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Dear Editors,

Please find my submission for geoforum 'Seeing the Copperbelt; Colonial power and the legibility of nature in Northern Rhodesia' attached.

This article contains original research which has not been published elsewhere, and, if accepted, it will not be published elsewhere including electronically in the same form, in English or in any other language, without the written consent of the copyright-holder. The research presented comes from my PhD theses which is under embargo until 2015.

The manuscript in 9662 words long, including footnotes. The text itself is 8771 words long, with archival referencing in the footnotes taking up 891 words.

In the interests of transparency, I would like to note at this stage that the research in this article comes from my PhD which was supervised by Gavin Bridge and that in my current post-doctoral fellowship I am being supervised by Scott Prudham.

Warm regards,
Tomas Frederiksen

Toronto, April 2011

Abstract

This article explores the relationship between colonial science and the extension of colonial power. It does this by examining the rise of the Zambian Copperbelt in the 1930s. This rise rested in part on a prospecting operation perhaps unparalleled in size and scope in the world at the time. Bringing new and modern prospecting techniques to the area which enabled the Northern Rhodesian subsurface to be 'seen' in new ways. Two prospecting operations are explored in detail: (1) the first large concession floated as the Rhodesian Congo Border Concession (RCBC) and (2) the first attempt to use geological science to generate a complete geological map of mineral resources on the Copperbelt on the Nkana Concession. Through examining the efforts of these two prospecting operations, the methodological, theoretical and epistemic challenges of producing a viable mineral investment and practicing science in the periphery are examined. The final section then examines the imbrications of knowledge production and economic and political goals in the late colonial period, arguing that disconnects between the logics and goals of science and those of capitalist extraction meant that the linkages between knowledge production and colonial power were problematic and often tenuous.

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1. Introduction

In 1926 Northern Rhodesia[1] stood on the cusp of what the government described as “one of the

[1] The colonial name for Zambia

greatest mineral developments ever experienced"[2]. Within a few years the Nchanga, Nkana, Roan Antelope and Mufulira mines of Northern Rhodesian Copperbelt would sweep onto the world investment stage in a shower of publicity. The mining press lauded this rich new mining field in the African interior. Between 1930 and 1964 Northern Rhodesia was transformed from a colonial 'backwater' into one of the world's largest exporters of copper (Parpart, 1983). As one journalist noted in the early days of this sea change:

> *"In no other area of the world has there been, during the present century, such a transformation of social values, such a development of commerce and industry and transportation, or such an intensive application of scientific knowledge to so large a region previously so primitive and so little known"* (Letcher, 1932, p. 15)

Only a few years before, the future had looked bleak. In contrast the success of mines in Kantanga, Congo just a few dozen miles to the north, the challenges of mining in Northern Rhodesia had earned it a reputation as the graveyard of mines, not their birthplace. A sparsely populated land-locked country with few resources and little investment had poor prospects in a policy climate which demanded that the colonies pay their way. It was a dramatic turnaround.

This dramatic rise was no mean feat. It rested in part on a prospecting operation perhaps unparalleled in size and scope in the world at the time. Capital poured into Northern Rhodesia as prospectors walked millions of miles and deployed a range of expensive and cutting-edge technologies to uncover one of "the world's great subterranean storehouses of wealth" (Rhodesian Mining Journal, 1932, p. 457). Bringing new and modern prospecting techniques to the area which enabled the Northern Rhodesian subsurface to be 'seen' in new ways, these

[2] National Archives of Zambia, Lusaka (henceforth, NAZ) RC 1375 Mining and geology, General review mines department staff and work 1932 p.2

operations revealed copper sulphide ores which had been "masked by deceptively poor-looking outcrops" (Wilson, 1992, p. 132). This paper explores this process of prospecting on the Northern Rhodesian Copperbelt as an extension of colonial power. Two prospecting operations are explored in detail: (1) the first large concession floated as the Rhodesian Congo Border Concession (RCBC) and (2) the first attempt to use geological science to generate a complete geological map of mineral resources on the Copperbelt on the Nkana Concession. Through examining the efforts of these two prospecting operations, the methodological, theoretical and epistemic challenges of producing a viable mineral investment and practicing science in the periphery are examined. The final section then examines the imbrications of knowledge production and economic and political goals in the late colonial period, arguing that disconnects between the logics and goals of science and those of capitalist extraction meant that the linkages between knowledge production and colonial power were problematic and often tenuous. Before all this, the paper begins by discussing the relationships between science, geology, power and colonial natures.

2. Seeing colonial natures

The idea that knowledge generation underpins the extension of colonial power has much traction in contemporary geographical research, and for good reason. Science has underpinned the expansion of European colonial power from it's earliest days and it can be argued that ”the growth of western global domination from the renaissance to the nineteenth century was as much a scientific process as an economic and military one." (Sörlin, 2000, p. 51). Much has been written on these processes in the early colonial period. Exploration cartography, in particular, has come to be an emblematic study for exploring the linkages between knowledge production - or ‘science’ - and the extension of colonial power into new areas and relationships (Butlin, 2009; Craib, 2004; Escolar, 2003). Certain practices of colonial scientists flourished as the knowledge produced served both political and commercial aims, animating the civilising project of imperial power and transforming newly acquired territories into profitable annexes to empire (Drayton, 2000). In the case examined in this paper, inter-war Northern Rhodesia was clearly not the first extension of control by imperial agents. Rather, it represented a pivotal moment in which a remarkably sparse presence was transformed and dramatically ‘thickened’ in the space of a decade. This transformation hinged on the Northern Rhodesian subsurface becoming visible, and visible in ways which encourage investment; it required the application of new technologies of understanding and appraisal - technologies which rested, in part, on the claims to authority which science could produce. This section explores the ways in which the activities of scientists work to enable the extension of colonial power relations into new natures.

