teacher and preparing us for our sophomore year. Everything you did was for our own good and all of us are better students because of you. You created a solid foundation for science for everyone you taught. You rock!”

“Thank you for teaching me everything about science. There are times when u were strict on us but it was for our own good... you also made sure we understand lessons well. You made me feel better about myself even when I was feeling the lowest. It was nice to see you around school and say hello. I miss you & being in your class.”

“Thank you for putting up with me and caring for me. I know I am a pain in the butt sometimes, but I appreciate you being there for me.”

“Thank you so much for being such an amazing teacher... I love how you always have such enthusiasm and such great pride in what you do.”

“You are the best teacher I’ve ever had. You are always very prompt about grading everything. You are joyful and always very enthusiastic when you learn something new, but also when you see a student finally ‘get’ a concept. Each and every one of your assignments has a purpose and helps us learn. You care very deeply for each and every one of your students and their well-being.”

“Thank you for being an amazing teacher. You are funny and kind and every time I walk into your classroom I get filled with joy. I always have a blast in your class.”

“You are my favorite teacher this year and I really enjoyed your class. Thanks for believing in me even when my grades weren’t the best.”

“Thank you for your support and just being helpful and showing me that I can do anything, that you believe in me. You’re so helpful and always ask if you can do anything to help.”

“I’m so happy that I was in your class this year. You have made my transition from middle school to high school easy. You are always so kind... I love your sense of humor... You are a great teacher and have taught me so much. You always have creative activities that make learning fun and exciting. Again, thank you for all you do. You will always have a place in my heart.”

“Thank you for helping me. Especially this second semester. You really motavaited [sic] me to do my best in your class. I know first semester I didn’t do so well, but now I pay attention in class and do the homework. Every day I look forward to your class because I like learning new things.”

“Thank you for being an amazing teacher! Thank you for doing so much for us and doing whatever you can to help us succeed.”

“Thanks for being so confident in me and being so nice. Also how many cool experiments you did with us... I like how you make things easier to understand... you also make sure that we understand the topic before moving to the next.”

“When anyone needs help, you are there. I don’t feel uncomfortable when asking you for help because you are really open to help me do better.”

From Dr. Larocque’s peer tutor [43]:

“Dr. Larocque ensured that all necessary accommodations for the student’s educational success that could be made were made... [She] continually took detailed notice of the student’s work during class and pointed it out as an example during class, resulting in the student feeling more included in the class. This notice and care further motivated the student to maintain a high level of work despite the language barrier... As a result of the attention and work she dedicates to each student’s learning, I have heard several students state that it is their ‘favorite class’ or the only class that they ‘really care about.’”

From SWE Next Club Members [43]:

In 2015-2017, I was faculty adviser for a new club at Maria Carrillo called SWE Next. SWE Next is way for girls to become part of the Society of Women Engineers before they obtain degrees in engineering [44]. Before graduating, one SWE Next member gave me a card. In it, she wrote “The life of the mind requires courage and sacrifice, and you have consistently demonstrated how to pursue what you love with grace and enthusiasm. Thank you, too, for pushing all of us to work at higher levels. I am very grateful that you started SWE, gave us real experience in the community, and taught us how to collaborate. I have learned many life lessons from you, and I will miss you immensely.” A member of SWE Next who graduated in June 2016 wrote “I now think of you as a mentor and a friend I can geek out with anytime about rocks or neurology or engineering or food science or whatever it may be. Thank you for sharing all of your vast wisdom with us about science and being a woman in the field. And mainly, for all the support and encouragement you have offered me this year.”

From Fellow Teachers at Maria Carrillo High School:

Dr. Larocque also developed effective relationships with fellow teachers. Former teaching colleague Anna Van Dordrecht said “For the 2014-15 and 2015-16 school years, Addie and I shared a classroom, so I got the chance to see first-hand the high level of investment and commitment she has for her students and subject. Because Addie has worked in the field and the university as a scientist, she is able to bring fascinating examples and stories of real-world science application into the classroom... In addition to being committed to student learning, Addie is deeply tuned in to the physical and emotional well-being of her students. She is both caring and empowering, and based on all of the interactions I’ve witnessed in the classroom, students are very confident that she cares for them as people not just students. Both her freshmen students and the older ones she’s worked with in the engineering club light up when they see her and seek her out in a crowd to say hello. Someone with such a high level of content expertise and such a big heart for students is most surely the kind of person we want in the classroom.” [45]

Mr. Joe Sims, English teacher at MCHS, wrote “Our first collaboration focused on Adrienne’s time living in Indonesia. Our freshman English and history classes are thematically focused on global literature and the humanities so it is vital to have guest speakers that are able to share their stories about their experiences from around the world. With this knowledge about our school’s curriculum, Adrienne generously made herself available to the entirety of our ninth grade English and Humanities core on her days off. At the time Adrienne spoke, my students were engaged in a project-based assignment focused on current events in Asia. Adrienne’s presentation was immersive as she quite literally transformed my classroom into a museum dedicated to Indonesian culture. Her presentation captivated my students and made the content of my class all the more real to them. It is supplemental educational experiences like these that will make students identify with becoming global citizens and ultimately allow for our goal to implement Common Core standards based on non-fiction “real-world” matters and concepts successful.” [46]

