Prof. Dr. Terry M. Seward (1940 – 2022)

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ABSTRACT

The geochemistry and geothermal community mourn the loss of a remarkable scholar, mentor, and friend, Terry M Seward, who passed away on December 24, 2022. Terry was a pioneering figure in the field of experimental geochemistry. His dedication to research, mentoring, and collaboration with colleagues will leave a long-lasting impact to researchers worldwide.

Figure 1: Terry Seward (circa 2018)

1. ACADEMIC CAREER

Terry began his formal academic career at McMaster University, Hamilton, Canada, where he completed a BSc degree in both chemistry and geology, awarded in 1965. His quest for knowledge led him to The University of Manchester, where he studied with Profs. Fyfe and McKenzie. There, he investigated the distribution of transition elements in the system $CaMgSi_2O_6$–$Na_2Si_2O_5$–H_20 at 1000 bars pressure (Seward, 1971) and was awarded his PhD. He also held a junior lecture position during this period. His experiences in Manchester confirmed and consolidated his love for experimental research, combining his chemistry and geology backgrounds.

Following his time in Manchester, Terry embarked on a journey that brought him to the other side of the world where he took up a position with the Chemistry Division of DSIR, New Zealand, under the mentorship of Dr. Jim Ellis, a world-leading hydrothermal chemist. There, his colleagues were chemists and he always said he benefited from this contact enormously. This is where Terry further developed his love of experimental research completing his first major contribution in this field "Thio complexes of gold and the transport of gold in hydrothermal ore solutions" (Seward, 1973). This groundbreaking work on the hydrothermal transport of gold was a seminal paper and led to many research projects by others in the following years. The significance of this contribution is underscored by the fact that his paper has been cited over 860 times.

Between 1976 and 1978 Terry held the prestigious position as an Alexander Humboldt Fellow at the Institute for Physical Chemistry and Electrochemistry, University of Karlsruhe, Germany. Here, he completed the study "The system hydrogen-water up to 440 C and 2500 bar pressure" with his then-mentor Prof. E.U. Franck ((Seward & Franck, 1981) cited over 190 times). These were very difficult experiments and only Terry's constant determination allowed him to complete the project.

On return to New Zealand, Terry became Group Leader of the Chemistry Division, DSIR. He spent a short time away in 1982 as a visiting professor at Pennsylvania State University, USA. This allowed him to collaborate in person with colleagues, particularly Prof. Hugh Barnes, well known for his books on hydrothermal chemistry. This collaboration lasted for the rest of their lives.

In 1988, Terry visited ETH Zurich, Switzerland, where he presented his research, introducing experimental hydrothermal geochemistry to this institution. His research was well-received, and he was invited back in 1989 to take up a full Professorship at ETH - a position that allowed him to continue and expand his previous research. In 1992, he became the Director of the Institute for Mineralogy, Petrology, and Geochemistry and in 1995 was appointed Chairman/head of Department of Earth Sciences and Dean of the Faculty.

Terry had many PhD and MSc students, as well as several post-doctoral fellows during his time at ETH. His dedication to mentoring the next generation of geochemists is evident and his reputation as an excellent and respected supervisor unsurpassed.

Between 1992-1995 he was appointed to the Board of Governors, for the Experimental Geochemistry Laboratories, Centre National de la Recherche Scientifique (CNRS), Orléans, France, and was also on the Board of Governors overseeing the Bavarian State High Pressure Laboratories, University of Bayreuth, Germany. His insights into experimental research were highly regarded.

During the period, Terry's personal research expanded to the use of the EXAFS synchrotron radiation for the study of metal complexation in hydrothermal solutions. Several outstanding contributions came from this research (Seward et al., 2000; Seward et al., 1996; Seward et al., 1999). Significant contributions were also produced in collaboration with doctoral, post-doctoral and professorial colleagues (Gammons & Seward, 1996; Renders & Seward, 1989; Williams-Jones & Seward, 1989)

In 1999, Terry took up an Air India Guest Professorship at the Indian Institute of Technology (IIT), Mumbai, (Powai), India.

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During which he gave lectures, discussed projects with staff and students, and presented a well-attended public lecture "The chemistry of aqueous solutions at high temperature: new insights from synchrotron studies with applications to earth sciences". This was a lecture where he was able to show his continuing advances into synchrotron techniques in the field of hydrothermal geochemistry.

In 2000, Terry returned for a sabbatical period to New Zealand where he had been awarded a Marsden Fund Senior Visiting Scientist position at the Institute of Geological and Nuclear of Sciences (IGNS). This was a time to meet with old colleagues and continue to pass on his knowledge in the field of hydrothermal chemistry especially applied to geothermal systems.

The Society of Economic Geologists (USA) appointed him as Distinguished Lecturer for the year 2001. In the same year he was elected as a Fellow of the European Association of Geochemistry and a Fellow of the Geochemical Society (USA) and was appointed President of the European Association of Geochemistry for the years 2002- 2003. Terry had always been an avid mineral collector and, in recognition of his research exploits and interest in minerals, a new mineral from Namibia was named in his honour (sewardite, $CaFe_2(AsO_4)_2(OH)_2$) (Roberts et al., 2002).

