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“Follow the Yellowcake Road”: Historical Geographies of Namibian Uranium from the Rössing Mine

Christopher R. Hill & Saima Nakuti Ashipala *

Abstract: »*Follow the Yellowcake Road*’: *Historische Geografien des namibischen Urans aus dem Tagebau Rössing*«. “Follow the Yellowcake Road,” a *World in Action* documentary broadcast in the UK on 10 March 1980, provided an insight into illegal uranium supplies from South African-occupied Namibia to Britain. Focusing on the secret logistics of uranium flight, haulage, and shipment routes, the documentary invites the viewer to think critically about the underlying geographies of nuclear energy and weapons, as well as about the role of African uranium in international politics and infrastructures of “becoming nuclear.” Just as the documentary enabled an alternative spatial imaginary by mapping the movement of “yellowcake” across borders, we also seek to re-interpret the historical geographies of Namibia’s Rössing mine, the largest uranium mine in the world at the time of opening in 1976. In the article, we explore the development and operation of Rössing through a series of spatial lenses, from the local environmental politics that surrounded the mine to the global strategies of Rio Tinto Zinc (RTZ), the multinational that brought the mine into production. By outlining these historical geographies, we shed light on spatial configurations between Namibian uranium mining and nuclear power more widely.

Keywords: Uranium, Namibia, Britain, mining multinationals, nuclear geography.

1. Introduction

On 10 March 1980, “Follow the Yellowcake Road,” a *World in Action* documentary about uranium supplies from the Rössing mine in Namibia to the UK, was broadcast on ITV (Fitzwalter and Allan 1980). These supplies were controversial because Namibia was occupied at the time, illegally according

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to UN resolutions and an advisory opinion of the International Court of Justice (ICJ), by Apartheid South Africa (Ashipala 2021). By honouring contracts it had signed with Rio Tinto Zinc (RTZ), a British-based multinational that developed and ran the mine, the UK government seemed to be perpetuating unlawful Apartheid rule over Namibian territory. In fact, the UK's contracts – of which a total of three were signed between 1966 and 1976 – were decisive in enabling RTZ to raise international capital for the mine, which the multinational was able to do with active support from the South African state (Clarke 1969a; Rogers 1975). The UK contracts came to stand in direct contravention not only of UK foreign policy, which regarded South Africa as having relinquished sovereign status over Namibia, but also of the UN's Decree No. 1 for the Protection of Natural Resources, which ruled in 1974 that “no person or entity” can prospect for and extract natural resources within the territory (UN Council for Namibia 1985).

In the opening scene of “Follow the Yellowcake Road,” the documentary focuses on the secret logistics of the uranium deliveries from Namibia to Britain. The camera crew track a heavy goods vehicle with a “radioactive” label, travelling under the guise of a kitchen hardware company between Orly airport in Paris to the UK's Springfield uranium plant in Preston, Lancashire. The voice-over explains that the truck is loaded with drums of uranium oxide from the Rössing mine, which arrived at Orly airport after a 6,000 mile journey on an unmarked Boeing 707 cargo plane, South African Airways flight 209. Unlike another secret route, where Rössing uranium was transported by the French airline, *Union de Transports Aériens* (UTA), the South African route could not take place over continental Africa owing to the implementation of no-fly zones by anti-Apartheid African states. During the making of the documentary, this “protest geography” also began to materialise in France, with French unions bringing about the suspension of uranium flights into Paris (Featherstone 2012; Roberts 1980). The delivery of Rössing uranium was subsequently taken up by German-owned container vessels, which transported the cargo to Zeebrugge, Belgium (Fitzwalter and Allan 1980).

“Follow the Yellowcake Road” draws attention to the liminal spaces in which “geographies of nuclear energy” can be grasped, not least because uranium from Rössing and other African mines was not classified as “nuclear” material in official reports (Hecht 2012). By mapping uranium as its material and legal properties alter in the nuclear process, we seek to provide an alternative perspective on nuclear geography. Perhaps because uranium is mutable and “underspecified technologically,” it is too often omitted in geographical framings of nuclear history and politics (Hecht 2020). In this regard, a presumed classification of what constitutes the “nuclear” still tends to underlie nuclear studies, with uranium mining, the foundational stage of nuclear production, often being cut from analysis (Kaijser et al. 2021). For us, however, it is precisely the mutable and uncertain status of uranium that makes

it a useful object to interrogate and theorise nuclear spaces. Since uranium undergoes material and ontological flux as it makes its journey from extraction to waste, it can reformulate the “zones, bodies, and communities” that make up the core components of nuclear geography (Alexis-Martin and Davies 2017). More than this, it can take definitions of this geography beyond nuclear radiation as a lone and principal determinant of space. It opens up this geography to the non-nuclear: to constellations of mining sites and historical mineral rights, to flows and patterns of global capital, and to industrial logistics and technological transformations.

The task of rethinking nuclear geography through uranium has immediate implications. First, it places nuclear sites in another global context by emphasising their reliance on historical forms of resource colonialism. It tends to be forgotten that 90 percent of world uranium is imported compared to around 50 to 60 percent of oil and 20 to 25 percent of coal and natural gas (Högselius 2018). By 1997, an estimated 75 percent of world uranium was being mined on Indigenous territories in Africa, Asia, Australia, and North and South America (Eva Goës et al. 1997; LaDuke 1999). At a time of energy crisis in which states are reconsidering nuclear energy – and in the wake of a “new scramble” for African resources – the historical geography of Rössing uranium thus offers a valuable case study (Carmody 2011; Klare 2012; Southall and Melber 2009). It enables us to situate the globalisation of the African uranium trade within historical dynamics that go back to British and German colonialism from the mid-19th century. Since Rössing is still an active mine – with the Chinese National Nuclear Corporation having taken over from RTZ in 2019 – it remains a key, relatively unregulated, frontier on the brink of another “global uranium rush” (Conde and Kallis 2012; DeBoom 2017; SAIEA 2010).