At Maria Carrillo, I initiated an informal collaboration among teachers in several departments (Science, Humanities, Art) who were interested in making explicit cross-curricular connections between our respective courses. Mr. Sims wrote “Adrienne and I brainstormed to create more cross-curricular opportunities for our students. We are currently developing plans to incorporate Earth Science into English, and vice versa, in a variety of ways. If successful, our students will see how astronomy influenced Shakespeare and explore geology, volcanoes, and Zen rock gardens while learning to write argumentative essays about these topics. In addition, Adrienne founded and facilitates a committee of like-minded educators to begin work on even more cross-curricular collaboration. This group now

consists of an art teacher, multiple English and humanities teachers, and a physics teacher. This group has grown exponentially since Adrienne began it and will continue to grow as we invite math teachers into the mix in the coming years. It is collaborative efforts like these that will excite our students and invigorate our teachers and it is visionaries like Adrienne that makes them possible... I am grateful to have the opportunity to work with a colleague that inspires every teacher that meets her. Adrienne is indispensable to our profession.” [46]

RSP teacher Ms. Sarah Thompson wrote “During her time here, Dr. Larocque has really impressed me. She presents material in a way that is interesting and engaging to her students... Her courses are rigorous, but she makes it accessible to every student. They love her class and feel that she is very approachable and caring. She is especially in tune with the students with special needs. Dr. Larocque makes them feel comfortable in their class and is able to help them learn the material in the way that is best for them... She provides valuable feedback for IEP meetings and always makes time to attend the meetings. Dr. Larocque has a good rapport with parents as well. She makes it easy for them know what is going on her classroom, and she is always available for discussions.” [47]

From Santa Rosa Administrators and Educators Outside the Classroom:

Principal Vicki Zands observed Dr. Larocque in the classroom in 2016. In her final evaluation, Principal Zands wrote “Dr. Larocque has shown great ability in understanding how students learn and what interests them. Her previous work outside of education has allowed her to really put the learning into context for the students. She uses a variety of media and hands-on activities to make the science real... Dr. Larocque places great emphasis on creating a community in her classroom where students feel safe to learn and share their experiences. She has high expectations for behavior and for academic achievement... Dr. Larocque works very hard to get to know her students as learners and as people. This information helps her to adapt her lessons to the needs of those students... Dr. Larocque uses a variety of formative and summative assessments to guide her teaching... Dr. Larocque spends a lot of time reflecting on her teaching and how she can reach her students... Dr. Larocque is a respected, important part of the Carrillo family. She is constantly improving her practice to meet the needs of her students.” [48]

In 2017, Vice Principal Katie Barr observed Dr. Larocque with her students. Ms. Barr said “Dr. Larocque is a masterful communicator and works diligently with her students to ensure they are connected to the content through sharing real-world experiences. In my observations I have witnessed her changing pace of lessons to ensure all students are engaged, using digital access to content so students have the opportunity to “play” with the material and learn through inquiry... I am extremely impressed by Dr.

Larocque's passion and empathy for her students. She noticeably sets high expectation for her students and gently guides them to meet her at the level of work she expects... Dr. Larocque has mastered differentiation and developed a system that allows students work at a pace that works for them... Dr. Larocque has developed an understanding of scaffolding and building upon previous knowledge that ensures that her students are gaining access to the content... In my observations I have witnessed her using sentence framing and inquiry to address the needs of her EL learners, in addition to assignment choices that allow options... It is clear that Dr. Larocque is thinking two or three steps ahead as she plans and builds her lessons. She gently guides students in their learning and builds their confidence by celebrating the small wins... She is constantly self-reflective and searches for ways to improve her lessons." [49]

An important initiative of Santa Rosa City Schools is to create an equitable learning environment. Dr. Larocque has had the opportunity to participate in Unconscious Bias Training and related activities. She was recruited for the district's Equity Steering Committee where she works on implementing equity initiatives with consultant Stephanie Graham. According to Ms. Graham, Dr. Larocque is "a consummate professional and an unrivaled advocate for educational equity and social justice... Addie is dedicated not only to Science education but also to helping every individual realize his/her full potential. She will do whatever it takes to scaffold students from where they are to where they need to be to master rigorous academic content. Not many teachers go this extra mile... Addie understands that there are groups of students in our schools whose needs are consistently undervalued and under addressed, and Addie chooses to serve THESE students over others...to reshape programs, practices and services so that culturally and linguistically diverse students are better served and more successful in our schools. Addie measures her own success and effectiveness based not on only on how well she performs but on how well her most under-served students perform under her tutelage." [50]

Other Evidence of Success in Secondary Education:

Because CLAD is not embedded in the Eminence Credential, Dr. Larocque took courses on-line through UC San Diego to obtain her authorization while teaching at Maria Carrillo High School. She completed the courses in 2016, receiving a grade of A in every course [51].

