Earth–Knowledge

History of Earth Sciences as Histories of Knowledge?

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Chapter 1

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1 Earth–Knowledge

History of Earth Sciences as Histories of Knowledge? An Introduction

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When the naturalist Friedrich Simony (1813–1896), later the first professor of geography at the University of Vienna, set out on an early morning in September 1843 to climb the 3,000-meter Dachstein mountains in the Eastern Alps, he was not traveling alone. A group of nine mountain guides, hunters, and herders, including one woman, accompanied him on his moonlit ascent across the glaciers to the summit. They not only carried the equipment and scientific instruments, but also operated some of them, and contributed their diverse local and practical knowledge, e.g., orienteering, moving, and bivouacking in the alpine terrain. After reaching the summit, the party spent 24 hours surveying and observing the glaciers and landforms. A Bengal fire signaled the success of the venture to the members of the Habsburg aristocracy who were summering in the valley (Simony 1844, Figure 1.1). The example of this undertaking – the basis for Simony's later studies of glacier phenomena, which would make the Dachstein ascent into a model for understanding other mountain glaciers (Penck 1898, 42; Kretschmer 2004, 45) – illustrates the significance of local actors and their expertise in scientific knowledge production. However, this example also shows how scientific knowledge can influence local knowledge. Published in Viennese newspapers, Simony's popular reports about his Dachstein promoted (alpine) tourism in the region, became part of the body of knowledge of mountain guides, and were subsequently even incorporated into literature.

The starting point of our considerations is the relationship between "knowledge" and "Earth," its transformations and how it is embedded in different historical contexts. Through its broad thematic cluster, the workshop[1] that preceded this volume opened fresh perspectives for research across and beyond the boundaries of disciplinary history in the Earth sciences. The resulting book brings together a heterogeneous ensemble of themes, epochs, and viewpoints. We consider our approaches as complementary to, rather than substitutes for, the histories of Earth sciences disciplines and their well-established fields of study. We are not only concerned with knowledge about the Earth per se, but also with how, when, and where various forms of knowledge have been used to gain insight into the Earth, and how the status of that knowledge has changed over longer time periods. This enables us to examine

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Figure 1.1 The summit of *Hoher Dachstein* captured by Friedrich Simony following his overnight stay from 16 to 17 September 1843. The figure with their back to the viewer is likely Simony's mountain guide, Johann Wallner (1802–1878). Watercolor, 48.1 cm × 34 cm.

Source: Austrian National Library (Inv. No.: 00298902).

not only different forms of knowledge, but also the various actors, sites, and practices of scientific knowledge production involved. Some of the individual contributions in this volume aim to broaden the history of the Earth sciences, both thematically and methodologically, by drawing on approaches in the history of knowledge. This allows us to shed light on a question that, so far, has received only limited attention in the history of the Earth sciences.

From the History of Science to the History of Knowledge

History of science has traditionally understood "science" as an interdisciplinary history of ideas and methods. Since the 1970s, however, the field has increasingly opened up to an analysis of the production and socio-cultural conditions of scientific knowledge. One major inspiration was the work of Ludwik Fleck ([1935] 1979) on the emergence and transformation of scientific facts and on "thought styles" and "thought collectives." Michel Foucault's (1969) work on the relationship between power and knowledge and the orders of the "sayable," as well as the research and writing of Pierre

Bourdieu (1984) on the social habitus of scientists, also contributed to this development. Finally, historical anthropology, with its interest in everyday historical practices, culturally shaped ways of life, and experience of actors, has also paved the way for the transfer of anthropological research approaches to practices and processes of (scientific) knowledge production (Tanner 2017; see Schröder 2023).

