

Resource-making controversies

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Resource-making controversies: Knowledge, anticipatory politics and economization of unconventional fossil fuels

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Abstract

Advancing relational accounts of ‘resource-making’ processes by deploying insights from science and technology studies, this article outlines crucial new lines of inquiry for geographical research on unconventional fossil fuels. The exploitation of various carbon-rich substitutes for hydrocarbons has rapidly expanded over the last two decades, to become a highly contentious issue which augments scientific dissensus and generates new collective engagements with the subsurface. The article invites geographers to examine the epistemically and politically transformative potential of such resource-making controversies in terms of reconfiguring: the production of geoscientific knowledge, anticipation of post-conventional energy systems, and temporal strategies of (de)economizing extractive futures.

Keywords

anticipation, controversies, economization, fracking, geopolitics, materiality, resources

1 Introduction

In response to resurgent concerns about resource scarcity and energy insecurity, the last two decades have seen rapid expansion in the development of alternative, so-called ‘unconventional’ fossil fuel resources, including lower grade and hard-to-access oil and gas extracted from shale basins and bituminous sands. Impelled by growing recognition that the era of ‘easy oil’ is coming to an end (Bridge and Le Billon, 2017), diverse carboniferous sediments of the earth’s crust are now the object of intensive exploration programmes, and in places have entered commercial production to reconfigure both the global energy economy and local ecologies and livelihoods. The unprecedented rate and scale at which unconventional sources have

begun to substitute for traditional fossil fuels offers a timely reminder of the longstanding tenet in geography and cognate disciplines that resources are not self-evident or static ‘natural’ entities. Rather, hydrocarbons can be understood as a relational and transient category, the qualities of which are both purposely reappraised and intensely contested in accordance with shifting social needs and values (Bakker and Bridge, 2006; Bakker, 2010; Bridge, 2009, 2011a; Richardson and Weszkalnys, 2014). Indeed,

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while continued reliance on conventional fossil fuels is increasingly questioned in light of the degrading resource base and adverse effects on the climate, their replacement with carbon-rich alternatives is even more contentious, not least due to higher investment costs and lower energy returns, difficulties with transferring existing technological solutions to geophysically and geoeconomically distant locations, and profound uncertainties over both the environmental risks and socio-economic benefits of extraction.

This paper advances non-essentialist, relational understandings of resources by calling for critical geographical research to attend more closely to the controversial forms of scientific, political and economic practice through which previously unexplored layers of the subsoil are constituted as future energy sources. In line with growing efforts to move beyond established political economy and political ecology questions of ‘resource-claiming’, I contend that we need to critically examine how heterogeneous geological substances are rendered into knowable and exploitable resources in the first place, or ‘resource-making’ (Ferry and Limbert, 2008; Bridge, 2011b; Kama, 2013; Li, 2014; Richardson and Weszkalnys, 2014). Thus, rather than simply awaiting discovery as higher-quality stocks become difficult to access, unconventional fossil fuels need to be specifically qualified as worthy of exploitation through targeted geological prospecting and techno-scientific experiments, then established as preferable sources of supply in the realm of energy policy and markets, and, finally, extracted, transported and refined into materials suitable for actual consumption. None of these interventions are straightforward: their implementation is subject to conflicting and disputed strategies among both industry experts and associated regulators and stakeholders, especially concerning the take-up of the technology of hydraulic fracturing or ‘fracking’ across the sector. In this regard, the rise of unconventional energy development does not so much acknowledge the unlimited

capacity of technological innovation or the invisible hand of the market to overcome resource scarcity but rather evidences the importance of wider social debates in challenging the logics of extractive capitalism and exploring alternative energy futures beyond the ‘end of oil’. This is especially the case given that such industries have now become relocated from the world’s territorial margins to the midst of Western democracies.

Yet, at a time when there is a surge to revive resource and energy geographies (Bridge, 2011b, 2014; Bridge et al., 2012; Calvert, 2016; Huber, 2015, 2018; Zimmerer, 2011), the making of unconventional fossil fuels and its effects on the science and politics of resource development have largely remained under the radar of critical geographical inquiry, especially when compared to the burgeoning literatures on ‘public perceptions of fracking’ (see, *inter alia*, Evensen and Stedman, 2016; Metze and Dodge, 2016; Thomas et al., 2017; Williams et al., 2017). While there is an increasingly rich body of geographical research on traditional fossil fuel resources and infrastructures, unconventional ones are only now beginning to elicit sustained scholarly interest, often triggered by the grubby realities of commercial exploitation, such as the bitumen and shale gas booms in Canada and the USA. Critical research in this field comprises political ecology analyses of local environmental hazards, social inequalities and grassroots resistance associated with expansive extraction (e.g. Christopherson and Rightor, 2014; Willow and Wylie, 2014; Zalik, 2015b), as well as political economy accounts of its implications for global energy markets (Bradshaw et al., 2015a, 2015b; Neville et al., 2017). The allocation of swathes of land for fracking, in particular, is often seen as an extension of neoliberal appropriation of nature, which engulfs local communities while sustaining the order of the carbon-fuelled capitalist economy (Fry et al., 2015; Hudgins and Poole, 2014; Mercer et al., 2014). Geographers are now

also joining other social scientists to address the dynamics of extractive politics across scale, noting how such struggles are played out around competing imaginations of territory and property, progress and modernization, social justice and future communities (e.g. Grant, 2014; Hesse et al., 2016; Kama, 2016; Sica, 2015; Steger and Milosevic, 2014; Zalik, 2015a). Evading deterministic accounts of unconventional as the last resource frontier (Dannreuther and Ostrowski, 2013; Klare, 2012), this work is beginning to interrogate the ways in which their exploration is negotiated and affects resource governance in the context of prevailing uncertainty and public discontent, to yield often very different outcomes in different places.

Following this shift of interest from resource appropriation and control towards more broadly conceived ‘resource-making’ practices, here I foreground unconventional fossil fuels development as an invaluable opportunity to ask new research questions about the role of scientific disagreements in resource-making and their potential to transform the political and economic spaces in which our collective futures are being worked out. I argue that critical resource geography would benefit from joining wider efforts to complement geographical theory with insights from science and technology studies (STS) and related developments in economic sociology and anthropology, particularly the work of Michel Callon, Timothy Mitchell and others. The following analysis specifically deploys three key perspectives from this literature, associated with the concepts of knowledge controversies, anticipatory politics and economization, with the aim to account for the making of new fossil fuel resources as a collective, indeterminate and spatio-temporally divergent process. After elaborating the notion of the ‘unconventional’ as a heuristic for this inquiry, in the next sections I examine the main implications of resource-making controversies in terms of

reconfiguring the production of geoscientific knowledge, the deliberation of post-oil energy futures and the setup of new extractive economies. A closely related question is how the constitution of future resources is bound to the material differences and dynamics of the subsurface, reflecting recent STS-informed accounts of resource materialities and temporalities on the fringes of anthropology and geography (e.g. Bakker and Bridge, 2006; Kama and Weszkalnys, 2017; Richardson and Weszkalnys, 2014). More broadly, this concern with subsurface potentialities also aligns with growing efforts to reinstate the *geos* as a legitimate concern for human geography research (Barry, 2013; Clark, 2011; Dalby, 2013; Dittmer, 2014; Elden, 2013; Whatmore, 2006). Empirically, the analysis takes the lead from my own research experience on oil shales and shale gas development in Europe, but it also engages with recent work on other industries in North America and elsewhere, whilst acknowledging that their business logics and socio-political resonances vary significantly across both different kinds of resources and regulatory contexts. However, my aim is not so much to offer a comprehensive review of recent publications, but to outline new analytical trajectories for exploring the epistemically and politically redistributive effects of resource-making controversies, and their complex engagements with matter and time.