Much of the formal professional development that Dr. Larocque has done has been in two areas: equity in education (described above), and implementation of the Next Generation Science Standards (NGSS). The state of California adopted the NGSS in 2013 [52]. In 2014 to 2016, members of the Science Department

at Maria Carrillo collaborated in developing a prototype to implement the new standards through a Teacher Based Reform (TBAR) grant [53]. The work was led by Ms. Anna Van Dordrecht, now Curriculum Coordinator for Science at the Sonoma County Office of Education, who wrote “Addie was an extremely important contributor in this group, both sharing the work she was doing in her own classroom and offering insights and questions that helped drive the work forward. Part of the reason her contributions were so essential for the success of the group is that she brings a different perspective from her work in research, universities, and international schools.” [45]. Subsequent to that work, Dr. Larocque was recruited by SCOE to be part of a 21st Century Science Teacher Leader Cohort to support Sonoma County teachers in the implementation of the Next Generation Science Standards [54].

In 2016, Dr. Larocque suggested to Anna Van Dordrecht that they should co-author an article about the use of storytelling to engage students and illustrate the science and engineering practices of NGSS, an approach that Ms. Van Dordrecht pioneered a decade earlier. Their article appeared in *California Classroom Science*, the on-line publication of the California Science Teachers Association [55]. Dr. Larocque continues to use and further develop this technique in her classroom.

Post-Secondary Teaching Level

While at the University of Manitoba, Dr. Larocque developed and taught undergraduate courses in Earth and Planetary Science, Environmental Earth Science, Inorganic Geochemistry, and Mineral Deposits. In addition, she created graduate courses in Environmental Geochemistry [56, 57]. Dr. Larocque worked diligently to inspire and educate students in and out of the classroom. She had excellent student evaluations and letters of support for the courses she taught there [58]. Letters of recommendation also confirm her commitment to her students’ professional and personal development. In academic settings, the decision to award promotion is based on a candidate’s research, teaching and service contributions. Dr. Larocque would not have been promoted to Associate Professor, particularly as hers was considered an early application, if her teaching was not of the highest caliber [15].

Ms. Michelle Nicolas, a former graduate student supervised by Dr. Larocque who is now Chief Geologist at the Manitoba Geological Survey, stated that Dr. Larocque “demands excellence from her students, and instills a sense of pride in each student as they learn from her. She encourages each student and helps them when needed, all the while giving them the room they need to learn and grow at their own pace... every student who has benefited from taking one of Dr. Larocque’s classes leaves with a sense of accomplishment and true understanding of the concepts taught. Dr. Larocque knows that all students, regardless of their

previous academic performance, are capable of learning, it [is] just a matter of finding what learning method works best for them, in order to assure academic success.” [59].

Dr. Daniel Layton-Matthews, former U of M student and now a Professor of Geological Sciences at Queen’s University, said “Her teaching style was very organized, concise and taught with enthusiasm. If questioned during lecture, Adrienne would spend the time during class to explain the theory until the student clearly understood the answer. If this was not enough, or the student did not feel comfortable asking questions in class, Adrienne was always willing to spend time out of class talking about her lectures. Her office door was always open, and many students (including myself) would often approach her with questions on other classes or career advice.” [60].

Ms. Shastri Ramnath was instructed and supervised by Dr. Larocque as an undergraduate and is now President and Principal Geologist for Orix Geoscience. Describing Dr. Larocque, she said “I have never seen someone get so excited about learning new things and teaching them to others... She really made science so interesting and exciting! I found that she did the same in class as well... I appreciated the simplicity to which she could explain very complex theories as I was able to understand the concepts with context in the bigger picture. I finally was able to learn about geochemistry, a topic that had intimidated me before I took Dr. Larocque’s class.” [61].

Dr. Michelle Huminicki, a faculty member at Brandon University who was taught and supervised at the undergraduate level by Dr. Larocque said “I first knew Dr. Larocque when she was teaching an advanced second year Geochemistry course at the University of Manitoba, Canada. Not only was the course material well researched, prepared, and presented but both lab work and class lectures provided practical as well as theoretical aspects vital to the background of any beginning (or advanced) earth scientist. Her knowledge and excellent ability to teach made for a very interesting and valuable course. In January 2000, Dr. Larocque also taught a third and fourth year Mineral Deposits course covering a diverse range of deposit types, mineralization, and processes. While covering such a large number of deposits, the thoroughness and attention to detail was always there. As a professor, Dr. Larocque encouraged group interaction and class presentations, which are essential to the learning process. She was an asset to the Department of Geological Sciences at the University of Manitoba and was more than well respected and appreciated by her students... I personally would not have the confidence and knowledge to be the geologist I am today if it weren’t for Dr. Larocque.” [62].

