Materialist Politics

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Introduction

How might one conceive of the relation between materials and politics? As is common enough in science and technology studies, this chapter centres on a case study: the field of metallurgy and the materiality of metals and other inorganic matter. The danger of using a case study, of course, is that the case simply becomes an illustration of an idea or principle which has been formulated somewhere else: that which we already *know*, and that which we simply want to make *clear*. Whereas what we would like from a case study is that it is something *more* than an example: that it tells us something that we do not know, or creates an effect that is somehow unanticipated. The case should be placed in a setting where it can resist our explanations of it in some ways. There should be some irreducibility to the case. In other words, the case must make a difference.

There are, nonetheless, good reasons to use metals and metallurgy to think about the relations between materiality and politics. One reason is simply that there is something of a neglect of the politics of metals today, whether in terms of their extraction, manufacture or use, or their repair. If the malleability of metals was once viewed as an index of the transformative capacities of capitalism, today metals seem to have disappeared from view. **We live, according to many theorists, in a world marked by flows of knowledge and information, but materials are no longer of much interest. Where once they lay at the heart of social theory, metals appear to have been relegated to the back stage.** In what follows, however, I am not concerned with the social shaping of metals. Rather, I put forward a different thesis to the classical one, namely that part of the political interest of metallurgy derives from its concern, as a form of field science, with the specificity of the case and the micropolitics of materials. My method is, to use Marilyn Strathern's terms, holographic (Strathern 1995). Through a study of the politics of a field science which is concerned with the specificity of the case, I seek to illuminate why a concern with the specificity of the case is important for those concerned with the study of politics.

The chapter develops two arguments. One is that metals are not the hard, inert objects that they are often thought to be. Metals form part of dynamic, informed assemblages in which the expertise of metallurgists and other material and social scientists have come to play a critical part. They have become 'informationally enriched', and part of the driving force for this informational enrichment comes from growing efforts to regulate the properties of the materials and the actions of those who develop and use them. The informational enrichment of materials, in short, has become a political matter. **The second argument is that part of the political importance of**

metals and other inorganic materials derives from a sense that they have an objectivity and an immalleability which cannot be explained away as an expression of political ideology or economic interest. Defects in metals or accidents which derive from or lead to the failure of metallic and other material structures cannot easily be denied, and cannot simply be viewed as a projection of the imagination of those who point to their occurrence. It is commonplace to stress the micropolitical importance of forms of creative, artistic and inventive activity. Yet there is also a way in which natural scientific expertise, and its public performance, may also disrupt earlier certainties, fostering the emergence of new objects and sites of contestation. Through their expertise in the failure of metals and material structures, material scientists and metallurgists may themselves play an unexpectedly political part, turning the apparently mundane properties of specific materials and material structures, such as their fragility or toxicity, into issues of wider significance. **The second part of this chapter focuses on an example in which a defect in a material structure, an oil pipeline, is understood to be an index of a much wider set of defects in corporate capitalism and its regulation.** In this case a critique of the relations between corporate capital and government relied on the demonstrability of facts about the properties of specific materials. If political action often involves the staging of a particular issue as a matter of collective importance, then non-human materials rather than human subjects were, in this instance, placed firmly centre stage (cf Rancière 2004a)[1].

Metals

To begin, it would be a mistake to think that metallurgy is simply a branch of physics. Indeed, from the point of view of the metallurgist, the properties of metals cannot simply be deduced from fundamental physical principles.[2] Alloys cannot be understood as combinations of pure substances, and the behaviour of metals in the conditions encountered in power stations or aircraft is quite different from any laboratory setting or simulation. Moreover, it would be a serious mistake to think that physics can simply be *applied* to the study of metals: or only if we take the word application to imply the need for a process, the path, *the deviation,* of translation (Callon and Latour 1981). One of the preoccupations of the metallurgist (and I use the term very broadly in this chapter to include all those concerned with the technical existence of metals and their relations to other substances[3]) is to be concerned with the specificity of the case, rather than account for the case in terms of general principles. General principles are important, of course, but only so far as they are not applied in any generalised way, and are acknowledged to be inadequate to the task in hand. The metallurgist *expects* that materials will be opaque, that the case will make a difference. In this way, the metallurgist is a good materialist, aware that materials will always, in some way, be resistant to external forces, and will generate their own effects (Stengers 1997). Although not all may agree with this proposition: the socialist historian of science and crystallographer JD Bernal, writing in the early 1950s, reckoned that following the development of X-ray crystallography it would be possible for metallurgists and other scientists to begin to take 'rational control' over the internal structure of metals:

> "The structural studies [following the development of X-ray crystallography]...explained the primary, economically valuable properties of metals – their plasticity and hardening, the means by which metals, can be forged, rolled and drawn – and made possible the beginning of a rational control of these processes" (Bernal 1969: 796)

While X-ray crystallography played a critical role in the development of molecular biology and solid state physics in the immediate post-war period, Bernal was over-enthusiastic about the possibility of turning metals into what we might call, following Foucault, docile objects. After all, X-ray crystallography is a technique which can only be used to determine internal structural features of carefully prepared specimens in a well-equipped laboratory. It cannot be applied directly to the study of metals in use, or in the field, where it is likely that they will be subject to variations of stress, or temperature and the affects of chemical action.

In so far as metallurgy addresses the question of the relation between the transformation of metals and features of their external environment, it addresses a central problem for science and technology studies. For STS was, of course, for a long time puzzled about the relation between 'external' (economic and social) forces and the shape of technologies. In this way, STS rediscovered a classical problem (Mackenzie 1996). In a remarkable passage, Marx formulated the relation between the historical development of capitalism, the division of labour in manufacture and the structure of metals, precisely in terms of their *shape*: "manufacture is characterised by the differentiation of the instruments of labour – a differentiation whereby tools of a given sort acquire fixed shapes, adapted to each particular application – and by the specialisation of these instruments, which allows full play to each special tool only in the hands of a specific kind of worker (Marx 1973: 460).

Contemporary metallurgy does not confine itself to external form and shape, however; rather one of the preoccupations of the metallurgist is with the question of how external forces and events become translated or absorbed at the level of molecular structure, and conversely how molecular structure is mediated in transformations of external form. As Roux and Magnin argue, metallurgy is not so much the science of the microscopic *or* the macroscopic, but a mesoscopic field which mediates between scales and spaces, and between different forms and techniques of analysis (Roux and Magnin 2004: 11). The metallurgist is an expert who is capable of bringing different spaces and objects of analysis simultaneously into view, moving between observations of external and internal structure, between quantum physics, thermodynamics, corrosion chemistry, crystallography and management strategy, between idealised atomic models and phase diagrams and materials in use, between the human and non-human elements of assemblages (cf Mackenzie 2002: 16).