This development process means that the roots of the current history of science are remarkably diverse. Nevertheless, its origins lie in (historical) science studies and the sociology of science, which are primarily concerned with the actors, practices, and contexts of scientific knowledge production (Jasanoff et al. 1995). In contrast to idealized notions of science defined by rationality, sociologists, philosophers, and historians drew connections between the parameters within which science operates, the social construction of knowledge, and the constitution of credibility in different social arrangements (Latour and Woolgar [1979] 1986; Shapin and Schaffer 1985; Knorr Cetina 1981, 2001; Pickering 1992; Golinski 2005; Gieryn 2018).

Bruno Latour's (1987, 4) distinction between "ready-made-science" and "science-in-the making" became the starting point of numerous studies in the history of science. It included not only the actions, exchanges, and negotiations of actors and institutions, but also the material side (Rheinberger 1997) of scientific knowledge production, such as the role of spaces and places of knowledge (van Damme 2020). The latter does not refer to physical entities, but to settings generated by practices of actors and their use of things in specific sociocultural contexts and material environments (among others Rheinberger et al. 1997; Ash 2000; Livingstone 2003; Rau 2013; Füssel et al. 2019). Scholars have paid particular attention to the laboratory (Latour 1988; Kohler 2008; Jackson 2017) and the field (Driver 2000; Vetter 2010; Harbsmeier and Ries 2012; MacGregor 2018) in creating knowledge and expertise. Both sites are also considered in relation to each other (Kohler 2002). Infrastructure projects such as canals, dams, and highways also came into focus as sites of scientific knowledge production (Heine and Meiske 2022). Further questions arose about the epistemic objects and things (Daston 2000; Rheinberger 2018), the instruments (Carneiro and Klemun 2011; Turnbull 2002; Withers 2013), and the bodies of scientists (Lawrence and Shapin 1998). Steven Shapin (2010) succinctly summed up the entire development: Science is "never pure" but is "produced by people with bodies, situated in time, space, culture, and society, and struggling for credibility and authority."

The shift from a "history of disciplines to a history of science in culture and society" (Müller-Wille et al. 2017, 3) led to the history of science converging with cultural studies (Jardine et al. 1996). The catchy phrase "science as culture," coined by Lorraine Daston (2001), indicates this shift. It emphasizes that science and its various fields of research all have their own cultures, traditions, and values, which, however, need to be historicized. This has been particularly evident in the questioning of epistemic categories and virtues

that were traditionally held to determine scientific thought, ethical action, and rationality – that is, the forms by which truth, objectivity, and credibility are established (Shapin 1994; Daston and Galison 2007; Gelhard et al. 2019). Equally important for the historiography of science was the establishment of relations to other spheres of life and society with which science shares its values, such as politics, economics, and administration. The significance of "science as culture" (Daston 2001) manifests itself in various dimensions such as language, images, symbols, objects, and other forms of media, which, in turn, influence and shape knowledge.

For a long time, the interest of historical research was exclusively focused on scientific knowledge. As we will now show, over the last 20 years, other forms of knowledge have been added to scientific knowledge and are treated as equal objects of research. Accordingly, the perspective of many scholars has shifted from social and cultural history, history of ideas, or history of science toward a history of knowledge; the fundamental concepts and integrative approaches of this history continue to be intensively discussed today (among others Burke 2012, 2016; Landwehr 2007; Sarasin 2011, 2020; Speich-Chassé and Gugerli 2012; Müller-Wille et al. 2017; Füssel 2019, 2021; Joas et al. 2019; Dupré and Somsen 2020; Östling and Larsson Heidenblad 2020; Schröder 2023).

History of Knowledge – More than History of Science

First of all, it should be noted that the term "history of knowledge" is not clearly defined (Füssel 2021, 17). The history of science and the history of knowledge have many similarities and common points of reference in their origins and methods. Therefore, the question arises of how the history of knowledge is to be distinguished from the history of science, if the latter "has always been concerned with knowledge" (Steinle 2018, 425). Although there are many commonalities between the two fields, there are also clear differences. Research topics in the history of knowledge are much broader and more transdisciplinary, going beyond the narrower history of science. Overall, the history of knowledge encompasses studies that deal with the emergence, use, and dissemination of knowledge across time and space. This also involves actors, practices, objects, sites, and forms of knowledge that have contributed to the emergence of scientific knowledge without being considered "scientific" in their own right.

