

Introduction: enquiries into the history of geology

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The International Commission on the History of Geological Sciences was founded in 1967 at a meeting in Yerevan, Armenia. After an initial attempt to form an association of historians of geology at the International Geological Congress (IGC) in Copenhagen in 1960, a fresh proposal was approved at the following IGC in New Delhi, in 1964. Steps were then taken that led to the formal establishment of INHIGEO at Yerevan three years later.

The realization of this project owed much to the foresight and determination of the eminent Russian historian of geology, V.V. Tikhomirov (1915–94). He was a passionate promoter of the study of the history of the geological sciences and was tireless in his efforts to establish an organization that would facilitate and encourage scholarship in this field. Following its foundation, Tikhomirov became INHIGEO's first president and served it for many years.

The formation of the Commission led to closer links and better cooperation among the worldwide community of scholars with an interest in the history of the geological sciences. Regular meetings (now on an annual basis) with accompanying excursions to locations of geological and cultural interest greatly facilitated the sharing of research results and the interchange of ideas among members. During the Commission's early years these symposia also contributed to a relaxation in the, at times, uneasy relationship between scientists from the East and West.

INHIGEO's declared aim to promote studies on the history of geology have born rich fruit, not least in the form of a large number of publications that have provided greater recognition among researchers of the value and relevance of historical studies to present day research in geology.

In the first section of this book contributors examine the path that led to the establishment of INHIGEO and its subsequent history. The succeeding parts of the book present essays on a range of themes relating to the history of geology, which provide insights into early views on the processes operating within the Earth and on its surface. The history of ideas on geological phenomena, studies of the exploration and assessment of resources in diverse countries, together with bibliographical sketches

of those who carried out such work, form part of these sections. Further articles discuss the educational benefits of teaching the history of the geosciences and the contribution of women to this field of study.

Fifty years of INHIGEO

Drawing on documents held in Russian archives, **Malakhova (2017)** outlines the sequence of events that led to the founding of INHIGEO and discusses the conduct of the Commission's affairs during the early years following its establishment. Her paper emphasizes the major part played by V.V. Tikhomirov in realizing the formation of this scholarly association. This remarkable man adopted and built on the earlier views of his countryman V. V. Vernadsky (**Malakhova 2017**) when he stated that the study of the history of geology could not be successfully accomplished in isolation, within any one country, but relied on contributions from scholars across the world, and that the founding of an international organization of historians, with an interest in this field of study, would be the best way to further this cause.

Grigelis & Czarniecki (2016) add personal recollections of their involvement and of their respective roles in the lead-up to the foundation of INHIGEO and trace its progress during the early years. This article includes photographs as well as caricatures of some of the first office-bearers, the latter attesting to the fact that such meetings can also have a humorous side. The accompanying excursions to sites of geological and cultural interest in the neighbourhood of Yerevan set the tone for field trips conducted as part of future INHIGEO gatherings (see also **Johnston & Taylor 2016**).

Bork & Cooper (2016) (INHIGEO Secretary-Generals from 2004 to 2008 and 2008 to 2016, respectively) cover the history of the Commission's affairs in more recent times. During the 26-year interval between the INHIGEO meeting held in Freiberg in 1970 (**Grigelis 2017; Malakhova 2017**) and 1996, when **Bork & Cooper (2016)** commence their substantive account, the fledgling

organization had proved itself to be a stable, well-managed and highly regarded entity that served its members well. INHIGEO's name was modified, substituting 'Commission' for the original 'Committee'. Following the first three INHIGEO meetings, held in countries of the Eastern Block, subsequent symposia were organized in Western Europe, North and South America and Asia. These meetings and their associated field trips, initially scheduled on a biennial basis, became annual gatherings from 1989.

The authors briefly comment on the stewardship of their predecessors as Secretary-General, Ursula Marvin (1988–96) and David Oldroyd (1996–2004). It was during Marvin's time in this role that the barrier of the Berlin Wall was removed and the Soviet Union broke up, which facilitated travel and ease of communication between scholars from the East and West. It was also during this period that INHIGEO changed its rules on governance and membership of the organization, creating a more open and democratic association.

As fieldwork constitutes a vital part of geological investigations, it is not surprising that the founders of INHIGEO decreed that excursions to sites of geological and cultural interest should form an essential part of its meetings. All INHIGEO symposia (with the exception of the abandoned Prague meeting) featured field trips, many with a duration of several days. **Johnston & Taylor (2016)**, in an appendix to their paper, provide a comprehensive record of excursions associated with INHIGEO symposia, including their respective themes and the localities visited. The authors comment on notable excursions and highlight those where the theme of the conference was conveniently matched and illustrated by nearby geological features in the field. In light of the fact that historians, albeit in small numbers, take part in geological excursions alongside geoscientists, the authors' discussion of the different mind sets that the former tend to bring to an investigation of geological phenomena in the field will be of interest to all historians of geoscience.

