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INHALT

REVIEW ESSAY

STUART A. HARRIS/ANATOLI BROUCHKOV/CHENG GUODONG: GEOCRYOLOGY: CHARACTERISTICS AND USE OF FROZEN GROUND AND PERMAFROST LANDFORMS, LONDON: CRC PRESS, 2018.

Andy Bruno

Concerns about the changing characteristics of frozen ground have become a major part of public discourse surrounding anthropogenic climate disruption. Journalists sometimes breathlessly describe the potential for permafrost »melt« to unleash methane which has long been stored in frozen landforms. In the atmosphere, methane functions as an even more potent greenhouse gas than the carbon dioxide that humans have been emitting by burning fossil fuels. As warming gives way to the conditions to spur more warming, a dreaded feedback loop could arise that leads to climate havoc spiraling even further out of control.

Though this scenario represents a severe threat to the ecological conditions that have dominated the planet since the end of the last ice age, its evocation occurs in the context of occasionally muddled understandings of the characteristics of frozen earth. There is the common but inaccurate description of permafrost »melting« rather than thawing, as if the process is similar to an ice cube turning into a puddle of water rather than a hard material becoming an unstable mush.[1] Current discourse about permafrost and what is happening to it in a warming world also results in depictions of the Arctic as a previously ahistorical and timeless place that is only now unfreezing in the face of modernity's onslaught.[2] Such a framing implicitly obscures the complexities and dynamism of Indigenous livelihoods in both the past and the present as well as the varied experience of imperial conquerors, mercurial merchants, exploratory scientists, and settler colonists. The cold, frost, and ice have an underappreciated history, as recent work in the environmental humanities has shown.[3]

In the case of permafrost, the contested disciplinary history of the study of frozen ground is much thornier than an assumed scientific consensus. There have been many approaches to the study of permafrost since it emerged as a scientific discipline in the first half of the twentieth century. Historian Pey-Yi Chu describes a dialectic involving a concentration on either structure or system that has characterized the field of knowledge surrounding frozen ground and its formation, properties, distribution, and dynamics. The issue of whether the substance of frozen materials in the earth or the process of freezing and changing under cold conditions constitutes the primary vector of the discipline has been the subject of cyclical and sometime acrimonious debate, even if many in the past and present have sought to reconcile these two standpoints. The very concept of permafrost first appeared as the German *Boden-Eis* (ground ice) and *Eis-Boden* (frozen soil) in the nineteenth century and later emerged as the Russian *vechnaia merzlota* (eternally frozen earth). As the Soviet Union expanded its industry into the coldest regions of the north in the 1920s and 1930s, it sought engineering solutions to the problems it faced with building infrastructure upon frozen ground. In order to assist these construction projects, scientist Mikhail Sumgin led an effort to institutionalize the study of frozen earth. This discipline came to be known as *merzlotovedenie*, focusing

1 For example, Thane Gustafson's book on climate politics in Russia repeatedly refers to permafrost melt. Thane Gustafson: *Klimat: Russia in the Age of Climate Change*, Cambridge, MA: Harvard University Press, 2021.

2 Countering the ›timelessness‹ of the Arctic, see Andrew Stuhl: *Unfreezing the Arctic: Science, Colonialism, and the Transformation of Inuit Lands*, Chicago: University of Chicago Press 2016. On the need to view the present and future of permafrost from the stance of multiple discontinuities, see Charlotte Wrigley: *Earth, Ice, Bone, Blood: Permafrost and Extinction in the Russian Arctic*, Minneapolis, MN: University of Minnesota Press 2023.