In producing a systematic and understandable totality from colonial natures which would be of use to commercial and governmental actors, abstraction, simplification and ordering was required. Through the production of scientific appraisals, an understandable and legible environment was produced as "nature is made to appear within a space of order and organization and … made available for calculation and commodification" (Gregory, 2001, p. 93). These appraisals worked to render natural resources visible, legible and – through the imposition of 'scientific order' – calculable (able to be represented in numerically quantifiable ways which could then be used in calculations), enabling nature to be understood and represented in ways which encourage and support investment (Demeritt, 2001; Gregory, 2001; Scott, 1998). James Scott describes the process of simplifying complex realities, such as the colonial natural environment, as rendering 'legible' (Scott, 1998). Rendering legible classifies and orders the complexity and chaos of the natural environment into a 'rationalised, standardised and administratively more convenient format' (Scott, 1998, p. 3). Through the knowledge produced by European scientists, colonial nature was simplified to produce both natural order and disordered nature: 'desirable' and 'undesirable' natures, 'normal' trends and processes and aberrations, and accentuate that which was important and that which could be safely ignored (Gregory, 2001; Scott, 1998). This rendering legible is a central process in the conversion of nature from biophysical environment to an object of human action, of producing nature. Foreign unruly natures might be tamed to the path of development and their resources unlocked. Scientific descriptions, charts and formulae offered an appearance of secure understanding upon which to intervene, invest and re-order social and environmental relations (Stafford, 1990). The activities and knowledges of European scientists actively conjured a space which could be known and thus acted upon confidently.

At the heart of this lay scientist’s claimed ability to establish ‘universal’ truths. This claim to authority stems from producing a placeless ‘view from nowhere’, understandings which are ‘objectively true’ everywhere, and transcend the location in which they were originally produced (Naylor, 2005).

> *“Scientific data are judged to be valid to the extent that they can travel beyond the limits of the laboratory or the exotic site, be reproduced elsewhere, and collated with other precise and calibrated data produced by other instruments in similar indoor or outdoor conditions.” (Bourguet et al., 2002, p. 3)*

Making science and knowledge travel was a challenging and problematic endeavour which relied upon multiple repeating practices of “standardization, calibration and reproduction” to produce abstract and mobile forms of knowledge (Powell, 2007a, p. 321). Producing simultaneously universal and mobile knowledge claims was a complex endeavour and subject to ruptures as nature did not move easily into the logics of science (Powell, 2007b). In the case of Northern Rhodesian mining, the production of geological maps and new visual registers of ore and mineral content based on numbers representing chemical properties and contents (rather than visual ones based on ore colour) was an on-going struggle to produce precise and replicable findings which could be compared internationally.

Geology itself was advantageously placed at the intersection of commercial and governmental interests in the colonial period, particularly in a territory where mining was at the heart of the ambitions of the colonial state as was the case in Northern Rhodesia (Stafford, 1990; Zeller, 2000). The exploratory nature of geological science performed multiple functions in extending claims to space and enabling the development of extractive commercial relations. Stafford argues that "geological maps symbolised regularity and improvement: they graphically charted the European conquest of the peripheral wilderness" extending the dominion of colonial power (Stafford, 1990, pages 73-4). In symbolically taming the wilderness of the African interior and revealing them ‘in truth’, scientific maps of the Northern Rhodesian subsurface produced a stable and detailed understanding upon which plans for manipulating the newly visible natures could be made. Geological science appraised nature in ways which held commercial significance. The geological maps drawn up in the nineteenth century not only charted the potential contours of strata and geological formations; they charted the probability of the occurrence of specific potential mineral deposits, deposits which held economic value. As Bruce Braun argues, geological knowledge linked nature with distant investment markets as the "geological language of probability speaks in the tongue of an economic and political language of possibility" (2000, p. 25). Through the work of prospectors and geologists, the Northern Rhodesian subsurface was produced as a 'resource' and made amenable to specific forms of analysis and understanding. Difference was produced. Gone was the homogeneity of the flat, gently undulating plateau of the Copperbelt, rendered into sight is its 'inner architecture', its distinct strata, layers, contours, ruptures, continuities, folds, faults, varying mineral properties, and with this, its potential economic value (Braun, 2000; Gregory, 2001). The concentration of minerals within an ore could be calculated and then weighed against the costs of extraction and transport and the current (and future) market value of the mineral. Through the practices of economic geology, elements of nature were able to move into the logics of capital as a commodities which could be priced and exchanged on global markets (Castree, 2003).

The process of producing 'scientific' knowledge was not always straightforward. There were good reasons why three decades of prospecting had not rendered the 'inner architecture' of the Northern Rhodesian Copperbelt visible for all. The subsurface is, by its very nature, hidden from view. Viewing it therefore, required effort and extrapolation. Generating this knowledge with the degree of accuracy and certainty required for large-scale investment in a remote tropical ‘backwater’ was a challenge. As the RCBC and other prospecting groups took over rights to explore the subsurface of vast swathes of Northern Rhodesia they took on these challenges. The following section investigates the early years of the RCBC operation exploring the challenges they overcame to produce the forms of knowledge that enabled significant investment. The subsequent section explores the efforts of geologists to develop a definitive geological map around Nkana– a master key to unlocking the geological secrets of the Northern Rhodesian subsurface. In considering these two efforts, the practical and theoretical challenges of 'knowing' the Northern Rhodesian underground are engaged before examining the links between these knowledges produced and the political economic processes of colonialism (Bridge, 2007; Howitt, 2001). The picture that emerges from this investigation belies accounts that characterise the linkages between colonial science and the extension of colonial power as smooth and unproblematic.

3. The Rhodesian Congo Border Concession

When the RCBC's manager in Africa, Raymond Brooks, arrived on the Northern Rhodesian Copperbelt in early 1923, evidence of the impact of 30 years of colonial rule was scarce. The Bwana Mkubwa mine at Ndola operated only fitfully and Brooks became one of a handful of Europeans in the area (Coleman, 1971). There was one road which connected Bwana Mkubwa with Ndola, cut as much for the manager of Bwana Mkubwa to ride his motorcycle to and fro as for the transportation of ore from the troubled mine (Brooks, 1944c). Brooks began organising his operations from an office in the back of a small private home (Brooks, 1944c). He was largely unsupported by the government of the time. Brooks' request for assistance in cutting and clearing roads in the area met with a terse response: "Mr Brooks, I will base no part of our programme for the development of NR on the doubtful possibility of finding mineral deposits of importance" (Brooks, 1944a, p. 80). Few, outside of a smattering of ever-optimistic mining investors, held much hope of finding economically significant mineral resources on the Copperbelt. That same year, 1923, Northern Rhodesia's total copper output was 6,600 tons; 30 miles away across the border in Katanga, annual copper production was over 80,000 tons

(Coleman, 1971; Schmitz, 1979).

