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Minecraft's territory: Alberta's oil sands, settler knowledge infrastructure and digital geographies

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Abstract

In 2017, the Alberta Geological Survey published an extension to the game Minecraft that allows players to virtually mine bitumen in Peace River, one of the three bitumen deposits in Alberta that together form the fourth largest oil reserve on Earth. This article uses the Minecraft extension to advance a novel synthesis of environmental and digital geographies, and to understand how they combine in settler knowledge infrastructures—the networks, institutions and practices through which geoscientific knowledge is constitutive for claims to territory by settler states. To advance these ideas, I show how the data used to create the virtual world within Minecraft are connected to real-world extraction, especially environmental harms that Alberta's provincial regulator sought to address in Peace River. That data, however, does not stand alone. It was interpreted through, and itself extended, knowledge practices that stretch back to early-twentieth century mapping and the on-going collection of extractive data by the state. The Minecraft model also extends Alberta's settler knowledge infrastructure as part of international collaborations with other geological agencies. Set in this broader context, the article pushes digital geographies to attend to how environments—geologic pasts, extractive presents, virtually played—prove constitutive for state claims to territory.

KEYWORDS

Alberta oil sands, digital geographies, Minecraft, Peace River, settler colonialism

1 | INTRODUCTION

In 2017, a videogame about the Alberta oil sands—the world's fourth largest oil reserve—made headlines when lobbyists and a Minnesota senator claimed that it encouraged 'ecoterrorism' (see Attebery, 2020; Dube, 2017; Habrel, 2018). The creator of *Thunderbird Strike*, Elizabeth LaPensée (2018), described the game otherwise, as an act of Indigenous survivance: a form of self-determination amid colonial oppression. If they want to, players can crash lightning down onto

mining trucks used to haul the viscous, bitumen-soaked sand that comprises the bulk of Alberta's 168 billion barrels of oil. However, survivance could take many paths. Players can reach the end without destroying anything or wield lightening to revive the bones of animals like Bison.

Amid the flurry of attention on LaPensées' award-winning game, little notice was paid to how, also in 2017, the Alberta Geological Survey (AGS) published an extension to the game Minecraft. The AGS was created in 1921 and is the province's principal agency for holding and advancing geoscientific knowledge. Its Minecraft extension prioritised one option: extracting bitumen from oil sands near Peace River. The Peace River oil sands are significant, although they are the smallest of Alberta's three main bitumen deposits in terms of current levels of production (second largest by area). The others are at Cold Lake and Athabasca, the latter of which is the industry epicentre and receives far and away the most attention from scholars and journalists concerned with its social and environmental impacts (e.g. Baker, 2021; Baker & Westman, 2018; Chastko, 2004; Hern & Johal, 2018; Simpson, 2019; Todd, 2022; Turner, 2017; Urquhart, 2018). Nevertheless, the Peace River deposits have been a sustained presence in Alberta since the 1960s, and its bitumen industry has grown rapidly in the last two decades. As Lee-Jones (2019) argues, Peace River's comparatively recent development is important for understanding the co-constitution of extraction and settler colonialism today.

Minecraft is often lauded for how its 'sandbox' style enables public geoscience and pedagogical innovation, while critics argue it reinforces extractive relations to Earth. The novel contribution of this article is to show how the virtual world within Alberta's Minecraft extension is not only a model of the natural world but is instead made possible by—and itself extends—a knowledge infrastructure that facilitates real-world extraction. How are virtual and real data connected? I argue both operate within a settler knowledge infrastructure, a phrase first used by Willmott (2023) that I develop with respect to the practices through which geoscientific knowledge makes possible both virtual and real-world extraction in settler colonial states. Further, and once the idea of 'settler knowledge infrastructures' is in place, it becomes clearer how the Minecraft extension is not merely local. Not only can it be played anywhere, the knowledge infrastructure that allowed data from real-world extraction to create a virtual world below Peace River also figures—along with the Minecraft extension itself—in international geoscientific collaborations both past and present.

The article has three sections that together anchor its original synthesis of environmental and digital geographies. Section 2 contextualises this study with respect to how settler colonial practices of knowledge production facilitate the extraction of value from land while separating those claims from the Indigenous dispossession on which they are premised (cf. Byrd, 2011). Adjacent concerns animate work on videogames, which often focus on how place and landscape—also extraction—shape spatial imaginaries. Bogost (2007), for instance, interprets videogames through the ideologies that gameplay advances or disrupts. By contrast, this article is not about interpreting gameplay. I do not treat Minecraft as a metaphor of the colonial world, though as I show many scholars make important arguments by doing so. Instead, I detail how the data used for Alberta's Minecraft extension, from the rationale for collecting it through to its use, directly (i.e. non-metaphorically) extend the knowledge infrastructure of settler colonialism. Section 3 focuses on collection of the data on which Alberta's Minecraft extension was built: complaints of nausea, dizziness and headaches from oil sands operations that forced people in the Peace River area from their homes. This data does not stand alone; it operates in a broader context that includes Alberta's longstanding practice of collecting and storing data from extractive processes. Section 4 connects the data used in the Minecraft extension to Alberta's knowledge infrastructure, including historical practices through which Alberta has mapped, and today manages, geoscientific knowledge. By connecting the Peace River data with Alberta's geoscientific practices, I show how the knowledge infrastructure of settler colonialism is not merely modelled within Minecraft, but itself part of producing new digital geographies. Section 5 concludes by showing how attention to settler knowledge infrastructures pushes digital geographies beyond the recognition of the social and environmental impacts of digital infrastructure, such as the water and electricity demands of data centres (e.g. Taffel, 2021). Those are important, but so too is understanding how settler knowledge infrastructures underpin digital geographies in ways crucial for understandings relations of geology and extractive politics (cf. Braun, 2000, 2002; Yusoff, 2024). Settler knowledge infrastructures, in other words, offer a new a point of departure for understanding digital geographies that are not confined to games but rather both constituted through, and constitutive for, extraction.

2 | SETTLER KNOWLEDGE INFRASTRUCTURES

Settler colonialism has always been entangled with knowledge production. Wolfe's (1999) foundational work on nineteenth-century anthropology, for instance, tied the term 'settler colonialism' to how claims about Indigenous peoples in Australia were forged through colonial social science. Then, as now, disciplinary knowledge production relied on

what Edwards (2010, p. 17, original emphasis) termed knowledge infrastructures, which '*comprise robust networks of people, artifacts, and institutions that generate, share, and maintain specific knowledge about the human and natural worlds*'. While early research on knowledge infrastructures focused on their materiality—libraries, journals, computers and et-cetera (Edwards, 1996, 2010)—the field increasingly focuses on how different publics are compelled and constrained by the conditions of existing knowledge infrastructures, such as in response to environmental harms (Fortun et al., 2021; cf. Edwards, 2017). Here I turn knowledge infrastructures explicitly to the networks, practices and institutions through which settler states claim sovereignty through territorial knowledge at and below the surface. This includes an approach to geoscientific knowledge that understands such knowledge as not merely instrumental to state power but a constitutive aspect of both Indigenous dispossession and the extraction of value from land (Braun, 2000, 2002). Historically, settler colonialism in Canada has consistently been an international endeavour shaped by jurisdictional contests and overseas financing of extractive industries (Barker, 2022; Mawani, 2018; Shipley, 2020). Critically, these histories also extend to knowledge production. From as early as 1790 the Hudson's Bay Company provided free shipping for staff working in their extractive economy to acquire books across its North American outposts; in turn, employees and HBC governors often facilitated knowledge production through collaboration in international scientific projects (Binnema, 2014).

Today, settler knowledge infrastructures must also be understood with respect to the material infrastructures of extraction (LaDuke & Cowen, 2020; Pasternak, 2023; Pasternak et al., 2023). Knowledge infrastructures are, in an important sense, what legitimates investment in material infrastructures as economically feasible undertakings. The extraction of coal, heavy oil, tight gas, lithium, uranium and other elements and minerals relies on the knowledge infrastructures of different geosciences. For instance, where to drill or mine, or what portion of subsurface resources constitute an official reserve, turns significantly on geoscientific knowledge. As such, the infrastructure through which knowledge is produced is key to understanding how settler colonial states constitute spatial claims to subsurface territory. To subsequently explain how contemporary knowledge infrastructures are connected to long-standing settler practices in ways that matter to new digital geographies, this section reviews previous work on Minecraft and digital geographies before situating Alberta's extension in the knowledge infrastructure of settler colonialism.