Ms. Sarah Mearon, a licensed Professional Geologist and environmental consultant in the State of California, did her undergraduate degree at the University of Manitoba and graduate studies at Stanford. She said “Dr. Larocque is an outstanding educator, scientist, and mentor who stands out as one of the most effective and memorable teachers in my educational history. Her [geochemistry] class was intensive and academically challenging, but it was clear that she really went the extra mile to ensure her students fully understood the material and would be able to use it as a building block for other courses in the curriculum. Dr. Larocque’s teaching style was informative, interactive, and always exciting. Her influence extended well beyond the duration of that class. She continued to occupy a prominent position as a well-known and well-respected mentor within the department throughout my time there.” [63].

Mr. Brian Skanderbeg is the former CEO of Claude Resources and current president and CEO of GFG Resources. He is another graduate of U of M who was instructed by Dr. Larocque, and said “Her very approachable nature and genuine interest in a student’s well-being resulted in my seeking her for advice. She posed key questions and eventually led me to make the decision to pursue geology as a degree and career. As a lecturer, Dr. Larocque taught me more in any single course than any of my other professors and more importantly provided a framework for learning that I still follow today. Her lecturing style and preparation allowed students to focus on the important concepts... In summary, she is an exceptionally qualified educator... Adrienne played a very significant role in my success as a geologist and professional.” [64].

Dr. James Franklin said “She paid particular attention to ensuring that her students understood some of the more complex geological interactions that attended various geological processes. Introductory – level courses are particularly challenging to develop, as most university students have no background in the Earth Sciences in Canada. Her dedication to the quality of her teaching became well known nationally... I know of no other person who has such a rich background in earth science, and who is so able to communicate the excitement and value of knowing about our earth to students of all ages. Hers’ is a rare talent amongst scientific researchers...to be able to excite students about the basic earth processes operating around us, while at the same time remaining a world-class expert in so many aspects of geoscience.” [30].

Since 2014, Dr. Larocque has been an Adjunct Instructor in the Earth and Space Sciences Department at Santa Rosa Junior College, teaching introductory Geology and Environmental Science classes (GEOL1, ENVS12) at night and in the summer [56]. In her evaluation for GEOL1 in 2016, students gave her an overall score of 4.84/5 [65]. Student comments are included below.

Comments from Students at Santa Rosa Junior College [65]:

“Dr. Laroque [sic] is an exceptional instructor. Her enthusiasm for the subject is infectious and she provides information in so many different ways, everyone has a way to come to understanding. I love the Sophia website – she posts videos, slide shows (used in the next class & available ahead of time), and more.”

“It’s a great class & a great instructor – and I am not even a science lover!”

“I like how she remains excited and enthusiastic throughout class, is relateable. [sic]”

“I came into this class, with a very low science academic confidence. I was only taking the class to fulfill GE requirements. I am pleasantly surprised at how much I enjoy this class and am really proud of all the knowledge I have gained thus far. I look forward to coming to each weekly class.”

“The HW has helped me further understand the course material. The professor is so engaging and humorous and makes sciences FUN!”

“Awesome teacher! Her love and knowledge for Geology makes me want to come to class. Her high energy keeps me interested and awake. I really like how she explains things. Instead of using Big Science Words that I will never remember or understand, she will use words that normal humans understand. Plus, the online slideshows and videos are extreamly [sic] handy!”

“Professor Larocque is honestly the best teacher ever! She is so nice, helpful, sweet, and approachable. You can definitely tell this is her passion and she makes class fun, especially since she shares her experiences and tells us examples or stories, or she makes funny jokes. She is always in class minimum 30 min. before, so she is always ready to help students. And she is also available to help or answer any questions after class. I love coming to her class and I’ve learned so much, I would recommend this class with her to anyone who is interested in taking geology or anyone who is doing their general education. She is the best teacher ever!”

“She is extremely enthusiastic about the subject. I really like all the different examples she gives in class. I would wish there would be more in-depth content as well. Overall, a lovely class.”

“I really enjoy this class. She is an excellent teacher who is engaging, fun, not-boring or monotone, and loves to interact with us. She is so energetic and excited about her subject and in turn makes me feel the same. If this course wasn’t just for fun I would hope that she would teach the next class in this branch.”

“She has an enthusiastic attitude about the subject that makes you want to learn more from her excitement. I love that she will give us different models for something that allows the material to make sense when presented in so many different ways. I also find it very helpful that she gives us materials before class so I feel more engaged instead of having to write everything down.”

6. Extraordinary Success in Science

Obtaining research funding is a highly competitive endeavor. Grant proposals are sent to experts in the field for review. At the beginning of her MSc program, Dr. Larocque applied for and received a grant from the Ontario Geological Survey (OGS) to fund her thesis research. It is *highly unusual* for a student to write a proposal, much less be successful in getting the funding. Her thesis was subsequently published by the OGS as an open file report [Larocque 1991; 9].