[Figure 1: Map showing extent of prospecting concessions in late 1920s [3]]

Brooks and was the beachhead of a much larger presence however. Between 1922-5 135,000 square miles of the surface of Northern Rhodesia – nearly half of the territory – came to be covered by six vast prospecting licenses; by 1940, this had increased to 203,000 square miles or some 70% of the country (See Figure 1 above) (Drysdall, 1972). These new licenses granted exclusive access to large areas of territory for a period of five years on condition of a minimum annual investment in the area (Coleman, 1971) This was a radical departure from earlier approaches that had failed to deliver a new mining industry and it was increasingly recognised that the numerous obstacles to prospecting could only be overcome by well-financed groups (Gann, 1969).[4] Such groups required extensive exclusive prospecting rights in order make substantial investment worthwhile. The first of these new concessions was floated as the 52,000 square mile Rhodesian Congo Border Concession on February 16th 1923 for £150,000 (Coleman, 1971). With this size, a working capital of at least £45,000 and with a promise of an annual investment of at least £9000 for five years, the RCBC license ushered in a new era of mineral prospecting in Northern Rhodesia (Bridge, 2007; Coleman, 1971). The effort to unlock the secrets of the Northern Rhodesian subsurface was unprecedented. Hundreds of geologists, engineers and prospectors and thousands of Africans employed between 1923-40 laboured on

[3] Adapted from: Rhodesian Anglo American Limited, 1929. Mining Developments in Northern Rhodesia; A Brief Narrative of the History, Physical, Political, and Economic Features of the Country,with Special Reference to the Mineral Industry. Radford, Cadlington, Ltd., Johannesburg, South Africa.

[4] The previous approach adopted in 1912 of allowing anyone willing to pay for a £1 license to prospect practically anywhere in the territory. The abrupt change caused significant outcry amongst those currently prospecting (NAZ B1/61/3 Part 2, Correspondence on issuing prospecting licenses BSAC 1923-4; NAZ B1/90/1 RCBC correspondence 1922-6)

one of, if not *the*, largest mineral prospecting effort of its kind for the time (Drysdall, 1972). The concessions came to total 203,000 square miles of which 156,000 square miles - 54% of the entire country - was prospected in detail. Prospectors walked over 3,000,000 miles through the Northern Rhodesian bush looking for minerals in this period (Drysdall, 1972). A new era of large-scale, modern, capital-intensive prospecting had begun in Northern Rhodesia.

Prospecting in Northern Rhodesia, prior to the arrival of RCBC was hampered by both physical and theoretical obstacles. The geology of the Northern Rhodesian Copperbelt was almost entirely unknown in comparison to the ores found across the border in Congo. Compared to its northern neighbour, prospecting for mineral deposits in Northern Rhodesia was an uphill struggle. *Firstly*, there were few outcrops. The ore was underneath laterite soils with prospectors complaining that "the country is so densely forested that prospecting is a difficult and monotonous task" (Rhodesian Anglo American Limited, 1929, p. 10). In Katanga, the ore literally stood out from the landscape "in large bare kopjes or hills standing prominently above the level of the country" which "obviously attracted attention at once" (ibid.). Ore was more difficult to see in Northern Rhodesia than its northern neighbour. *Secondly*, what outcrops there were gave little indication of richer ores below. Where, in Congo, surface outcrops contained rich mineral deposits, in Northern Rhodesia "mineral indications on the surface of copper deposits are, almost without exception, negligible" (Rhodesian Anglo American Limited, 1929, p. 12). *Thirdly*, it was assumed that the geology on the Northern Rhodesian Copperbelt matched that on the Congolese side where ore grades tailed off sharply at depth. Experimental shafts sunk beneath the water table in the Congo had demonstrated that "the tenor of the ore above water level was representative of the orebody as a whole" (Rhodesian Anglo American Limited, 1929, p. 11).

This proved to be a crucial theoretical error. In assuming, not unfairly, that the geology on the southern side of the border was largely analogous to that on the northern side, early prospectors placed themselves at a massive disadvantage. They were effectively looking for Congolese ores in Northern Rhodesia and thus overlooked deposits which did not match their view of copper ores in this region. When the search took on a different focus, and used a different register, the economic landscape of Northern Rhodesia was rapidly transformed.

For the most part, the RCBC relied on the same rudimentary methods used previously by prospectors which were only able to locate ore bodies with a surface expression. However, the RCBC brought a new scale to the enterprise and was "rigidly systematic" which meant little was overlooked (Drysdall, 1972, p. 59). The RCBC's 'systematic approach' had two facets – systematically covering the entire concession on foot looking for evidence of mineral deposits, and systematically visiting every African settlement and offering large rewards for anyone who led them to outcrops. The archive is largely silent on which was more effective.[5] As prospectors were employed – twenty in total – the first task lay in cutting a road to the concession acquired in Nkana, 35 miles away (Brooks, 1944c). Brooks then dispatched ten two-man teams, each with around 20 Africans as helpers, into the field every dry season who conducted traverses of specific areas looking for evidence of minerals such as soil and vegetation changes ('dambos' or 'copper clearings' where copper content in the soil stunted vegetation growth – particularly, large trees) and rock outcrops. These teams cut and then burned a base line through the bush and then

[5] This is not strictly true as many accounts, with the common penchant for 'the lonely prospector' myth, paint the prospecting process as one carried out by individuals with the dozens of Africans involved written from the process. However, from the geological reports from the RCBC prospecting parties that remain, the providence of the original find is not always clear. Raymond Brooks was at pains to point out the importance of African help in finding copper outcrops: Brooks, R., 1944b. Native Aid Important in Finding Rhodesian Coppers. Engineering and Mining Journal (NY) 145 (6), 83-85..

burned two parallel lines 5-7 miles either side of the original line (Rhodesian Anglo American Limited, 1929). With stations marked every quarter-mile on all these lines, traverses were conducted between corresponding stations on these strips "using a prismatic compass and a wheel equipped with a bicycle cyclometer" noting any changes in vegetation, outcrops and other geographical features such as streams, taking samples where pertinent (Brooks, 1944a, p. 83; Rhodesian Anglo American Limited, 1929). Walking around 12 miles each per day these teams could "thoroughly prospect between 85 and 100 square miles per month" (Brooks, 1944a; Rhodesian Anglo American Limited, 1929, p. 30). Rudimentary technology was paired with a structured approach to produce an unprecedented amount of information about the Copperbelt.