From the point of view of contemporary metallurgy, metals are sites of transformation. Internally, they contain features such as grain boundaries, regular lattice structures, impurities, dislocations and catalytic sites, which provide the basis for both stability and rigidity *and* movement, elasticity and flow, changes in intensive and extensive properties.

They are spaces within which minute changes occur routinely, and catastrophic failures may represent the crystallisation of a series of infinitesimal movements rather than the immediate impact of an external force (cf Tarde 2001). It is common enough in social theory to draw an opposition between the static, the bounded or the rigid, and the fluid or the mobile. Indeed, for some, speaking of boundaries and rigidities at all is simply thought to be *passé*. **But it would be wrong to oppose the solidity of metals with the fluidity of fluids, or boundedness with flow. Rather, it is a question of recognising that solidity may itself be the product of certain form of fluidity.** After all, metals are extraordinarily fluid – full of local sources of transformation and instability – actually more fluid than fluids. Indeed, Deleuze and Guattari took the insights of the metallurgists to be an argument for vitalism: "**what metal and metallurgy bring to light is a life proper to matter, a vital state of matter as such, a material vitalism that doubtless exists everywhere but is ordinarily hidden or covered, rendered unrecognisable…**" (Deleuze and Guattari 1987: 411). The metallurgist is not just concerned with the shape or mold within which metals are formed, or with their malleability, but with what can be termed the continuous modulation or variation of metals (ibid., see also Deleuze 1979).

So metals flow, and they share certain properties with living materials; it is just that they often flow more slowly, and from the point of view of the metallurgist, more profoundly and irreversibly than fluids. They can contain historical records of their past, in a way that most fluids cannot. They have surfaces, but their surfaces are sites of transformation, such as corrosion and friction, as well as functioning as boundaries (Bowden and Tabor 2001). Metals' capacity to continue to exist over years and decades depends on fatigue and creep; the minute internal transformation of metals under fluctuating conditions of stress and temperature. So metals are quite unlike glass (which may shatter under the impact of an external force), or many fluids (which may simply move to another place, adapting to the shape of the container in which they are placed). Metals have the capacity to render external energies into novel internal forms, "modifying [themselves] through the invention of new internal structures" (Simondon 1992: 305). Metals are solid and hard and (for a period) can endure without ever remaining the same[4]. Their stability as material forms is intimately associated with both their internal transformation, and their fragility (Roux and Magnin 2004).

But if metals have something of a metastable existence, passing slowly between states, they also come to exist in other forms generated through the work of metallurgists, and the demands of regulators. In Bensaude-Vincent and Stengers' account of the *History of Chemistry*, instead of merely imposing a *shape* on matter, chemists proffer a "different notion of matter":

> "Whether functional or structural, new materials are no longer intended to replace traditional materials. They are made to solve specific problems, and for this reason they embody a different notion of matter. Instead of imposing a shape on the mass of material, one develops an "informed material" in the sense that the material structure becomes richer and richer in information. Accomplishing this requires detailed comprehension of the microscopic structure of materials, because it is in playing with these molecular, atomic and even subatomic

> structures that one can invent materials adapted to industrial demands and control the factors needed for their reproduction, whether they are new or traditional" (Benaude-Vincent and Stengers 1996: 206)

The same observation applies to metallurgy. The product of the contemporary metallurgist's labour is not necessarily a new metal; it is likely to be the 'informational enrichment' of materials, multiplying their forms of existence. Through the work of metallurgists, metals acquire multiple lives: in simulations, micrographs, X-ray crystallography, and samples taken from materials in use. In each of these settings, metals exist in different forms (more or less prepared, more or less purified, more or less isolated from other chemicals) which depend on particular informational-material practices of experiment and field research (cf Mol 2002: 6, Barry 2005). Metals not only have a lively existence, their forms of existence increasingly depend on the informational-material assemblages through which they circulate. Moreover, although metallurgy might not provide the basis for the level of control of the properties of metals envisaged by Bernal, it nonetheless plays a critical role in their management and government. Consider, for example, the importance of the tests and measurements which are routinely carried out on systems such as power stations, aircraft and oil platforms, in order to ensure their integrity and safety. Such measurements are governmental acts: they are intended to manage the potentially unruly conduct of socio-material assemblages, aligning them with broader economic and governmental objectives. Just as the regulation of drugs demands the multiplication of their forms of existence as informed materials (through *in vivo* and *in vitro* investigations and through clinical and pre-clinical trials), metals are also subject to a series of commercial and regulatory tests, the results of which may or may not be made public (cf Barry 2005, McGoey 2007).

Metallurgy might be described as something of a social and political science, if we understand the notion of the social in the sense given to it by the sociologist, Gabriel Tarde. For Tarde it was possible to refer atomic or molecular societies as well as and human societies and he argued that the same concepts could refer to the societies described by the physical and life sciences as much as those analysed by sociologists (Tarde 1999). The metallurgist might follow Tarde in acknowledging that there is no discontinuity between the realm of the social and the natural, the human and the non-human, or between the informational and the material, the living and the non-living (Whatmore 2006, Barry and Thrift 2007, Thrift 2008). Whereas Bernal imagined that metallurgy would make it possible to establish something like a socialist administration of metals, resulting in a direct alignment between the internal structure of metals and economic need through the use of techniques such X-ray crystallography, contemporary metallurgists pursue a more flexible approach. For metallurgy assumes that there could be no correspondence between material and social and economic structure. Rather, the metallurgist multiplies the forms in which metals exist, while recognising that complete knowledge and control is impossible. Metallurgy is an interdisciplinary discipline, concerned with the study of systems, platforms or processes, assemblages of which metals and other materials are only a part.[5]