II The ‘unconventional’: Resource-making as ontological politics

While the terminology of ‘fracking’ has become popularized in both academic and public circles, it is important to note that the category of ‘unconventional’ denotes far more than the supplementary oil and gas flows enabled by horizontal drilling and fracturing of shale basins. In industry jargon, the term may refer to either alternative ‘sources’ or ‘places’ of extraction (Bridge and Wood, 2010). Both means of

supply have emerged as a substitute for hydrocarbons derived from easily accessible and highly permeable reservoirs. Yet, the development of unconventional *sources*, in contrast to recent attempts at deepwater drilling in the Arctic and other peripheral locations, arguably no longer exemplifies the geographically expanding character of resource appropriation towards the Global South and the circumpolar North (e.g. Bridge, 2009). Reversing the trend of frontier expansionism, these extractive ventures are aimed at locally available deposits with a wide range of organic matter content and degrees of energy return, which have previously either remained underexplored or deemed sub-economic for production. In addition to tight oil and shale gas which have become exploitable through fracking, unconventional sources include extra-heavy crude oils, bituminous sands, oil shales, coal-bed methane, clathrate hydrates, and other energy-potent sediments that are widely distributed across the earth's crust.¹ In this regard, unconvensionals are by no means novel resources. The sheer existence of such 'indigenous' fossil fuel deposits has long captivated the political imagination of certain nation-states in their quest for reducing dependence on energy imports and volatile market prices and alleviating the possibility of depleting conventional supplies. Thus, even though 'unconventional' has now come to serve as a common denominator for all kinds of fossil energy substitutes, it is crucial to bear in mind that these do not amount to a uniform resource category or even a similar socio-historical phenomenon. Quite the contrary, their exploration spans distinct technological histories and political-economic experiments aimed at self-sufficient energy provisioning, which in the case of bitumen and oil shales reach back more than a hundred years, to the very beginning of the 'oil era' (see Yergin, 2009: 7, 178), while shale gas and tight oil development is more recent, having largely taken off in wake of the 1970s energy crises (Bradshaw et al., 2015a;

Stevens, 2010). The recurrent consideration of such fossil fuels in state energy policies is thus characteristic of attempts to render 'vertical territory' subject to the building of national identity and sovereignty (Braun, 2000; Elden, 2013). Indeed, geopolitical interests in unconventional energy development have always been underpinned by a form of nationalist 'geologic politics' (cf. Clark, 2013).

These techno-politically divergent histories are closely bound to the fact that unconventional fossil fuels are notoriously heterogeneous, even if categorized under a single name, both in terms of the material composition and spatial distribution of resource basins. Conventional petroleum is, of course, also far from a homogeneous substance (Bridge and Le Billon, 2017), but a given unconventional deposit may encompass sedimentary layers with vastly different geological origins, geochemical and mineralogical composition, and resultant density, porosity and permeability. As a result, the qualities and quantities of the resource may vary hugely even across the same basin. While this problem has long been admitted by geologists and technology developers, it raises insurmountable challenges for the industries' global expansion, chiefly for three reasons. First, since national geological surveys of such resources have been conducted in relative isolation from other countries, the material and spatial heterogeneity of basins has implied regionally specific methods for resource assessment and grading, which in combination with deficient and uneven drilling data compound difficulties in estimating the size of the world's remaining fossil fuel resources, not to mention technically or economically recoverable resources (EIA/ARI, 2013; McGlade, 2012; Mohr and Evans, 2010). Second, depositional heterogeneity complicates the invention of standard extraction technologies that could be applied to diverse basins without painstaking customization (Stevens, 2010). Finally, it also affects the processing, distribution and marketisation of end-

products, for example, by risking the capacity of infrastructure such as refineries, processing plants and pipelines, or by complicating the regulation of market prices and environmental liabilities in relation to established fuels (Grant, 2014; Kama, 2013).

To speak of ‘*the* unconventional’ as something uniform therefore implies that the differential qualities and affordances of geological substances can be subsumed under their supposed family resemblance to oil and gas; or more precisely, their *shared potential* to be converted into liquid hydrocarbons upon technological manipulation. In light of the issues listed above, it would be easy to dismiss this account as misleading. Nevertheless, I propose that critical scholarship should take issue with this idea of shared potentiality and specifically trace the unconventional as something unified, but rather in the sense of being idealistically constructed than existentially given in a ‘bedrock naturalist’ sense (Bakker and Bridge, 2006). This is because the exercise of making sense of heterogeneous geological strata as a resource suitable for exploitation – and a *global* resource in particular – necessarily involves their abstraction as a singular category (cf. McCormack, 2012), so that they can be conceived as part of a continuum of hydrocarbons that become available when higher-quality reserves decline. Indeed, diverse geological and technopolitical origins notwithstanding, a common feature shared by all unconvensionals is that their ‘resourceness’ is presumed to progressively take shape across a temporal horizon, shifting from mere geological occurrences to definite volumetric appraisals which are eventually merged with conventional reserves. As such, the production of bituminous sands, extra heavy oils and shale-based hydrocarbons has been growing exponentially over the last decade and a half, especially in North America, and is now firmly aligned with mainstream industry. However, the majority of the world’s organic-rich formations are conceded to be ‘not as yet’ commercially exploitable

(cf. Hinchliffe and Bingham, 2008; Weszkalnys, 2014). Worse still, in light of growing concerns over the destruction of local environments and global climate, it is disputed whether the bulk of such deposits should become utilized at all. That said, *by definition*, all unconvensionals are envisaged to become feasible to exploit at some point in time, once that knowledge of their properties and technical malleability has improved, that political and economic circumstances have changed, or that hydrocarbon availability has become even more constrained. What is deemed unconventional today is thus upheld by the very possibility that it might indeed become conventional in the not so distant future.

As a starting point then, the unconventional can be conceptualized as a *liminal resource category*, the essence and significance of which is either not yet granted or is established only provisionally. Although many world organic-rich deposits have long been imagined as an inevitable successor to the petroleum industry, their ‘resourceness’ is still in the process of being assembled via multiple competing efforts to test the viability and desirability of exploitation (Bakker and Bridge, 2006; Li, 2014, Richardson and Weszkalnys, 2014). Indeed, the designation of diverse sedimentary rocks ‘as oil’ or ‘as gas’ (Mitchell, 2010) is neither straightforward nor uniformly conducted across different geographical localities and socio-political regimes. To approach resource-making as a relational and spatio-temporally differentiated process therefore raises the question of who acclaims the epistemic and political authority to define unconvensionals, under what conditions their efforts succeed or fail and, further, in what ways resources come to matter in association with the generative capacities of geological materials themselves. In brief, I suggest that resource-making can be considered as a form of ‘ontological politics’ (Kama, 2016; cf. Mol, 1999). This implies that resources could, at least potentially, have been made otherwise or

even be *unmade* if circumstances change. Therefore, we need to examine how certain enactments of the resource are reinforced at the expense of other possible ‘resource ontologies’, which have become either obscured in the past (Richardson and Weszkalnys, 2014) or can still be detected amidst contemporary disputes over new extractive initiatives, as explained later.