The innovation the RCBC brought to enlisting Africans to help find outcrops was twofold – firstly they paid a great deal more than previous prospectors, and secondly they armed Africans with geological hammers. Working on the assumption that the local peoples would have seen any interesting outcrops they showed some samples of the types of rock they were looking for and then offered £5 (the equivalent of an annual salary at the time) "for disclosure of any formation in place that showed even minor evidences of copper staining or other metal content" (Brooks, 1944b, p. 84). By contrast, previous prospectors had offered beads, Calico and blankets in exchange for such information (Bradley, 1952; Coleman, 1971; Gann, 1969). The hammers enabled Africans to collect samples of outcrops which their own tools could not. After three years of prospecting along these lines the RCBC made 141 new discoveries of (predominantly copper) ore occurrences (Brooks, 1944a).[6]

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[6] Many of these were very small deposits. Bancroft derisively commented later that samples of these 'occurrences' sometimes sampled whole thing Bancroft, J.A., 1961. Mining in Northern Rhodesia: a chronicle of mineral exploration and mining development. British South Africa Company, London..

The RCBC efforts revealed an abundance of mineral outcrops with traces of copper minerals. The prospectors had no doubt they were in 'copper country' (Brooks, 1944b). These weak mineralisations indicated that they may have been close to areas with more concentrated mineralisations – levels which may have made the ore economically attractive. Pitting, trenching and drilling were then used to explore beneath the surface. As the prospecting project demonstrated the presence of copper ores, the RCBC increased its use of modern cutting-edge technologies to locate minerals. In particular, the RCBC were the first to conduct drilling on the Northern Rhodesian Copperbelt and pioneered the use of electro-prospecting and aerial surveys for prospecting in Africa (Rhodesian Mining Journal, 1932). All of these technologies however, were rarely straightforward in their operation in the bush and often unreliable in their results.

Given the usefulness of variations in vegetation in indicating copper content in soils and thus the rocks underlying the soils, and the difficulty of travel in the region, aerial surveys were ordered to quickly assess vegetation over large areas.[7] In 1926-7 the Aircraft Operating Company photographed 12,000 square miles of the Northern Rhodesian Copperbelt to look for 'copper clearings' (Rhodesian Mining Journal, 1932; Walker, 1929).[8] This technique however, was more expensive and less effective at providing an objective view of the landscape than had been hoped. Firstly, insurance regulations required that planes flying at less than 10,000 feet should always be within 10 miles of an emergency landing ground (Bancroft, 1961). This required the

[7] Many of the earliest prospects pegged on the Copperbelt like Roan Antelope were discovered using this method.

[8] While unlikely the first surveying of its type in the world, this was pioneering use of the relatively recent technology of aerial photographic surveys which were first regularly used during the First World War (Cronin, 2007). Large aerial surveys for mineral prospecting in Northern Rhodesia predated similar efforts in Canada for example Cronin, M., 2007. Northern Visions: Aerial Surveying and the Canadian Mining Industry, 1919–1928 Technology and Culture 48 (2), 303-330..

clearing of landing strips at 20-mile intervals along the length of the area to be surveyed.[9] Clearing these strips was costly and arduous as they were liable to flood in the rainy season and cleared vegetation quickly grew back. The regular appearance (and rapid reappearance) of termite and ant hills, which were resistant to dynamite blasting, made levelling the ground for the landing strips cumbersome (Bancroft, 1961; Drysdall, 1972). The cost of this meant that the RCBC directors quickly abandoned plans to photograph the entire concessions and settled for its eastern-most portion (Brooks, 1944b). Further, the resulting pictures either revealed little – during the rainy season clouds obscured the ground and during the dry season smoke from grass fires did the same – or were too general to be of use. The clearings which were found could also be caused by swampy soils and hill slopes which both inhibited tree growth (Hunter, 1946; Walker, 1929). Further, for the copper content of the underlying rock to affect vegetation, the soils needed to be relatively thin. 95% of ores in Nchanga Mine were covered with forest and the Roan Antelope ore continued two miles beyond the clearing which had originally given prospectors clues to its presence (Walker, 1929). The leading Anglo-American geologist of the time, J. Bancroft, described their information as "misleading rather than helpful" (Bancroft, 1961, p. 86). As technology and infrastructure improved, the aerial survey came to be a regular fixture of mineral prospecting in the area (Garlick, 1953-4). At this early stage, however, it was of limited use.

Perhaps the most significant technology the RCBC brought to bear on the Northern Rhodesian Copperbelt which had not been used previously, was drilling. As surface outcrops were an unreliable guide to what lay beneath, 'seeing' the subsurface was very important. This inability to

[9] These strips were not an excessive precaution – the survey experienced two 'forced landings' in its early operations: Walker, G., 1929. Surveying From the Air in Central Africa. Engineering and Mining Journal (NY) 127 (2), 49-52..

trace ores at depth had proved a serious obstacle to the establishment of mining prior to the First World War. Without drilling, measuring the extent of ore bodies at depth had only been possible through digging a shaft down to the ore – an expensive and labour intensive task (but one which had been repeatedly undertaken, if only to relatively shallow depths). With drilling, directly sampling ores deep underground was possible and gave a much clearer picture of the extent of ore beds. Drilling also made it much easier to prospect below the water table which had previously proved an important physical barrier.[10]

More fundamental an obstacle however, was the belief that prospecting much below the water table was pointless anyway. Believing that the geology of the Northern Rhodesian Copperbelt would closely match that of the Congolese Copperbelt, prospectors and miners believed that all ores of worth would be found above the water table. When the Copper Venture Syndicate (CV) first took a holding in the Copperbelt, before they applied for the larger concession which was floated as the RCBC, they bought the rights to a small claim called Nkana (see Figure 1 above). This claim held some promise, with evidence of African copper mining, malachite outcrops, and some development shafts with ores assaying at 3-6% copper that had been intermittently developed for a number of years.[11] When CV took over the property, a total of 22 prospecting pits and shafts had been dug but only four of these had attempted to go beyond the waterline (usually only by a few metres) and only one had gone deeper than 100 feet.[12] So deeply ingrained was the belief that there was little purpose in looking further, and so costly was it, that it was not attempted.

[10] NAZ A3/33/4 Northern copper company, A report by Mr Bentley 1910

[11] Archives of the London School of Economics' British Library of Economics and Political Science, London (henceforth, LSE) Selection Trust Papers G/37 Nkana Northern Rhodesia 1922

[12] LSE Selection Trust Papers G/37 Nkana Northern Rhodesia 1922

Drilling required substantial investment. While drilling overcame the liminal water table with comparative ease, substantial financial backing was required to carry out a drilling programme on the Copperbelt in this period. The equipment was expensive and drill operating a skilled task. Drilling cost around 30 shillings per foot and a team could drill approximately 300ft per month.[13] As many of the minerals which eventually came to be mined often lay over 500 feet down, this meant that drilling a single hole to 'prove' the existence of ore could take 2 months and cost hundreds of pounds. Aside from the costs of buying and operating the drill, simply moving them around on the Copperbelt was problematic. For example, moving the first drill to Nchanga (which discovered the fabled 'river lode' - the first discovery of rich copper sulphides in Northern Rhodesia) took the combined efforts of a British engineer employed specifically for the job and 128 labourers nearly a month to drag the 5-ton drill and boiler a distance of 53 miles across the Northern Rhodesian bush and the Kafue river (Brooks, 1944c).