Minecraft offers two modes of play: survival mode and creative mode. The former has been critiqued for its ideology, which defaults players to white skin, positions them as entering a pristine world of 'untouched' nature and normalises the violence of extraction as the primary way to accumulate rewards (Brazelton, 2020; cf. Euteneuer, 2018). Gameplay that converts resources to in-game capital, Bird (2021) argues, reproduces and reinforces Indigenous dispossession in digital form. In this mode of play, Minecraft has been described as a 'god game' in which Earth and multiple 'others' exist to be subdued (Bird, 2024). The reinforcement of extraction is central to critical scholarship that views videogames as technocultural artefacts that reproduce imaginaries of empire (Ash & Gallacher, 2011; Dyer-Witheford & Peuter, 2009). Extraction, on such critiques, is closely connected to how virtual spaces represent 'others' and the ways affective experiences reward and reinforce structures of feeling during gameplay (Shaw & Warf, 2009). These affective experiences also include notions of time and temporality co-produced through digital geographies (Kitchin, 2023). Once set in a settler colonial context—where 'settler time' is part of relegating Indigenous peoples to the past (Rifkin, 2017)—gameplay oriented to extraction is key to examining how digital dispossession naturalises lands of Indigenous peoples as available for extractive ends (Bird, 2021, 2024). These digital geographies also have volumetric elements that demand attention, as Kendall (2024) argues, owing to how they can reinforce spatial imaginations conducive to extraction. Finally, there is also extraction *from* gameplay as big data infrastructures operate as a continuation of colonialism wherein users provide data to and are subject to surveillance by, corporations (Mejias & Couldry, 2024).

In contrast to survival mode, Minecraft's creative mode has been lauded by geoscientists, geographers and other educators. Lara (2017) describes it as an invaluable tool for teaching geology because of how it raises questions between science and fantasy. Others argue games like Minecraft and Pokémon allow students to virtually engage landscapes outside the constraints of fieldwork, which helps to address issues of inclusion in geoscience education (e.g. McGowan & Alcott, 2022; Rader et al., 2021). Archaeologists following Deleuze argue Minecraft's ideological elements are not inherently extractive and embrace the game to reimagine digital things 'through anti-fascism, decolonisation, craft, degrowth and prefiguration' (Morgan, 2021, p. 1593). Virtual worlds are also used to produce literary geographies by reconstructing islands and other spaces of fictionalised worlds (Bushell, 2024). Yet even in creative mode, Minecraft is not neutral. As Danielsson (2024) argues, platform constraints can result in Minecraft facilitating a relatively narrow vision of how to imagine or reimagine space. As such, even though Minecraft's creative mode offers pedagogical tools, it too must be critically appraised. López López et al. (2019) show, for instance, how uses of Minecraft in educational settings, such as to 'recreate colonies' in Australia, can reinscribe settler colonial notions of *terra nullius* and perpetuate Indigenous erasure.

Debates over Minecraft target connections to extraction and education, respectively. Both are tied to how Minecraft is used to construct spatial worlds. Minecraft in this sense carries its own ontology: three-dimensional blocks comprise

what is; those blocks constitute a world in which assembly and disassembly are both commensurate with acceptable relations to land; blocks anchor spacetime as players encounter environments in creative or survival modes. There is a social ontology too, which owes in part to the fact that players need not travel the same paths or even follow paths of their own previous play. There is so much freedom in Minecraft that Declos (2024, p. 118, original emphasis) argues its ontology can frustrate presumptions that, when people play it, they are playing the '*same game*'. However, this is only freedom within a spatialised world that, as Chang (2024) argues, selectively represents the real world that virtual models are built upon such as the sounds, or in Alberta's case the strata, that underpin different possibilities within Minecraft.

How are the world's within and without of Minecraft connected? My argument is that a satisfactory answer must attend to the knowledge infrastructure that connects socio-physical and socio-virtual space. This concern stands adjacent to work on how new digital geographies are taking shape in and through multiple platforms (Ash et al., 2018). As Turnbull et al. (2023) argue, digital geographies are entangled with environmental considerations in multiple ways—from the material demands of technological production to what is disclosed via user experience. As Rivera (2023) argues, these entanglements also characterise the relationship of geographic knowledge, settler colonialism, and the ways that digital tools and technologies articulate with forms of oppression or resistance. The latter concerns can be expanded on by examining how geoscientific data are tethered to digital geographies of settler colonialism. In Alberta, what is important to press is how its Minecraft simulation of real-world landscapes brings an entire network of thought, institutions and practice—a knowledge infrastructure—with it. Focusing on the knowledge infrastructures that produced Alberta's Minecraft data pushes scholarship beyond gameplay and beyond critical work on the material impacts of digital technology. It focuses attention on the continuity of knowledge infrastructure that makes real-world extraction possible and the ways *that* knowledge infrastructure is extended digitally. Critical to understanding Alberta's Minecraft extension, then, is understanding the place of geosciences in its settler knowledge infrastructure.

Before moving to that discussion, however, it is important to acknowledge how, although not always named as such, settler knowledge infrastructures are often targeted in critiques of settler colonial practices by numerous Indigenous scholars across epistemic, ethical and ontological domains. For instance: Simpson (2014) refuses anthropology's epistemic, normative and political account of Indigenous sovereignty and frustrates the relationship of its disciplinary infrastructure and state assertions (cf. Cattelino, 2008); Tallbear (2013) rejects the suite of practices that tie genetic sciences to the disciplining of Indigenous membership; Liboiron (2021a, 2021b) upends practices that position 'pollution' as anything other than an extension of extractive practices while arguing that citational practices and presumptions of access to Indigenous lands perpetuate extractive relations in academic research; Estes (2019) pushes against settler histories that ignore links of structural oppression and extractive infrastructure (cf. Blackhawk, 2023; Coulthard, 2014) and; Byrd (2011) uses colonial networks of 19th century planetary sciences as a fillip for explaining how Indigenous dispossession is partitioned from settler claims to legitimacy. These critiques target the entire artifice of settler colonialism. To use Wolfe's (1999, p. 2) famous phrase, they show how settler colonialism is constituted as a 'structure and not an event'. That is, a way of organising Indigenous oppression that ramifies across the organisation of, and distribution of power within, settler societies. More recently, Willmott (2023, p. 18) explicitly references how 'settler knowledge infrastructures' combine practices of quantification and fiscal discipline with forms of political surveillance and the delegitimisation of Indigenous knowledge (cf. Neu, 2000). These knowledge infrastructures did not anticipate settler colonialism, they were co-produced through it: practices of accounting developed to manage slave plantations underpin settler colonial economies in North America, and private property registers were developed through Indigenous dispossession rather than being extensions of European practices (Bhandar, 2018; Nichols, 2020; Rosenthal, 2018).

The geoscientific knowledge necessary for resource extraction was also developed through settler colonial practices, not in advance of them. One of the most sustained accounts of the role of geology in Canada's political imagination and infrastructural expansions is Zeller's (1999) *Inventing Canada* (see also Sandlos & Keeling, 2021). Therein, Zeller details the combination of Victorian sciences (geology and botany, especially) through which the search for coal and other resources shaped Canadian state building in the nineteenth century. The Geological Survey of Canada, founded in 1842, was a prominent organisation that coordinated much of the environmental knowledge needed for colonialisation (Zaslow, 1975). As Zeller (1991, 2000) notes, scientific collaborations extended internationally such that geology both materially and metaphorically animated colonial thought—Canada was the 'gem' of the British empire and a source for coal and other resources. Zeller's view is critiqued by Braun (2002, p. 47), however, for granting the Geological Survey of Canada a primarily enumerative role, and for assuming 'an instrumental relation between the state and knowledge of its territory'. Braun (2000) instead advances the claim that geologic knowledge was constitutive for political rationality rather than merely instrumental to pregiven notions of sovereign power. This view, and variants of it, have since developed alongside a growing subfield of political geology (e.g. Bobbette, 2023; Bosworth, 2024; Marston, 2024;

Walker & Johnson, 2018; Whitington & Oguz, 2023; Yusoff, 2024). My aim is to make explicit how knowledge infrastructures—at once epistemological, ontological and normative—are key to understanding how settler practices forge connections between geology and state power. These infrastructures further situate the social dimensions of geological knowledge that Baker (1999, p. 633) distinguished when he defined geology as both '(1) a body of knowledge about Earth and (2) a way of thinking about Earth'.

Braun's (2000, 2002) initial arguments, including those regarding how geology produced 'vertical territory' and other spatial claims to Earth's subsurface, positioned the connection between knowledge and a way of thinking through postcolonial scholarship. That framework has since been significantly adjusted through explicit accounts of settler colonialism (e.g. Cameron, 2015; Harris, 2004). Recent work has also revisited considerations of geology and political rationality from an explicitly settler colonial framework. Schmidt's (2020) account of 'settler geology' draws on Wolfe (1999) to argue that Alberta's governance structure is constituted through a 'temporal syntax' consistent with settler colonial uses of evolution to naturalise racial hierarchy. In Alberta's case, Schmidt (2020) claims the 'temporal syntax' that orders geological processes naturalises the relationship of past geological environments to governance structures of contemporary extraction. Todd (2022) takes this idea further to consider how the temporality of 'settler geology' in Alberta not only makes claims to geologic resources, but also weaponizes Indigenous kinship relations to fossils (and fossil fuels) to extractive ends. This article contributes to these arguments by examining how the knowledge infrastructure of Alberta's extractive industry advances settler colonialism in both the proximate rationale for data collection and digital extensions of geoscientific practices.