Further, due to their shifting temporal status between the present and the ‘not-as-yet’, unconventional evidence how resources become catalysts for both deliberate interventions and contestation around future operations of extractive capitalism (cf. Barry, 2006; Greenhough, 2016). More precisely, the ontological politics of resource-making is *performative*, since it enables industry and governments to delineate specific pathways to exploitation, whilst simultaneously making it possible for other actors to resist and divert those pathways. Being, etymologically speaking, something that is ‘not limited or bound down by convention’, the unconventional thus serves as the definitional other for the mainstream. In other words, through the self-fulfilling prophecy of one day ‘becoming conventional’, as oft-deployed industry rhetoric puts it, the unconventional enables the prevailing order to be undermined, so that it becomes receptive to alternative configurations of resources. Or, as Mitchell argues, the transmutation of diverse earthly substances into usable hydrocarbons, both materially and discursively, requires ‘opening up anew the politics of nature’ (2013: 252). Drawing on conceptual insights from STS, I now introduce three novel lines of inquiry inferred by this approach, before proceeding to detail each in the next sections.

Firstly, the making of unconventional resources highlights an acute need for in-depth studies of the *knowledge practices* through which the underground is rendered intelligible and attributed with specific meanings, qualities and values (cf. Bridge, 2011a; Robertson,

2012). This directs us to the work of resource geologists, since it is initially their task to determine what geological occurrences are worthy of exploration, before such ‘discoveries’ are configured as assets and commodities that enter the routines of investment, exchange and production. Yet, the process of generating knowledge on unexplored geological strata is anything but immune to uncertainty and disputation. Much like the ‘knowledge controversies’ documented in environmental and life sciences (e.g. Barry, 2012; Callon et al., 2009; Sarewitz, 2004; Whatmore, 2009), geoscientific knowledge claims have thereby become conflicted across industry experts and regulatory authorities and, even more significantly, destabilized through the interventions of various industry outsiders, non-specialists and lay publics. What the case of unconventional specifically illuminates, however, is how these shifts in the politics of knowledge are underscored by contending conceptions and definitions of geological resources. Such ‘geo-social’ controversies may consequently transform science-policy relations and generate new political encounters with the subsurface.

Secondly, geoscientific knowledge controversies are seldom limited to dissensus over pre-established matters, but rather evidence how ‘rival technical solutions become experiments in the composition of the collective world’ (Mitchell, 2013: 240). As such, they highlight the *politics of anticipation* at the heart of contemporary social operations (Adams et al. 2009; Anderson, 2010). Since any attempts to exploit new fossil fuel resources are prone to substantial unknowns – both ‘below-ground’ and ‘above-ground’ (Bridge and Wood, 2010) – it is difficult to predict their success or failure at the outset, based on either existing trends in hydrocarbon production or normative calls for less carbon-intensive energy systems. Rather, we need to examine how the prospects of specific industries become informed by competing constructions of their past legacies and potential

future benefits and harms against the backdrop of wider reconfiguration of the carbon economy (cf. Bridge, 2011b; Mitchell, 2013). Instead of being solely determined by established scientific and regulatory authorities, the deliberation of ‘post-conventional energy futures’ (Kuchler, 2017) extends to wider spaces of dissensus across diverse members of the public, whose collective identities and political subjectivities are shaped in the course of the controversy (Callon et al., 2007).

In this context, and *thirdly*, I contend that anticipatory politics of resource-making is inevitably bound to the question of how such lower-grade fossil fuels are deemed economic to produce, or ‘*economized*’ (Çalışkan and Callon, 2010). Notably, while several basins such as Bakken shales, Alberta bituminous sands and Orinoco heavy oils have reached commercial-scale production, other unconventional continue to be explored in marginal industries that are yet to be tested as part of global market operations. Even in America, as Zalik (2015a) points out, commercialization is chiefly enabled by a confluence of geopolitical and financial security considerations, as corporations seek to shift their reserve holdings away from riskier frontier locations to familiar regulatory regimes, with the support of large-scale state subsidies and abundant investment capital. Beyond their apparent success, however, many developers struggle with improving their extraction techniques and reaching economies of scale, and even more so with demonstrating the adaptability of their experiments to geoeconomically disparate locations. In any case, geographical research should be cautious about adhering to linear projections of technological innovation and economization, according to which new commodities can only be brought to the market once the technology is fully proven (cf. Mitchell, 2008). As I discuss towards the end of this paper, we need to take notice of competing attempts

to economize and de-economize extractive industries, especially considering the growing dominance of speculative finance in the sector.

III Geo-social controversies: The shifting knowledge politics of resource-making

Supported by popular fears about an impending peak in petroleum availability and ensuing security risks, industry tends to promote unconventional fossil fuels as the inevitable means to elongate the path towards the end of oil, perhaps indefinitely. Insofar as unconvensionals are defined by reference to liquid hydrocarbons, they acquire the full status as resources when their production is merged with the mainstream sector, as it has gradually happened with bituminous sands and shale resources in Canada and the USA. For the time being, however, their capacity to mitigate the decline of conventional supplies cannot be fully determined due to profound uncertainties, including over the layout and dynamics of the deep subsurface, its susceptibility to technological interventions, and the long-term impacts of these interventions on both the environment and human health. Limited understanding of geological propensities makes it difficult to evaluate both the size of recoverable resources and associated technical and environmental risks, which is further compounded by the heterogeneity of world deposits. Equally, the outlooks of any industry are subject to indeterminate geopolitical developments around international markets and climate policies (Bradshaw et al., 2015b; IEA, 2011). Given these combined uncertainties, policymakers and regulators are left to navigate between deficient and conflicting assessments, which in turn become routinely challenged by competing claims to expertise, particularly with regard to less-explored basins. The lack of reliable knowledge has thus given way to intense and increasingly polarized disputes, including over

the legitimacy and longevity of the North American boom (Kök-Kalaycı, 2016; Zalik, 2015b) and the spread of fracking to other regions, most notably Argentina, Australia, China and Europe (Kuchler, 2017; Mercer et al., 2014; Neville et al., 2017). In the European Union, these disagreements have become so widespread and fuelled local opposition to the extent that several states have now suspended exploration or banned fracking altogether.