Dr. Larocque’s doctoral research was supported by research grants from the National Science and Engineering Research Council of Canada, the government agency responsible for granting research funds to scientists and engineers in all fields throughout Canada, and Audrey Resources Inc., the operator of the mine where Dr. Larocque carried out her thesis field work [66]. She wrote the grant proposals for both the government and industry grants, again, an *unusual accomplishment* for a graduate student.

While at the University of Manitoba, Dr. Larocque was successful in supporting her research and equipment acquisitions through grants obtained from university, government and industry sources. Some grants were applied for independently; others were sought as part of research consortia [67].

NSERC is equivalent to the National Science Foundation in the US. Competition for grants is fierce. Operating grants typically are awarded for 4 years, but must be renewed each year. It is not uncommon for NSERC to reduce or entirely eliminate grant funds if the Council feels that the monies are not being used effectively. In 2000, Dr. Larocque’s operating grant from NSERC (equivalent to the US National Science Foundation) was renewed at the same level, even though she had been on maternity leave, then a reduced appointment (60%), since 1998 [68]. The fact that her full grant was renewed when she was effectively a half-time employee indicates the importance of her continued research in the opinion of this national body.

C) Additional Evidence of National/International Recognition of Eminence

Many examples of evidence of Dr. Larocque's international reputation have been described in previous sections. These include her success in obtaining research grants, requests from other scientists to collaborate or advise them on their research, invitations to contribute papers to thematic journal issues, requests to give presentations in short courses, and letters of support from leading scientists from around the world.

As stated before, editors of scientific journals solicit reviews from *known experts in the field*. Between 1994 and 2002, editors of professional journals in *North America and Europe* solicited reviews for more than 14 manuscripts from Dr. Larocque [27, 28]. Between 1999 and 2003, she reviewed 4 grant proposals submitted to *national granting agencies* in the US (National Science Foundation) and Canada (NSERC) [27]. In addition, Dr. Larocque was recruited to serve on NSERC's prestigious Committee on Research Partnerships. According to Isabelle Blain, then Corporate Secretary of the CRP, "The excellent reputation of the NSERC research partnerships programs is due in large part to the hard work of *respected members of the research community* who provide thoughtful advice to Council on program and policy development." [69; emphasis added].

Throughout her scientific career, Dr. Larocque was invited to give many presentations at universities and in government agencies all over Canada and the US, at the expense of the inviting organizations. These invitations were extended by universities (Sonoma State, UC Davis, Brigham Young University, Louisiana State, University of New Mexico, New Mexico State, Iowa State), government organizations in Canada and the US, and various industry groups [70]. This indicates the high level of national and international interest in her research.

LIST OF SUPPORTING DOCUMENTS AND LINKS:

Copies of all of the documents listed below are located in the appendices, as indicated. Originals are available for viewing upon request.

[1] Education and Work Experience (Appendix I).

[2] <http://www.earthsci.carleton.ca/future-students/graduate/ottawa-carleton-geoscience-centre>

[3] Transcript from University of Western Ontario (Appendix I).

[4] Transcript from Queen's University (Appendix I).

[5] <http://www.topuniversities.com/where-to-study/north-america/canada/top-universities-canada-province-20132014>

- [6] Academic Credentials Report from Foreign Credentials Service of America (Appendix I).
- [7] <http://www.lanl.gov/careers/career-options/postdoctoral-research/postdoc-program/postdoc-appointment-types.php>
- [8] Letter of verification of employment at Los Alamos National Laboratory (Appendix I).
- [9] List of publications (Appendix II).
- [10] List of presentations at professional meetings (Appendix II).
- [11] <http://www.prnewswire.co.uk/news-releases/thomson-scientific-analyzes-10-years-of-geology-research-to-rank-the-most-cited-published-papers-153465745.html>
- [12] List of courses taught at University of Manitoba and Santa Rosa Junior College. This includes undergraduate and graduate courses (Appendix III).
- [13] List of students supervised at University of Manitoba (Appendix III).
- [14] List of professional committees and university service (Appendix II).
- [15] Letter from President Szathmáry of the University of Manitoba announcing Dr. Larocque's promotion from Assistant to Associate Professor (Appendix I).
- [16] List of presentations in short courses, symposia and special sessions (Appendix II).
- [17] <http://econgeol.geoscienceworld.org/>
- [18] <http://www.segweb.org/>
- [19] Letter of support from Dr. John Thompson of Cornell University, written for Dr. Larocque's application for an Eminence Credential in Earth Science (see Appendix IV).
- [20] <http://e-sga.org/publications/mineralium-deposita/>
- [21] <http://www.iavcei.org/>
- [22] <http://www.mineralogicalassociation.ca/>
- [23] <http://www.segweb.org/store/SearchResults.aspx?Category=REV> (Dr. Larocque's papers are in volumes 7 and 11).
- [24] Letter from Dr. Mark Hannington, formerly a research scientist at the Geological Survey of Canada and currently the holder of a research chair in Economic Geology endowed by Goldcorp at the University of Ottawa, written in support of Dr. Larocque's application for an Eminence Credential in Earth Science (Appendix IV).
- [25] Letter from Dr. Jennifer Jackman, formerly of the Canada Center for Mineral and Energy Technology, written in support of Dr. Larocque's application for an Eminence Credential in Earth Science (Appendix IV).
- [26] http://en.wikipedia.org/wiki/Louis_J._Cabri
- [27] List of reviews solicited by international professional journals and granting agencies (Appendix II).