3 | EXTRACTIVE DATA INFRASTRUCTURES

Making Alberta's Minecraft extension required data. Critically, the network, institutions and practices that produced that data directly entangle geoscience with extraction; this section traces this knowledge infrastructure. The point of entry is the study published alongside the Minecraft extension, which at first glance appears an odd catalyst; its focus is on noxious odours from extractive operations near Peace River. Yet, like other 'negative ecologies'—where environmental knowledge is produced in response to harms (Bond, 2022)—the report and policy documents that contextualise it offer critical insights into why subsurface modelling of the region was undertaken. I then examine the subsurface modelling report to show how geological data was assembled and presented. Together, the background study and modelling report show how the data used for Minecraft was itself an extension of the knowledge infrastructures of settler colonialism. Describing this knowledge infrastructure is not the prelude to analysis. Instead, it establishes connections to geoscientific practices in Alberta that are developed further in the subsequent section.

On 7 October 2013 the Alberta Energy Regulator (AER), which regulates oil and gas operations in the province, held a planning meeting to organise a study into emissions and odours from bitumen extraction in the Peace River region (see Figure 1). An eight-day hearing was ultimately convened, during which people complained of 'headaches, nausea and dizziness' some severe enough to force people from their homes, lands and farms (AER, 2013, p. 2). Concerns for children, pets and livestock were raised. So too were those regarding how people knew of regulations limiting pollution for individual operators but understood that 'guidelines do not exist for total hydrocarbon emissions' (AER, 2013, p. 2). Some participants called the entire history of Alberta's regulatory framework into question. In its response to public input, the Alberta Energy Regulator rejected the idea of revisiting Alberta's regulatory history in favour of establishing a panel to 'develop recommendations for solutions...' (AER, 2013, p. 11). By the following March, the solutions-focused regulatory exercise published its report, which was organised into categories for addressing issues of odours and emissions. It began with geology before considering issues of health, operations, monitoring and modelling, gaps in the existing regulatory framework and stakeholder engagements (AER, 2014).

Why start a report into odours and emissions with geology? In one sense, it was about identifying a source for odours that parsed extractive activities from Earth's geologic composition. As the panel noted, 'higher levels of sulphur and aromatic compounds' were found in what is known as the Gordondale formation, a source of bitumen with geochemistry uncharacteristic of other bitumen plays (AER, 2014, p. 11). In other words, extraction alone would not sufficiently explain noxious odours. Instead, causal explanations had a geological bedrock to which there could be a technological and regulatory solution. In another sense, however, geology mattered to the narrative that the regulator provided about extraction in Peace River and its recent, rapid expansion. Although conventional oil and gas extraction has been a mainstay in the region since the 1950s, the region's bitumen is too deep to be mined from the surface and so requires what are known as in situ methods of extraction. Many in situ extraction technologies exist,

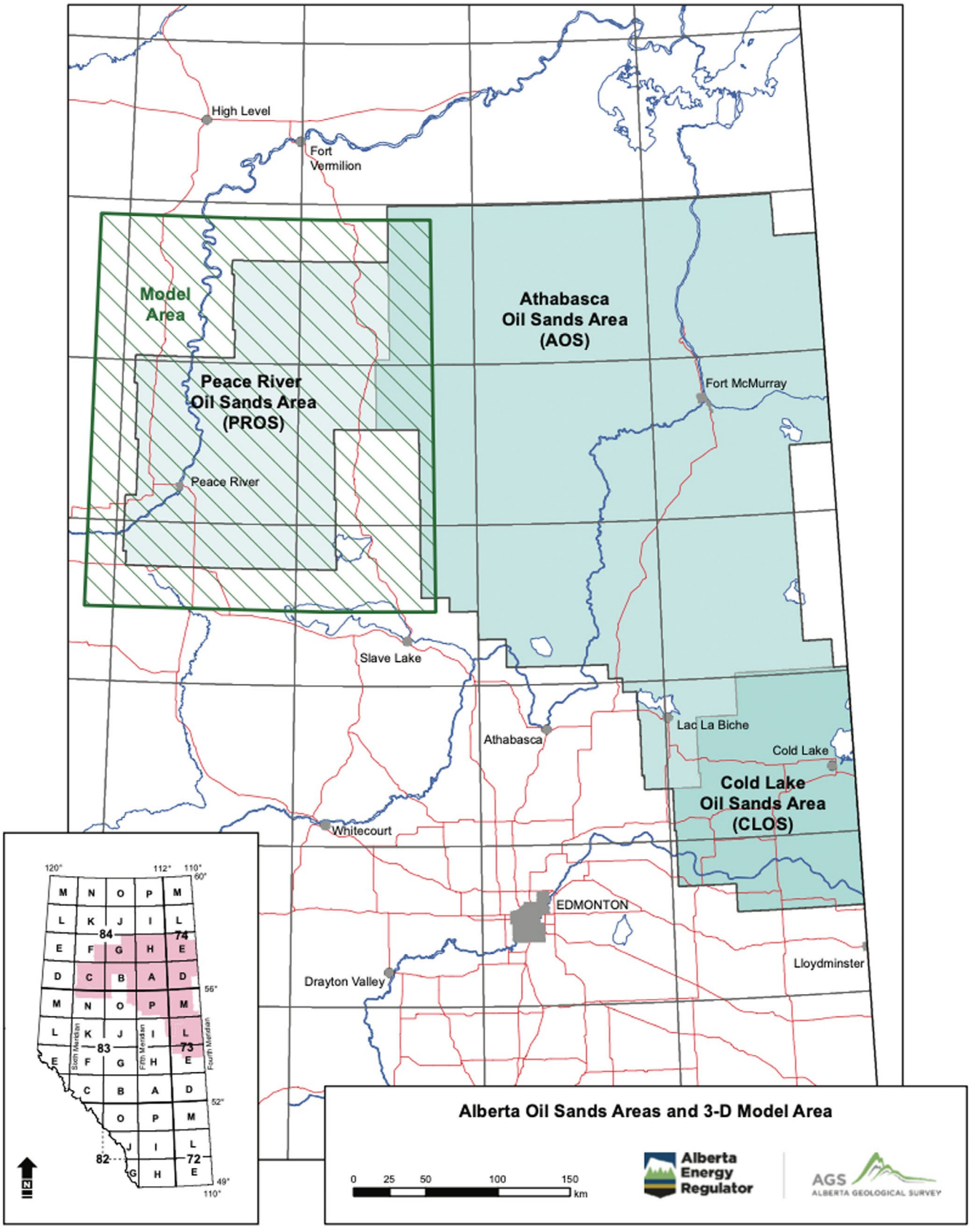

FIGURE 1 A map of Alberta's bitumen plays, with the Peace River area modelled by the Alberta Geological Survey highlighted by diagonal stripes. Courtesy of the Alberta Geological Survey. Reproduced under Alberta's Open Government Licence (from Anderson et al., 2015, p. 3).

including using cycles of high-pressure, high-temperature steam to mobilise bitumen deep underground. In Peace River, the primary in situ technology is called CHOP—cold heavy oil production—which 'involves deliberate initiation of sand influx into a perforated oil well, and continued production of substantial quantities of sand along with the oil, perhaps for many years' (Dusseault, 2002, p. 29). Sometimes the acronym CHOPS is used to signal the 'sand' component. What arrives at the surface of a CHOP well is a mixture of sand, water and oil which is then heated in production tanks before being transported for processing (AER, 2014, p. 2). Between 2000 and 2013, the number of CHOP wells in the Peace River region went from a handful to 910 while production soared to highs of over 1.5 million barrels a month (AER, 2014, p. 3).

The regulator's narrative mattered to the panel's findings and recommendation owing to how it framed one of the report's central claims: Peace River's bitumen deposits were a geologic aberration that landed in a regulatory gap regarding air quality (AER, 2014). In fact, since 2010, locals had been monitoring air quality at the encouragement of government and industry. When the regulator studied the problem, it was the residents who submitted monthly summaries of 'dates, times and the nature of emissions incidents and health effects' from January 2011 to the end of 2013 (AER, 2014, p. 40). Identifying this gap in regulation, the regulator argued that the oversight regarding the region's unique geology was part of what had allowed unexpectedly high pollutants to cause the problems people complained about. It was also something that subsequent regulatory responses could address—including later directives on odours and emissions in the Peace River area (see AER, 2018). In support of a sufficient regulatory response, the report also called for additional studies to 'assist policy makers and regulators to better understand potential linkages between odours and emissions from heavy oil operations' (AER, 2014, p. 24). By the next spring, in May 2015, the Alberta Geological Survey (AGS) had published a new study of the region that focused on the relationships of odour and geology. The AGS study combined sampling from bitumen wells across the province with lab testing of gases and, critically, the construction of a digital 3D geological model of the Peace River area (Figure 2).