Metals and metallurgy provide then a particularly good case study for thinking about the properties of materials. They clearly illustrate the principle of irreducibility: the behaviour of metals resists any reduction of their properties, whether to their external (social) environment, or to the fundamentals of physics. Metallurgists are mediators between form of economic calculation, government regulation and the analysis of material properties (cf Osborne 2004). Moreover, metallurgy, like agricultural research, zoology, anthropology and geography, is reliant on field research, a form of artisanal and itinerant practice (Deleuze and Guattari 1987: 411), and not just laboratory experimentation (Schaffer 2003, Livingstone 2003). As a field science, metallurgy should be, in principle, attuned to the specificity of the case. It is attentive to the general problem of how to address the study of the particular. Whereas many physicists, for example, may be preoccupied by the problem of how to represent the particular in terms of the general, metallurgists are often confronted by a rather different question. Namely, **how is it possible to understand and manage the properties of objects which exhibit general problems (such as fracture, conduction, phase transition, creep, or corrosion) but in specific ways, and in very different settings and locations?**

Politics

For Bernal the development of X-ray crystallography promised the possibility of a direct alignment between molecular and economic structures: the internal structure of metals would come to reflect economic needs. But how might envisage the relation between failures of metals, or better of specific socio-material assemblages, and more systematic failures in the economic and political order? This question is not hypothetical. In the recent past, the cases of Chernobyl and Three Mile Island, BSE and CJD, Brent Spar, GM crops and Bhopal, have come to be see by many not just as accidents, but as indices of more systemic failures. Failures in socio-material assemblages have been viewed as signs of the existence of wider series of problems concerning the relations between science and politics, and between governments, corporations, and citizens (e.g Beck 1992, Berkhout et al 2003). Their occurrence has demanded, according to many, a new politics of science and a new politics of the environment, science and risk.[6] Particular accidents have come to be understood as markers of general problems, and as specific cases that demand general solutions and wider forms of political action. In short, particular failures have been constituted as political events.[7]

In these circumstances, how might one envisage the relation between metallurgy, metals and politics? If metallurgy is an example of a field science, an itinerant practice, which itself is entangled with the study of the particular in its environment, then how do the insights of metallurgists come to have more general significance? What is the relation between the claims made by metallurgists about the specificity of the particular, and the claims by those with an interest in politics concerning the relations between particular occasions and collective issues and concerns? **In what follows I focus on an example of an occasion in which metallurgy plays a remarkable and unexpected role. The case raises two questions. The first concerns the relation between the properties and behaviour of metals and the organisation of political and economic life. How can**

particular material processes, including accidents, come to be constituted as events of general significance to others? And in what circumstances are they not? Secondly, why might political controversy focus on the behaviour of metals and other non-human substances rather than the behaviour of humans? And how can the work of metallurgists be made to have such potent political agency?[8]

The case in this chapter is an enquiry by the UK parliament's House of Commons select committee on Trade and Industry into the activities of the UK government's Export Credit Guarantee Department's (ECGD) in 2005. In particular, it focused on the operation of the Department's Business Principles which were expected to govern the relation between the Department and the companies to whom it provided financial assistance. Yet although the enquiry had a very specific focus and examined the activities of particular and arguably minor government agency, these activities raised, according to critics, wider questions. Did the government exercise control over the behaviour of corporations in other countries, or does the government primarily act to facilitate corporations' activities? What is the character of relations between the government and multinational corporations? Or, even more broadly, are the 'Business Principles' of the British government simply particular features of the operation of neo-liberalism or the 'neo-liberal state' (Harvey 2005).

While the remit of the select committee was to address the implementation and effectiveness of Business principles by the ECGD it nonetheless came to focus on a particular example of the implementation of these principles. This was the financial support given by the ECGD, in conjunction with the International Finance Corporation (IFC) and the European Bank for Reconstruction of Development (EBRD), for **the construction of the Baku-Tbilisi-Ceyhan (BTC) oil pipeline, one of the largest single construction projects in the world in the early 2000s.**[9] The development of the pipeline had been promoted in the 1990s by both the Turkish government and the US Clinton administration as a way of bringing oil from the Caspian Sea along a route, through Azerbaijan, Georgia and Turkey, which avoided both Iran and Russia. At the same time, this explicitly geopolitical investment would serve to bring Azerbaijan, and possibly other Turkic speaking republics of the former Soviet Union, into the US or Turkish sphere of influence. The involvement of the IFC, EBRD and ECGD in the project was intended to reduce the financial risk to investors, but also helped to ensure that the US and UK governments, in particular, would have a direct interest in the completion of the project.[10] Oil companies were willing to be submitted to the greater scrutiny that the receipt of public finance would entail, in part because it would ensure that Western governments would have this interest.

However, even within this restricted focus on the financial support of the ECGD for the BTC pipeline, the select committee channelled its critical scrutiny still further. **Prompted by the work of a coalition of NGOs, critical of the work of the ECGD, the committee devoted considerable time to the failure of a particular coating material used on joints between sections of the pipeline**[11]. More precisely still, it was concerned with the very specific issue of what the ECGD knew about the procurement and use of this coating material in late 2003 during the period when the Department was considering

whether to support the construction of the pipeline. Indeed, the case of the coating material was the *only* issue related to the BTC pipeline discussed in the House of Commons, with the exception of a brief discussion of the case of the Kurdish nationalist activist, Ferhat Kaya, who was allegedly tortured in the police station in the Turkish town of Ardahan, near to the Georgian border, on account of his criticism of the BTC project (Bakuceyhan 2004b, House of Commons 2005: 13).

The centrality of this particular coating material to the concerns of British Members of Parliament is moreover surprising when viewed in relation to debates elsewhere. For a time, during 2003-5, the pipeline acquired a remarkable political geography. In Washington DC, in particular, BTC came to have a very different significance. The offices of the ombudsman of the International Finance Corporation on Pennsylvania Avenue, for example, investigated a series of specific alleged violations of Bank guidelines by the BTC company in Georgia, following representations made by the Georgian environmental NGO, Green Alternative (Green Alternative 2004). These concerned, for example, the alleged failure of the BTC company to ensure adequate compensation to villagers whose houses had been damaged by subcontractors. Elsewhere in Washington, the State Department was forced to intervene following the decision of the Georgian government of Mikheil Saakashvili temporarily to halt construction of the pipeline in July 2004, and the issue was discussed in meetings between Saakashvili and Colin Powell and Donald Rumsfeld.[12] Moreover, the failure of the coating material described by the metallurgist had not lead to any oil leak or effect on the environment. There was no specific accident to which anyone could point, although NGO critics described it as an 'environmental time-bomb' and linked it by association to a series of events involving BP, including connections between the oil company and Colombian paramilitaries (Gillard 2004). Nor did the problem have any discernable impact on the complex geopolitical situation within which the pipeline was embedded. The failure of the coating material was not considered of particular importance by villagers living near the pipeline route who were incensed by their failure to receive compensation that they had expected to receive due to the presence of oil industry construction work near to their homes.[13] In a meeting with Georgian workers and residents in the city of Rustavi nearby to the pipeline route, I was told that up to 50 km of pipeline had had to be relayed.[14] But this was of little concern to the workers, who were angry about low pay, long working hours and poor food, and had been engaged in unofficial strike action in the same period. However, the issue of working conditions and wages was not considered by the Select Committee, even though it might reasonably have done so. After all, the working and wages of the Georgian pipeline workers were governed by the Host Government Agreement between the BTC company and the Georgian government, which allowed for the pipeline *not* to be governed by some of the conditions of Georgian labour law. This agreement appeared to violate the terms of the OECD Guidelines on Multinational enterprises, which stipulate that multinationals should not seek or accept exemptions from the provisions of local law (OECD 2000: 19). It was, potentially, a good example of neo-liberal government in practice. The question of this particular exemption from the guidelines, however, was not considered an issue, in public at least, either in London or Washington DC.[15]