3 Julia Herzberg/Andreas Renner/Ingrid Schierle (eds.): *The Russian Cold: Histories of Frost, Snow, and Ice*, New York: Berghahn 2021. Julia Herzberg/Christian Kehrt/Franziska Torma (eds.): *Ice and Snow in the Cold War: Histories of Extreme Climatic Environments*, New York: Berghahn 2018.

on the study of the substance of *vechnaia merzlota*, which Sumgin defined as a physical structure in the ground continuously frozen for at least two years.[4]

Only in the 1940s was the Russian *vechnaia merzlota* translated into English as »permafrost«. The combination of an adjective (*vechnaia*, eternal or perpetual) and an ambiguous noun without a direct equivalent (*merzlota*, frozen earth) resulted in the single noun permafrost, which conceptually reinforced the notion that it was a substance rather than a process. Sumgin's assembly of a new scientific edifice faced challenges in his lifetime and beyond. In the 1930s, Ukrainian geographer Sergei Parkhomenko polemicized against the Sumgin's conceptions, calling them sloppy and incoherent.[5] Although Sumgin's ideas persisted, they were reconsidered after Sumgin's death in the 1950s. Inspired by systems thinking and dialectical materialism, hydrogeologist Petr Shvetsov sought to establish a new paradigm for the study of frozen earth that focused on the dynamics affecting the space of the cryolithozone rather than on the substance of permafrost. Instead of *merzlotovedenie*, which was often translated as permafrost studies, he proposed calling the discipline *geokriologiia* or geocryology.[6]

The book under review represents a mature contemporary overview of the discipline of geocryology. Authored by an international team consisting of British-Canadian Stuart Harris, Anatoli Brouchkov from Russia, and Cheng Guodong from China, *Geocryology: Characteristics and Use of Frozen Ground and Permafrost Landforms* was published in 2018. It seeks to provide a comprehensive manual of the »young science« of geocryology.[7] Exquisitely illustrated (especially in the electronic version with color photographs), the volume consists of three parts with numerous chapters, spanning more than eight-hundred pages including the front and end matter. Broad in scope and accessible to non-experts hoping to understand the discipline's main contours and terminology, the book aims to elaborate on varied concepts employed by frozen earth scientists while also making those from different national scientific traditions comprehensible to each other. Thus, even for a scientific textbook far from the humanities and social sciences, it presents a wealth of material for conceptual historians to consider. In my review, I will highlight some of these dimensions of the book while leaving an assessment of the merits of its presentation of the science to others.[8]

In the preface and the introduction to Part 1, the authors offer two slightly different definitions of geocryology. They first characterize it as »the study of permafrost, its nature, characteristics, processes and distribution« and later as »the science studying the effect of ground temperatures below 0°C on the surface layers of the crust of the Earth« (1, xv). These two definitions encompass a continued dialectic between system and structure that Chu highlights, as does the parenthetical equation of the two fields – »*geokriologiia (merzlotovedenie)*« – in the Russian version of the book.[9] The volume reflects the emergence of a systems approach in contemporary science, even as it maintains an overall orientation toward engineering problems. In this sense it can be seen as an attempt at a synthesis of the field that strives to resolve tensions but does not always succeed in doing so.

The first part describes the general characteristics of the formation of permafrost, the cryogenic processes regulating it, and its distribution. Early on, the authors introduce the notion of layers of the cryolithozone distinguishing an active layer of the ground that seasonally thaws and refreezes from permafrost that remains perennially frozen ground. There may be unfrozen segments among and beneath these layers that could be called »taliks«, though the naming practices vary among regions and languages. The study of frozen earth features a number of Russian terms from earlier periods used to describe parts of permafrost layers that do not appear in the Western literature. One is *pereletok,* which refers to seasonally frozen soil that does not melt for a few years. Paying particular attention to heat flows, the authors outline

4 Pey-Yi Chu: *The Life of Permafrost: A History of Frozen Earth in Russian and Soviet Science*, Toronto: University of Toronto Press 2020.

5 Ibid., pp. 69–103.

6 Ibid., pp. 127–163.

7 Stuart A. Harris/Anatoli Brouchkov/Cheng Guodong: *Geocryology: Characteristics and Use of Frozen Ground and Permafrost Landforms*, London: CRC Press 2018, p. xv. Hereafter cited with page number in brackets.