These differences in approach to the study of the history of geoscience, with reference to the work and aims of INHIGEO and its members, are discussed by **Rudwick (2016)**. Interwoven with an absorbing account of his own career path from scientist to historian of science, the author examines the methods that are commonly followed by the majority of geologists studying the history of this scientific discipline – and finds them wanting. He deplores the practice that evaluates the work of earlier scholars on the basis of present day scientific knowledge and instead favours an approach to historical studies that judges an investigator's achievements in the context of the understanding of the natural world

at the time the work was performed. In doing so, he notes his early uneasiness about the direction and activities of INHIGEO and advocates a path leading to a balance between the scientific and historical approaches to the study of the history of geology.

Writing about the history of the geological sciences

Historians of geoscience direct their research to past achievements in their field of study and seek to trace and evaluate the efforts of earlier thinkers and investigators of the nature of the Earth – whether they were lay or learned people. The findings from past enquiries, which extend back over millennia to the ancient world, have benefited the following generations of scholars in their attempts to record, interpret and understand the history of our planet.

From as early as the beginning of the nineteenth century, scholars have written historical accounts of knowledge acquired by the examination and interpretation of geological phenomena, and of the investigators who engaged in such work (see, for example, Cuvier 1825). A number of these studies encompass the entire field of geology, whereas others deal mainly with the history of one of its subdisciplines.

Works with a broad coverage of the history of geology include those of Adams (1954), Ellenberger (1988, 1994) and Rudwick (2005, 2014). These publications provide readers with insights into the thinking and views of investigators into the nature of the physical Earth and on their interpretation of former life forms preserved in rocks, from ancient Greek and Roman times to more recent years. The information supplied by the authors allows the reader to reach an understanding of the advances made in geological knowledge over the centuries and familiarizes them with the main actors involved in these scholarly endeavours.

Geological Societies, which were founded from the start of the nineteenth century, have been of considerable importance in facilitating debate on geological topics and disseminating the results of freshly acquired knowledge on the subject. The oldest of these, the Geological Society of London, was formed in 1807. Gordon Herries Davies (2007) chronicled its history over a period of 100 years, a time during which its publications included many reports on new research findings that had a major impact on our understanding of the Earth (see also articles on this subject in this book).

Views on the formation and age of the Earth, based respectively on scientific evidence and religious beliefs, have at times been hotly debated,

particularly during parts of the eighteenth and nineteenth centuries. A succession of writers has, in more recent times, traced and debated matters relating to this topic; see, for example, Gillespie (1959) and Kölbl-Ebert (2009).

Chroniclers of geology have also given their attention to researching the history of some of its applied branches, such as engineering geology (Kiersch 1991), and to sciences or activities in which its knowledge plays a useful, but more peripheral, part. The latter include the diverse links between geology and medicine (Duffin *et al.* 2013) and the application of geological knowledge to warfare (Rose & Nathanail 2000).

The comparatively low priority that has, at times, been accorded to historical studies by members of the geological community has prompted the question: Why do we study the history of geology? In response, Cooper (2016) approaches the subject from an Australian perspective and lists examples that demonstrate the value of earlier scholarship to present day research. Other articles in this book provide further evidence in support of his conclusions.

On theories, ideas and concepts in geology

The Earth, its origin, its constitution and the forces that have shaped it, together with the fossilized organic remains enclosed in its rocks, have been the subject of enquiry since ancient times. The philosophers of antiquity contemplated the natural world and its changing phenomena and attempted to understand and explain these in the context of the knowledge of their time. During part of the Middle Ages and extending into the early nineteenth century, such studies were often profoundly influenced by religious beliefs. A rapidly increasing knowledge of the rock formations of the Earth and their composition, based largely on the interpretation of evidence observed and collected in the field, led to the adoption of the term 'geology' in the early nineteenth century and to its recognition as a separate scientific discipline.

In her essay, Kölbl-Ebert (2016) stresses the importance of taking into account the history of theology and philosophy in assessing progress in the advancement of geological knowledge. In this context, the author discusses the views of the natural world, ranging from those of the early Greek philosophers to Islamic scholars in the Middle Ages, and the influence of their thinking on European scholarship in the following centuries. She also refers to the legacy of their ideas on later perceptions of the Earth.