Why then should this Committee, prompted by NGOs campaigning against the pipeline, take such particular interest in these cracks, and the specific issue of pipeline coating material, rather than the working conditions of Georgian pipeline workers or the partial exemption of BTC from the terms of Georgian labour law, for example? Why was the politics of an 'informed material' considered more significant that the politics of class? (Gibson-Graham 2006). If politics, as Rancière suggests, involves making objects and problems visible, why were the failures of material objects rather than the working conditions of labourers rendered visible to the committee? (Rancière 2004b: 226). **Why should defects in materials rather than defects in labour relations, pay and working conditions stand in for wider problems between business and the UK government or, more generally, between state and capital? Why, in this case, did the properties of materials come to have such political significance?** (Barry 2001: 215)

An answer to these questions is complex. For if metallurgy is a form of field research which needs to address the specificity of the case, the same is true of field research concerned with the study of politics. An analysis of this event would involve consideration, for example, of the critical historical role of the Green movement in both Soviet and post-Soviet Georgian politics.[16] It would involve examination of the particular timing of the failure of the coating material which occurred just before the decision of the ECGD to support the development of the pipeline. It would involve an analysis of how the question of the reputation of oil corporations has become a focus for both management and political action, particularly following public criticism of Shell concerning the disposal of the Brent Spar oil platform in 1995 (Power 2007: 128-129). Crucially, it would involve an assessment of the preoccupation with formal procedures of accountability and transparency in political and economic life (Power 1997, West and Sanders 2003, Best 2005). In these circumstances, **the production of information about materials, as much as the production of information about labour relations or human rights, can in principle become a public political matter.**

The salience of the politics of materials rather than the politics of labour in the House of Commons also turns partly on the legitimacy of particular sources of evidence. After all, the failure of the coating material could not be denied, for everyone, including BP, accepted that it had happened. Long sections of pipeline had to be repaired as a consequence of the failure of the coating material. Once acknowledged, this could not be simply explained away by any suggestion that the failure of the coating material was conjured up by the opponents of the oil company or the government for political or financial gain. Unlike the material demands by pipeline workers that they should work shorter hours and be paid at higher rates, claims concerning the existence of cracks could not so easily be accused of being self-interested or, indeed, even 'politically motivated'. In comparison to the protests of the pipeline workers, the materiality of cracks in the pipeline coating material was less clearly entangled in the complexities of Georgian politics in the aftermath of the Rose Revolution.[17] And unlike the demands of Georgian workers, which were mediated by local lawyers and trade union representatives who did not speak English, the existence of cracks was mediated directly in London through the work of well-funded international NGOs.[18]

In what follows, however, I focus more narrowly on the question of the presentation of evidence in the House of Commons. After all, the potential significance of evidence depends on the setting in which the evidence is presented and the audience to whom it is presented (Shapin and Schaffer 1985). In representing evidence of the failure of pipeline coating material in the House of Commons, radical NGOs sought to effect a radical translation in its significance. Evidence of the existence of material failure mattered in the House of Commons not primarily because it involved information about materials, and their local conditions of existence in use, but because of NGOs' sense of the materiality of this information in relation to the behaviour of the government and the multinational. Critics expected that evidence presented in the House of Commons would have a quasi-legal effect, demonstrating the guilt of the multinational and its supporters in government in a public forum. In this setting, the particular was of little interest in terms of its particularity, but in terms of how far it could be seen as a manifestation of the wider forms of complicity between corporate business and government. It provided the basis for an empirical critique of the capitalist state one might say, pointing to the existence of a network of relations between officials and businessmen that otherwise would be unacknowledged.[19] But how was it possible to translate knowledge of the behaviour of informed materials in a specific locality, of no obvious significance to a group of parliamentarians, into information which was of material importance to the recommendations of a select committee? How could one translate a (technical) 'fact' about the failure of materials in the field into a (quasi-legal) 'fact' which would matter to the deliberations of a select committee and demonstrate the guilt of the government and the multinational? (Latour 2004)[20] Critical to the NGOs' case before the select committee was the testimony of a metallurgist concerning the period prior to the start of pipeline construction of the pipeline in 2003. This testimony was expected to acquire political agency once presented in the House of Commons.

In November 2003, shortly after the Rose Revolution in Georgia that led to the end of the government of Eduard Shevardnadze, cracks in the material that covered the connections between separate sections of pipe emerged during the construction. The BTC company claimed that the cause of the fault was that the field joint coating covering the connections had been mis-applied as the temperature dropped in November, but that following further investigations and tests the problem had been rectified. Despite the previous existence of cracks in the coating material, the pipeline could be buried safely. The metallurgist, himself a consultant who had offered his services to BP, the major oil company involved in the BTC project, was incensed that the company had previously failed to think through the relations between their actions in selecting this particular coating material for the oil pipeline, and the behaviour of the pipeline in the field. The metallurgist explained to the parliamentarians:

> Metallurgist [reading from a report commissioned by BP concerning the field joint coating material] – *"...The coating may or may not be damaged in cold weather, but it will certainly not suffer the same damage from soil stressing as the alternatives available"*