The 3D model was made possible through data that tied the AGS study of Peace River to Alberta's geoscientific knowledge infrastructure, which is itself indebted to extractive activities. This knowledge infrastructure began in earnest in the 1930s, when Alberta started requiring oil and gas companies to submit geological cuttings from each 10-ft interval of drilled wells. After 1942, this was relaxed to samples from drilled cores being required upon request, in part owing to the emergence of electric well logs that produced data at sufficient resolution (Breen, 1993). The result of this policy, and the infrastructure holding geological data, is that the AGS has access to 1.55 million boxes of well core, over 20 million cutting samples (equivalent to around 84 million metres of drilling) and the daily drilling reports of over 415,000 wells (AER, 2024; cf. Pow, 1969). So, when the 3D modelling exercise of the Peace River area was undertaken, it proceeded within an infrastructure in which geoscientific knowledge in Alberta is derived from extraction. Indeed, reflecting on the AGS's broader, provincial 3D modelling programme—which includes the Peace River data used in the Minecraft extension—MacCormack et al. (2019b, p. 28) acknowledged that the AGS 'relied heavily upon the >500,000 wells that have been drilled throughout the province by the petroleum industry'. This is one aspect of how the connections of knowledge about Earth and a way of thinking about Earth turns on extraction as a key input to settler knowledge infrastructure.

The findings of the 3D modelling study focused on providing policy support for geochemical analysis of bitumen plays in the Peace River region (see Anderson et al., 2015). Yet the study also provided the basis for using the data derived from extraction for a digital model in Minecraft. This relationship is made explicit when the Minecraft extension is downloaded, where users can find the modelling study hyperlinked under the 'learn more' section (https://ags.aer.ca/public-geoscience/minecraft). However, it is not only the proximate rationale for producing the data set used in the digital 3D model, and later Minecraft, that is important to consider. It is important to understand how both operate within the knowledge infrastructure of settler colonialism in Alberta. That infrastructure includes the networks, institutions and practices that collect and maintain data derived from extractive activity in its material forms—geologic cores stored by government agencies, for instance—and via the epistemic practices through which geoscientific knowledge is produced. In this broader context, neither Minecraft nor the 3D model of the Peace River region are merely a way to learn more about geology and bitumen in Alberta, they also extend the knowledge infrastructure of settler colonialism.

4 | EXTENDING EXTRACTIVE KNOWLEDGE INFRASTRUCTURE

Before you download and play Alberta's Minecraft extension, you can watch and scroll through a 360° video tour on YouTube. Crafted out of transparent Minecraft blocks, the tour takes you past the town of Peace River and then

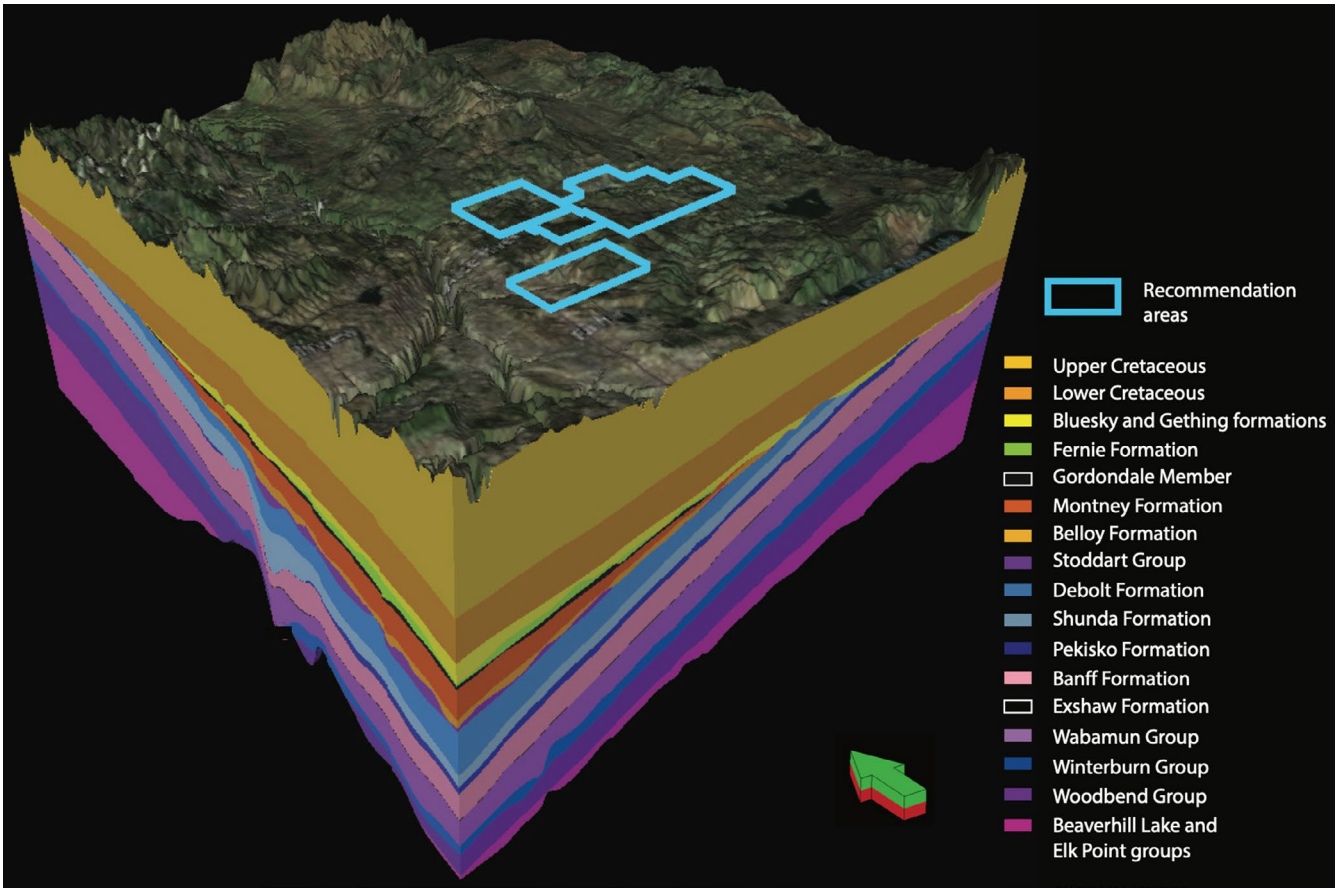

FIGURE 2 A 3D model of the Peace River region's geology, with key areas of bitumen production in blue boxes labelled as 'recommendation areas.' Courtesy of the Alberta Geological Survey. Reproduced under Alberta's Open Government Licence (From Anderson et al., 2015, p. 12).

underground to where bitumen can be found (Figure 3). Narrated with details about Alberta's geology, the video tour then takes you out on Minecraft's 'tracks' for a god's eye view of the 3D model. It discusses the province's geological unconformity—a time gap in the geological record owing to erosion—as it descends to the model base. It then narrates the geological history of Alberta from deep time to the present. It begins in the pre-Cambrian basement before moving up, and temporally forward, through mountain building eras, past glacial cycles and into the present. The paleogeographies of past landscapes are pointed out but no mention is made of smelly substances or other facts that would disclose the backend infrastructure or extractive activities that underpin the model data. This is not especially surprising; not only because it is a game, but because it is characteristic of settler knowledge infrastructures to anchor themselves in Earth's history as opposed to the social processes or technologies through which Indigenous dispossession proceeds. This is what Byrd (2011) critiques as the separation of state legitimacy from Indigenous dispossession and what Schmidt (2020) identifies as a form of 'settler geology' that naturalises Earth's past to governance structures in the present. In this context, one way to examine Minecraft as extending settler knowledge infrastructure is to connect features of its data to the broader histories and geographies of extraction in the Peace River area.

When you start playing in Alberta's Minecraft world at Peace River, you begin on a platform where a legend explains the geologic time series—stratigraphy—you will encounter. Series, it is helpful to recall, are comprised of groups, which are themselves comprised of formations. In the original model data, there are 17 digital layers corresponding to the Peace River area's geology: several are groups but nine are formations (see Figure 2 above). In the Minecraft version, this fine-grained representation is collapsed to a seven-layer series that corresponds to different kinds of blocks available within the game. However, each of these series, groups and formations have longer histories that reflect efforts of align knowledge of Alberta's geology with international knowledge networks while also refining its local features. For instance, references to the Devonian in Minecraft and in Alberta's report on odours and emissions recall one of the most famous controversies of nineteenth-century British geology and subsequent extensions of geological thought to accommodate its outcome—the Devonian—elsewhere (Rudwick, 1985).