The drill revealed two important things – the mineral content of an ore and the specific location of that ore in space. Drilling, however, is not a straightforward task and frequently proved to be a technical challenge and fallible as a way of 'knowing' the underground. Early drilling on the Northern Rhodesian Copperbelt struggled to locate samples and indicate their copper content confidently. Drilling gives the capacity to sample rock along a specific vector into the subsurface. By measuring the distance along this vector it is possible to say where the sample was originally located. However, accurately fixing the original location of the sample was not always easy. Firstly, making the drill go in a consistently straight line is difficult when the ore

[13] LSE Selection Trust Papers G/29 Report on W Selkirk's visit to Rhodesia 1926

being drilled through is not uniform. The differing angles of the beds and the transition from soft to hard ores can deflect the drill from its path, introducing uncertainty as to where in space the sample is from (Squirrell, 1953-4). Further, the drill vector could bypass subterranean ores. The drill sample is, by necessity, very thin along the vector. If the drill path fails to intersect the vein of ore, the area will be believed, potentially falsely, to contain no economically significant minerals.

The key information which drillers were looking for was the average copper content of specific section of the subsurface. The difference between 'payable' ores and those which would be abandoned could be as little as a 1% of mineral concentration so accuracy was of paramount importance. Early drilling used churn drills which, as their name suggests, grind up the ore at the drill point. Water is pumped down the hole and the ground up ore returns to the surface as a sludge. These drills, by not retrieving single-continuous rock samples failed to detect the presence of small concentrations of sulphides making them seem more diluted than they actually were (Parker and Gray, 1935-6). This happened at Chambishi where the use of a churn drill diluted the samples obscuring the presence of 35 million tons of rich ore (Parker and Gray, 1935-6). Drilling thus switched to diamond or shot drills which retrieve core samples in addition to sludge. These too faced potential problems. The core could break and/or slip down the barrel of the drill giving the impression that the core came from a different place than anticipated.[14] When the core fragmented, or much of it was lost, it was easy to then over or underestimate the mineral content of the ore. The mineralised ores were particularly prone to these problems with the core

[14] Archives of Zambia Consolidated Copper Mines – Investment Holdings, Ndola, Zambia (henceforth, ZCCM) 16/2/1e PHC 26 Notes on drill sampling

often fragmenting when the sulphide vein was reached.[15]

Drilling was on the Northern Rhodesian Copperbelt not straightforward. It proved to be a painstaking process where the drill bit inched forward four feet at a time followed by pumping water until it ran clear to make sure all the sludges had been caught and then slowly removing the core.[16] The unreliability of the drill core made the recovery and accuracy of sludges particularly important. However, sludges too were not free from error and often gave misleading results. *Firstly*, as drill holes reached depth or travelled through a fragile ore, rock and sediment from higher up the hole could cave into the drill hole diluting the sludge with sediment from a different place along the drill vector than anticipated.[17] *Secondly*, the oil used to lubricate the drill collected the copper sulphides they were seeking to measure, further changing the picture of copper content in the recovered samples.[18] *Thirdly*, if the drill path crossed a geological fault, the sludges could simply drain down the fault and never be recovered (Squirrell, 1953-4).[19] *Fourthly*, the sludges were dried in tins over open fires which if not constantly stirred could cause the copper sulphides to oxidise, tainting the sample.[20]

These challenges meant that even after 30 years of experience of drilling in the area, core recovery was often around 33% and many holes were abandoned if it was considered 'bad drilling ground' (Squirrell, 1953-4). Drilling was problematic and "exceptional precautions" had to be taken to ensure accuracy, but it remained the most reliable indicator of subsurface geology

[15] ZCCM 16/2/1e PHC 26 Notes on drill sampling
[16] ZCCM 16/2/1e PHC 26 Notes on drill sampling
[17] ZCCM 16/2/1e PHC 26 Notes on drill sampling
[18] ZCCM 16/2/1e PHC 26 Notes on drill sampling
[19] ZCCM 16/2/1e PHC 26 Notes on drill sampling
[20] ZCCM 16/2/1e PHC 26 Notes on drill sampling

(Hunter, 1946, p. 606). As individual drill samples could be unreliable, dozens were often commissioned if the area seemed promising. Even then, drilling would only trigger further development as none of the prospecting techniques used could replace sinking a development shaft. Only by comparing what was indicated by drilling and what was found when a shaft was cut could the accuracy of drill sampling be derived (Hunter, 1946). It was in the process of deep drilling that prospectors first encountered the extensive veins of copper sulphide ores which came to form the basis of future Copperbelt development. These sulphide ores, while still lower grade (3 – 4.5%) than those of the copper oxides across the border, were far more amenable to concentration and processing technologies and thus very commercially valuable. These finds sparked a flurry of interest in the region which brought new concessions, new capital and new prospectors and an ongoing prospecting effort. Adjacent concessions were snapped up by the groups already active in the region and, as opportunities for expansion receded, groups were forced to make the most of the concessions they had. It was in this vein of being unable to gain access to new ground and thus being forced to concentrate efforts on producing a definitive account of the land which could be accessed, that geological mapping of the Nkana concession was conducted.

4. Geologising the Copperbelt

In 1923, the geologist Russell Parker was dispatched to reassess the development work carried out, 20 years previous, at the Roan Antelope and Rietbok claims (Beatty, 1931). Parker was under explicit instructions to look for the possibility of sulphide ores underlying the surface oxides (Beatty, 1931). Exploring their development shafts, Parker noted that the original workers had not discerned that the width of the mineralised shales increased with depth and increased in concentration. Importantly, working from a visual register shaped by Congolese outcrops, they simply stopped digging the shaft when the green oxidised ore petered out. Parker sampled the ore at the base of the shaft and found rich copper sulphides, implying that they underlay the exposed ore (Wilson, 1992). Working on the possibility that the two parallel reefs may be a syncline (an inverted arch of ore) they began a drilling programme between the two outcrops at intervals of 1000 feet (Coleman, 1971; Wilson, 1992).[21] They quickly discovered that a wide mineralised band of ore continued at a depth of 500 feet (Wilson, 1992). This band of ore however was simply a grey shale, unremarkable in appearance and not widely recognised as copper-bearing ore. Its copper content only came to light because drill samples were routinely assayed for copper content. Parker's discovery transformed the search for copper in Northern Rhodesia. All previous prospects were now subject to deep drilling to see if the weak surface deposits hid rich sulphides.

