Introduction of Sigurdur R. Gislason for the 2018 Patterson metal

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It is my honor to introduce Sigurdur 'Siggi' Reynir GISLASON, of the University of Iceland for the Patterson Medal in Environmental Geochemistry of the Geochemical Society. Few if any scientists have neither addressed nor have made as large a contribution to resolving environmental issues as Siggi. His major contributions have fallen into three broad categories: Carbon Capture and Storage (CCS), volcanic hazards, and how natural processes affect climate at a global scale as I will detail below.

Siggi first got involved with carbon capture and storage, in 2006 when he was contacted by Olafur Grimsson, the Icelandic President, to devise an Icelandic solution to CCS. This request rapidly evolved into the CarbFix project, a collaboration between Siggi, Wally Broecker (Columbia University), Reykjavik Energy, and myself to design and demonstrate the viability of capturing and storing anthropogenic CO_2 as stable carbonate minerals through its reaction with basaltic rocks. Over the course of the past decade, Siggi has worked in close collaboration with geothermal energy companies, engineering companies, the Ministry for the Environment and a suite of Icelandic and international scientists to design the injection system, characterise the subsurface geology/hydrology, define the optimal injection conditions, and develop an extensive monitoring strategies. The challenge to put together and complete a large-scale environmental field project such as this is huge, not even counting the efforts required to get permission to inject carbon as radioactive tracers into the subsurface. Finally in 2012 after years of background work, CO_2 began to be injected into the subsurface and has been highly successful. Using a suite of novel and reactive and conservative tracers CarbFix has demonstrated the conversion of more than 95% of the injected CO_2 into stable calcite in less than two years at 20-50°C, providing safe and efficient mineral storage of anthropogenic carbon. This is the first pilot- and industrial-scale demonstration

of mineral carbonation. The success of this project has received worldwide attention since the publication of its major findings in an article published in Science magazine (Matter et al., 2016).

The research within the CarbFix project continues at present. Siggi, leading the CarbFix collaboration, which has developed new technology to co-inject CO_2 with mixed-acid gases that both provides safe storage for toxic gases such as H_2S, and also has lowered considerably the costs of the overall CCS process (to approximately \$30/ton CO_2 captured and stored). As such, this method has now been adopted as routine at the Hellisheidi geothermal power plant, the largest in Europe, and deployment is planned at other power plants.

In some ways, the community may have underestimated Siggi's role in the CarbFix project as he is commonly neither the first, second, nor even last author on many of the papers reporting the various results from the CarbFix project. This is due to his personal generosity; he always places students, post-docs and junior faculty in more prominent positions on author list to help promote their careers, at times underselling greatly his contribution and leadership in the project.

Although just Siggi's successful demonstration of carbon mineral storage in less than 2 years at the industrial scale, merits the Patterson medal all on its own, as it testifies to our ability to use geochemistry to tackle the global carbon challenge, Siggi could also be awarded the Patterson medal in recognition of his success in characterising, quantifying and better understanding volcanic hazards or his contribution to demonstrating how Earth surface processes influence global warming.

Siggi's contributions to towards understanding the effects of volcanic hazards are vast, ranging from defining potential toxic gas and metal transport to working directly with Icelandic Department of Civil Protection and Emergency Management to help evacuate people from affected areas. I feel that two of his contributions are particularly noteworthy. First, Siggi was the first scientist to collect fresh volcanic ash from the explosive 2010 Eyjafjallajökull volcanic eruption,

the eruption that shutdown air traffic over most of Europe for a week. Siggi drove into a nearly completely dark ash cloud at much personal risk to collect these samples. Siggi, together with collaborators at the Nano-centre in Copenhagen and University of Iceland, developed a protocol to assess the risk to air traffic and pollution of volcanic ash. A summary of this work was published by Siggi with 12 co-authors in the Proceedings of the National Academy of Sciences in 2011 (Gislason et al., 2011). Siggi's second major contribution to quantifying volcanic hazards determined and quantified the distribution and potential consequences of toxic gases, notably SO_2 from the 2014-2015 Bardarbunga eruption, aiding in our understanding of how to better protect the population from these toxic gases as reported in Gislason et al. (2015).

Siggi has also made major contributions to our understanding of how Earth surface geochemistry influences the global carbon cycle and ultimate global temperature. In a series of highly influential studies, Siggi with students and co-workers were the first to demonstrate and quantify the direct link between increasing Earth surface temperature, increased weathering rates of Ca-Mg-silicates, and CO_2 drawdown in a study spanning over nearly 40 years, and generating over 200,000 individual data points – including the daily weathering fluxes of 8 Icelandic river catchments (Gislason et al., 2009).

What is perhaps most impressive about Siggi is his broad skill set to approaching each and every subject. He is equally skilled in performing detailed field work, precise experiments and geochemical modelling. Some photos of Siggi in his various modes are shown in Figs. 1-8. It is though the combination of these complimentary skills that he has been able to make such large advances in Environmental geochemistry.

I hope and anticipate that Siggi's successful application of the fundamentals of geochemistry towards solving major global challenges inspires numerous other scientists to use their skills to continue making the world safer and more sustainable.

References

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Figures

Figure 1. Siggi in the field during the 2010 Eyjafjallajökull eruption.

Figure 2. Siggi sampling on the Skaftá River, November 2006.

Figure 3. Siggi filtering river water samples, September, 2002.

Figure 4. Siggi sampling fresh volcanic ash from the 2010 Eyjafjallajökull volcanic eruption at April 15th at 12:01. Photo Ómar Óskarsson

Figure 5. Siggi driving to sample ask from the flank eruption of the Eyjafjallajökull volcano, March 2010.

Figure 6. Siggi explainging the CarbFix CO_2-H_2S injection system, June 2016.

Figure 7. Siggi working on plug flow experiments with Didre Clark, September 2017.

Siggi discussing results of CarbFix injection while in Tuscany with Fidel Grandia, Edda Aradottir, Ingvi Gunnarsson, and Eric Oelkers during March 2017