The formulation of the geological principle that later became known as uniformitarianism is

mainly attributed to Hutton (1795) and Lyell (1830–33), whose work influenced the thinking of generations of geologists. Racki (2016) informs us that a Polish scholar, Hugo Kollataj, independently arrived at similar conclusions about the unchanging nature of geological processes, past and present, more than 20 years before Lyell published his work in 1830–33.

There is little doubt that controversy enlivens debate. This applies equally to ideas and concepts in science as to other fields of human endeavour. Among the more contested and much debated rival geological theories of the twentieth century are those of Earth expansion v. plate tectonics. Cwojdzinski (2016) provides a detailed discussion of the history of this debate on global tectonics. The author's own views on this subject may well provoke further discussion.

Another clash of views, albeit on a geographically more restricted level, was concerned with the structure of the orogens in the Swiss Alps during part of the nineteenth century (Letsch 2016). The author provides an account of the views and ideas of the Swiss geologists who attempted to explain the tectonic development of the Alps prior to the acceptance of nappe tectonics.

Given the spectacular nature of volcanic activity, which has been observed in many parts of the world throughout human history, it will be surprising to readers of this book to learn that, as Taylor (2016) points out, neither the ancients nor later populations before the start of the early modern age had a word for volcano in their languages. In his essay, the author provides an overview of the changing perceptions and the interest of both scholars and the general public in volcanoes and their place in nature. Alvarado & Patino (2016) stress the impact of volcanic activity and the resulting landforms and products on the local population in the Latin American country of Costa Rica. They trace the history of observation and the study of volcanic phenomena from their mention in legends of pre-Columbian times to their scientific examination in more recent years.

Although geomorphology is generally considered a relative newcomer as a discipline concerned with the study of the natural world, some of its essential elements, including changing landforms, were already a subject of interest in ancient times. Orme (2016) discusses the historical background that contributed to the rise of modern geomorphology as a dynamic discipline.

A model attempting to explain the diffusion of Western science into non-European nations is examined by Lucas & Alvarado (2016) in the context of studies of vertebrate palaeontology in Central America.

From the eighteenth century, the study of Earth materials and properties in the field was increasingly supplemented by their detailed analysis in the laboratory. **Newcomb (2016)** provides an historical overview of the development of instruments and of the evolving technology that led to a better understanding of the natural world.

Teaching the history of geoscience

Is there a role for the history and philosophy of the geological sciences in education? Using examples from her wide teaching experience and drawing on field examples and pertinent learned arguments in the literature, the answer of **Figueirôa (2016)** to this question is decidedly in the affirmative. In her conclusions, she points out that the inclusion of well-chosen historical case studies in teaching programmes can encourage experimentation and the comprehension of complex situations and help to better prepare students to deal with global challenges of the Earth.

In her contribution to this discussion, **Clary (2016)** provides practical examples for use in the teaching of the history of geology. Based on the assumption that controversies in the history of geology are likely to arouse the interest of students and facilitate their understanding of the nature of scientific endeavours, the author details four case studies that introduce new ideas on the interpretation of geological and palaeontological features, the nature of which led to much debate and, at times, disagreement among geologists.

Zhou (2016) discusses the history of higher geological education in China, which commenced in 1909 with the establishment of the country's first university in Beijing. The history of its expansion, progress and the direction of such studies over the last 100 years have been extensively documented in the country's literature.

On the contribution of women to the geosciences

In studies of the history of geology from ancient to comparatively recent times, the attention of historians tended to be almost exclusively focused on the contributions of male scholars. The work of women in this field, either in a supporting role or as original observers and chroniclers of geological phenomena, has rarely been given prominence. **Kölbl-Ebert & Turner (2016)** demonstrate that the involvement of women in significant geological activities can be traced back to the early Middle Ages. They discuss the difficulties encountered by women in carrying out geological work and in gaining recognition for their contributions.

Eminent geologists, their life and work

Studies of the life and careers of geologists can reward historians with valuable insights into the motivations, the thinking and approaches to the work they accomplished in earlier times. It also allows the researcher to pay tribute to the achievements and contributions made by earlier investigators towards advances in our understanding of the Earth.

The individuals who are the subject of these biographical studies have all made major contributions to geological knowledge in their respective countries. Two among them, **Shchurovsky** in Russia, himself a noted historian of geology, in the mid-nineteenth century (**Bessudnova 2016**) and **Dutton** in the USA, some 50 years later (**Aalto 2016**), are also remembered as early popularizers of science. **Frenguelli**, a medical practitioner from Italy, whose interests turned to geology in Argentina, carried out pioneering work on stratigraphy and palaeontology in his adopted country during the first half of the twentieth century (**Riccardi 2016a**). **Kobayashi**, who was a founding member of **INHIGEO**, is chiefly remembered for his innovative ideas on the origin of the Japanese islands (**Sato et al. 2016**).