As a result, the history of knowledge encompasses technical, craft, process, and tacit knowledge (Polanyi 1985), as well as social and symbolic knowledge as a component of applied practical, lay, or everyday expertise (Hanson 2008). In short, the history of knowledge is not necessarily the history of science. Its approach encompasses a much broader range of "knowledge actors" (Dorsch 2016), such as local or indigenous informants and intermediaries, women and family members, lay researchers, artisans, artists, missionaries, merchants, civil servants, soldiers, journalists, popularizers,

and even outsiders (among others Raj 2007; Fischer-Tiné 2013; Habermas and Przyrembel 2013; Dieckmann 2021). Last but not least, studies in the history of ignorance examine the tensions between knowing and not-knowing (Proctor 2008; Burke 2023), the contested question of which knowledge could be considered scientific at a given time (Mulsow and Rexroth 2014; Epple et al. 2020), and the (dis)possession or endangerment of specific forms of knowledge (Rupnow et al. 2008; Mulsow 2022).

In recent years, the term "history of knowledge" has been associated with a range of novel meanings arising from this diversity of research questions. These include questions about the relationship between scientific research and information used and disseminated in commerce, popularization and journalism, and the "poetic" constitution of knowledge in literature and art (Buckland 2013; for an overview, see Mulsow and Daston 2019, 159). As a result, the history of knowledge – which is interested in expanding the concept of knowledge itself – has drawn on the history of science by rethinking the practices of scientific knowledge production and their social and cultural implications. However, there is still a considerable need to clarify, differentiate, and demarcate the history of knowledge to avoid falling into the trap of creating a fashionable term that describes long-established concepts or creates problematic connections (Marchand 2019; Bod 2020). It is not surprising, therefore, that this pluralism of methods, combined with the claim to totality of the history of knowledge, has not remained without criticism, and that some critical voices toward the history of knowledge seem to be quite justified. Lorraine Daston (2017, 143) sums up the critique when she questions the field's claim to inclusiveness and flexibility, which "could easily become rubbery." Since the history of knowledge includes the entire body of knowledge available to the members of a given culture or cultures, it runs the risk of being too arbitrary (Steinle 2018, 427).

It is obvious that we want to avoid these pitfalls. Nevertheless, we also consider it an advantage that the history of knowledge lacks a common and elaborated theoretical foundation. As we have seen, the "toolbox" (Füssel 2021, 35) of the history of knowledge offers possibilities for enriching the established disciplinary histories in the Earth sciences and for tracing the emergence, transformation, and (re)use of (scientific) knowledge beyond the usual scholarly paths. This will help us to uncover blind spots that have been missed by previous research.

The History of Earth Sciences – A Complex Field of Research in Transition

The history of the Earth sciences has not been unaffected by the trends in history of science scholarship (for an overview see Oldroyd 1996, 2003; Doel 1997; Good 1998; Grapes et al. 2008; Taylor 2008; Rudwick 2014; Aronova, Sepkoski, and Tamborini 2025). It was not until the nineteenth century that the "modern" Earth sciences began to evolve into diverse, independent, and

academically established scientific disciplines. This ongoing process continues to inform how the history of Earth sciences is practiced and written today. Depending on the field of study, it is divided into separate histories of individual disciplines and corresponding working groups, such as for the history of geology, geography, geophysics, mineralogy, paleontology, meteorology, climatology, oceanography, and so on. Often focusing on dominant concepts, theories, methods, institutions, or the biographies of outstanding scientists, these forms of historiography are still widely practiced by specialists and undoubtedly play a fundamental role in disciplinary historical research.