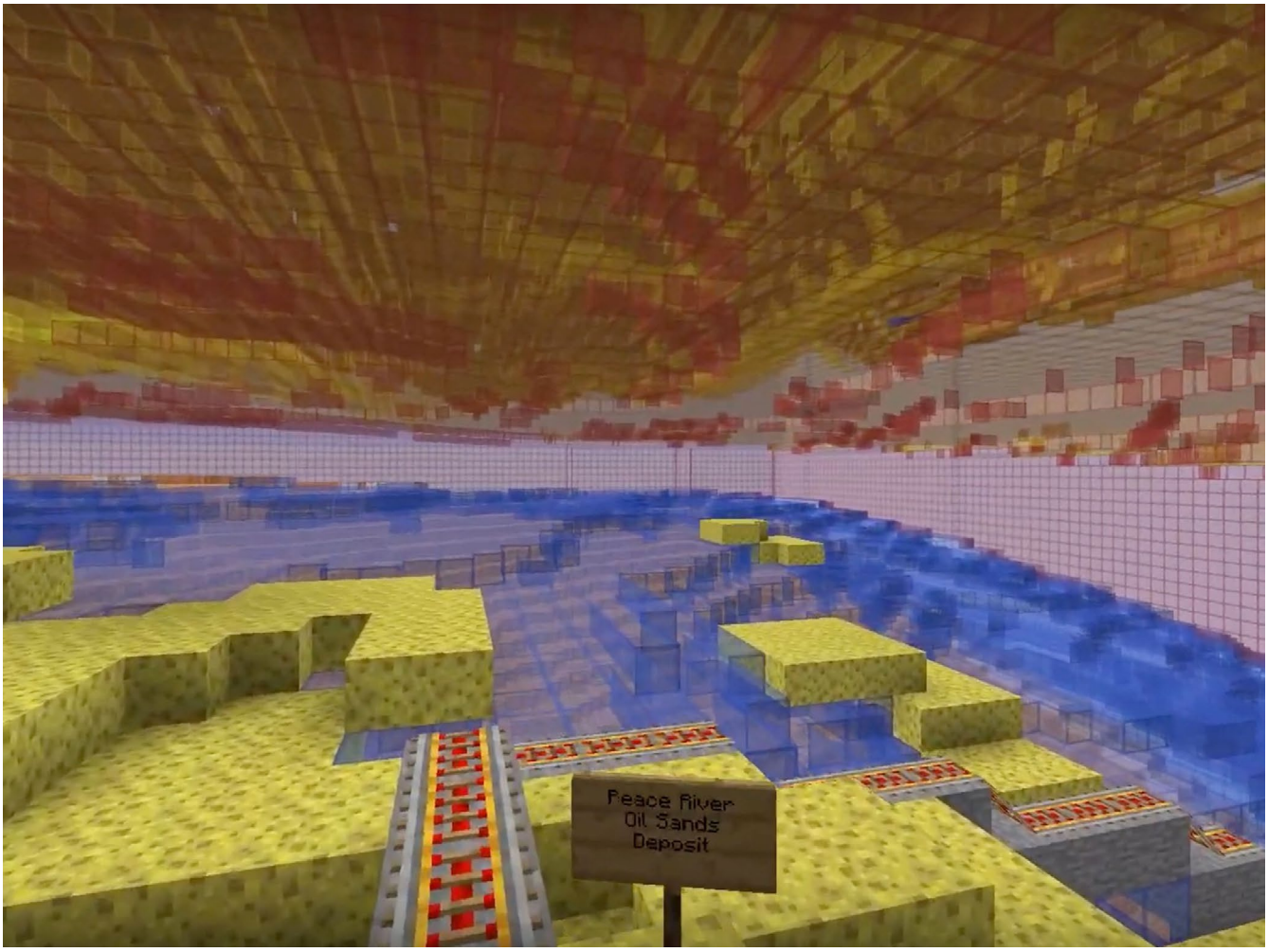

FIGURE 3 Inside the Minecraft model of the Peace River area where yellow blocks of 'bitumen' can be mined. Courtesy of the Alberta Geological Survey and reproduced under Alberta's Open Government Licence, full citation in MacCormack and Galloway (2017). Available on YouTube: https://youtu.be/X5BSODE8cAw?si=LR5N6zwWC96BMfxR.

In the late-nineteenth and early-twentieth centuries, much of the geological work done in Alberta was by canoe or some other watercraft. Because you can get a boat in Minecraft, you can also float down the Peace River in the game—a somewhat unfluid activity given the blocky construction of the Minecraft landscape. Early geologists and geographers paddled as a primary mode of transportation to map outwards from rivers. In the Peace River area, one of the first maps to consolidate the region's geology bears precisely these traits. Made in 1919 and published by the Canadian Geological Survey (then part of the Department of Mines) the map shown in Figure 4 details the arterial geology of the main rivers of the Mackenzie River Basin, with Peace River forming part of its most southern portions in the west. The legend for the map shows many of the naming conventions that became standard for Alberta's Athabasca oil sands further east, such as the Grand Rapids, Clearwater and McMurray formations. Those in Peace River, such as the Ft. St. John group, have also retained significance as data from extractive industries was collected by the Alberta government.

Higher resolution maps soon followed, such as in 1930 by the Alberta Geological Survey. In that work, undertaken by Rutherford (1930), appraisals of Peace River's water resources were set beside early approximations of its economic geology. As Figure 5 shows, Rutherford's work also connected geology to property and survey boundaries at the surface, known as Alberta's Township Survey, as well as to highways and railroads. In this sense, the 1930 map is not only a representation but also an act of commensuration between geologic time and geographies of settler colonialism. In it, human geographies in the present are not discontinuous with geology. Instead, the two combine in accounts of how territory is known through the knowledge practices of state-led sciences. Critically, surface survey boundaries also play a key role in assigning subsurface oil rights as leases are granted to companies for exploration and extraction (see Breen, 1993). For

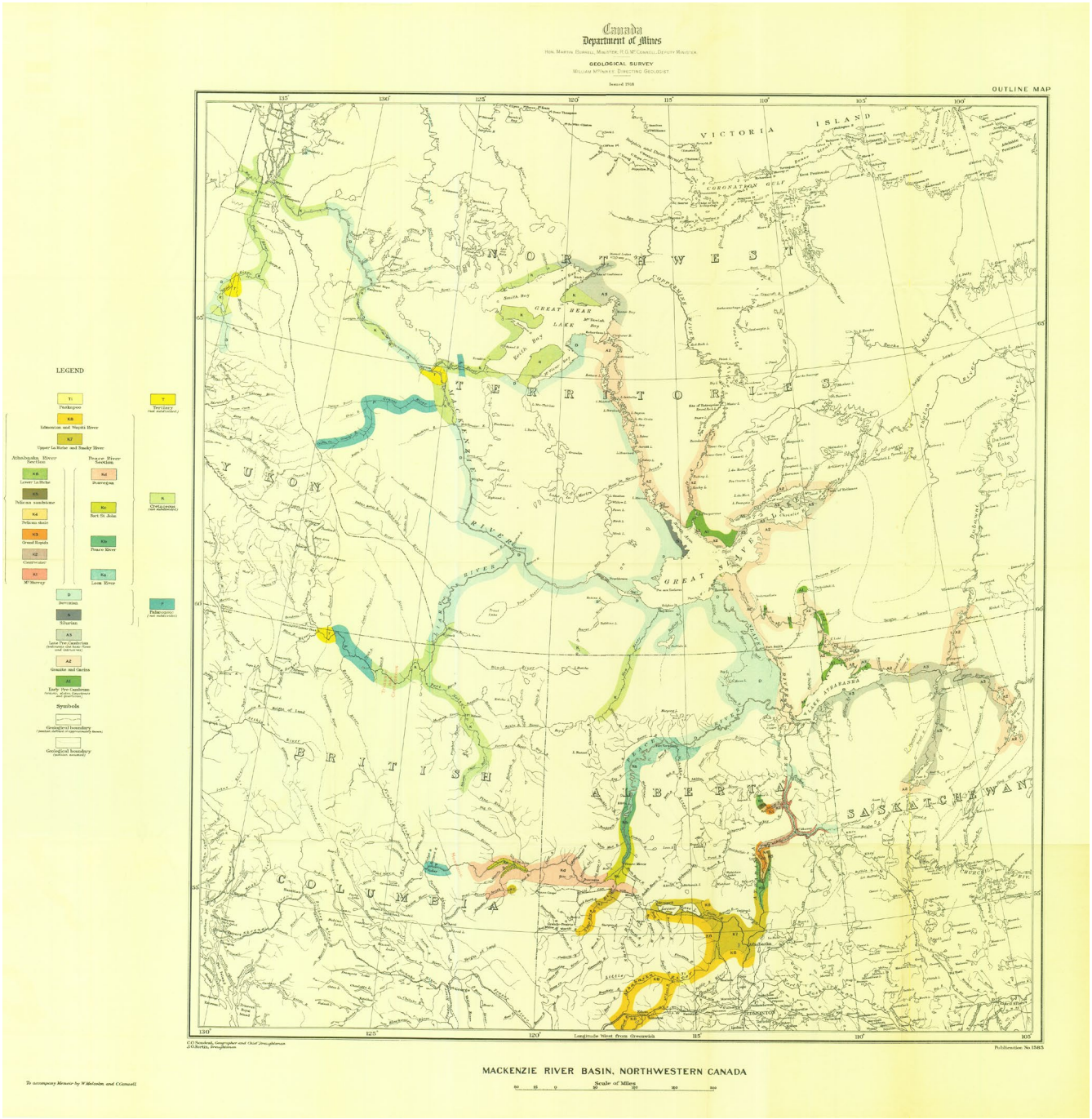

FIGURE 4 The Mackenzie River Basin and its Geology. Reproduced from Camsell and Malcom's (1919) *The Mackenzie River Basin*, Ottawa, Department of Mines.

