nano-scale. The book is light on the recent advances in the medical applications of nanotechnology, but covers a wide variety of literature related to characterization of nanomaterials and their interaction with biological and physiological systems. An interesting aspect of the book is that each chapter ends with a few succinct take-home messages that are helpful in understanding the complex material. Additionally, an extensive set of references is included, which makes this book a must-have for researchers in the area of nanotechnology.

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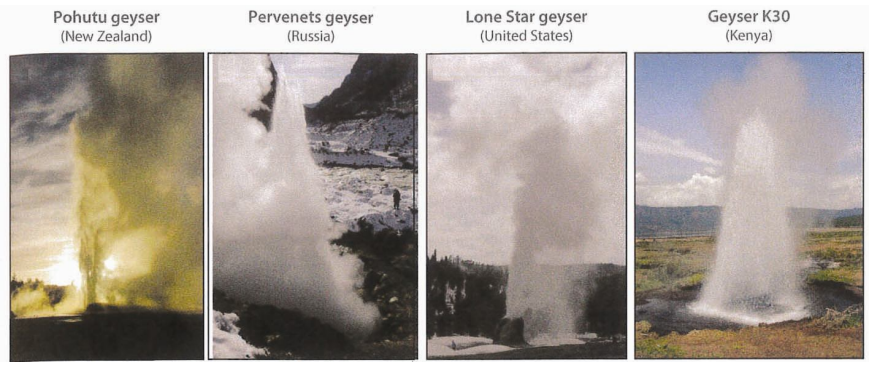
The editors of the 2017 *Annual Review of Earth and Planetary Sciences* in their introductory piece, to drive home their point, quote from a song *Once in a Lifetime* sung by David Byrne and his music band *Talking Heads*: 'How did we get here?'. The volume, as the editors tell us, is an attempt to address this fundamental question about how we got here. To me, it is a generic question, not necessarily applicable in the context of this volume. This is a fundamental question that drives the entire enterprise called science and motivates us to keep asking difficult questions about our existence and endlessly explore for answers. Each of the articles in this volume, no doubt, is expected to provide the current status of some aspects of this grand undertaking. We only need to see if this compendium meets those expectations.

In some respects, the prefatory article by Susan Werner Kieffer, a geological physicist and planetary scientist, with varied interests like volcanology, meteoritic impacts, geysers and planetology to thermodynamics and river hydraulics sets the stage for the rest of the pedagogical reviews in this volume expectedly on apparently disparate topics but united at a fundamental level – to gain knowledge of evolution of the Earth, its biological entities and the mysterious little-known worlds beyond the Earth. This article is followed by a review that overlaps one of her own research interests. Here, Shaul Hurwitz and Michael Manga analyse the complex dynamics of geysers – the hot springs characterized by interminable or continuous discharges of water and vapour. Susan Kieffer's planetary research interests also find their match in a bunch of articles in the volume that essentially deals with the evolution of solar system. Among these, Erik H. Hauri and co-authors discuss the origin and evolution of magmatic water based on accumulated analytical results on the lunar rock samples during the last 40 years. In an article titled, 'Forming planets via pebble accretion', Anders Johansen and Lambrechts review aspects of early stages of planet formation by pebble accretion. Thorsten Kleine and Richard J. Walker present the latest research on tungsten isotopes – a new kind of radiometric chronometer for planetary accretion and differentiation. In another review William F. Bottke and Marc D. Norman track the research developments in the late heavy bombardment – an event of elevated impact flux, believed to have happened between 4.1 and 3.8 billion years ago. It still remains controversial whether there was indeed a phase of cataclysmic planetary instability that heavily cratered the terrestrial planets or an artifact of sampling materials. Keke Zhang and co-authors review recent advances in data generation on high-precision gravitational measurements by orbiting spacecraft and use such data as a means of determining the basic shape, internal structure and gravitational field of the outer planets.

Two articles in this volume are devoted to the understanding the drivers of global change. For the last two decades the aerosol–cloud–climate interactions have been a topic of active research, but they have not been fully understood. Using the data derived from laboratory experiments, field observations, satellites, and numerical modelling, Storelvmo reviews the recent progress in our understanding of how aerosol affects the cloud properties, and how such processes result in climate forcing. Another area of interest in this regard has been the science of glacier–climate interactions, though they are comparatively fairly well understood. Andrew N. Mackintosh and co-authors show the usefulness of studies on the world's glaciers in reconstructing climate since the ice ages. C. Kevin Boyce and Jung-Eun Lee go further back in time and review the evolution of terrestrial flora from the Proterozoic through to the Neogene in the context of how vegetation influenced climate through time.