While the implications of growing public discontent for governance and participatory decision-making are increasingly studied from environmental psychology and social justice perspectives (e.g. Cotton, 2016; Evensen and Stedman, 2016; Whitton et al., 2017), it is less noted how such controversies disclose a dearth of both expert consensus and public trust in the geosciences. Drawing on STS approaches to knowledge controversies, I suggest that while disputes are integral to the conduct of science, their overspill to the public sphere holds significant potential for the democratization of geology and associated disciplines, in the sense that it necessitates both a reconfiguration of the processes of specialist knowledge production and new modes of citizen engagement with the expertise at stake (e.g. Callon et al., 2009; Chilvers and Kearnes, 2016; Whatmore, 2009). Expert calculations of potentially exploitable resources or resulting geophysical hazards, such as fugitive methane and induced seismicity, are thus no longer taken for granted, but rendered open to wider interrogation, contestation and politicization. Moreover, there is no clear divide between expert and non-expert knowledge, since specialists from other disciplines and sectors as diverse as environmental sciences, economics and public health increasingly scrutinize industry expertise, along with a growing array of civil society groups, affected communities and even laypersons. As long noted in STS, such concerned groups cannot be silenced with more education – as presumed by the ‘public deficit’ of knowledge perspective that so often informs

governmental consultation practices – but they contribute their own knowledge claims, value judgements and firsthand experiences to the dispute (Espig and de Rijke, 2016; Lis and Stasik, 2017; Lis et al., forthcoming; see also Chilvers and Kearnes, 2016). Furthermore, one could argue that the divergence of such ‘knowledge polities’ enables the geological domain to be conceived and acted upon in different ways, with the result that subterranean matters themselves acquire differential political capacities (cf. Whatmore, 2013). What can be termed more specifically as *geo-social controversies* therefore comprise a series of collective engagements with subsurface potentialities, enlisting both human and non-human agencies.

Traditionally, the making of extractive resources has converged upon nationally appointed institutions of geoscientific expertise, most notably state-run geological surveys and their counterparts. Working alongside commercial consultancies and industry geologists, it is the preserve of these ‘centres of calculation’ (Latour, 1999) to develop methods for visualizing the otherwise invisible bowels of the earth and to consolidate evaluations on resource availability and technological readiness, although the division of labour between different epistemic communities may vary significantly between countries. As ongoing problems with calculating shale energy resources indicate, however, such representations of the subsoil are always provisional and subject to diverse forms of specialist interpretation which remain invariably disputed (Kama and Kuchler, 2019; Kuchler, 2017; McGlade et al., 2013; see also Valdivia, 2015). This is exacerbated by longstanding discrepancies between geological and economic estimates of exploitable resources across the hydrocarbon sector (Mitchell, 2013; Wood, 2016). In this regard, controversies in the geosciences can be seen as a norm rather than something specific to unconventional fossil fuels. Yet, it is important to note how the development of suitable ‘geometrics’

(Elden, 2013) for unconventional has taken place in close association with the invention of particular extraction technologies and their painstaking adaptation to the specificities of the local resource base (Hemmingsen, 2009; Kama, 2013; Kök-Kalaycı, 2016). Subsoil heterogeneity therefore sets important limitations for any estimates of both ‘ultimately available’ in-place stocks, not to mention technologically or economically recoverable resources, and especially *reserves* which are even more difficult to calculate due to the fact that they also incorporate the unknown, yet-to-be-discovered stocks which are projected to become available by inference to known accumulations. However, the expected end result is still a uniform methodology for the assessment and grading of different resource categories with decreasing degrees of probability, including proven, probable and possible reserves, which is underscored by the assumption that world deposits are largely analogous to each other (Bowker, 1994; Kuchler, 2017). Following STS terminology, local methodological intricacies consequently become ‘black-boxed’ and codified, in order to render them comparable across distinct ‘metrological regimes’ (Barry, 2006), especially around more prominent calculative centres such as the US Geological Survey, whose methodology sets the standard across the world. In the case of Alberta bituminous sands and Orinoco heavy oils, this metrological labour culminated with the highly publicized and controversial merger of unconventional deposits with the world’s proven oil reserves in 2002 and 2007 respectively, although they remain separately measured.

More fundamentally, the degree of standardization that occurs across industry conceals how divergent epistemologies of resource assessment rely on locally specific conceptions of the resource or ‘resource ontologies’. Defined as ‘assumptions about what resource substances are, their affordances, and what sustains them’ (Richardson and Weszkalnys,

2014: 19), alternative resource ontologies may either have become historically obscured, or indeed co-exist until the present day. A striking example here is the juxtaposition of ‘oil sands’ and ‘tar sands’ as two competing discourses of economic panacea and socio-ecological hazard, which delineate debates around unconventional oil production in Canada (Grant, 2016; Zalik, 2015b). Another example is oil shales which until this day continue to be conceived differently in different countries as both a solid mineral ore and a liquid hydrocarbon resource, whereas either categorization implies distinct and largely incompatible methods of assessment as well as contending socio-political enactments of the resource (Kama, 2013, 2016). Similarly, the exploitation of shale- and coal-based methane blurs the distinction between solid and liquid resources, especially with regard to legal discourses of property rights and resource allocation (Hesse et al., 2016).

The extent to which these geometrics are locally contingent and associated with specific resource ontologies becomes evident when extraction technologies are transferred from established industries to distant resource basins. What has supposedly ‘worked’ in one place does not necessarily count as a self-evident solution in another context, as recent struggles with moving fracking to Europe make acutely clear (Lis and Stankiewicz, 2016; Vesalon and Crețan, 2015; Williams et al., 2017). As a result, technology transfer may both augment existing scientific disputes and render any disagreements subject to public scrutiny. In this situation, the prospects of exploitation cannot solely be decided by expert estimates of recoverable resources or industry-government negotiations over regulation and revenue distribution, thus exposing the limits of technocratic approaches to resource governance. For those at the receiving end in Europe, the claim that fracking has already proven a viable energy solution in the USA does not automatically justify its

implementation in their vicinity, regardless of whether local populations have much experience with extractive industries. As recent analyses of EU ‘anti-fracking’ protests show, distinct democratic habits and regulatory demands make it difficult for the most experienced companies to gain exploration rights; and even if they do, this does not necessarily imply a ‘social licence to operate’ (Bradshaw and Waite, 2017; Lis and Stasik, 2017; Vesalon and Creţan, 2015). At the same time, the EU authorities have explicitly pledged not to follow the American ‘revolution’ and instead advocate a cautious ‘evolution’ by developing a local knowledge base on the subject before deciding whether shale should become a resource for Europe (European Parliament, 2014).

Conversely, there is also some evidence to suggest that the prospect of technology transfer has simultaneous effects upon the host industry, as it reopens previously black-boxed resource ontologies. Here, my recent study of oil shales production in Estonia shows how the industry’s aspirations to capitalize upon local technological expertise and export its carbon-intensive technology to the USA and Middle East have stirred up a hornet’s nest of socio-political agones over national energy sovereignty which had hitherto remained largely suppressed (Kama, 2013, 2016). In the course of renewed contestation, the relatively isolated problem of the state energy mix has become rehearsed as part of global political and moral dilemmas of sustaining the oil-fuelled capitalist economy. Such ‘issue linkages’ are also noted to be common to controversies surrounding other unconventional (Neville and Weinthal, 2016; Neville et al., 2017).