instance, all 14 of the oil wells drilled in the Peace River region by 1933 were precisely located in reports by the Geological Survey of Canada that detailed their legal land location alongside accounts of the geological knowledge gained from them (see Hume, 1933). Establishing legitimacy for extraction stood opposite the ways new legal geographies at the surface dispossessed Indigenous First Nations and Métis people in Alberta and elsewhere in Canada (e.g. Blomley, 2003; Harris, 2004; Rück, 2021).

Subsurface mapping exercises like that in Figure 5 are a clear counterpoint to claims that, historically, territory was conceptualised in two-dimensions areas while three-dimensional 'volumes' now present new opportunities to understand territorial formations (cf. Bridge, 2013; Elden, 2013). Instead, such maps show how areas and volumes of territory were co-constitutive of settler colonial claims in Alberta. Moreover, the commensuration of geographic space with geologic time took place through networks and institutions that connected data gained by extraction—submitted from

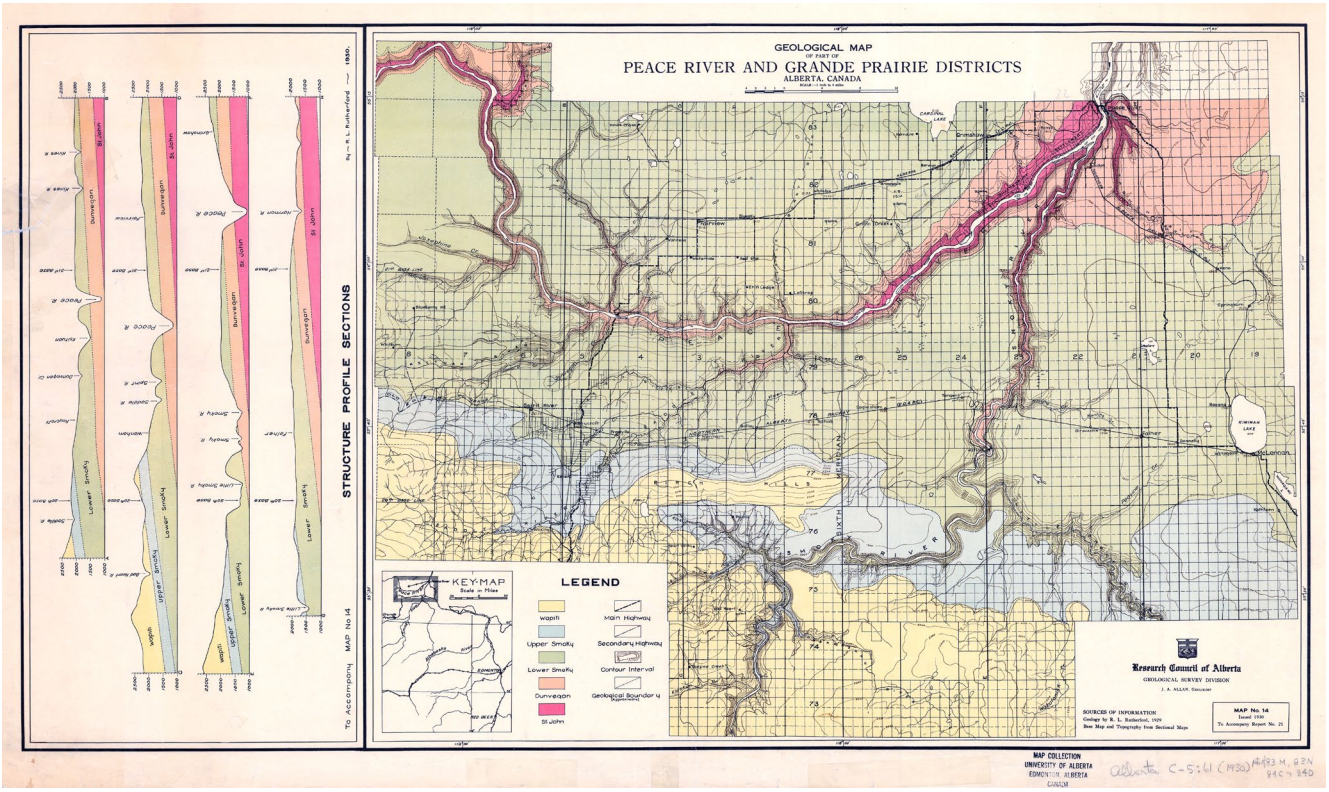

FIGURE 5 The Geology of the Peace River and Grand Prairie Districts. In this map, the town of Peace River is in the top right corner with geologic cross-sections on the left, including identification of the 'St John Group'. From Rutherford (1930), courtesy of Peel Archives, University of Alberta. Originally published by Geological Survey Division of the Alberta Research Council, now part of the Alberta Geological Survey; reproduced under Alberta's Open Government Licence.

industry to government—with knowledge practices of state-led organisations such as the Canadian Geological Survey and the Alberta Geological Survey. These networks, institutions and data together formed a knowledge infrastructure both premised on extraction and constitutive of settler colonial claims to territory: a settler knowledge infrastructure. Focusing on settler knowledge infrastructures offers a framework for treating spatial areas and volumes together and for recognising how settler colonial divisions of power structure unjust policies for Indigenous peoples. For instance, Tough (2004) identified how the transfer of jurisdiction over all natural resources from Canada to Alberta in 1930 infringed Indigenous rights above and below ground.

Although naming conventions now discriminate more finely across Peace River's geological formations, when the AGS identified the source of odours it drew on nomenclature established over a century ago. As stated in the original caption to Figure 6 below, which is from the 2015 3D modelling study by the AGS, the source of the 'zone between the base of the Fort St. John Group and the base of PROS [Peace River Oil Sands] surface is considered high probability' for odours (Anderson et al., 2015, p. 40). Here, Alberta's knowledge infrastructure can be understood, in part, through the ways that its local naming conventions have been sustained from its early mapping exercises into the contemporary geologic account that anchors the Minecraft data as well. Importantly, naming conventions are not neutral. Their study is part of a growing literature on the function and role of names in settler colonial claims to space and sovereignty (Rose-Redwood et al., 2010; Tucker & Rose-Redwood, 2015).

Beyond naming conventions, the knowledge infrastructure that makes in situ extraction from the Peace River area possible also has a longer tenure. In the 1960s, Shell Oil began experimenting with in situ technologies in the region by using high-temperature steam to mobilise bitumen some 550–750 m below the surface. The inconclusive tests, combined with licensing restrictions then in place, put the project on hold until the late 1970s. When I inquired into the subsequent renewal of the project at Shell's archives in The Hague, the only publicly available record I received was a 1985 article in *Shell World*. That article describes how, even though the initial project didn't come to commercial scale, a new project was afoot to develop the 4 billion barrels of oil under Shell's leased area of 61,000 hectares (No Author, 1985). The new experimental project was called PRISP—Peace River In Situ Project—and was funded by Alberta Oil Sands

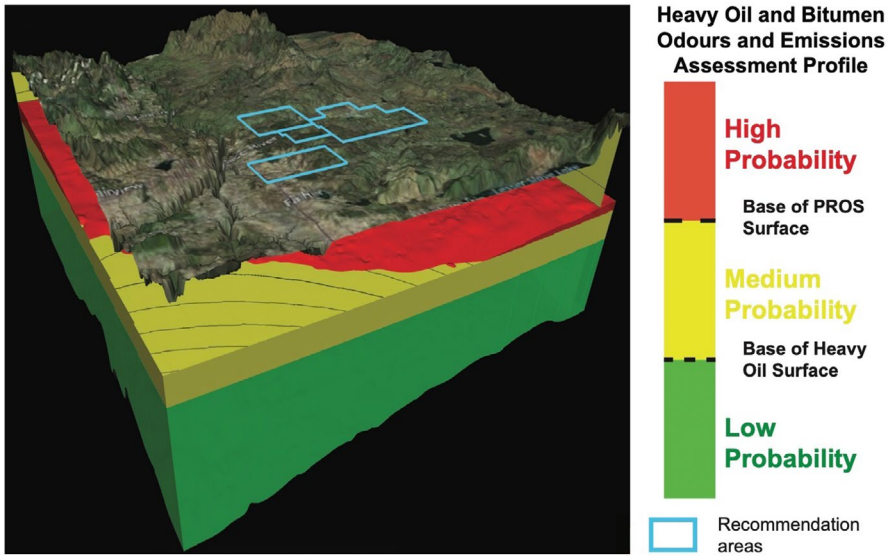

FIGURE 6 The high probability areas of odours and emissions in Peace River bitumen operations. Courtesy of the Alberta Geological Survey. Reproduced under Alberta's Open Government Licence (from Anderson et al., 2015, p. 40).