Government agencies, institutions and societies

Many governments in the nineteenth century recognized the need to acquire a greater knowledge of their country's natural resources and of their distribution and usefulness to the nation. This led to the establishment, among other agencies, of geological surveying organizations, which were given the task of mapping their country's geology and of identifying and assessing its mineral resources. In Austria (**Klemun 2016**), Spain (**Rábano 2016**) and Portugal (**Mota & Carneiro 2016**) such surveys resulted, in time, in the production of geological maps of these countries. The authors relate the sometimes troubled history of these agencies, all founded in the mid-eighteenth century, which led to the establishment of modern day geological surveys in their respective countries.

Government-initiated geological surveys commenced some decades later in Mexico. Both **Azueta (2016)** and **Morelos-Rodríguez (2016)**, in their respective articles, discuss early geological investigations, carried out mainly by visiting scientists, naturalists and mineral surveyors, before the establishment of a national agency staffed by Mexican geologists.

Taquet (2016) reviews the works of scholars on the history of geology in France, starting with the momentous contributions by **Georges Cuvier** in the nineteenth century. Such studies have gained

fresh impetus over the last 40 years following the foundation of the French Committee for the History of Geology.

The nineteenth century also saw the establishment of museums of science (and of universities) in many parts of the world. The La Plata Museum in Argentina organized its own geological expeditions in the late nineteenth century, not solely to enrich its collections, but also to map parts of the country's geology (**Riccardi 2016b**).

Substantive geological activities in China, by Chinese scholars, did not commence until the early twentieth century, when the first universities and the Chinese Geological Society were founded. **Zhang (2016)** traces the history of geological developments in China from the establishment of its first institutions and agencies, through a period when geological thinking and activities were subject to ideological influences, but leading to a flourishing of scientific work in a more liberal environment in recent times.

Regional geological studies

The results of geological explorations within countries or regions – be their purpose the mapping and ordering of rock formations, the search for mineral deposits, the collection and identification of fossils or the study of natural phenomena – provided the basic building blocks that allowed future scholars to construct a more comprehensive overview of the distribution of rock formations on a global scale, to assist them in forming views on the nature of the Earth's dynamic processes and to propose theories about its origin.

Sundquist (2016) reviews geology-related studies in Sweden from as early as the fifteenth to the mid-nineteenth centuries. He records the contributions by scholars, many of whom, including the celebrated Linnaeus, engaged in a wide range of scientific studies. The eminent British geologist, Roderick Murchison, was able to draw on such earlier work during his visit to Sweden (**Diemer 2016**) and was the first to recognize Silurian rocks in that country.

Grigelis (2017) provides an account of investigations leading to the identification of the mineral resources and the production of geological maps of Lithuania. Contributions were made by members of the general public and religious orders, by university staff and survey organizations.

An exceptionally large number of Polish nationals conducted surveys, including those of a geological nature, in Siberia in the late nineteenth and the early twentieth century (**Graniczny et al. 2017**). The authors record the contribution that each of these individuals made to the geological knowledge of this isolated region.

The proliferation of exploratory expeditions to Antarctica, largely at the beginning of the twentieth century, forms the subject of an article by **Clary & Sharpe (2016)**. The authors highlight the geological work carried on these journeys and the contributions such discoveries made to a better understanding of the continent's geology.

Reviews on the history of petroleum exploration and production

Although the occurrence of petroleum seeping from the ground has been known since ancient times, commercial quantities from wells were not obtained until the middle of the nineteenth century. **Wolkowicz et al. (2016)** record the history of petroleum exploration and production in Poland, where oil production preceded the drilling of the first well in Pennsylvania. The noteworthy rise of the Mexican oil industry in the early 1900s and the contributions to this development by the American geologist E.L. DeGoyler, is recorded and analysed by **Gerali & Riguzzi (2016)**.

The need to discover and to procure petroleum products became a major priority for the economy of many countries, including Australia, in the nineteenth century. **Gerali & Gregory (2016)** review the country-wide search for oil, with a particular emphasis on Western Australia. They comment on the importance of oil discoveries as a necessary resource in the establishment of the country as an independent economic entity.

Concluding remarks

The number and quality of the contributions prepared for this book testify to the increasing interest in, and to the wide-ranging scholarship on, the history of the geosciences. The increase in the membership of INHIGEO over recent years, in a larger number of countries (**Bork & Cooper 2016**), provides further evidence of a growing regard for historical studies of the geological sciences among members of the geological community and historians of science. Planned meetings, up to 2021, and the declared agenda of the Commission to foster research and communication among its members, provide ample opportunities for the continuation of scholarly activities on the history of geology.

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