[28] Letter from Dr. Robert Zierenberg of UC Davis requesting Dr. Larocque to review a paper for *Economic Geology* (Appendix II).

[29] Letter from Dr. Jay Hodgson in support of Dr. Larocque's application for her Eminence Credential in Earth Science (Appendix IV). Dr. Hodgson was Dr. Larocque's PhD supervisor at Queen's University. He retired from Queen's to become Chief Geologist at Barrick Gold Corporation. He now is an independent consultant to mineral exploration and mining companies worldwide (Appendix IV).

[30] Letter from Dr. James Franklin, former Chief Scientist of the Geological Survey of Canada, in support of Dr. Larocque's application for her Eminence Credential in Earth Science (Appendix IV).

[31] Letter from Dr. Paul Spry of Iowa State University written in support of Dr. Larocque's application for Eminence Credential (Appendix IV).

[32] Letter from Dr. Jeffrey Keith, Associate Academic Vice President at Brigham Young University, in support of Dr. Larocque's application for an Eminence Credential in Earth Science (Appendix IV).

[33] Letter from Dr. Jeffrey Keith, Professor of Geology at Brigham Young University in Utah, written in support of Dr. Larocque's application for promotion at the University of Manitoba (Appendix IV).

[34] Letter from Dr. Fraser Goff, senior scientist at Los Alamos National Laboratory (now retired) and adjunct professor at two colleges in New Mexico, written in support of Dr. Larocque's application for an Eminence Credential in Earth Science (Appendix IV).

[35] Letter from Dr. Nigel Cook, Past-President of the International Association on the genesis of Ore Deposits (IAGOD), and current Chairman (2014-2018) of the International Mineralogical Association's Commission on Ore Mineralogy, written in support of Dr. Larocque's application for an Eminence Credential in Earth Science (Appendix IV).

[36] http://www.segweb.org/store_info/REV/REV-11-Additional-Product-Info.pdf (scroll down for biographies of contributors).

[37] <http://www.btb.termiumplus.gc.ca/tpv2alpha/alpha-eng.html?lang=eng&i=1&index=alt&srchtxt=METALS%20IN%20THE%20ENVIRONMENT%20RESEARCH%20NETWORK>

[38] Letter from Dr. Pat Rasmussen, senior research scientist at Health Canada, in support of Dr. Larocque's application for an Eminence Credential in Earth Science (Appendix IV).

[39] Hawley Medal Citation:

<http://www.mineralogicalassociation.ca/index.php?p=32&page=hawley01.php#citation>

[40] List of winners of Hawley Medal: <http://www.mineralogicalassociation.ca/index.php?p=56>

- [41] Thomson Scientific Most Cited Published Papers: <http://www.prnewswire.com/news-releases/thomson-scientific-analyzes-10-years-of-geology-research-to-rank-the-most-cited-published-papers-58022417.html>
- [42] <http://www.mineralogicalassociation.ca/index.php?p=54>
- [42] Letters and e-mail messages from parents of students at Maria Carrillo High School (Appendix IV).
- [43] Letters and notes from students, including letter of support from Peer Tutor Carolina Avelar for Dr. Larocque's application for second issuance of her Eminence Credential in Earth Science (Appendix IV).
- [44] <http://societyofwomenengineers.swe.org/swenext>
- [45] Letter from Anna Van Dordrecht in support of Dr. Larocque's application for second issuance of her Eminence Credential in Earth Science. Ms. Van Dordrecht is a former teaching colleague of Dr. Larocque at Maria Carrillo High School. She currently is Curriculum Coordinator for Science at the Sonoma County Office of Education. A copy of the letter is included in Appendix IV.
- [46] Letter from MCHS English teacher Mr. Joe Sims describing cross-curricular collaboration, written in support of Dr. Larocque's application for second issuance of her Eminence Credential in Earth Science. A copy of the letter is included in Appendix IV.
- [47] Letter from RSP teacher Ms. Sarah Thompson in support of Dr. Larocque's application for second issuance of her Eminence Credential in Earth Science. A copy of the letter is included in Appendix IV.
- [48] 2016 evaluation by Principal Vicki Zands of Maria Carrillo High School. A copy is included in Appendix III.
- [49] 2017 evaluation by Vice Principal Katie Barr of Maria Carrillo High School. A copy is included in Appendix III.
- [50] Letter of support from educational consultant Ms. Stephanie Graham in support of Dr. Larocque's application for second issuance of Eminence Credential in Earth Science. A copy of the letter is included in Appendix IV.
- [51] CLAD grade reports from UC San Diego Extension. Copies are included in Appendix III.
- [52] California Department of Education: Next Generation Science Standards
<http://www.cde.ca.gov/pd/ca/sc/ngssintrod.asp>.
- [53] Agenda for one of the TBAR group's monthly meetings (Appendix III).
- [54] Information sheet about NGSS Teacher Leader cohort (Appendix III).
- [55] Article for *California Classroom Science*: The Power of Storytelling in the NGSS classroom:
<http://www.classroomscience.org/the-power-of-storytelling-in-the-ngss-classroom>.
- [56] List of courses taught at University of Manitoba (including undergraduate and graduate courses) and Santa Rosa Junior College (Appendix III).