> I cannot believe the crassness of these statements. They are saying that they did not know if the joint coating would be damaged, or not, during backfilling – absolutely astounding! But then of course they could always find out "on the job", another example of the "guinea pig" engineering culture.
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> Then they say definitively that it will not suffer soil stressing as badly as alternatives – when they did not test any of these alternatives. This is the judgement of the crystal ball! It is certainly not an engineering judgement. The fact is that had the joint been coated with a mimic three layer system employing injection moulded PE top coat, the field joint would actually have had a superior soil stressing resistance....
>
> Little or no reference is made in the WP [ie the BP] report with regard to in-ground performance of the epoxy yet this is fundamental to the coatings ability to protect the pipe in the long term.
>
> Oil and gas pipelines are not passive, inert items, they are *live, dynamic structures* that move due to ground movement and most importantly, pressure changes within the pipe...The coating has to accommodate such movement. The operating temperature will fluctuate with pressure changes and should the pipeline be shut down for any time, the pipe temperature will drop down to the in-ground ambient – estimated by BP to be -5^0 to $+50^0$ C...How will this affect the performance of the coating particularly at the PE/epoxy interface...? This question has been discussed throughout the whole pipeline industry and I am yet to hear any individual say – "it will be OK, the system is fully proven" (my emphasis)[21]

The metallurgist argued, furthermore, that the modified epoxy coating had been inadequately tested, that the specification for the coating was inadequate, documentation unsatisfactory, and that tried and tested alternatives were not properly considered. In short, using SPC2888 involved a considerable and unnecessary risk: "if you have something that does the job and these other systems have been extensively applied and [have] a working history why change and in particular to use this very important pipeline as a proving ground for an experiment with a new coating system" (Mortimore 2004: 7). Earlier he had warned BP, "have you considered the insurance implications of this?" (Mortimore 2002). For the NGOs and a journalist, the defects in SPC2888 embodied defects in BP itself and its relations with ECGD and the lenders group consultants who ECGD relied upon in their exercise of due diligence. These consultants, according to the journalist were, in effect, told by the lenders to rely on the integrity of BP in providing them with accurate information. This was a scandal: due diligence assumed that the company could be trusted even when there were those who were able to provide evidence to show why it should not be. The failure to investigate defects in coating material reflected wider defects in the activities of multinationals, banks and government, and their all too intimate relations:

> "This statement [that the Lenders group did not want the problem examined further] provides an extraordinary insight into the approach taken by the Lenders group [including the ECGD] after its much vaunted due diligence procedures were exposed by the *Sunday Times*. They went on to limit the investigation of the field joint coating issue to a simple desktop study..." (Gillard 2004: 4-5)

But if the metallurgist's willingness to speak openly about his concerns with BP provided the opportunity for radical NGOs to demonstrate the complicity of multinationals and government, his extraordinary statement to the House of Commons points to a very different kind of politics, and a different form of expertise, to that of the NGO critics. If politics partly revolves around the question of how the particular is figured as an instance of interest to a collective, then the metallurgist's political concerns, and his understanding of the relation between the particular and the general, are quite distinct. For although the metallurgist spoke of cracks in coating materials, he viewed these as an index of a 'guinea pig engineering culture' that failed to attend to the liveliness of materials rather than as a sign of political complicity. Nor would he imply a link, for example, between the oil company's poor quality control procedures and the association of its activities with human rights abuse by the Turkish police, evidenced by the case of Ferhat Kaya. For NGO critics of the multinational, the torture of the Ferhat Kaya and the failure of the coating material, along with a whole series of other specific events and incidents were all considered signs of the state of relations between government and the oil business.

Although the metallurgist gave evidence, he also gave his evidence with passion and anger. In so doing, he gave up the pretence that his evidence was, as the evidence of a scientist might be expected to be, dispassionate (Bennington 1994: 135). His anger derived partly about how badly particular elements - this steel, this soil, this coating material, the skills of these subcontractors, the winter climate of Georgia, and so on - had been assembled together. And he detailed the reasons why this occurred, with the specificity of this case which had so many surprising wider consequences. **Metallurgy here stands as an example of an itinerant and artisanal practice which, potentially at least, addresses the impossibility of fully governing the behaviour of materials; taking proper notice of their differential resistance.** The metallurgist was not surprised by the failure of materials, because materials are not the dead inert substances they are sometimes imagined to be. Nor was he disinterested and unaffected. The intensity of the metallurgist's anger, expressed in Parliament, stemmed from his belief that the oil company had put such a badly formed assemblage together. It had tried something out without having properly checked to see if it was going to work.[22] The metallurgist entered into the unfamiliar terrain of public politics not because it was in his interests to do so (it almost certainly was not, and he claimed to have become ill as a result of his intervention), nor because of his anti-corporate politics (there is no reason to suppose that he had these). **His preoccupation was with the irreducibility of the properties of metals and a defence of the autonomy of his modest expertise of the behaviour of an informed material.** His was a more-than-human politics (Whatmore 2006).

The significance of the metallurgist's testimony was judged in a public setting: the select committee (cf Lynch 1998, Schaffer 2005). Within the UK parliament, select committees

have a particular significance. As in the US congress, a select committee is a group of politicians, selected from all parties, who interrogate the conduct of government and the development and implementation of legislation in public. A parliamentary committee is not a court of a law for its recommendations do not carry the force of law. Nor is it community of experts for, although a select committee may seek expert advice and is likely to have its own expert advisor, it does not claim any expertise itself. Yet, like a court of law, a select committee is expected to function as a space where matters of fact can be established and judgements can be made on the basis of the evidence presented before it (cf Latour 2004). Moreover, on account of the authority of parliament, it is able to request evidence and witnesses who may not be available otherwise and who, with exceptions, are required to give evidence in public. However, unlike the main chamber of the House of Commons, its final recommendations are expected, in general, to reflect the views of all of its members, and not just the views of the governing party or the statistical majority of the members of Parliament (Waldron 1999: 127). In this way, a select committee is potentially in the position to claim that its views are both based on consideration of evidence and, at the same time, to be able to articulate, in principle, a non-party political agreement based on this consideration. Perhaps more than any other parliamentary institution, parliamentary committees claim to be able to act as 'modest (political) witnesses': ladies and gentlemen who confront evidence with disinterest (Shapin and Schaffer 1985, Latour and Weibel 2005) and yet who also represent the public interest. In effect they are thought to perform a function, regarded as essential in the institution of British parliamentary democracy, that it is possible to reach an agreement, not through consensus, and despite underlying disagreement, given the existence of an appropriate institutional mechanism and the prevalence of a certain form of ethical conduct in political life. At the same time, they were concerned to judge not just the veracity of the metallurgist's statement, but whether it was a matter of public concern. Should the failure in materials be an index of a wider failure in the relations between business and government? Should it even become an event which inaugurated a transformation in these relations?