Nevertheless, in the 1980s, some historians of the Earth sciences began to adopt approaches inspired by the sociology of science and science studies, and increasingly to examine the influence of social and cultural factors in producing geoscientific knowledge (for an overview, see Wainwright 2012). Roy Porter's (1977) monograph on the development of British Earth sciences furnished a first social-history approach to the formation of geology as a discipline. In addition, research into nineteenth-century controversies about the creation of new geological formations offered a fruitful starting point for historians in the field (Rudwick 1985; Secord 1986; Oldroyd 1990). These novel approaches are most recently evident in Martin Rudwick's monumental volumes on "geohistory," which cover the period from the late seventeenth to the early nineteenth centuries (Rudwick 2005, 2008). Further studies on social, cultural, and political aspects in the history of Earth sciences have dealt with the relationships between science, religion, and society (Gould 1987; Gillispie [1951] 1996; Kölbl-Ebert 2009) and the influences of art (Cohen and Hublin 1989; Rosenberg 2001) on scientific knowledge production. Similarly, transnational exchanges in creating new institutions and research fields (Schimkat 2008; Krüger 2013) and the role of women and gender (Burek and Higgs 2007; Kölbl-Ebert and Turner 2016) have attracted scholarly interest.

Novel approaches in the history of science and the history of knowledge play an increasingly important role in various research projects, e.g., studying the role of geoscientific knowledge in the formation of (nation) states (Klemun 2012b; Shen 2014). Other scholars have addressed processes of knowledge production. They studied the circulation and making of geoscientific knowledge (Skurnik 2017) in the "field" (Driver 2001; Henniges 2017; Wisnicki 2019), its subsequent transformation in print by academic publishing houses (Holtorf 2017; Meyer 2021; Alexander 2023), and its final dissemination and application among users (Güttler 2014). As a result, practices and processes of observing (Cocco 2012; Böttcher 2020), mapping (Cosgrove 1999), visualizing (Driver 1995; Klemun 2020), traveling (Wyse Jackson 2007), collecting, archiving, and ordering (Décultot et al. 2020; Mattes 2022a), as well as the printing and publishing (Withers and Keighren 2011) of "world knowledge" (Schröder 2011) are becoming more and more prominent as objects of research. This particularly concerns instruments and epistemic things (Vaccari 2011; Klemun 2012a), the generation of powerful

imaginaries (Möhring et al. 2019) in the form of books (Wardenga 2005), graphics, paintings, and photographs (Rudwick 1992; Wiese 2011), as well as maps and atlases (Withers 1999; Schelhaas 2009; Buchholz 2020).

This development of the history of knowledge as a discipline has led not only to an enlargement of research questions and topics, but also to the study of a broader range of sources. This includes the archives of associations, amateurs, publishers, and bureaucratic institutions; market-oriented products of popular culture; and artistic or literary works in various stages of processing and contexts of use, in which geoscientific forms of knowledge and countercultures are recorded, classified, and controlled, but also negotiated or popularized (O'Connor 2007; Finnegan 2009; Dawson 2016). Research encompasses such topics as the entanglement and hierarchy of bureaucratic, practical, and mineralogical knowledge in mining; interaction and knowledge exchange between scientific institutions and the local knowledge of natural science associations; and the practical knowledge of farmers, miners, and craftsmen (among others Hamm 1997; Felten 2018; Mattes 2022b).

Finally, the history of knowledge is also playing a growing role in the study of human history in the Anthropocene – in particular, how humans contributed as a geological factor to environmental transformation and climate change (Adeney Thomas et al. 2020; Renn 2020). In addition to the question of how knowledge about the Earth emerges and changes over time, scholars have examined how it spreads and circulates globally in social networks (Secord 2018). These studies also go beyond a Eurocentric perspective and include cultural encounters and the influence of local knowledge of other cultures on the formation of Earth knowledge (Fan 2004; Cruikshank 2005; Chakrabarti 2020; Bashford et al. 2023). In this way, it is possible to trace on different scales how various modes of knowledge have informed and influenced societies, and the environments in which they have been embedded (Westermann and Höhler 2020). Such a combination of approaches from global and environmental studies, history of knowledge, and history of Earth sciences is evident in a number of recent works, such as on the history of seismology and climatology (Coen 2013, 2018), and on expert knowledge in the nineteenth- to twentieth-century exploitation of mineral resources (Wu 2015; Fischer 2017; Wendt 2022) and geoengineering (Bennemann 2020; Lehmann 2022). In this context, the problematic relationship between knowledge and power in colonial and imperial settings comes to the fore (Ballantyne 2008; Gräbel 2015; Beattie et al. 2014; Brescius 2019; Feichtinger and Heiss 2020).