- [57] Syllabus for Dr. Larocque's undergraduate course in Inorganic Geochemistry at the University of Manitoba (Appendix III).
- [58] Sample student evaluations from University of Manitoba, including analysis, raw data and student comments (Appendix III).
- [59] Letter of recommendation from Ms. Michelle Nicolas in support of Dr. Larocque's application for Eminence Credential (Appendix IV).
- [60] Letter of recommendation from Dr. Dan Layton-Matthews written in support of Dr. Larocque's application for Eminence Credential (Appendix IV).
- [61] Letter of recommendation from Ms. Shastri Ramnath in support of Dr. Larocque's application for Eminence Credential (Appendix IV).
- [62] Letter of recommendation from Michelle Huminicki in support of Dr. Larocque's application for Eminence Credential (Appendix IV).
- [63] Letter from Ms. Sarah Mearon (MSc, P Geo in the state of California) in support of Dr. Larocque's application for Eminence Credential. Ms. Mearon was an undergraduate student at the University of Manitoba who later completed her MSc at Stanford (Appendix IV).
- [64] Letter from Mr. Brian Skanderbeg, MSc, in support of Dr. Larocque's application for Eminence Credential (Appendix IV).
- [65] Student comments and ranking of Dr. Larocque's teaching at Santa Rosa Junior College (Appendix III).
- [66] Letter from Michel Bouchard of Audrey Resources in support of grant application to NSERC (Appendix II).
- [67] List of research grants obtained (Appendix II).
- [68] Memo from NSERC regarding renewal of operating grant (Appendix II).
- [69] Letter of thanks from Isabelle Blain, Corporate Secretary of NSERC Committee on Research Partnerships (Appendix II).
- [70] List of invited seminars and guest lectures (Appendix II).

APPENDICES

I. Educational and Employment History in Earth Science

- a. MSc transcript
- b. PhD transcript
- c. Copy of Academic Credentials Report from Foreign Credentials Services of America. The original report has already been reviewed by the Commission on Teacher Credentialing as part of Dr. Larocque's application for an Emergency 30 Day Substitute Teaching Permit.
- d. List of Educational and Work Experience
- e. Letter of verification of employment at Los Alamos National Laboratory
- f. Letter from President Szathmáry of the University of Manitoba confirming Dr. Larocque's promotion to Associate Professor

II. Research and Service Accomplishments

- a. List of publications in refereed journals
- b. Hawley Medal Citation
- c. List of presentations at professional meetings
- d. List of presentations in short courses and symposia
- e. List of invited seminars and guest lectures
- f. List of research grants obtained
- g. Letter from Michel Bouchard regarding company support for NSERC grant application
- h. Memo from NSERC regarding renewal of operating grant
- i. Letter from NSERC regarding membership on Committee on Research Partnerships
- j. List of reviews of grant proposals and manuscripts submitted to journals
- k. Letter from Dr. Robert Zierenberg regarding review of paper

III. Teaching Accomplishments

- a. List of courses taught at University of Manitoba and Santa Rosa Junior College
- b. List of student theses supervised: This includes undergraduate and graduate students whose thesis research Dr. Larocque supervised.
- c. University of Manitoba course syllabus for 7.277 Principles of Inorganic Geochemistry.
- d. Analysis of teaching evaluations: At the University of Manitoba, students are requested (but not compelled) to complete anonymous evaluations of their instructors at the end of each course. Two examples are included. The first is for Earth and the Environment (7.132). The second is for Principles in Inorganic Geochemistry (7.277), a demanding course required by all students in Geological Sciences.
- e. Written comments from student evaluations for 7.277 Principles of Inorganic Geochemistry.

- f. Raw teaching evaluations
- g. Student comments and ranking of Dr. Larocque's teaching at Santa Rosa Junior College.
- h. 2016 evaluation by Principal Vicki Zands, Maria Carrillo High School.
- i. 2017 evaluation by Vice Principal Katie Barr, Maria Carrillo High School.
- j. Dr. Larocque's CLAD grade reports from UC San Diego Extension.
- k. Agenda for one of the TBAR group's monthly meetings.
- l. Information sheet about NGSS Teacher Leader Cohort.