Either way, geo-social controversies effectively work to de-essentialize established notions of resources and multiply concerns with subsurface potentialities beyond the confines of scientific institutions and the in-house expertise of industry. These controversies thus open up a broader question of how ‘vertical territory’ is

rendered intelligible and acquires agentic capacities in ways that mobilize a wide array of everyday political agencies, beyond the codified techniques of traditional geopolitical actors (Barry, 2013; Dittmer, 2014; Elden, 2013; Squire, 2016). This can also be considered as a form of *subterranean geopolitics* (Valdivia, 2015). To date, such diversification of geopolitics has most visibly involved coordinated attempts by well-established NGO coalitions to identify and report select instances of contradicting evidence sourced from both published research and local witnesses. By mobilizing concrete examples, NGOs are able to associate local issues with more global campaigns (Neville and Weinthal, 2016), effectively discrediting the ‘scientization’ of the issue on behalf of industry protagonists by way of a ‘logic of abduction’ (cf. Barry, 2013). This may easily turn into a tug-of-war between various mobilizations of evidence and counter-evidence, which serve to corroborate certain storylines of desired futures, but do not actually facilitate meaningful debate (Espig and de Rijke, 2016; Lis et al., forthcoming; Metze and Dodge, 2016). In this way, civil society activists primarily work to augment, communicate and reroute the scientific controversy, without necessarily contributing much original knowledge on the *geos*. The influence of such ‘counter-expertise’ (Beck, 1995) therefore hinges on the credibility of NGOs to act as spokespersons for alternative resource ontologies, as well as to simulate industry experts by adopting their technical and financial lexicon and navigating the corridors of policy capitals similarly to professional lobbyists. That said, other concerned groups may prefer to confront extraction with their own vocabularies and experiential knowledge, as recent actions taken by Native American communities make clear (e.g. Willow, 2016; Zalik, 2015a). It is in this regard that we can witness the influx of more original geo-expertise. On occasion, this may be aided by critical scholars whose work is deliberately

aimed at co-producing environmental monitoring data with affected communities, such as the WellWatch (Wylie and Albright, 2014), Citizen Sense (Gabrys, 2017) and Watershed Knowledge Mapping (Kinchy, 2017) projects around the Marcellus shale boom in the USA.

Overall, geo-social controversies illuminate not just the shifting politics of geoscientific knowledge production, but wider spaces of dissensus emerging around the prospects of the carbon economy. In this regard, the case of unconventional links STS-led controversy studies with geographical research on the future, which has so far focused mostly on governmental exercises of emergency planning, scenario-building and similar ‘anticipatory knowledge practices’, especially regarding biosecurity (e.g. Anderson, 2007, 2010; de Goede and Randalls, 2009; Hinchliffe and Bingham, 2008). However, since efforts to govern vertical territory are plagued by profound uncertainties, post-oil energy futures cannot simply be mapped out and calculated as ‘possible states of the world’ (Callon et al., 2009). Instead, their radical openness calls for critical engagement with more distributed anticipatory politics which exceed traditional accounts of the geopolitics and governance of resources.

IV Anticipatory politics: The democratic potential of deliberating post-conventional energy futures

While the production of shale-based hydrocarbons, bituminous sands and heavy oils in the Americas is growing rapidly, various other kinds and locations of lower-grade, carbon-rich fossil fuels remain ‘not as yet’ exploitable and they may in reality never be taken out of the ground due to the need to curb global emissions (McGlade and Ekins, 2015). It is difficult to predict even the prospects of those industries already in operation, because this hinges on a range of post-oil futures under contemplation as

part of the ongoing reconfiguration of the carbon economy (Bridge, 2011b; Mitchell, 2013). Nevertheless, unconventional fossil fuels continue to be perpetuated by both national discourses of energy sovereignty and companies’ investment portfolios in the anticipation of abundant supply and monetary gain. This is especially the case since unconvensionals do not merely epitomize the progressive expansion of capitalism to previously underexploited parts of nature – from ‘easy oil’ to ‘extreme oil’ (Klare, 2012) – but have in fact always shadowed the hydrocarbon industry as ‘resources of the future’. The lure of such future resources is thus not entirely virtual but corroborated by the presence of vast sedimentary deposits, as well as by longstanding technological experiments with materializing this ‘geological potential’ (cf. Weszkalnys, 2015).

To advance the conceptualization of a liminal resource category, the unconventional can be understood as a complex interplay of both competing ‘anticipations’ of the future potentialities of resource materials *and* ‘retentions’ of their complex techno-political histories (Barry, 2014; Born, 2009; Kama, 2016; Kama and Weszkalnys, 2017; Weszkalnys, 2014). Following a Husserlian conception of time, neither of these temporal modalities can be accessed in and of themselves. Rather, both anticipations and retentions are constructed as they converge in the present moment, being strategically deployed by industry and its proponents to legitimize continued prospecting and licensing of concessions – and likewise by others to challenge these investments. Select examples of purportedly successful exploitation, transposed either from the industry’s distant past or from a faraway geographical location, are thereby acted upon as an *already existing index* of a future energy economy to come. So, even though the bulk of such geological endowment – including entire resource categories such as oil shales and clathrate hydrates – remains unrealized as something that ‘has not and may never

happen', through the promissory logic of one day becoming *conventionalized* it nevertheless has very real consequences in the here and now, as specific futures associated with exploitation are continuously 'made present while remaining absent' (Adams et al., 2009; Anderson, 2010: 783; de Goede and Randalls, 2009). This 'potential politics' of resource-making (cf. Massumi, 2007) thereby comes to bear genuine effects on the design of national energy policies, infrastructural networks and markets, perturbing the choice between high- and low-carbon pathways as a 'fluid, unproblematic, unviolent transition' (Boyer, 2011: 5). A good example of this predicament is the widespread promotion of shale gas as a 'bridge fuel' which alongside conventional gas is alleged to facilitate decarbonization despite much controversy over fugitive emissions. This is particularly evident in Europe where the industry has become subject to conflicting strategies of energy securitization and risk management without even moving beyond the exploration stage.

The dilemma of whether unconventional ought to have any significant role in the energy mix thus invokes a 'realm of latent futures in the making' (Adam and Groves, 2007: 17). For Adam and Groves, latency refers to virtual and unpredictable, yet irreversible environmental harms, including those unleashed by penetrating the deepest layers of the subsurface. Extending their concept, I posit that there are multiple 'latent future presents' encoded in the carbon economy and continuously unfolding, even if never fully materialized, in the sense that the industry has been populated by a myriad of competing resource imaginaries since the very inception of scarcity and, later, the twin concerns of 'peak oil' and climate change. Most notably, these latent futures take on ambiguous meanings as both a *threat* of calculable risks and incalculable hazards, and a *promise* of future opportunities and profit; or as Anderson remarks, 'both that which must be secured against and that which must be enabled'

(2010: 782). In other words, it is precisely the distinction between desirable and undesirable possibilities which is at stake in the anticipatory politics inherent to geo-social controversies.

This concurs with the argument that anticipatory politics should be approached more broadly as a 'space of contestation and dissensus' in which possible futures are codified and rendered actionable by a host of social actors (Kinsley, 2011; see also Barry, 2001). Attending to these unfolding politics makes it necessary to investigate the competing rationales and modes of action which mediate the deliberation of unconventional energy development – specifically, how such 'anticipatory logics' (Anderson, 2010) are forged in a confluence of indefinable futurities and deliberate invocations of the past. Recent studies of fracking and oil sands reveal, however, that logics such as precaution, prevention, preemption and preparedness are no longer exercised by regulatory and industry circles alone (Fleming and Reins, 2016; Grant, 2014; Kinchy, 2017). Instead, their authority to speak for 'future presents' is challenged by various other experts and non-experts, who may hold very different perceptions and epistemes of time (Bear, 2016; Szolucha, 2018). Such interventions convey a sense of democratic openness which cannot be projected from the 'public deficit' perspective – 'a future-orientated temporality that refocuses attention away from people's inability to engage on the terms that science chooses, and enables lay knowledges that are *not temporally structured in the same way*' (Brace and Geoghegan, 2010: 292, emphasis added). As noted, these lay knowledges are not necessarily removed from expert knowledge production, but may importantly traverse established modes of epistemic authority (see also Gabrys, 2017).