The Aim of This Volume

As editors, we were aware from the very beginning that not all the contributions published here can be understood as histories of knowledge. Consequently, this volume does not claim to be either a coherent history of science or a history of knowledge for the Earth sciences. Rather, we see it

both as a reflection of previous research and as a further step toward a history of the Earth sciences that is expanded by approaches from the history of knowledge. This is why we focus on the history of knowledge only to a limited extent. We are primarily concerned with the emergence, (re)use, and dissemination of scientific knowledge, as well as those forms of knowledge that are not (strictly speaking) regarded as "scientific" but have nevertheless contributed to scientific knowledge production (Joas et al. 2019). We emphasize the hybrid nature of knowledge at the interface of different fields of expertise, stakeholders, and sites; our focus is those forms of knowledge that have been part of research processes, both directly and indirectly, or have contributed to them. Of particular interest to us are the diverse types of knowledge, including practical, nonverbal, tacit, symbolic, and local knowledge, as well as the relationship between established and non-accredited knowledge.

The contributions to this volume examine the practices of production, circulation, and (re)use of knowledge about the Earth, and their social and cultural implications from modern times to contemporary history. We are especially interested in how knowledge and its diversity determine patterns of scientific action. At the heart of our volume is the consideration that the study of different forms of knowledge is a far greater mobilizing force for historical research than previously thought. At the same time, we understand knowledge as a fragile outcome of intense processes of negotiation (Füssel 2019, 35), an approach that gives us valuable insight into the question of how authority is produced in various cultural and social contexts.

Viewing the history of Earth sciences as a history of knowledge allows us to rethink established narratives and to change perspectives. Our aim in doing this is to critically examine the extent to which history of knowledge approaches can thematically and methodologically advance the history of Earth sciences beyond well-trodden paths and offer additional potential for analysis. This goal has several consequences for the conception of this volume, which is not limited to a single disciplinary-historical focus but brings together a heterogeneous ensemble of themes and time periods that can be located in both the history of the Earth sciences and the history of knowledge. Likewise, we do not claim to cover the entire thematic breadth of current research in the histories of science and knowledge. Rather, the authors of this volume cast individual spotlights on different topics and time periods, which nonetheless have common aspects and strands.

In laying out the thematic scope and methodological approaches of this volume and to clarify the relations between the individual contributions, we have identified three dominant dimensions, which we have touched upon above: Actors and practices of knowledge; spaces of knowledge; and knowledge forms and transformation processes. Although the contributions presented here do not address all these dimensions to the same extent, they each combine innovative approaches from at least two of them and explore the advantages and limitations of writing a history of science as a history of knowledge in practice. Each will ask: Who produces a particular form of

knowledge and by what means? How, when, where, and (potentially) why does a particular knowledge emerge, circulate, and disappear? And finally, how does knowledge affect the self-image, perception, and options for action of individuals, groups, institutions, and society as a whole?

