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Two Planets – Which Future?

This issue of *Elements* presents evidence of a time when water played an important role in shaping the landscape of Mars. Deep valleys were carved, sediment was transported and

deposited, and at a smaller scale, a patina of secondary, hydrated minerals formed. Now this red planet lies desolate. The shifting polar ice caps are the only obvious remnant of a once-active hydrologic cycle. If life exists on Mars, it must be in recesses that may still harbor the right geochemical conditions and the water required to sustain primitive organisms.

In contrast to Mars, our blue planet is active at every scale. A physical dynamo drives the active tectonics that shape ocean basins and continents. Water fills the Earth's basins with oceans that circulate and in turn drive a constantly changing climate. For the Earth, we speak of cycles—tectonic, rock, hydrologic, geochemical—each with its own spatial and temporal scale. Caught among the coupled processes that drive these cycles are life forms that fill nearly every ecologic niche; even in the harshest of environments, extremophiles adapt and prosper. Despite the complexity of each of these systems, a Gaia Earth has sustained life for many hundreds of millions of years, and even catastrophic extinctions have been followed by yet another cycle of diversification and new species. However, during the past hundreds of years, the human species has become a threat to this balance, a threat to even the pattern of changing seasons as the climate warms. As professional geoscientists, we each know a particular part of this story. Among scientists from all disciplines, we are the most privileged because this story is our business, but I wonder if we are taking care of business.

There has been only one other time in history when, as the human species, we stood on the brink of massive global change, and that was with the development and proliferation of nuclear weapons. In 1945, Little Boy was dropped on Hiroshima and Fat Man on Nagasaki. Today, eight countries hold more than 27,000 nuclear and thermonuclear weapons. Thankfully, no nuclear weapon has been used by one country against another for the past sixty years. For the moment, the world has stepped back from the commitment to mutually assured destruction. I want to suggest that the geoscience community might consider the actions of physicists, facing the development of nuclear weapons, as a guide for us in the face of the looming crisis of global climate

change. The first characteristic of the physics story is the very early warning at the highest levels of government of the implications of nuclear fission. From the first days in 1938 when fission was realized by Otto Hahn and Fritz Strassmann in Berlin, physicists understood that the huge amounts of energy released by fission had the makings of a powerful weapon. Albert Einstein, prodded by Leo Szilard, Eugene Wigner, and Edward Teller, wrote directly to President Roosevelt about the possibility of creating an atomic bomb. Advised by Vannevar Bush, Roosevelt launched the Manhattan Project. However, from the earliest days within the Manhattan project, there was already concern for limiting the use and spread of nuclear weapons. By 1947, the Doomsday Clock of the *Bulletin of the Atomic Scientists* marked the time to nuclear annihilation at “midnight.” In 1955, the Russell-Einstein Manifesto was issued, and this

call led to the first Pugwash Conference in Nova Scotia in 1957. The Pugwash Conferences on Science and World Affairs and Professor Joseph Rotblat, a founder and president of the Pugwash Council, shared the Nobel Peace Prize in 1995.

Today, we see parallel developments, as climate change is addressed with the series of meetings of the

Conference of the Parties (COP), the third of which resulted in the Kyoto Protocol of 1997. The Intergovernmental Panel on Climate Change was created in 1988, and their assessment reports, most recently in 2001, provide the scientific basis for the proposed policies for limiting greenhouse gas emissions. Global warming “stories” are now part of the daily “feed” from the media. Still, considering the scale and likely consequences of global climate change, a sense of urgency among governments, scientific societies, and individual scientists is nearly absent. There is often a reluctance to cross from our science into the political and policy arenas where important issues will be decided. With nuclear weapons, we were confronted with an instantaneous release of energy that would kill millions. With global climate change the pace of change is slower, but the results will be no less devastating. Perhaps, the value of studying other planets, such as Mars, is that they offer us good examples of the potential for dramatic changes at the global scale. When the world was confronted with the threat of nuclear weapons, we were fortunate that the physicists were not shy. Now, confronted with global climate change, I hope that the geoscience community meets its challenge, as there really is not much time left.

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