As such, geo-social controversies unveil a 'crisis of democracy' where it is unclear whose anticipatory knowledge counts and who gets to establish the consequences of this knowledge in

deciding over the trajectories of the energy sector (Steger and Milosevic, 2014). Ongoing struggles over epistemic and political authority may consequently challenge science-policy relations or the devolution of power between national and subnational authorities, as the current stalemate in UK shale gas development reveals (Bradshaw and Waite, 2017). But even more significantly, the proliferation of protest campaigns around prospective extraction sites illuminates how ‘fracking has the capacity both to fracture formerly cohesive communities and to bring formerly disparate communities together’ (Willow and Wylie, 2014: 227). Similarly to widespread contestation of bituminous sands in Canada, the ‘anti-fracking’ fronts on both sides of the Atlantic reshape the social fabric by giving rise to divided and often irreconcilable public concerns, which cannot be occluded by narrowly designed calculations of environmental safety and techno-economic feasibility, but reveal, more fundamentally, historically wedged social inequalities, distrust of political regimes and desired modes of future collective life (Espig and de Rijke, 2016; Fry et al., 2015; Lis and Stankiewicz, 2016; Sica, 2015; Steger and Milosevic, 2014; Thomas et al., 2017; Williams et al., 2017). Despite being loosely defined, such ‘political situations’ (Barry, 2012) show tremendous potential to mobilize resistance across all segments of society, from the usual suspects of NGOs and green parties, to the farming and indigenous communities affected by exploration, to local health practitioners and ‘Lancashire Nanas’ representing the rights of future generations (e.g. Szolucha, 2016; Willow, 2016). Their emergence thus affirms the STS concept of ‘issue-politics’, where shared concerns over novel technological inventions are noted to generate new collective identities and political subjectivities across diverse actors who otherwise have very little in common (Callon et al., 2009; Latour, 2005; Marres, 2005).

Like other knowledge controversies, the epistemic and moral struggles of deliberating post-conventional energy futures are best approached as ‘generative events’ – not just because they give voice to alternative knowledge polities, but because they give birth to *new publics* (Whatmore, 2009). As Whatmore cautions, however, this democratic potential is ‘neither automatic nor guaranteed’, since it corresponds to ‘situated achievements’ which need sustained effort and experimentation for any social change to be achieved (Whatmore and Landström, 2011: 604). As the controversy takes its course, some newly-defined stakeholder groups may indeed come up with alternative proposals for energy provision alongside – or even in opposition to – the grand policy imaginaries of energy security and technological modernization that prevail amongst so many resource-holding governments. Yet, the capacity of these emergent ‘energy publics’ to make a difference should in no way be taken for granted, especially when confined within formal practices of consultation (Chilvers and Kearnes, 2016; Pallett et al., 2017).

Further, it is crucial to avoid here binary characterizations of pro- and anti-extraction publics – the popular depiction of ‘proponents’ and ‘opponents’ which implies that the two camps exhibit clearly-defined identities and agendas. Rather than enabling actors to speak from fixed positions, the plurality of issue definitions and futurities at stake necessitates constant cross-examination of evidence between partisan groups, so that no clear-cut division is always evident – or at least not before the controversy is (temporarily) settled. Quite the contrary, oppositional framing may in fact be a deliberate strategy undertaken by state-industry allies in order to discredit dissenting anticipatory knowledges as incompetent, irrelevant or outright dangerous (Hudgins and Poole, 2014; Kama, 2016; Lis and Stankiewicz, 2016). Similarly, those who contest extraction often mobilize counter-evidence with the sole aim to

influence the framing and trajectory of the controversy (Metze and Dodge, 2016; Neville and Weinthal, 2016). Nevertheless, beyond mere antagonism (cf. Mouffe, 2005), widespread resistance to new extractive projects in established democratic contexts arguably puts into motion more productive processes of identity- and place-building, as manifested in the declaration of a growing array of localities as ‘frack-free’ (Fry et al., 2015; Neville and Weinthal, 2016; Short and Szolucha, 2019). Insofar as these fragmented yet increasingly translocal movements continue to explore alternative social values, energy citizenships and intergenerational justice, they conjoin the incoherent and indeterminable but nonetheless unifying impetus of contemporary environmental resistance (see Ansems de Vries and Rosenow, 2015). An urgent analytical task is hence to explore what geopolitical collectives are implicated by such pre-emptive freedom from extraction, and to what extent their emergence makes it possible to disrupt established knowledge-power relations.

Here, a key point of dispute is whether unconventional fossil fuels ought to become economically feasible to exploit. As elaborated next, this represents a third register of resource-making controversies, where concerns around ‘below-ground’ indeterminacies intersect with ‘above-ground’ strategies of resource appropriation, pricing and speculation. The following therefore develops the relational conceptualization of un conventionals as a product of a series of collective future-oriented practices, which include the restructuring and decarbonization of energy sectors and, increasingly, financialization of extractive industries.

V Economization: Divergent temporal politics in materializing new extractive industries

By definition, the notion of un conventionals as a liminal resource category indicates that such

‘resources of the future’ portend to become one day indeed exploitable. In practice, however, it is more than doubtful whether all such geological occurrences will be commercially produced and incorporated within conventional reserves, especially as current states of exploration vary significantly across different basins. That said, it is important to bear in mind that un conventionals do not correspond to entirely novel or recent phenomena, since smaller-scale experiments with producing alternative fossil fuels have long endured on the borderlands of mainstream extractive economies. Even as bituminous sands and shale-based hydrocarbons have turned into a multi-million dollar business, the desire to harness their energy content has occupied governments and technology developers for many decades, including at times when market prices were at their lowest (Hemmingsen, 2009; Kök-Kalaycı, 2016). Furthermore, their commercialization in North America can be explained as a place-specific response to geopolitical and economic security concerns – instigated by close allies of the state, industry and finance capital – rather than the logical end result of sustained innovation and high prices (Wood, 2016; Zalik, 2015a). Although these extractive ventures are now transgressing to other parts of the globe, to reinvigorate hopes for self-sufficient energy provisioning, they have so far proven notoriously difficult to implement beyond the immediate proximity of established industries and boomtown cultures. Meanwhile, lower-grade un conventionals such as oil shales have persistently failed to acquire the status of a global resource despite century-long efforts to capitalize on their potential.

This remarkable endurance of un conventionals as future resources, which may or may not become eventually exploited, begs for the question of what it actually means for these resource economies *to be economic* (Callon et al., 2007). Following the STS-led economic sociology of Callon and others, ‘to be economic’ can be understood as the product of a

wide range of social techniques that are aimed at rendering something internal to the frame of economic calculation or, briefly, ‘economization’. As a ‘process that is historical, contingent and disputable’, economization and its outcomes are subject to intense ‘trials of strength’ which enlist various competing economic practitioners, but also their technical and institutional settings and the materiality of things entering valuation and market transactions (Callon et al., 2007: 3; Çalışkan and Callon, 2010). What Mitchell (2013) identifies as the ‘new politics of nature’ inherent to the making of un conventionals therefore depends foremost on how the carbon economy will be collectively reworked vis-à-vis the material properties of the changing resource base and the associated infrastructures through which such new commodities are circulated (such as ‘dilbit pipelines’; see Grant, 2014). Rather than being predetermined by the course of ‘the market’ as having some universal form of existence, economization is arguably co-performed by a variety of human and non-human agencies, yielding distinct outcomes in different places and times.