The Contributions to This Volume

In the first paper, Anne Mariss looks at the work of the German traveler Johann Reinhold Forster (1729–1798) and his production of mineralogical knowledge. She examines both empirical and text-based practices, focusing on Forster's own observations, his collecting practices of natural objects and cultural artifacts, and his second-hand knowledge. In the process, a close relationship becomes apparent between practices, objects, texts, and theories. It is particularly revealing that Forster, as a theologian and naturalist trained in the study of language, gained valuable insights into the shape of the Earth's crust from both ancient mythology and empirical observation. The coexistence of various new and traditional worldviews gives rise to what Mariss calls the "productive area of enlightened natural history." As a "scientific world-maker," Forster always kept an eye on the details without losing sight of the big picture, which served him well with his students. He further developed his thoughts in salons and letters, by taking positions on various controversies. For example, in his lectures at the Dissenting Warrington Academy in England, Forster abandoned the idea that fossils should be understood as "lusus naturae," or wonders of nature. However, in the protected space of his private correspondence, he adopted the explanation of species extinction as an explanation; this ran counter to his publicly expressed positions. In the Republic of Letters, knowledge was created not only through personal observation, but also through the interaction of teaching, reading, and discussion.

In her chapter on ice core paleoclimatology as a novel field between glaciology, laboratory physics, and climate science, Dania Achermann explores the question of how disciplinary staging took place in an interdisciplinary context. She links this question to the distinction between two disciplinary traditions: Classical glaciologists in the field and physicists in the laboratory. Both field and laboratory researchers are characterized by different self-representations, which are documented, for example, in the photographs of researchers working on Greenland's ice sheet. The emergence of the laboratory in the field, which gained importance with the establishment of interdisciplinary climatology, was accompanied by a change in the researchers' self-representations. As they crossed the boundaries between laboratory and field and opened a new area of knowledge between established disciplines, the descriptions of their physical experiments in their autobiographies and the evidence that they had actually been there played an important role in their identity formation. Former laboratory scientists also adopted the image of the field researcher, taking their cue from the self-representations of polar

heroes. According to Achermann, the "staging replaced the ideal of a bodiless laboratory science, despite the fact that laboratory research still remained part of the job." By showing that the physical deployment of researchers in the icy landscape played a key role, Achermann extends traditional explanations of discipline formation based on the establishment of university chairs and journals.

The value placed on local phenomena as a starting point for universal knowledge has been characteristic of geological epistemology since the second half of the eighteenth century. While "place specificity" was originally associated with progress (Taylor 2007), the opposite was true in the case of geology in Nazi Germany, as Martina Kölbl-Ebert argues in her paper. The transition from volcanism to impact theory occurred much later in Munich and Tübingen than it did in the United States, although both German communities were concerned with the Nördlinger Ries, an impact crater in southern Germany that was thought to be of volcanic origin until the 1960s. In the United States, there was more methodological diversity in the geosciences, including a greater openness of stratigraphic scientists to mineralogical and actualist approaches. This better embedded local geology in global contexts and international research. In Germany, however, the two rival communities clung to their traditional practices and fieldwork, stratigraphy, and Nazi holistic ideology. This self-isolation continued after the war. In her analysis, Kölbl-Ebert makes use of Ludwik Fleck's (1935) concept of the "thought collective," which illuminates why communities in Germany remained resistant to influences from the United States long after 1945. Her contribution is an excellent illustration of how local practices, ideological, and symbolic knowledge, especially the notion of the uniqueness of geological phenomena, adapted to Nazi ideology and thus determined its persistence. The paper demonstrates the extent to which a hermetic space because of self-isolation from international practices ensured the persistence of research in Germany.

Sandra Klos's contribution understands the social practice of self-representation in curricula vitae – which were requested of new members by the Academy of Sciences in Vienna – as a key source for understanding the self-image and social habits of geologists. These CVs prove to be a social practice that encompasses the collective system of attitudes, values, and behaviors underlying the everyday sociability of Earth scientists. The autobiographies of the three Earth scientists presented here were not initially available to the public, but were intended for publication after their deaths, which influenced their design. These autobiographical texts were later used by the Academy in writing obituaries. Klos relates the careers of the three Earth scientists in the autobiographies to the values of physical fitness, masculinity, and work. In their autobiographies, they shared these characteristics with their community to emphasize their identity as field researchers. Moreover, the self-descriptions of the three geologists are situated at the intersection of two institutional spaces, the Geological Survey and the Academy of Sciences in Vienna, and mark an important biographical moment for the protagonists – their admission to the Academy.