Despite their exhaustive preoccupation with the circumstances surrounding the failure of SPC288, the parliamentarians ultimately were unconvinced about its wider significance. After all, their concern was with the behaviour of ECGD in relation to BP, and its adherence to its 'business principles', not with the conduct of BP itself. The domain of the market economy (BP) was considered outside of the domain of politics (Barry and Slater 2005). "It was not surprising", according to the select committee, "that quality assurance problems occur during major construction projects such as the BTC pipeline. What matters is that those problems are identified and addressed" (House of Commons 2005: 12). For the parliamentarians, the ECGD and the government had done all they could reasonably do to ensure that the problem of the pipeline coating was addressed: the ECGD had taken "proportionate and consistent action" (ibid.: 13). They had done enough to investigate the properties of SPC288. As MPs they were not in a position to make a judgement about the behaviour of materials, only about the behaviour of government. And they based their judgement, in the manner of a court, not through commissioning a piece of independent field research on the situation in Georgia, but on the basis of evidence presented before them (cf Latour 2004: 101)

Nonetheless, there is no simple explanation of the parliamentarians' decision.[23] To account for the decision one would need to consider the particular composition of the committee and its relations to Government ministers, for example, and the level of trust of parliamentarians in BP in comparison to other UK companies. And one would need to examine the work of other metallurgists commissioned by both BP and the ECGD and the evidence they provided. The metallurgist's evidence was, after all, but one of a number of published and unpublished reports of the performance of the pipeline that circulated between Georgia and BP and government offices in Baku and London (cf Bridge and Wood 2005). There is moreover the question of whether a scientist, who expressed his views with such anger, was trusted by those who listened to his testimony. But in my reading, part of the reason why the evidence of the metallurgist was not thought to be a matter of wider concern is the way in which his intervention was read too politically by both politicians and NGOs. In effect, he was viewed as an agent or an instrument of an explicitly political campaign against the government and the oil company. In this way, his concern with the specificity of materials, and the particular location and manner of their use, was understood too readily within a given political context. His micropolitics, which relied on his own understanding of the dynamic behaviour of informed materials, was over-interpreted in macro or molar political terms (cf Deleuze and Guattari 1987: 216, Barry and Thrift 2007: 514). In this situation, the failure of materials and the metallurgist's evidence concerning this failure could not be made to matter beyond the confines of Parliament.

Conclusions

Radical critics of capitalism have often developed their arguments either through an analysis of capitalism's systemic features and/or by making visible, through specific cases, the forms of human misery, inequality and exploitation that are associated with capitalism's development. General analyses of capitalism's systemic features have framed particular accounts, and specific examples have been taken as indices of systemic problems. In the case discussed here, the failure of material structures was taken by radical critics as a sign of wider defects in the relations between government and business. This was a critical strategy grounded in a form of legal empiricism.

Yet if the behaviour of materials is sometimes taken to be an index of wider social relations, there is nothing naturally political about metals or other materials, or how they are shaped. If one common feature of political life is that specific issues or problems are made (for a time and in particular settings) into matters of collective or 'universal' significance (Zizek 2004: 70, Runciman 2006), and thereby become political, then there is no necessary reason why the behaviour or properties of specific materials should be considered a political matter. To be sure, forms of critical analysis both help them to become so, yet such critical analysis can also interpret the political significance of materials in reductive ways (Mitchell 2002: 52). It is not inevitable that the behaviour of materials should be of interest to others, or be the object of disagreement across a range of sites and settings within which political matters are addressed, whether in public or not. Materials acquire more-than-local political agency only occasionally, not in general.

The political importance of metals and metallurgy arises therefore in particular circumstances and sites. In this case, it depended on the coincidental timing of a stage in a decision-making process, (whether or not to provide financial support for the construction of a pipeline) with a material event (the emergence of cracks in pipeline coating material). It depended on the behaviour of metals and liquid epoxy coating materials when applied in freezing conditions. It depended on the progressive formation of London as a centre of expertise and political debate concerning the question of corporate social responsibility in recent years. It depended on the preoccupation with formal processes of accountability, transparency and reputation in contemporary political and economic life, which made it possible for both an oil company and a government department to be accused of failing to be transparent, and for this to be considered potentially a matter of public political interest. And it depended on the existence of a parliamentary political assembly which, for a period, became interested to hear evidence of the complicity between government and business.

In these circumstances, the analysis of political events needs to attend to the timing and spacing of political life, the moment and setting of politics, as well as the specificity of its techniques, institutions, forms of evidence and speech. But it should also address **the ways in which the behaviour of metals and other materials plays a critical part in politics.** Metals are not the inert objects they are sometimes imagined to be, merely shaped by social and economic forces. They are elements of lively dynamic assemblages which may act in unanticipated ways, serving as the catalyst for political events. **Metallurgists are well aware of the difficulty of applying the general principles of physics and chemistry to particular cases, and of the need to recognise the unpredictability of material processes and the fragility of materials.** Metallurgy is a form of artisanal and itinerant practice that needs to attend to the specificity of the case. These lessons are also relevant to those concerned with the study of politics.

References

Abashidze, B (2003) *Baku-Tbilisi-Ceyhan: the legal analysis of the Host Government Agreement*, Tbilisi: Georgian Young Lawyers Association

Anderson, B (2006) 'Becoming and being hopeful: towards a theory of affect', *Environment and Planning D*, **24**(5): 733-752

Bakuceyhan campaign (2004b) Statement of Ferhat Kaya regarding arrest and ill-treatment following work on BTC pipeline, http://www.bakuceyhan.org.uk/ferhat_statement.htm

Barry, A (2001) *Political Machines: Governing a Technological Society*, London: Athlone

Barry, A (2002) 'The anti-political economy', *Economy and Society*, 31, 2, 268-284

Barry, A (2005) 'Pharmaceutical Matters: the invention of informed materials', *Theory, Culture and Society*, 22, 1, 51-69

Barry, A (2006) 'Technological Zones', *European Journal of Social Theory*, 9, 2, 239-253

Barry, A and D Slater (eds) (2005) *The Technological Economy*, London: Routledge