IV. Letters of Recommendation

- a. Letters written in support of Dr. Larocque's application for an Eminence Credential in Earth Science:
 - i. Dr. Jennifer Jackman was a senior research scientist (physicist) and recently retired as Director General of the Materials Technology Laboratory at the Canada Centre for Mineral and Energy Technology (CANMET), a Canadian government department. She instructed Dr. Larocque in the operation of the ion microprobe (SIMS).
 - ii. Dr. James Franklin, formerly Chief Scientist of the Geological Survey of Canada, was Dr. Larocque's co-supervisor during her summer employment in Mineral Resources Division at the GSC and external referee for her doctoral defense. He is world-renowned for his work on mineral deposits.
 - iii. Dr. Paul Spry is a Professor of Economic Geology and former Chairman of the Department of Geological and Atmospheric Sciences at Iowa State University. He is the author of countless articles and books about mineralogy and ore deposits and was the Thayer Lindsley Distinguished Lecturer for the Society of Economic Geologists in 2013. Dr. Spry has been on many editorial boards for scientific journals and is the Chairman of the Working Group on Ores and Metamorphism, part of the International Association on the Genesis of Ore Deposits.
 - iv. Dr. Mark Hannington was formerly a research scientist at the Geological Survey of Canada and is currently the holder of a research chair in Economic Geology endowed by Goldcorp at the University of Ottawa.
 - v. Dr. Jay Hodgson was Dr. Larocque's PhD supervisor at Queen's University. He took early retirement from Queen's to become Chief Geologist for Barrick Gold Corporation, and is now an independent consultant to mining and mineral exploration companies worldwide.
 - vi. Dr. Jeffrey Keith is Associate Academic Vice President of Brigham Young University. He was Dr. Larocque's research colleague and co-recipient of the Hawley Medal of the Mineralogical Association of Canada.
 - vii. Dr. John Thompson of Cornell University, written for Dr. Larocque's application for an Eminence Credential in Earth Science.
 - viii. Dr. Fraser Goff was a senior scientist (now retired) and research colleague when Dr. Larocque was a postdoctoral fellow at Los Alamos National Laboratory. He currently is an adjunct professor at two colleges in New Mexico.

- ix. Dr. Nigel Cook is Past-President of the International Association on the genesis of Ore Deposits (IAGOD), and current Chairman (2014-2018) of the International Mineralogical Association's Commission on Ore Mineralogy. He is a world-renowned mineralogist.
- x. Dr. Pat Rasmussen is a senior research scientist at Health Canada.
- xi. Ms. Michelle (Boulet) Nicolas (MSc) was one of Dr. Larocque's graduate students and is now Chief Geologist for Sedimentary Geoscience at the Manitoba Geological Survey (<http://ca.linkedin.com/pub/michelle-nicolas/5b/188/824>).
- xii. Ms. Shastri Ramnath (MSc, MBA) was an undergraduate student who took Dr. Larocque's 2nd-year Geochemistry course and did her senior thesis under Dr. Larocque's supervision. She is President and Principal Geoscientist at Orix Geoscience Inc. (<http://ca.linkedin.com/pub/shastri-ramnath-msc-mba-p-geo/29/484/252>).
- xiii. Dr. Daniel Layton-Matthews was an undergraduate who took Dr. Larocque's 2nd-year Geochemistry course and did his senior thesis under her supervision. He is now an Associate Professor at Queen's University in Canada (<http://ca.linkedin.com/pub/dan-layton-matthews/44/b82/9b7>).
- xiv. Dr. Michelle Huminicki was an undergraduate who took 2nd-year Geochemistry and 4th-year Mineral Deposits courses with Dr. Larocque. She also worked for Dr. Larocque for one summer and did her senior thesis under Dr. Larocque's supervision. She is currently an Instructional Associate at Brandon University in Canada (<http://www.brandonu.ca/geology/faculty-staff/m-huminicki/>).
- xv. Ms. Sarah Mearon was an undergraduate student at the University of Manitoba who later completed her MSc at Stanford. She is a licensed Professional Geologist and environmental consultant in the state of California.
- xvi. Mr. Brian Skanderbeg was an undergraduate student at the University of Manitoba who went on to complete his MSc at Rhodes University in Grahamstown, South Africa. He was formerly the Chief Operating Officer for Claude Resources Inc., a mining company in Canada. He currently is president, CEO, and director of GFG Resources.
- b. Letters written in support of Dr. Larocque's application for second issuance of her Eminence Credential in Earth Science.
 - i. Ms. Anna Van Dordrecht is a former teaching colleague of Dr. Larocque at Maria Carrillo High School. She currently is Curriculum Coordinator for Science at the Sonoma County Office of Education.
 - ii. Mr. Joe Sims is an English teacher at Maria Carrillo High School.
 - iii. Ms. Sarah Thompson is an RSP teacher at Maria Carrillo High School.
 - iv. Ms. Stephanie Graham is an educational consultant working with Santa Rosa City Schools staff on equity initiatives in the district.
- c. Letters and e-mails from parents of former students at Maria Carrillo High School.
- d. Notes and letters from students at Maria Carrillo High School and Santa Rosa High School.

V. Sample Research Publications

Papers marked by an asterisk in the List of Publications are included in this section.