With almost every single surface outcrop demonstrating copper content logged by the RCBC – and these outcrops numbered into the 100s – the challenge lay in deciding which of these merited further exploration. Exploration concessions were time-limited and drilling was still costly. With Parker's discovery a new approach was taken to the Nkana concession. Instead of looking for old mines and trying to see if they were worth following up, the entire Nkana concession would be subjected to geological mapping. It was assumed that the same stratigraphic series of rocks occurred all over the concession, that the same sulphide ores would be overlain and underlain by the same rocks.[22] If the inner architecture of the entire concession could be mapped, then they could divine where the mineralised ore existed but showed no surface manifestations. Geology,

[21] LSE Selection Trust Papers G/29 Report on W Selkirk's visit to Rhodesia 1926

[22] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession

and scientific geology's perceived capacity to produce universal truths, was to be brought in to develop a new view of the region's resources. In a three-year programme, Parker worked on the most comprehensive mapping of the geology of the area under the supervision of Anton Gray and TF Andrews (Parker and Gray, 1935-6).[23] However, divining the geological structure of the concession with any degree of detail was deeply problematic, even when backed with substantial resources and expertise.

The aim of the geological mapping was conclusively to prove the presence or absence of minerals through a scientific survey of 18,000 square miles by a team of trained geologists. With three years on the concession, the process was structured over three dry seasons from 1926-9: the first aimed at noting every single outcrop and surface occurrence of every single mineral, the second followed up with detailed pitting and mapping, the final with pegging claims for future exploration (Parker and Gray, 1935-6). These much-reduced claims would be then be drilled. The approach used was similar to that of the RCBC three years earlier. Using streams as baselines, Parker and his colleagues paced the concession radially from base points. As there were very few outcrops, soil and vegetation became important as indicators of the underlying rocks. Neither of these were totally reliable. The geologists struggled to establish 'rules' for which vegetation occurred on which type of rock.[24] Soils transitioned gradually around geological borders and, where slopes were involved, soils moved so as to further complicate the picture.[25] When outcrops were discovered, the geologists were frustrated by their inability to date the rocks due to the absence of fossils. Confused by the folds, faults and discontinuities of the

[23] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession
[24] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession
[25] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession

nature they were charting, they laboured to generate a comprehensive stratigraphic series which would place the ores they discovered in relation to each other physically and chronologically. As they noted the samples they found they treated them as unique specimens adopting local names 'Lufubu Schists' and 'Muva Series' which they later struggled to correlate into a single comprehensive schema covering the entire concession.[26]

After some effort, they came to develop the 'Roan Series' which documented the rocks which overlay and underlay the mineralised shales found and could then theoretically be used to trace the occurrence of the copper deposits across the concession (Parker and Gray, 1935-6).[27] However, while general zones of rock occurrences near the surface (but under soils) were known, the precise boundaries between the rocks were often unclear.[28] When the production of difference and clarity was the aim, this was something of a flaw. The final map after three years of effort is prefaced by six pages of clauses and conditions about the uncertainty of the final results. The detailed geological reports from different areas of the concession attached as appendices are riddled with further clauses and riders on the certainty of findings.[29] Of most concern was that, using mainly surface indications, they found no new deposits worth mining.

The recommendations of the report hinged upon a weakness of geological knowledge which highlighted the science's taxonomic roots: the geologists had no idea where the copper came from. This failure of theory, of being able to understand geology as a dynamic rather than purely taxonomic science, had very real economic consequences. There were two theories – the 'hot

[26] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession
[27] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession
[28] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession
[29] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession

water theory' and the 'cold water theory'.[30] The 'hot water theory' held that the copper came from fluid movement from below related to igneous intrusions after the shales were deposited. If this theory was correct then future claims should centre on the areas near known granitic rocks or, alternatively, the whole area as there may be intrusions which had no surface outcrops. The 'cold water theory' held that meteoric water had effectively washed coppers down from the surface and they had accumulated (for an unknown reason) in the shales mined at Roan Antelope.[31] If this theory was correct then the whole area should be retained as the shales could theoretically be found underlaying most of the concession.[32] Cutting-edge geological theory proved itself largely unable to confidently predict where ores may lie and therefore where to claim. Instead, what predictions were made were riddled with so many qualifiers as to give the impression that the suggestions made were simply best guesses.[33] The decision of which areas of the concession to retain was left to the directors in London.

5. Power and the view from nowhere

It is tempting to view this as a story of failure; for the RCBC, a failure of tools, for the Nkana geologists, a failure of theory. However, in indicating the occurrence of large bodies of copper sulphides on the Copperbelt and paving the way for further development, prospecting was ultimately a success. While many of the individual techniques either failed or only unreliably indicated the presence of ores falling far short of the desired definitive, objective account, a

[30] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession

[31] Subsequent research points to the copper deposits being laid at the same time as the original sediments Dixon, C.J., 1979. Atlas of Economic Mineral Deposits. Cornell University Press, Ithaca, New York..

[32] ZZCM 16/2/1e PHC 25 Geological reports and reconnaissance maps Nkana concession

[33] Though they were, ultimately, fairly accurate Coleman, F.L., 1971. The Northern Rhodesia Copperbelt, 1899-1962: technological development up to the end of the Central African Federation. Manchester University Press; Augustus M. Kelley, Manchester; Clifton, N.J..

rough picture was none the less painted which gave enough confidence to enable further investment. The resulting recommendations from the Nkana effort led to the drilling of an area near the Mufulira stream. This rapidly became the richest ore body discovered on the Copperbelt at the time. Tellingly however, the decision to drill was not taken on the basis of a single indicator, and still less on the speculations of geologists, but on the correspondence of a number of indicators. Copper deposits at a nearby spring, thin vegetation and inferences drawn from the geological mapping were all required before the decision to drill could be taken (Parker and Gray, 1935-6). The decision to drill led to the decision to sink a development shaft and then, and only then, was a full-scale mine planned. The work of the Nkana geologists, for all its flaws and hesitant conclusions was hugely influential in shaping understandings of the geology of the Northern Rhodesian Copperbelt. It remained the largest systematic effort in producing a geological map in the region for many years with the 'Roan Series' becoming a definitive register for future mapping (Hunter, 1946).