Barry A and N Thrift (2007) 'Gabriel Tarde: imitation, invention and economy', *Economy and Society*, 36, 4, 509-25
Barry, A, G Born and G Weszkalnys (2008) 'Logics of Interdisciplinarity', *Economy and Society*, 37, 1, 20-49
Bennington, G (1994) *Legislations: the politics of deconstruction*, London: Verso
Bernal JD (1969), *Science in History volume 3: the Natural Sciences in our Time*, Harmondsworth: Penguin
Bensaude-Vincent, B and I Stengers (1996), *The History of Chemistry*, Cambridge, MA: Harvard University Press
Best, J (2005) *The Limits of Transparency: ambiguity and the history of international finance*, Ithaca: Cornell University Press
Bowden, TP and D Tabor (2001) *The Friction and Lubrication of Solids*, Oxford: Oxford University Press
Bridge, G and A Wood (2005) 'Geographies of Knowledge, Practices of Globalization: Learning from the Oil Exploration and Production Industry', *Area*, 37, 2, 199-208
Callon, M and B Latour (1981) 'Unscrewing the big Leviathan: how actors macrostructure reality and how scientists help them do so', in K Knorr-Cetina and A Cicourel (eds) *Advances in Social Theory and Methodology*, London: Routledge and Kegan Paul
Croissant, M and B Aras (eds) (1999) *Oil and Geopolitics in the Caspian Sea Region*, London: Praeger
Deleuze, G (1979) 'Metal, metallurgy, music, Husserl, Simondon', Vincennes, 27th February, www.webdeleuze.com
Deleuze, G and F Guattari (1987), *Thousand Plateaus: Capitalism and Schizophrenia*, London: Athlone
Dewsbury, JD (2007) 'Unthinking subjects: Alain Badiou and the event of thought in thinking politics', *Trans Inst Br Geogr* NS 32, 443-459
Gibson-Graham, JK (2006) *A Postcapitalist Politics*, Minneapolis: Minnesota University Press
Gillard, M (2004) Written evidence to the House of Commons Trade and Industry select committee, http://www.publications.parliament.uk/pa/cm200405/cmselect/cmtrdind/374/374we07.htm
Green Alternative (2004) Complaint to IFC ombudsman, http://www.cao-ombudsman.org/html-english/documents/Tsemi2AssessmentReport_FINAL.pdf
House of Commons (2004) Trade and Industry Select Committee: Memoranda regarding ECGD support for the Baku-Tbilisi-Ceyhan pipeline project
House of Commons (2005) Implementation of ECGD's Business Principles: Government Response to the Committee's Ninth Report of Session 2004-5, HC-374-I
Jessop, B (1990) *State Theory: Putting Capitalist States in their Place*, Cambridge: Polity
Latour, B (1999) *Pandora's Hope: Essays on the Reality of Science Studies*, Cambridge, MA: Harvard University Press
Latour, B (2004) 'Scientific Facts and Legal Objectivity' in A Pottage and M Mundy (eds) *Law, Anthropology and the Constitution of the Social*, Cambridge: Cambridge University Press

Law, J (2002) *Aircraft Stories: Decentering the Object in Technoscience*, Durham, NC: Duke University Press
Livingstone, D (2003) *Putting Science in its Place: Geographies of Scientific Knowledge*, Chicago: Chicago University Press
Lynch, M (1998) 'The Discursive Production of Uncertainty: the OJ Simpson 'Dream Team' and the Sociology of Knowledge Machine, *Social Studies of Science*, **28**, 5-6, 829-868
MacKenzie, A (2002) *Transductions: Bodies and Machines at Speed*, London: Continuum
MacKenzie, D (1996) *Knowing Machines: Essays on Technical Change*, Cambridge, MA: MIT press
Marres, N (2005) *No Issue, No Publics: Democratic Deficits and the Displacement of Politics*, University of Amesterdam, PhD thesis
Marx, K (1973) *Capital, volume I*, Harmondsworth: Penguin
McGoey, L (2007) 'On the will to ignorance in bureaucracy', *Economy and Society*, **36**, 2, 212-35
Miliband, R (1973) *The State in Capitalist Society*, London: Quartet
Mitchell, T (2002) *Rule of Experts: Egypt, Techno-Politics, Modernity*, Berkeley, CA: California University Press.
Mol, A (2002) *The Body Multiple: Ontology in Medical Practice*, Durham, NC: Duke University Press
OECD (2000) The OECD guidelines for Multinational Enterprises, Paris: OECD http://www.oecd.org/dataoecd/56/36/1922428.pdf
Osborne, T (2004) 'On mediators: on intellectuals and the ideas trade in the knowledge society', *Economy and Society*, 33, 4, 430-447
Power, M (1997) *The Audit Society*, Oxford: Clarendon Press
Power, M (2007) *Organised Uncertainty: Organising a World of Risk Management*, Oxford: Oxford University Press
Rancière, J (2004a) *The Politics of Aesthetics*, London: Continuum
Rancière, J (2004b) *The Philosopher and his Poor*, Durham, NC: Duke University Press
Roux, J and T Magnin (2004), *La Condition de Fragilité: entre science des matériaux et sociologie*, St Étienne: Publications de l'Université de Saint-Étienne
Runciman, D (2006) *The Politics of Good Intentions: History, Fear and Hypocrisy in the New World Order*, Princeton: Princeton University Press
Schaffer, S (2003) 'Enlightenment Brought Down to Earth', *History of Science*, 41, 257-268
Schaffer, S (2005) 'Public Experiments' in B Latour and P Weibel (eds) *Making Things Public*, Cambridge, Mass.: MIT press
Shapin, S and S Schaffer (1985) *Leviathan and the Air Pump: Hobbes, Boyle and the Experimental Life*, Princeton: Princeton University Press
Simondon, G (1992) 'The Genesis of the Individual' in J Crary and S Kwinter (eds) *Incorporations*, New York: Zone
Stengers, I and B Bensaude-Vincent (2003) *100 Mots pour commencer à penser les Sciences*, Paris: Les Empêcheurs de Penser en Rond
Strathern, M (1995) *The Relation : Issues in Complexity and Scale*, Cambridge : Prickly Pear Press