8 Readers seeking a review of the book from within the field might consult: Ming-ko Woo: »Review of Geocryology: Characteristics and Use of Frozen Ground and Permafrost Landforms«, in: *Arctic: Journal of the Arctic Institute of North America* 71 (June 2018), no. 2, pp. 233–235; Shemin Ge: »Review of Geocryology: Characteristics and Use of Frozen Ground and Permafrost Landforms«, in. *Arctic, Antarctic, and Alpine Research* 51 (2019), no. 1, pp. 313–314.

9 Stiuart A. Kharris/Anatolii Brushkov/Chėn Guodong: *Geokriologiia: kharakteristiki i ispol'zovanie vechnoi merzloty* [Geocryology: Characteristics and Utilization of Permafrost], vol. 1, Moscow: DirectMedia 2020, p. 11. On this convention in Russian language works, see Chu: *The Life of Permafrost* (note 4), p. 159.

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the cryogenic processes that affect the freezing, thawing, cracking, and upheaving of ground and thus determine the emergence and extent of permafrost zones and other features of frozen landscapes. The distribution of permafrost depends on an array of climatic, geographic, and terrain-related factors. As the authors note, permafrost »occurs on all continents except perhaps Australia« (xv), but beyond Eurasia (including the Qinghai-Tibetan plateau) and North America, it primarily appears in patches in the highlands. A belt that extends around most of the Arctic and subarctic is interspersed with continuous and discontinuous permafrost and contains areas of meters-thick, perennially frozen ground. A chapter in this part outlines current techniques for mapping, modeling, and monitoring permafrost zones.

In Part 2, Harris, Brouchkov, and Cheng provide an extensive overview of the landforms that occur in permafrost regions. They begin with ice wedges and tessellons that can produce patterns of polygons on the surface and, in the case of the former, often begin the process of permafrost formation. In a chapter devoted to massive ground ice in lowland areas, they discuss how some but not all subterranean icy beds might be remnants from previous glaciation and outline various processes such as cryosuction that might have contributed to their formation. Alternative processes of origin are particularly important for *yedoma* (also called ice complexes), an ice-rich type of permafrost that extends back to the Pleistocene in territories not glaciated during the last ice age. Chapters also cover mounds (including pingo domes and peaty palsas), slush flows and avalanches, blocky materials and landforms in cold climates, cryogenic patterned ground (including the appearance of circles, polygons, and stripes), and a variety of pits, heaps, streams, lakes, and *alas* (or *alaas*) connected to thermokarst and other effects of thermal erosion. The authors note that despite a more restricted usage when it was introduced in the Soviet Union in 1930s, »the term thermokarst has now expanded to cover any modification of the ground surface by all processes involving melting of all kinds of ground ice« (398). Anthropogenic and non-anthropogenic thermokarst processes in permafrost regions have been the subject of much discussion in the literature on climate change.

The third part of *Geocryology* »examines how engineers have developed techniques to enable development in permafrost areas« (443). It opens with praise of the Russians who »conquered the northern part of Siberia between 1490 and 1692« and, like their successors in North America, eventually supplanted Indigenous knowledge with modern science (441). This part is oriented more toward an understanding of permafrost as an object to be confronted in the service of industry, overshadowing more process-based approaches to understanding the dynamics of the cryolithozone. The authors open the part with a chapter on the mechanics of frozen soils and another on general construction principles and practices that reviews the various types of foundations that can be employed. The rest of the book focuses on specific types of infrastructure (roads, railways, airfields, pipelines, water supplies, and sewage systems) and industries (oil and gas, mining, agriculture, and forestry). These chapters feature vivid illustrations of attempts to build on permafrost and include repeated evaluations of the problems related to thawing ground in a warming climate. At the very end, however, the potential effects of global warming are understood as possible catalysts to an expansion of agricultural lands, especially in Siberia, rather than as factors generating new precarities for the web of life.