Technology Research Authority (AOSTRA), which provided 50% of the $130 million investment, together with Shell Explorer (a Canadian subsidiary of Shell Oil Company of Houston) and Amoco Canada Petroleum Company.

It is important to note that AOSTRA was created by the Alberta government in 1974 expressly to facilitate in situ bitumen extraction techniques through scientific and technological partnerships with industry and international partners (AOSTRA, 1990; Tretter, 2020). The geopolitical context at the time involved both waning conventional supplies in Alberta, the 1973 international oil crisis and Alberta's efforts to establish its bitumen mining industry through both *in situ* and surface mining activities (see: Mitchell, 2011; Pratt, 1976). Indeed, the year prior to AOSTRA's creation the Canadian Society of Petroleum Geologists (now the Canadian Energy Geoscience Association) held a conference in Calgary. During that conference, J. W. Kramers of the Alberta Research Council—another Alberta government research agency—correlated the geology of Peace River to other oil sands deposits while fellow conference participants made the case for including all bitumen resources as part of Alberta's official reserve (see Figure 7). In this way, the geology of Peace River was connected to broader mappings of heavy oil in Alberta. As Simpson (2019) has discussed in detail, those other mappings, such as for the Athabasca oil sands, were key to consolidating a political imaginary around the idea of the oil sands as a resource and to undermining territorial claims of Indigenous peoples. With respect to Peace River, new institutional infrastructures for extractive knowledge (e.g. AOSTRA) and international discussions over Alberta's oil sands were also situated with respect to heavy oil in the United States and Venezuela at the conference. In his address to conference participants, George Govier (1974), who began chairing the Petroleum and Natural Gas Conservation Board in 1963—the historical antecedent of the Alberta Energy Regulator—drew on growing geological knowledge to estimate Peace River's total reserve at 50 billion barrels.

The new endeavour at Peace River had significantly more success than earlier experiments, and by 1990 was producing 100,000 barrels of oil per day (AOSTRA, 1990). As already evident from above, the thermal steam technology used for in situ experiments at Peace River eventually gave way to technologies using sand (i.e. CHOP). However, these earlier experimental forays also mattered in other ways because they were part of proving that bitumen resources could be counted as legitimate reserves on global markets (see generally Carrigy, 1986). In this sense, the knowledge infrastructure extended through the Shell partnership with AOSTRA and Amoco was part of establishing the geological possibility of economically feasible extraction. It was not the only aspect of that infrastructure, but nevertheless important to how in 2002 leading international actors, such as the United States Energy Information Administration and the *Oil & Gas Journal* counted Alberta's bitumen as part of its official reserve (Government of Alberta, 2003). Four years later, in 2006, the Peace River reserve was recalculated to 68.99 billion barrels of oil (AER, 2014).

Knowledge infrastructures shaped, and were shaped by, the extraction of value from land in Alberta. These knowledge infrastructures were not merely instrumental to settler colonialism, but instead constitutive of state claims to territory. They also matter for gaining international legitimacy across both geoscientific knowledge and establishing official reserves. Maps that make commensurate surface and subsurface claims, for example, form a crucial part of a knowledge

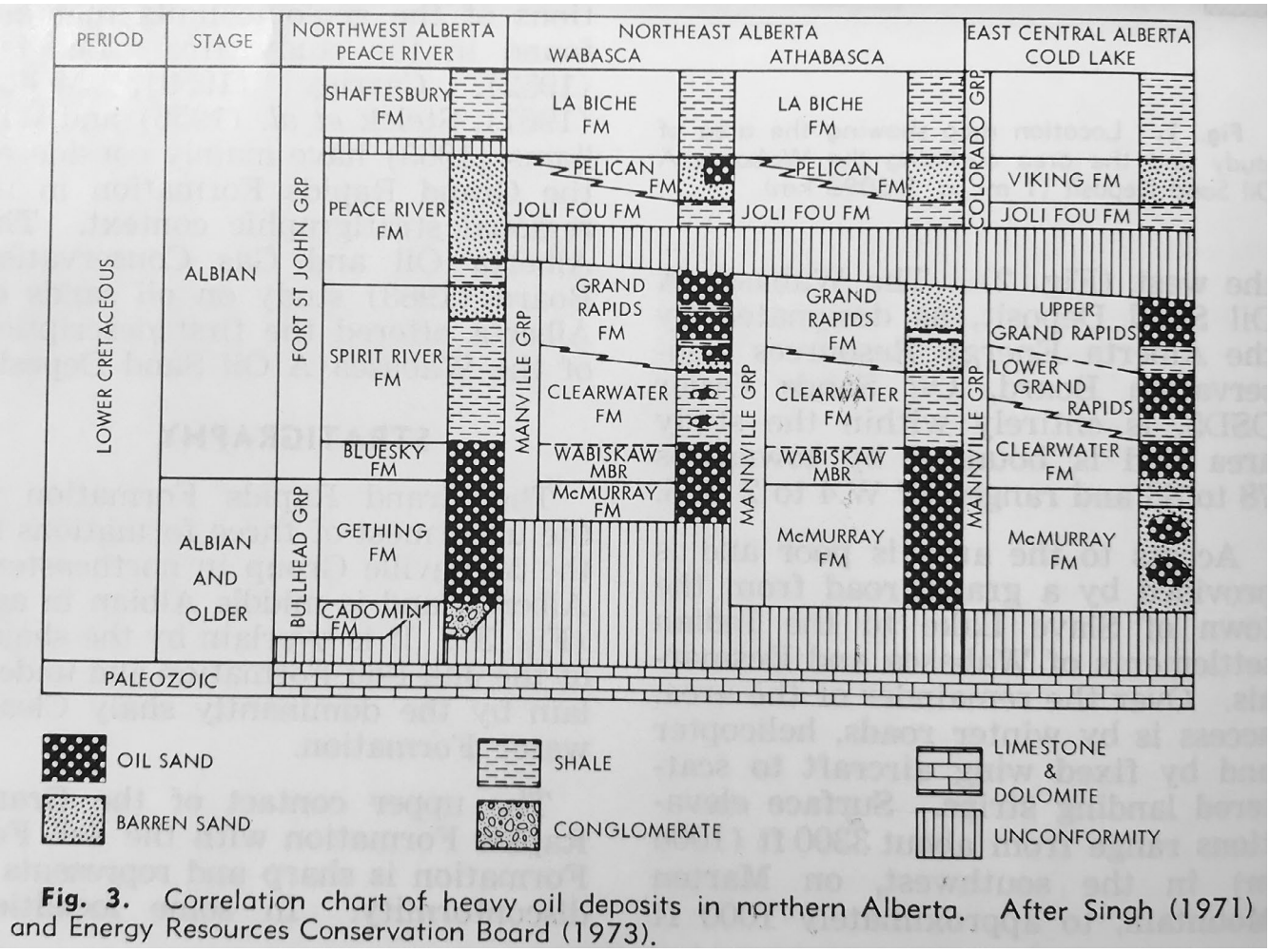

Fig. 3. Correlation chart of heavy oil deposits in northern Alberta. After Singh (1971) and Energy Resources Conservation Board (1973).