The strength in the application of scientific approaches to prospecting was not necessarily the reliability of individual techniques, but their ability to gather, organise and coordinate information. Even where theories about ore formation were woefully ill-equipped to deal with a new mineralogy in the African interior far-removed from its European roots, the scientists were able to systematise enough proximate indicators of the presence of minerals to enable further investment. Geological science's strength and weakness lay in its comparative and standardising approach. This approach meant that encountering entirely new mineralogical formations was particularly challenging and apt to yield false assumptions. The geology of the Northern Rhodesian Copperbelt was assumed to echo that of the Congolese Copperbelt, its main, and nearest, comparator. This belief led prospectors to ignore the possibility of ores below the water table which were not evident above it. However, this same comparative approach gave the scientific approach the capacity to abstract and organise large and diverse forms of information. Where the visual register of 'green ore' failed, it was replaced by a new visual register of numbers. The copper content calculated in laboratories enabled the copper to be 'seen', quantified and abstracted from the Northern Rhodesian subsurface and understood on the London Stock Exchange. The search for rules and systems, the abstraction of elements of nature into proximate comparable indicators, enabled Northern Rhodesian nature to be understood in ways which were readily legible across geographical space. The systematic approach which made extensive use of crosschecking for errors, triangulation and aimed for an ever-improving accuracy and fixity of knowledge - the same practices which strived to produce an objective ‘view from nowhere - gave rise to a stable and reliable enough picture for investments to be made. Through combining and coordinating different indicators, the geologists, engineers and prospectors of 1920s Northern Rhodesia rendered African nature, quite literally, visible in new ways and in new places. In assembling diverse and unique information points, the scientific endeavour was able to turn the Northern Rhodesian subsurface into a seemingly objective 'systematic totality', which could be assessed by investors and planned upon by managers and board members in distant London (Gregory, 2001).

In the final abstracted report and maps the process of knowledge creation and much of its inherent uncertainty was omitted. While "every geologist when he drew a line on a map contributed to it out of his imagination and presumed a certain continuity", in the final artefact these leaps of imagination are silenced (Hallimond in Parker and Gray, 1935-6, p. 338). These cognitive leaps, the widespread lack of topographical certainty in the traverses, and the uncertainty about mineral concentrations and extents were subsumed by the charts, maps and tables which scientific prospecting produced. The final product projected a coherent, ordered, stable space with a continuity of knowledge about nature – a 'systemic totality' – upon which action could be decided. Writing this uncertainty from the record, dividing the data from its origins, is central in producing the objectivity and universality of scientific knowledge (Mitchell, 2002). In asserting this objectivity, this supreme 'view from nowhere', alternate ways of knowing, upon which the scientific knowledge often depended, were obscured. Without this claim to the authority of science, the prospectors were just simply interested travellers strolling through the Northern Rhodesian bush; with it, they were agents of human progress, carving and burning the contours of the future mining industry into the Northern Rhodesian landscape.

Even as development gathered pace at a number of mines, the mining press initially dared to only obliquely describe potential riches rather than give confident figures of the ore reserves at individual mines (S. A. Engineering and Mining Journal, 1929). The geologists on the ground were well aware of the uncertainties of their knowledge and kept to the language of 'indicated' reserves. In London, however, these quickly became 'proved' reserves (McGregor, 1930). The uncertainties of knowledge production were further written from the record when presented to the investing public. At the first shareholders meeting of the newly floated Nchanga mine, for example, reserves were described as "definitely proved".[34] To counter previous hesitancy, the early 1930s saw a promotional blitz of articles on Northern Rhodesian copper fill the pages of the world's mining press. Some of these articles kept themselves to purely the technical aspects

[34] ZCCM 18/2/9b PHC/NCCM annual reports 1927, 1937-1966, Nchanga annual report 1927 p.5

of extraction. Many others however, lauded Northern Rhodesian copper hagiographically and sought to communicate the findings through narratives of past riches.[35] Chester Beatty, a key financier of a number of the mines, invited comparisons to ancient tales of mineral abundance in Africa in one article in the mining press:

> *"There is an account of over-production of copper at the time of Ramses II. Apparently the production of the copper mines of the Sinai Peninsula exceeded all expectation because they speak of the enormous quantity stored in thousands of bars at the palace. In fact, it must have looked like a yard at one of our refineries." (Beatty, 1931, p. 521)*

The analogy to the British Empire here is far from subtle. Beatty went as far as claiming that the mines of Northern Rhodesia held 20,000,000 tones of copper in its ores – 28% of the world's known copper reserves at the time (Beatty, 1931). This was clearly an exaggeration given the uncertainty of much of the information on which the claim was based. However, equally clear was that eight years of prospecting in Northern Rhodesia had uncovered enormous supplies of copper-rich ore. This selling act points to one of the tensions which has dogged the mining industry to this day - that it remains, at heart, a frequently speculative enterprise. The subsurface remains robustly opaque despite the continued application of all manner of scientific techniques to reveal the objective 'view from nowhere'. Successive decades of applying science to reduce the risks of investment have far from succeeded in removing it altogether pointing to a deeper tension between mining promoters' need to produce an attractive investment and scientists' desire to provide a precise account of the extent of knowledge and understanding (Tsing,

[35] The mining press was of uneven reliability. Some journals had exacting standards of impartiality while others were open to persuasion and often served as promotional brochures for emerging fields McCarty, J.W., 1961-2. British investment in Western Australian gold mining, 1894-1914. University Studies in History 4, 7-23..

2000).[36]

As much as scientific uncertainty was omitted from the final maps and representations the Northern Rhodesian Copperbelt, so too were Africans. The centrality of Africans to identifying, locating, and guiding Europeans to mineral outcrops is largely unmentioned, their presence in prospecting parties a footnote, their role in guiding European prospectors to outcrops commonly ignored. If they were mentioned, Africans were more likely to be portrayed as an obstacle to the production of scientific knowledge than its aides. Further, any prior claims which Africans may have had to the land and subsurface charted are ignored in these representations. Symbolic dispossession of Africans of the rights to the land had already occurred when concessions were first granted based on questionable treaties signed 30 years earlier (Faber, 1971; Krishnamurthy, 1972; Slinn, 1971). It was only further underlined in the creation of vast reams of data and maps and representations which erased African presence from the landscape. This was an empty frontier, there for the taking. If African presence in the mining areas was mentioned, it would be to underline the proximity of a ready source of labour. In the understandings of the Northern Rhodesian Copperbelt which circulated in London in the 1920s and 1930s, African labour power, as much as the mineral reserves which underlay it, was a commodity.