Following this approach, a key question is not so much whether unconventional energy development overall coheres with existing mechanisms of extractive capitalism, but in what ways particular projects interfere with the design of regional economic regimes. Unconventionals, like any hydrocarbons, are always ‘inserted into a very specific localized [...] political economy even if the properties of the wider oil assemblage are in some sense normalized’ (Watts, 2013: 1018). For example, the exploitation of extra-heavy crudes in Venezuela and oil shales in Estonia, Brazil and China is inextricably entangled with nationalist energy policies and cross-subsidized by other heavy industry, to the extent that their operations are at odds with free market imperatives (Bradshaw et al., 2015a; Kama, 2013). Whilst being in no way immune to developments in the ‘oil assemblage’ and fluctuations in global prices, these

industries remain chiefly local achievements and, as such, prove difficult to replicate elsewhere. The production of bituminous sands remains likewise limited to Canada. By contrast, following the boom of shale gas and oil production in the USA, we have seen immediate effects on the dynamics of market pricing, responses from competing actors such as LNG suppliers or OPEC to increase output, as well as growing efforts to exploit similar world deposits (Bradshaw et al., 2015b; Bridge and Le Billon, 2017; Neville et al., 2017; Stevens, 2010). Supported by technology transfer, these industries gradually take the place of more global arrangements, leading to the restructuring of markets. It is therefore necessary to examine the concrete cases in which economization is accomplished in the presence of ‘rival calculative regimes’ (Callon, 2007; Mitchell, 2008), and whether these solutions are subsequently deemed portable across disparate resource ontologies and materialities.

What is particularly intriguing in the case of un conventionals, however, is the resurgent idea of speculative gain that fuels such ‘anticipatory economies’ (Bridge, 2017; Weszkalnys, 2015). In part, the development of lower-grade fossil fuels has always been a highly speculative endeavour, where the life-long ambitions of geologists and technology developers to evoke new subsurface resources converge upon national aspirations of energy sovereignty and resource-based modernization (cf. Tsing, 2005). Yet, the current investment frenzy is additionally tied to the quest of firms for capital accumulation via financial markets and their subsequent ‘liquidification’ by acquisition and mergers, with the result that they become progressively decoupled from real-life production. This has been especially the case in the USA shale boom since the financial crisis of 2008 and Wall Street’s renewed interest in productive sectors (Kök-Kalaycı, 2016; Rogers, 2013; Mitchell, 2013; see also Ouma, 2014). But already earlier, the highly speculative nature

of these industries had become evident with the infiltration of financial expertise into what used to be a primarily technical knowledge community, as well as the leading role assumed by independent 'junior' developers, both privately and state-owned, in mobilizing technology development and licensing of concessions. Unlike major corporations, these junior firms are heavily reliant on attracting investment capital through bonds, public trading and private equity (cf. Majury, 2014). As Wood (2016) argues in reference to tight oil, juniors thereby come to act as 'proprietary vessels of oil and gas assets', turning into objects of market exchange much like the prospective commodity itself, or at least insofar as their accumulated resource holdings continue to uphold future gain. Actual production is thus often postponed in favour of short-term profit maximization through the circulation of valuations and financial derivatives, which are yet to be proven through projected cash flow from extraction; or as Wood says, 'they provide a means to liquidate the future in the present while creating a financial path dependence on future production' (2016: 46). Economization in this regard is not so much defined by access to energy markets, but above all to venture capital markets.

It is therefore critical to interrogate the making of unconvensionals against the financialization of extractive industries, whereby the exchange value of purported holdings as projected earnings becomes inflated far beyond their use value (Labban, 2010; Zalik, 2015a). Indeed, the sheer size of organic-rich deposits may be deployed as a key projective device (Weszkalnys, 2015), which informs national energy security strategies and facilitates industry's access to both concessionary rights and investments, especially when translated into monetizable assets as proven and probable reserves. In practice, however, such projections of cornucopian futures often fail to match geological realities following closer exploration. With the large-scale write-offs of shale gas

reserves that have occurred in the Marcellus play and more recently in Poland, these claims to geophysical existence seem to have been laid bare (Kama and Kuchler, 2019; McGlade et al., 2013). In fear of market inefficiency, regulators such as the US Securities and Exchange Commission are now taking steps towards tying reserve growth back to evidence of actual production, whilst still trying to maintain the lax neoliberal business environment (Pons, 2015). But even with declining oil prices, such corrections may have little effect in a situation where industry's profit margins are predominantly tied to projections of future market demand and reserve replacement.

Should unconventional energy development then be regarded as merely another case of 'profiting without producing'? It appears that some evidence of depositional existence and exploitability is still required in order to materialize even the most speculative industries, and arguably has always been. As noted earlier, central to the 'economy of appearances' (Tsing, 2005) that enables the capture of investment capital in the absence of full-scale production are strategic 'retentions' of purportedly successful, albeit limited experiments with converting fuzzy geological strata into useable fuels. Indeed, as Callon reminds us, 'to produce merchandise from things that are not yet completely economized, one has to use what exists, edge one's way in, articulate' (2007: 327). My own research on oil shales (Kama, 2013) shows that such rhetorical references to already-existing or foregone projects are often supplemented with the build-up of tangible evidence, or what Bowker (1994) calls 'infrastructural work', which gives developers a vantage in constituting the subsoil as a resource. This may include the strategic exhibition of exploratory drilling data and laboratory samples of first produce; or the hasty construction of extraction platforms, processing plants, pipelines and other 'capital sinks'; or the pre-emptive installation of environmental monitoring equipment on concessions. In a way that

is not dissimilar to the ‘abductive logics’ of anti-extraction activists described above (Barry, 2013), such infrastructures operate as ‘gestures’ at future prospectivity, which alongside reserve inventories are not just indispensable in securing the firm’s value and its liquidity but help to induce the resource out of mere geologic propensities and economic conjectures (Weszkalnys, 2015).

These gestures are both performative and incremental, as they add to the resourceness of unconventional as *economic assets*. Yet, their success is not guaranteed, since it is far too common for exploration to become suspended or indefinitely delayed. The intended evidence may fail to convince investors, governments and shareholders alike. Memories of earlier boom-bust cycles come to inform the deferral of new projects, replacing high hopes with deep doubts. The spatio-temporal disjuncture between existing industries, combined with depositional heterogeneity, further augments expert dissensus and public distrust, jeopardizing the spread of technologies such as fracking. Meanwhile, however, in the frenzy of expectations and lucrative deals generated by projected returns, such anticipatory economies may also spin off other extractive sectors, without ever becoming fully realized themselves. Indeed, it can be hard to tell apart purely fictitious ventures and those aimed at actual production, since some speculative investments may eventually materialize whilst others will fail. As ethnographic studies of corporate circles show, such ambiguities may be present even in a single company, as different experts forge incongruous temporal strategies that conflict on daily basis (Kama, 2013; Pons, 2015).