FIGURE 7 Correlation of Alberta's heavy oil deposits at Peace River, Wabiskaw & Athabasca and Cold Lake. From Kramers (1974, p. 70) in *Oil Sands: Fuel of the Future*, © Canadian Society of Petroleum Geologists. Reproduced by permission of the Canadian Energy Geoscience Association (CEGA) whose permission is required for further use.

infrastructure that anchors claims to space through the knowledge gained from extraction. That knowledge infrastructure is what lies behind the Minecraft extension, and it has also part of international collaborations. For instance, shortly after its launch the Minecraft extension featured in a broader initiative that the AGS and the Alberta Energy Regulator took forward with Geological Survey Organizations from around the world. The aim of that international initiative is to coordinate knowledge and to consolidate geoscientific practices in 3D modelling efforts across scales, from domestic jurisdictions like New South Wales (Australia) and Minnesota (USA) through to countries including Finland, Denmark (including Greenland) and the United Kingdom (see MacCormack et al., 2019a). This international effort stands in Alberta's longer tradition of viewing geoscientific knowledge as 'a fundamental underpinning of the infrastructure of modern societies' (MacCormack et al., 2019a, p. 2). In Alberta's contribution to the international 3D modelling project, the Minecraft extension is part of a broader suite of knowledge and modelling practices that leaves no uncertainty about the province's aim of integrating disparate forms of knowledge to develop 'a single-source of geological truth for the province' (MacCormack et al., 2019b, p. 25).

5 | DIGITAL GEOLOGIES AND EXTRACTIVE INFRASTRUCTURES

What is the geological truth about Alberta? One truth is that Alberta's geological knowledge is tied to extraction and the knowledge infrastructure—storage facilities, databases and modelling practices—that establish geoscientific understanding. That knowledge infrastructure extends to, and when it features in international collaborations is extended

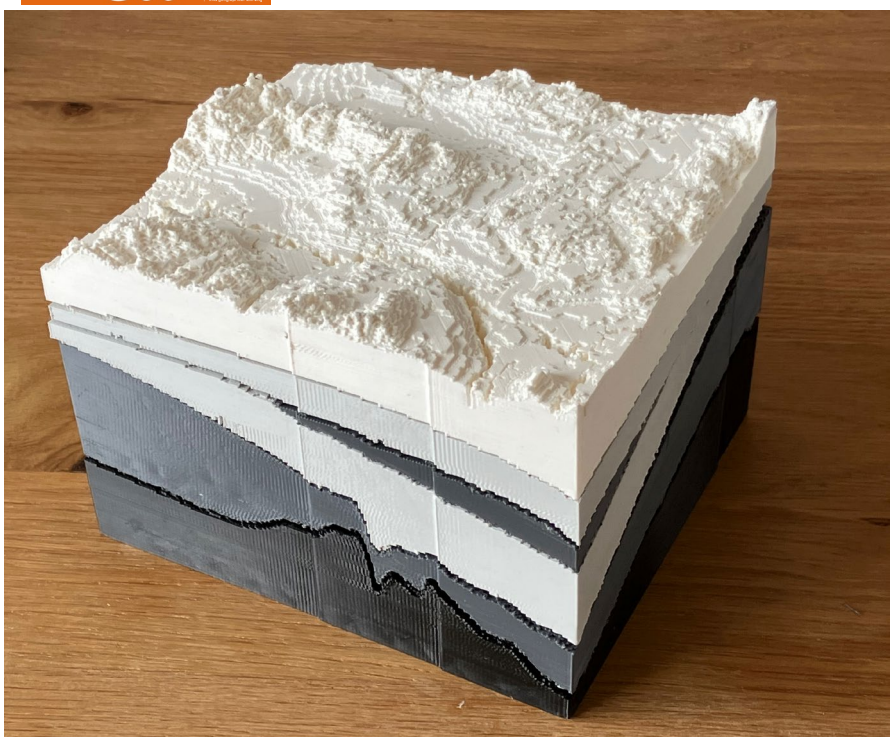

FIGURE 8 The 3D print of the Minecraft model of Peace River. Photo by author. Data from MacCormack and Galloway (2018): https://ags.aer.ca/publication/dig-2018-0012.

by, its Minecraft extension. It is also critical to the physical infrastructure that Indigenous games like *Thunderbird Strike* critique and which they counter through alternate protocols and practices (Kinder, 2021; Miner, 2022). Here, what I have focused on is how the knowledge infrastructure behind Alberta's Minecraft data is not merely an ideological expression of settler colonialism but a direct extension of it. This involves a complex relationship in which state agencies have historically funded and facilitated the geosciences and technologies required for extraction, while at the same time relying on extractive data to know and govern territory. Rivera (2024) argues that, when those practices are extended digitally, they perpetuate forms of symbolic and material violence against Indigenous peoples through multiple forms that digital geographies may take. For discussions of digital geographies in settler colonial contexts, then, it is crucial to examine how settler knowledge infrastructure is not merely instrumental to the extraction of value from land, but constitutive for it.

In this context, one part of this project involved printing the physical version of the Minecraft world. A 3D print of Alberta's geological formation at Peace River could hold a certain irony if petroleum products were used to critically study how some paleogeographies, knowledge and relations are prioritised and others obscured. For the print, we used 855.6 g of polylactic acid (PLA) which is a biodegradable material sourced from plants. Then, the roughly 2 billion years of Earth's history covered by the Minecraft data took shape in four days, 15 hours and 56 minutes of print time that produced six stratigraphic layers that model Peace River's geology (Figure 8). The model pieces come apart (in ascending order) with a Paleoproterzoic base, then up through the Devonian, a layer covering the Permian to the Carboniferous, then one from the Jurassic to the Triassic, the Lower Cretaceous, and finally, the Quaternary to Upper Cretaceous.

The 3D print of the Minecraft world presents a way to think through digital geographies that do not remain only as such. Numerous geographers have shown how digital geographies are entangled with broader relationships and practices, such as with non-humans, the environment and the ontological and epistemic norms that shape spatial relations (e.g. Ash et al., 2019; Davies et al., 2024; Pickren, 2018) The impact of Bitcoin mining on rivers when electricity comes from hydroelectric dams, for instance, rearranges waters while extending new extractive economies (Lally et al., 2022). Taffel (2021) has argued for a kind of consonance that links the 'media ecologies' generating diverse environmental impacts to the different sites and sources of content, software and hardware. Moreover, different data, their uses and production are all socially situated in ways that require attention to multiple kinds of relations through which they are baked into ways of knowing and acting (Kitchin, 2021). What I am arguing is that key to siting digital geographies in settler colonial contexts is an appraisal of how knowledge infrastructures from heterogenous data—maps, mining

cores, citizen observations of noxious odours, 3D models and Minecraft's ontology—are constitutive to spatial claims that both facilitate extraction and are premised on Indigenous dispossession.

What happens when digital geographies manifest geologic data materially, in this case a 3D print built from extractive data? Here, to think through settler knowledge infrastructures is also to consider the spatial formations that different digital geographies enable and constrain. A model like the one in Figure 8 is a series-scale version of what these permutations might look like. It can sit on my desk, allow you to run your fingers over its contours to feel some connection to ancient paleogeographies, or be taken to lectures and passed around. It is entangled with requirements for gameplay, yet also able to circulate alongside more fine-grained representations in international collaborations developing standards and practices for 3D geologic models (i.e. Figure 2; see MacCormack et al., 2019b). The settler knowledge infrastructures that make these connections and entanglements possible normalise inequalities that often only come into view when things go, or in the Alberta case smell, awry (cf. Star, 1999).

When things are off, and when responses to them proceed as they did in Peace River, an approach to digital geographies attentive to knowledge infrastructures can provide insights that resonate with work on the relationship of geology to political thought. Braun (2000, 2002) insisted geological knowledge be treated as constitutive of state territory, and Yusoff (2024) argues geology is a vehicle for multiple infrastructures—material, affective, historical, managerial—through which racialised, colonial oppression operates. A focus on settler knowledge infrastructures offers a way to orient state-led digital geographies with respect to multiple considerations that a study of Alberta's Minecraft extension shows connections with: the establishment of geological truth through data heavily reliant on extraction; the practices of seeking epistemic legitimacy through international collaborations, such as with geological survey organisations; or, the use of geosciences to foreground causal relations to health concerns and to distinguish smelly geologies from extractive practices requiring regulations of the kind settler colonial institutions can govern.

Settler knowledge infrastructure enables the data generated in response to bad odours to be a regulatory response, a Minecraft world, a part of geoscientific collaboration internationally, or a digital file that I can email across campus to make a 3D print. Regardless of form, these digital geographies are constituted by, and operate as extensions of, settler knowledge infrastructures. These networks are robust: filing systems and facilities for well logs and kilometres of core samples and drill cuttings, computer models, Minecraft expertise, regulators that gather information and compel studies, and a tradition of mapping that makes both surface and subsurface commensurate in state claims to territory. Here, Alberta makes for a compelling case of a more widespread concern regarding how digital geographies, and the spatial claims constituted through them, multiply in ways that produce a body of knowledge about Earth, and a way of thinking about Earth, that extends the reach of extraction.

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DATA AVAILABILITY STATEMENT

All digital data, and many of the reports, used in this study are freely available from the Alberta Geological Survey's website: https://ags.aer.ca/. Others are available from Natural Resources Canada: https://natural-resources.canada.ca/.

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