That practices do not function independently of theories is the subject of Philipp Meyer's contribution on map production at Justus Perthes's Geographische Anstalt in Gotha between 1900 and 1930. This case study reveals that, although cartographers took on board new scientific theories of optics for the representation of terrain in maps, this new knowledge still had to be translated into map-making practice. At the same time, Meyer shows that the map production process was not only determined by cartographers and their knowledge. In a publishing house, many different actors worked together, such as engravers, printers, colorists, lithographers, stenographers, typesetters, bookbinders, sales representatives, editors, and cartographers. To contemporaries, Meyer notes, it was a "finely branched working organism." He sees the mapmaker's work as an interface between networks of conceptual and implicit knowledge, professional discourse and printing practice, experience and personal attitude. Finally, "taste" and "skill" were decisive to implementing new scientific theories in the process of map design and printing. In his reflections, he draws on Alf Lüdtke's (2015) concept of willfulness (Eigen-Sinn) for industrial workers, which refers to the "moment of individual deviation, the nonfulfillment of social expectation, and practices of the non-intended" in order to "act and mean differently than it is expected." Meyer uses three different cartographic projects as case studies to show how mapmakers employed this willfulness to take new and unexplored paths, translating new theories into established practices. This gave them a certain degree of authority over the publisher and other actors involved in the process of map making.

To whom does a phenomenon belong? Which branch of knowledge is primarily concerned with it, and why? Susanne Grunwald asks these questions in her article on prehistoric, vitrified forts. Using this phenomenon as a case study, she discusses what we now call chemistry, geology, and archaeology, and how researchers and experts from different fields shared their knowledge in the late eighteenth and early nineteenth centuries. She notes that this process has been marginalized by the history of science because of its disciplinary focus. Vitrified forts were originally considered the preserve of ancient history, and their function remained unexplained for a long time. They were first popularized by Scottish naturalists in the late eighteenth century. These naturalists approached this "new" phenomenon from their respective standpoints, describing it chemically, mineralogically, and in relation to their interest in volcanism. "Vitrified forts" soon gained importance as a missing link between the unwritten past and the Middle Ages. When knowledge of this phenomenon reached Saxony, it was no longer a cultural asset for naturalists but became the subject of chemical and mineralogical debates about the effects of fire and heat. Military specialists soon changed their own view of the phenomenon and began to discuss the function of vitrified forts as defensive installations.

In her paper on "Bibliographic data as knowledge proxies," Anna Regener uses the tools of digital humanities, GIS, and book history to investigate the

circulation of knowledge in book form. At first glance, her contribution seems to be thematically and methodologically different from the others. However, Regener shows the potential that lies in combining approaches from the history of science and knowledge with those of library history (Steinbach-Hüther et al. 2019). She uses bibliographic metadata on author, title, year, and place of publication to create a geography of books and map the paths of this "materialized knowledge in motion." Her analysis of knowledge transfer using the example of German historical geography books follows James A. Secord (2004, 668) in noting that it is "a history that retains the virtues of the local but operates on a larger unit of analysis than a single country." For Regener, libraries are specific spaces of knowledge. They are not only places for collecting knowledge, but also "representations of state, social order" and of "powerful actors that shape society's knowledge of itself and the world through selection." In this way, she can identify "imbalances in production, storage, and consumption as well as the scientific frontiers formed by language and scholarly neglect." By revealing "persistent modes of circulation" through her bibliographical analysis, she comes to unexpected conclusions about the boundaries of knowledge circulation and the limits of interlingual exchanges.

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Note

1 The workshop was held on 12–13 October 2020 under the title "Historisches Forum: Erde, Natur, Wissen" (Historical Forum: Earth, Nature, Knowledge) and was sponsored by the Leibniz Institute for Regional Geography (IfL) in Leipzig, Germany.

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