Over the intervening years, many important studies were completed, and papers published on the hydrothermal geochemistry of metals including gold, silver and copper in high temperature solutions (Boily & Seward, 2005; Mountain & Seward, 1999, 2003; Stefánsson & Seward, 2003a, 2003b, 2004; Zakaznova-Herzog & Seward, 2006; Zakaznova-Herzog et al., 2006)

Terry retired from ETH in 2006, nevertheless, he continued with his research. In 2007, he was appointed as a visiting Professor, University of Bristol, England, and in 2008 as an Invited Guest Professor, at Tongji University, Shanghai, China. In 2009, he held the Cox - Endowed Professorship, Stanford University, USA.

Deciding to return to New Zealand in 2010 he was appointed as Professor of Geochemistry at Victoria University of Wellington, New Zealand, where he continued with several MSc and four PhD students under his tutelage. Several important contributions resulted from these graduate theses (Olsen et al., 2018, 2019; Passarella, 2021; Sajkowski et al., 2021, 2022)

Terry's excellence in geochemistry was further recognised by being the first recipient of the S.H. Wilson Medal of the Geoscience Society of New Zealand for "lifetime excellence in geochemistry" in 2013. In 2014, he accepted his second Alexander von Humboldt Fellowship, to spend time at the Helmholtz Centre, GFZ (German Federal Geosciences Research Centre), Potsdam, Germany.

In 2014-2018, he was appointed to the X-ray Absorption Spectroscopy Program Advisory Committee of the Australian Synchrotron.

In 2019 Terry moved from Victoria University of Wellington to GNS Science. During this time, he was a researcher as part of the MBIE Endeavour Programme: Geothermal: The Next Generation. Terry continued diligently on his research at GNS and was in the process of establishing a high temperature-pressure UV-Vis spectroscopy facility to study hydrothermal solution chemistry at supercritical conditions. Unfortunately, despite his unwavering commitment and passion, Terry's journey was cut short by the onset of ill health. He passed away in December 2022, leaving behind a legacy of remarkable contributions to the field of geochemistry.

His dedication, intellectual curiosity, and tireless efforts had a profound impact on his peers and students. Many of these researchers continue his passion for experimental geochemistry in hundreds of locations around the world.

2. CONTRIBUTIONS TO NEW ZEALAND'S GEOTHERMAL RESEARCH

The late 1960s and early 1970s marked a significant of advancement in the study of hydrothermal transport of metals, accomplished mainly through laboratory experimentation. Pioneers like Hugh Barnes, David Crerar, and Terry Seward played a pivotal role by publishing ground-breaking papers on the transport of metals such as iron, copper, and gold. Although these studies were focussed on the genesis of ore deposits, it was evident that these results were equally applicable to geochemical processes in geothermal systems.

During this time, geothermal power development was also rapidly developing in New Zealand and had been since the 1950s. The need for accurate thermodynamic data for the dissolved components in geothermal fluids was crucial to prediction of issues such as mineral scaling and corrosion.

Terry's research at the time, and later in his career, contributed greatly to the essential data that are needed for prediction of geochemical issues relevant to geothermal power production. Examples include the measurement of the first ionisation constant of silicic acid (Seward, 1974) and the dissociation of hydrogen sulfide (Suleimenov & Seward, 1995). These data have been integral to ongoing geochemical modelling of geothermal fluids.

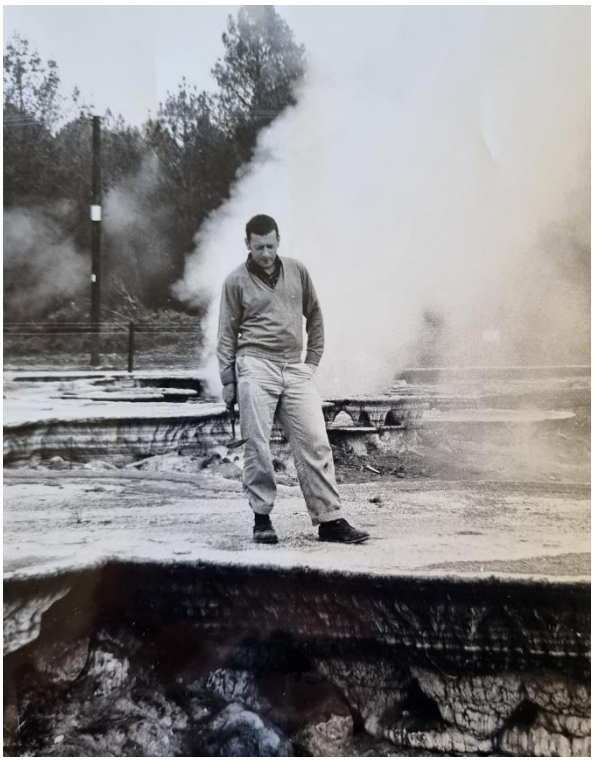

Figure 2: Terry Seward at Ohaaki Pool circa 1970

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Terry's contributions extended to increased understanding of individual geothermal systems in New Zealand. In several publications, the geology and geochemistry of these systems were studied and documented (Krupp et al., 1986; Krupp & Seward, 1987; Seward & Sheppard, 1986).

In summary, Terry's journey is celebrated by pioneering work in experimental geochemistry and significant contributions to our understanding of hydrothermal systems. His dedication to research, mentoring, and collaboration with colleagues will leave a long-lasting impact to researchers worldwide.

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