If *Geocryology* aimed to synthesize disparate approaches and resolve the long-standing tensions in the study of frozen ground in the cryolithozone, it was at most only partially successful. A number of strains between structure and system reappear. Regardless of the manual's utility for geocryologists, the conceptual messiness of the science abides. A preface to the two-volume Russian translation of the book highlights the slipperiness of technical terms in different languages and outlines the editorial team's attempts at clarification. For the Russian version, Brouchkov provided additional commentary to elaborate on certain topics. While evincing pride in Russia's pioneering work in geocryology and establishing much of the terminology of the field, his team also found it necessary to introduce some novel terms from the Anglophone literature into the Russian scientific vocabulary. They cite the word *kasty* to capture the »ice wedge casts«, which refers to a residue of melted ice wedge formations that can appear in the ground.[10] Even eighty years after the ambiguous and contested *vechnaia merzlota* became the problematic, but often reified, permafrost, the transfer of concepts and the perennial risk of misinterpretation remains.

Different understandings of terms involve Indigenous knowledge as well. The authors of *Geocryology* respectfully comment on the cultural and economic

10 Ibid., p. 12.

significance of concepts such as *alaas* for the Sakha people. Still, their overview of this topic does not integrate Indigenous knowledge. From the perspective of geocryology, *Alaas* is a land formation that occurs when a thermokarst lake atop ice-rich permafrost drains and leaves flat arable valleys. The book explains a cycle of the stages as *alaas* fluctuates and matures. For the Sakha people, a geophysical conception of *alaas* only captures a small part of the term's significance. In their view, *alaas* represents something closer to homeland that provides sustenance and spiritual connection. Based on her decades of ethnographic work with Sakha people, anthropologist Susan Alexandra Crate emphasizes the importance of the notion of living »by the *alaas*« for the Sakha. This entails economic and cosmological connections to a physical and mental landscape. As Crate shows, Sakha knowledge of *alaas* includes important observations about the environment that cannot simply be subsumed by scientific epistemologies. It is necessary to operate at very local scales to enrich geocryology with Indigenous insight.[11]

A final tension appears in the approach to global warming among two of the authors: Stuart Harris and Anatoli Brouchkov. Although there is commentary on limiting environmental damage and considerable discussion of the effects of the climate in cold regions, the English version never clearly pins the recent warming trend on the anthropogenic emissions of greenhouse gases. Indeed, in a separate publication from 2022, Harris expresses doubt concerning the global character of the warming trend and its human causation, suggesting that temperature increases in the Northern Hemisphere can likely be traced back to shifts in deep-water thermohaline flows. He states that there »is no evidence to indicate that carbon dioxide is of any special importance in the processes so that the measures taken by governments to alleviate it as a problem are not needed«.[12] This claim sharply contradicts the strong consensus of the expert climatologists at the Intergovernmental Panel on Climate Change regarding the cause, character, impact, and urgency of addressing the warming trend. Harris's belief is also disputed by Brouchkov in one of his commentaries in the Russian edition of the book. There, Brouchkov asserts that »warming from the greenhouse effect dominates over other important factors« and describes those who deny this as mostly residing outside »the professional sphere«.[13] I wonder whether Brouchkov would apply this dismissal to his own co-author. A public that is aware of the risks of permafrost disappearance would benefit from a deeper understanding of geocryology. However, Harris's disconcerting denial of the existence of anthropogenic warming eliminates any confidence one may place in him as an appropriate expert.

11 Susan Alexandra Crate: *Once Upon the Permafrost: Knowing Culture and Climate Change in Siberia*, Tucson: University of Arizona Press 2021.

12 Stuart A. Harris: »Causes and Mechanism of Global Warming/Climate Change«, in: id. (ed.): *The Nature, Causes, Effects and Mitigation of Climate Change on the Environment*, London: IntechOpen 2022, pp. 17–44, https://www.intechopen.com/chapters/79908 (accessed on 01.03.2023).

13 Stiuart A. Kharris/Anatolii Brushkov/Chèn Guodong: *Geokriologiia: kharakteristiki i ispol´zovanie vechnoi merzloty*, vol. 2, Moscow: DirectMedia 2020, pp. 215–216.

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