Interestingly, at a time when policy debates tend to focus on the impacts of impending exploitation, as if it will indeed happen, many emergent publics are taking notice of the inherent contradictions and radical openness of such anticipatory economies. Environmental groups around the globe now advocate the need to

divest from fossil-dependent futures, having swiftly adopted the vocabularies of ‘unburnable carbon’ and ‘stranded assets’ devised by leading think-thanks (Ayling and Gunningham, 2017; Healy and Barry, 2017; Zalik, 2015a; see also Ansar et al, 2013; Carbon Tracker, 2013; McGlade and Ekins, 2015). The fundamental aim of the divestment movement is not to identify more viable means of extraction, but to *de-economize* unconventional outright. This obfuscates further the boundary between the economic and non-economic, and productive and non-productive sectors.

Attending to these (de)economizing struggles does not contradict the tenet that resources must be regarded as ‘more than economic’ achievements (Bakker, 2012). Quite the contrary, if we follow the Callonian idea of ‘economic-ness’ as something that neither has universal modalities nor can be measured against given parameters, but rather is assembled in tandem with locally-specific resource ontologies and technologies, then this brings into focus various affective, embodied and experimental modes of resource-making (see Bakker, 2010; Le Billon, 2013; Weszkalnys, 2016). It is precisely these affective engagements, especially the interplay of threats and promises, which enable unconventional to be rendered economically and politically operational beyond mere geological potency.

VI Conclusions

With this paper, I have identified substantive new lines of inquiry for geographical studies of alternative fossil fuel resources in the making, by bringing critical resource geographies into dialogue with recent conceptual trends in science and technology studies, as well as with the resurgent interest in the *geos* across the social sciences more generally. In doing so, I argue that we need a more relational and distributed account of resource-making controversies as ‘collective *geo-politics*’ (cf. Conway,

2016), to address both the shifting politics of geoscientific knowledge and vernacular geopolitical engagements with the subsurface. My approach therefore makes it imperative to conduct, in true STS fashion, more in-depth ethnographic and archival research on geoscientific assessments of resource availability, techno-economic feasibility and environmental safety, including how knowledges of specific geological basins are translated across disparate metrological and regulatory regimes. Given the uncertainties at stake, however, it also necessitates an investigation of the ways in which expert dissensus renders the ontological politics of resource-making open to wider public interrogation and reconfiguration. It is through these unfolding spaces of geo-politics that specific resource futures are rendered actionable and conventionalized, while others are cast aside.

The value of this perspective is threefold. First, future research is likely to observe important changes in the formation of epistemic authority around policy-making and regulation of extractive industries – not just due to conflicts between rival forms of expertise, but also those arising from the ‘abductive’ strategies of civil society coalitions. It remains to be seen to what extent these epistemic communities will be further democratized through the involvement of other extra-industry practitioners, local experiential knowledges and community-led monitoring programmes, which in combination with nascent scholarly experiments around ‘co-production of knowledge’ may lead to the rise of entirely novel forms of citizen geosciences (cf. Irwin, 1995; Jasanoff, 2004). Although the contributions of such experiments are admittedly still limited, they indicate an important scope for both transdisciplinary and activist research beyond the science-policy interface (see also Jenkins et al., 2015).

Secondly, I noted how the democratic potential of resource-making controversies is augmented by competing anticipations of the industries’ prospective gains and unwelcome

risks *and* strategic retentions of extractive legacies against the backdrop of wider reconfiguration of the carbon economy. Here, the deliberation of post-conventional energy futures is clearly defined by the anticipatory knowledge techniques and public consultation exercises of various regulatory authorities and expert bodies, but not exclusively so. For what is becoming increasingly evident is that the process of envisaging and contesting subsurface potentialities per se is generating new political agencies, collective identities and forms of energy citizenship, which can neither be reduced to the ‘public deficit’ model nor fully explained by the popular depiction of pro- and anti-extraction groups. This makes it crucial to bring STS-led approaches together with the ‘geographies of the future’ (Anderson, 2010), in order to investigate and to empower the divergent conceptions of earth futures forged by the nascent publics arising from geo-social controversies.

In this context, and thirdly, I have emphasized the need to analyse anticipatory politics through the lens of ‘economization’, especially concerning the financialization of extractive industries. At a time when the ‘transition’ from conventional to unconventional sources is uncertain, the influx of financial capital and expertise has led to multiple, spatio-temporally divergent strategies of materializing extractive futures in the absence of globally proven industry. By accounting for these strategies, research on unconvensionals thus crucially complements the nascent ‘geographies of marketization’ scholarship concerned with the reordering of capitalist borderlands in response to emergent modes of commodity exchange (Berndt and Boeckler, 2012). As briefly discussed, however, we must also urgently take notice of alternative modes of economization, including various affective and experimental interventions by emergent publics, which may serve to ‘de-economize’ extraction. In turn, this raises important questions of power and inequality, as it would be naïve to assume that divestment groups and

other ‘economists-in-the-wild’ (Callon, 2007) are the equal of industry-state allies in performing anticipatory economies.

An equally crucial task, which exceeds the scope of this paper, is to explore how the materialities of fossil fuel resources become co-constituted with new extractive economies ‘from the outset’ (Braun, 2008: 669), rather than simply preceding any challenges as ‘biophysical’ properties inherent to resources – or geophysical for that matter (Bakker and Bridge, 2006). Indeed, if we understand resource materialities as contingent, distributed, and multiple (Kama, 2013; Richardson and Weszkalnys, 2014), then what are the implications of diverse enactments of geological potential for the outcomes of resource assessment, marketization, and the industries’ transposition across distant geographies? Conversely, in what ways might rival appraisals of exploitable resources and (de)economizing techniques transfigure resource materials themselves (see also Hébert, 2014)? This shows a pressing need to examine the role of technology beyond the ‘market devices’ that mediate the framing of resources as exchangeable assets and commodities; an issue that remains curiously overlooked in STS-led economic sociology (Callon et al., 2007; Çalışkan, 2010; Çalışkan and Callon, 2010). Finally, future research should also attend to the ‘entanglement of geology and finance’ (Wood, 2016: 45), given that subsurface potentialities are capitalized in the present whilst delineating the economic regimes that become possible thereafter. It is unclear to what extent the recent wave of financialization becomes decoupled from actual production, and indeed whether it really differs from preceding forms of speculation central to any resource-making endeavours (Ouma et al., 2018). A persisting question for critical geographical research is therefore how to account for the differential capacities of earth materials vis-à-vis their progressive shaping through technological and economic registers and other complex

relations with time. In brief, the conundrum of unconventional resources as liminal and processual resources-in-the-making requires us to recognize ‘resource temporalities’ (Kama and Weszkalnys, 2017) as equally important to questions of ontological politics and materialities in our conceptualization of geo-social controversies.

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Note

1. In technical literature, these are often depicted as a continuum of fossil fuels with decreasing recovery potential and energy returns, ranging from crude oils with higher API gravity and conventional natural gas to less viscous or permeable sources such as bitumen and shale-based hydrocarbons, to kerogen-rich oil shales and gas hydrates (see Bradshaw et al., 2015a). There are other geo-energy resources which do not fit this categorization, such as geothermal energy.

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