Tarde, G (1999) *Monadologie et Sociologie*, Paris: Les Empêcheurs de Penser en Rond
Tarde, G (2001) *Les Lois de L'Imitation*, Paris: Les Empêcheurs de Penser en Rond
Thrift, N (2008) *Non-Representational Theory: Space, Politics, Affect*, London: Routledge
Waldron, J (1999) *The Dignity of Legislation*, Cambridge: Cambridge University Press
West, H and T Sanders (eds) (2003) *Transparency and Conspiracy: Ethnographies of Suspicion in the New World Order*, Durham, NC: Duke University Press
Whatmore, S (2006) 'Materialist returns: practicing cultural geography in and for a more-than-human world', *Cultural Geographies*, 13, 600-609
Wheatley, J (2005) *Georgia from National Awakening to Rose Revolution: delayed Transition in Post-Soviet Politics*, Aldershot: Ashgate
Whitehead, AN (1985) *Science and the Modern World*, London: Free Association Books
Zizek, S (2004) 'Afterword' to Rancière (2004a)

[1] On the constitution of non-human entities as political issues see Barry 2001, Marres 2005
[2] In this respect, this chapter follows others which argue for the need to over-turn the conventional hierarchy of the disciplines which places 'fundamental' sciences (physics, molecular biology and the neurosciences) at the top of the hierarchy, and less fundamental disciplines, including chemistry, agronomy, metallurgy, physical geography and social anthropology further down (Schaffer 2003, Stengers and Bensaude-Vincent 2003, Barry 2005).
[3] In the chapter I leave aside the question of how the relation between metallurgy and the broader field of materials science is conceived by actors. Metallurgy, along with materials science more broadly, is in any case an interdisciplinary field which incorporates elements of chemistry, physics, crystallography and, indeed, management theory (see note 3). On the broader question of the interdisciplinarity of disciplines see Barry, Born and Weszkalnys 2008.
[4] Whitehead uses the example of the mountain to explain endurance as a process of transformation: "The mountain endures. But when after ages it is worn away, it has gone", Whitehead 1985: 107
[5] 'In industry, it is rarer to see a "materials department", rather technical departments will now tend to be identified by the product - or in the aerospace sector as the "system" or "platform". An aeroengine is a system in this sense, and the technical team will involve materials scientists alongside aerodynamicists, structural engineers, electrical engineers, designers, etc. [In] university research, we are moving slowly to this systems approach, or "interdisciplinary" research as it is more normally called in the academic sector. Many of the modern challenges in materials are not solely about "new" materials, but rather materials integration into systems with specified overall function.' P Grant, pers communication, 2007.
[6] David Runciman provides an elegant analysis of the constitution of 9/11 as an event of world historical importance (Runciman 2006).
[7] The constitution of an occasion or an accident as an event depends, of course, on its mediation by others (cf Barry 2002, Dewsbury 2007).
[8] This question is posed by Timothy Mitchell, "[An analysis of human agency] means acknowledging something of the unresolvable tension, the inseparable mixture, the impossible multiplicity, out of which intention and agency must emerge. It means acknowledging that human agency, like capital, is a technical body, is something made" (Mitchell 2002: 53).
[9] ECGD provided up to $150 million cover for the project, House of Commons 2005: 9
[10] This chapter draws on research for an ESRC funded project on 'Social and Human Rights Impact on the Governance of Technology' (2004-5). The research involved including with officials of the World Bank, the UK government and the European Bank Reconstruction and Development and four periods of

fieldwork in Turkey, Azerbaijan and Georgia in 2004. On the geopolitics of oil development in the Caspian region in the immediate post-Soviet period see Croissant and Aras 1999 and Ebel and Menon 1999.

[11] Cornerhouse describes itself as a group which aims to support democratic and community movements for environmental and social justice through research and advocacy. Its approach is based on evidence: "we try to take a "bottom-up" approach, filled with examples, to issues of global significance which are often handled in a more abstract way", www.thecornerhouse.org.uk

[12] Rumsfeld Intervention Rescues $3bn BP pipeline, *Independent*, 9th August 2004

[13] On the question of the relation between expectation and affect see Anderson 2006.

[14] Fieldnotes, April 2004

[15] International and national NGOs did, however, raise a series of other issues concerning the terms of the Host Government Agreement. However, the Georgian NGO which scrutinized the text of the agreement worked with a Georgian translation of the text and appeared not to have noticed this particular exemption of the pipeline from the terms of Georgian law (Abashidze 2003). Although the construction of the BTC pipeline was subject to unprecedented levels of monitoring and thousands of pages of documentation were published about the environmental and social impact about the pipeline, there is very limited public information about workers' wages and conditions. By contrast, the level of detail available to Marx through the reports of the Inspectors of Factories in the mid-19th century is considerable (Marx 1973)

[16] The Georgian Green Movement had been founded as early as 1988 (Wheatley 2005: 48). One of its first leaders, Zurab Zhvania, was Prime Minister (2004-5) in the Saakashvili government. In comparison to Georgia, political interest in environmental issues is undeveloped in neighbouring countries including Azerbaijan and Turkey.

[17] For example, it was rumoured that the workers' protest was instigated by politicians opposed to Saakashvili. Whether this was true or not, cracks in materials could not so easily have been accused of being so politically motivated.

[18] On the role of mediators see Osborne 2004.

[19] In this respect the strategy of the NGOs bares comparison with the empirical critique of the capitalist state provided by Ralph Miliband who pointed to the existence of specific networks of relations between government and business: "the world of administration and the world of large-scale enterprise are now increasingly linked in terms of an almost interchanging personnel" (Miliband 1973: 112). Miliband was famously criticized by Poulantzas for his narrowly empirical focus on human agents, which failed to account for the structural conditions of state action (Jessop 1990: 250).

[20] As Bruno Latour notes the word 'fact' means something quite different in science and the law; "rather than confuse the two, we should sharpen the contrast: when it is said that the facts are there, or that they are stubborn, that phrase does not have the same meaning in science as it does in law, where, however stubborn the facts are, they will never have any real hold on the case as such, whose solidity depends on the rules of law that are applicable to the case" (Latour 2004: 89). While the operation of a select committee has some similarities to a court of law it is a distinct form of political assembly, the characteristics of which have yet to be investigated.

[21] *House of Commons Trade and Industry select committee*, ninth report 2004-5, written evidence, p.60

[22] The work of the metallurgist is an indicator of the complex geography of knowledge production in the oil industry which relies on the production of a whole series of different forms of knowledge, which may be more or less attuned to the existence of local specificities (Bridge and Wood 2005: 206).

[23] For an extended account of the complexity of the idea of 'decision' see Law 2002: 143-162.