The necessity of mining promoters to sell the authenticity of the geological reports and cast them within larger narratives points to how the practices of science in and of themselves, however self-authorising they may be, are of little consequence without being linked to economic and political flows. If knowledge underpins the extension of colonial power, then it only ever does so

[36] I am grateful to Matt Himley for making this point

in partial and contingent ways. The knowledges produced by the vast projects of ordering and classifying nature undertaken in the colonial period not only enabled the assumption of European control in new territories, they were also used to legitimate it. The 'constructed visibility' of distant natures was central to the colonial enterprise as it projected an apparent objectivity and placed the capacity to see the 'truth' of things firmly in the realm of European scientific knowledge (Gregory, 2001; Mitchell, 1990). In seeing the 'truth' of colonial natures, authority was claimed and other knowledges were implicitly dismissed as inferior. If the best use of resources came from knowledge, and the peoples of Africa were characterised by their ignorance – the ‘profligate native’ myth - then it followed that the best use of nature came from the assumption of control by Europeans who possessed the requisite knowledge and insight. Dispossession of Africans was seen as a precondition for progress in Northern Rhodesia (Drayton, 2000). In the case of the Northern Rhodesian Copperbelt, the science of geology was instrumental in both legitimating this dispossession and unlocking the 'redemptive forces' of territory. The ‘view from nowhere’ produced by the prospecting operations on the Northern Rhodesian Copperbelt was thus an intensely political one which had very real consequences of dispossession for many Africans living on the Northern Rhodesian Copperbelt.

6. Conclusion

Revealing the extensive rich copper sulphide deposits in the north-Northern Rhodesian underground was far from straightforward. Prospectors generated unprecedented volumes of information as they walked millions of miles through the Northern Rhodesian veld. Probing the depths of the subsurface, digging many times deeper than anyone had attempted before, revealed a new world of mineral wealth which had been previously, quite literally, overlooked. All of the techniques and technologies that prospectors used to view, capture and fix Northern Rhodesian nature were, to a greater or lesser extent unreliable. Instead, it took the capacities of networks of scientists to organise, systematise, triangulate and crosscheck the different methods before a reliable picture of the Northern Rhodesian subsurface could be reached. Through the techniques and technologies of colonial scientists, the information gathered by prospectors was transformed into systematic representations of the latent economic value of aspects of Northern Rhodesian nature. These representations – charts, diagrams, maps, tables and figures – enabled a new set of calculations of the commercial potential of mining in Northern Rhodesia and triggered a new round of investment which ultimately led to the birth of the Northern Rhodesian Copperbelt. By the end of this prospecting operation, The Economist "foresaw a magnificent future for the distant north" (cited in Gann, 1969, p. 209). By the late 1920s the Copperbelt was in a headlong rush to develop new copper producing mines. Between 1927 - 1930, the labour force on the Copperbelt trebled from 10,000 to 30,000 as part of a massive construction effort building large mines across the Copperbelt (Gann, 1969).[37] By 1932, £17,000,000 had been spent on mines development and annual Northern Rhodesian copper output had reached 88,600 tons with 3,000,000 tons of raw ore being extracted from the subsurface (Berger, 1974; Hailey, 1938; Perrings, 1979). In total around £35,000,000 was spent bringing these mines to production (Hunter, 1946).

Through the endeavours of scientists in the periphery then, regimes of access to and control over the natural environment of Northern Rhodesia were changed. Through the accounts and

[37] NAZ KSN 2/1 Ndola District Notebook. This growth of urban populations is a much-studied facet of Copperbelt history with a sizeable body of work seeking to understand the apparent conundrum of 'modern' urban populations in the heart of 'traditional' rural Africa. James Ferguson's 'Expectations of Modernity' is a notable recent intervention in this debate Ferguson, J., 1999. Expectations of modernity: myths and meanings of urban life on the Zambian Copperbelt. University of California Press, Berkeley, Calif. ; London..

knowledge of these explorers, prospectors and geologists, the penetration of European capital was invited and enabled. The geological maps produced represented both the untapped wealth of the Northern Rhodesian Copperbelt but also the extension of control over these areas. As the geological maps represented the Northern Rhodesian underground, they also contained claims to what was represented. They linked political and economic objectives as they underlined the need for European intervention to release the trapped wealth. In so doing they marginalised other claims, writing any previous claims by local African peoples from the landscape. These maps linked the Northern Rhodesian subsurface with centres of political and economic coordination in London and enabled the space to be increasingly understood, managed and manipulated remotely (Allen, 2003). This was an important transformation of the relationship between the African interior and Britain. It effectively drew Northern Rhodesia, and the Northern Rhodesian subsurface, closer to the centres of finance in the City of London. This closer connection translated into increasing flows of capital and the rise of the Copperbelt as a global centre of commodity production.

For many studies of colonial science, directly state-sponsored activities are at the forefront. By the interwar period and onwards, a period of remarkable intensification of extractive industry across the colonised world, it was no longer state agents at the vanguards of scientific knowledge generation in the periphery. In sub-Saharan Africa at least, this was also the period which witnessed a growing interventionist agenda, an agenda bankrolled to no small extent by the growth of extractive industry. The growth of the mining industry produced the revenue flows upon which the Northern Rhodesian colonial state was built. The state, in turn, used its growing reach to enable the activities of the mining companies frequently through dispossessing Africans of their land and livelihoods (Berger, 1974; Parpart, 1983; Perrings, 1979). The link then, between colonial science and the extension and intensification of colonial power is far from straightforward. In the case of Northern Rhodesia, the extension of colonial presence and power rested on the activities of commercially-funded scientists. Perhaps unwittingly, the prospectors of Northern Rhodesian Copperbelt became the architects of African dispossession. The knowledges they produced were fundamentally shaped by the political and economic context in which they were forged. Their mettle and character depended on these pressures. It was arguably the very malleability of the knowledges produced by European scientists, rather than their abstract fixity or placeless universality, which gave them such reach.

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Seeing the Copperbelt

Colonial power and the legibility of nature Northern Rhodesia

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Highlights

- describes a pivotal moment in the rise of the Northern Rhodesian Copperbelt to becoming a world-leading centre of copper production
- explores the methodological, theoretical and epistemic challenges of practising science in the periphery
- offers an account of the difficulty of producing a commercial natural resource in the African interior
- offers a critique of how knowledge production underpins the extension of colonial power

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Figure

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