In the category of articles that review our understanding of life across Earth's history, Mary T. Silcox and Sergi López-Torres present the research developments in understanding the origin and evolution of primates, with whom humans have a shared ancestry. Their review centres on new fossil discoveries, molecular data and related technological advances. One of Darwin's major concerns when he proposed the theory of evolution was the fragmentary nature of fossil records. The last 160 years since Darwin witnessed phenomenal improvement in the documentation of the species in time and space, thanks to the tireless efforts of palaeontologists. Mark E. Patzkowsky provides a deep-time perspective on the origin and evolution of regional biotas of



Examples of geysers from each of the major geyser fields.

the past, thereby bringing new depth to our understanding of life's diversity, community evolution and palaeoecological niches. Evolutionarily the late Ediacaran (late Precambrian times: ~635–542 million years) was a highly dynamic period characterized by strong environmental and biogeochemical flux that impacted the distribution of oceanic biota, Earth's earliest complex multicellular inhabitants, in time and space. L. Droser and co-authors show how environments and ecology controlled the diversity, distribution and forms of Ediacaran biota. The geochemical flux of the early Earth is a topic of discussion in another article by Shuhei Ono, who goes farther back in time to 2.45 Ga (giga-annum: billion years) before present and reviews the current understanding on changes in Earth's sulphur cycle and composition of the early Earth's atmosphere. What is the origin of sulphur mass-independent fractionation in Archean sedimentary rocks and why is the signal absent in the younger rocks? The studies provide strong evidence for an early anoxic atmosphere, which eventually become oxygenated. This transition was the most important interval for evolution of more complex life forms.

It has always been a challenge to develop the evolutionary history of the Earth's continental lithosphere (the rigid outer layer of Earth), primarily because the record of the continental lithosphere is patchy and incomplete. The preserved geological records contain only less than 5% of the rocks that are older than 3 Ga. It is only since ~3 Ga that the continental lithosphere stabilized due to thermal cooling and plate tectonics in its current format became a dominant tectonic regime. Using high-quality U–Pb zircon analyses and other geochemical evidences, Chris J. Hawkesworth and co-authors present available database and provide insight into secular evolution of processes involved in the generation and recycling of the lithosphere through time. Carmala N. Garzione and co-authors attempt to integrate results from the studies of the lithospheric structure, geologic evolution, and timing and rate of the Central Andean growth. They demonstrate a spatially and temporally punctuated uplift history of this region – the largest orogenic plateau on Earth. Another interesting area, which is also under studied is the Southeast Asia that includes countries of Malaysia, Brunei, and Indonesia along with southern Thailand, the Philippines, and the Malay Archipelago – a place of happening: subduction, earthquakes, volcanism, collision, faulting, subsidence, uplift, and, of course, young landforms. Robert Hall reviews the available data derived from seismic and multibeam data obtained from oil exploration surveys, and computational models to yield new understanding of this highly complex and active region.

Despite the fact that plate tectonics as a theory was formulated about 50 years ago, and insights were obtained from seismic tomography and numerical simulations of mantle convections, mechanical details and physical nature of the lithosphere–asthenosphere system (LAS) beneath the ocean remain little known Hitoshi Kawakatsu and Hisashi Utada review the observational constraints of LAS and seismic data for the ocean to better understand the system. They also stress the importance of deploying dense array ocean bottom sensors. The occurrence of the 2004 Indian Ocean earthquake exposed the limitations of the then existing seismological techniques to realistically capture properties of great earthquakes. One of the successful techniques that has emerged is back-projection analysis, also fostered by the deployment of large, dense seismic arrays over the past two decades. Eric Kiser and Miaki Ishii in their article discuss the basics and applicability of this technique. Yosihiko Ogata reviews the advances in statistical methods, including Bayesian models and their applicability in earthquake predictability studies.

The olivine–spinel series of transformations in a subduction slab can generate thermal strain, transformation strain and buoyancy forces within and the volume changes induce large stresses sometimes generating large earthquakes at those depths. S. J. S. Morris employs numerical models to explain the large deviatoric stresses predicted by the existing slab models, and shows how deviatoric stress at the grain scale averaged over a sample containing many grains can be hydrostatic stress at large scales. Seismic velocity can be slowed by partial melting of minerals, and melt is implicated, but not shown definitively, to account for low-velocity regions in the upper mantle. Anelastic solids represent a subset of viscoelastic materials, and they have a unique equilibrium configuration and ultimately recover fully after removal of a transient load. Rock anelasticity is important for seismology because it leads to dispersion and attenuation of seismic waves. Yasuko Takei takes a detailed look at the recent advances in our understanding of polycrystal anelesticity behaviour that occurs just prior to actual melting. Experimental studies have captured a significant enhancement of polycrystal anelasticity just before partial melting in the absence of melt. This newly recognized effect help in reconciling previously conflicting seismological and geochemical observations.

Some of the articles are of broad interest and can be used as supplementary material for teaching in the earth science departments. At the end of the introductory article, the editors once again go back to the song of David Byrne which ends with a rather fatalistic conclusion – the world is the 'same as it ever was'. On the contrary, as the editors point out, the authors of this volume with their insights help us see how everything is in a mode of continuous change and reorganization. Every time we look around we tend to agree with Heraclitus, the pre-Socratic Greek philosopher, who is credited to have said: 'Change is the only constant in life'. This truth we learn and relearn each time we get to read the science of Earth and planetary processes. The 2017 Annual Review, like its preceding volumes, mirrors those exciting moments of discovery of accumulated knowledge on how the Earth and its planetary siblings evolved and changed through time.

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