A focus on uranium also problematises attempts to use the “nuclear fuel cycle” as a conceptual model for nuclear geography. Since uranium as an element is neither combustible nor capable of ecological reingestion, the terms “fuel” and “cycle” have inherent flaws. The multiple routes that uranium takes across the fuel cycle also test narrative arcs that trace uranium from source to usage and waste. Such arcs gloss over environmental outcomes and waste products within each stage of nuclear production, a practice that tends to privilege linear, international circuits of nuclear power to multi-faceted, local ones of land and environment. As the Rössing mine highlights, the traceability of uranium is also limited: its country of origin or nuclear geography often become “lost” in the midst of industrial modification or regulation-dodging. More recently, the onset of waste mining and application of biotechnologies to uranium extraction have further destabilised the fuel cycle as a self-enclosed spatial unit for nuclear geography (Labban 2014; Majumder 2017). These practices reveal how spaces of nuclear production and waste extend beyond the “hole in the ground,” either at the point of extraction or

geological storage (Bridge 2009). Following the “yellowcake road” reveals the nuclear fuel cycle not so much as a coherent, heuristic for nuclear geography as a series of spatial entanglements that enable us to peer into that geography’s disconnects and tensions.

In this article, we demonstrate the construction of a nuclear geography out of Rössing, until 1984 the world’s largest uranium mine. In the opening section, we examine the pre-industrial historical geography of the Rössing mine, heeding Robyn D’Avignon’s suggestion that it is “during exploration [...] that the expectations and grievances for future extractive projects take shape in the political imagination and modes of storytelling” (D’Avignon 2022). Put another way, the geopolitics of Namibian uranium cannot be fully grasped without rooting them in African relations with the mineralised lands that surrounded Rössing, or in colonial efforts to “environ” and exploit those lands (Kalb 2022). Here, the concept of “vertical geopolitics” enables us to glimpse African agency by stressing spatial depth rather than breadth; by stressing the deep geological and eco-resources of a place rather than the wingspan of imperial power politics (Elden 2013). In the second section of the article, we tackle the “horizontal” geographies of Rössing through the global history of RTZ. We suggest that business methods, geological sciences, and mining techniques accrued outside Namibia were instrumental in meeting the engineering and financial demands of a mineral prospect that contained uranium of only a 0.03 percent grade (Rössing Uranium Limited 1985). When RTZ acquired rights to Rössing from the South African government in 1966, its global and comparative knowledge systems, networks, and resources were brought into convergence on Namibia and the Rössing site.

In the third section, we show how the shareholder structure of the company created by RTZ to manage and run the mine, Rössing Uranium Limited (RUL), embodied a powerful bloc of private and state investors in the international order. We suggest that this “shareholder geography” was pivotal in resisting and circumventing African and UN pressure against the extraction and exportation of Namibian uranium. In turn, this gave rise to the underhanded logistics and tactics exposed in “Follow the Yellowcake Road,” with an inverted international order having been configured around South Africa as a “rogue” state and potential nuclear proliferator. The distribution of Namibian uranium and its “nuclearity” were also underpinned by this international context, as we show in the final section of the article on “distribution geographies.” The value of Namibian uranium derived not so much from its sale price, which differed for individual contracts and spot purchases, but from what private companies and states could do with it. The uranium was supplied in a basic oxide form (U_3O_8) that could be further enriched for profit; it was initially purchasable in domestic and “soft currencies” for preferred customers; and it was not restricted by the safeguards imposed by the Non-

Proliferation Treaty (NPT) on other uranium sources, meaning it could be used for military as well as civil purposes.

As two researchers based in Namibia and the UK who are engaged in long-term studies of the Rössing mine, we have carried out substantial archival work on this topic, including in company and state collections across Namibia, the UK, Germany, and South Africa. Since these collections provide insights into the overlapping roles of RTZ, RUL, and policy departments from multiple states, they are invaluable in revealing how forms of geographical power were imposed on Namibia, its people, and its resources. For this reason, we also draw on collections that prioritise resistance to uranium mining in Namibia, including those of the South West African People's Organisation (SWAPO) and the British Campaign against Namibian Uranium Contracts (CANUC). These collections show how the Rössing mine was highly contested, but they also privilege a nationalism that reconciled itself to uranium mining as the state's staple industry, as well as a westernised protest politics that was largely removed from the everyday experiences of Namibian miners and their families. In our longer-term research, then, we continue to work towards a social history of the Rössing mine; one in which subjectivities of environmental change and labour in Namibia provide a foundation from which to think about uranium geopolitics.

2. Vertical Geopolitics

The Rössing mine did not enter production until 1976, almost fifty years after rock samples from the area were confirmed as containing uranium (Rössing Uranium Limited 2022). In order to appreciate the contexts in which the mine emerged, however, it is necessary to refer to struggles over mineralised lands that go back to the onset of informal colonialism in the territory from at least the mid-19th century. As Saima Ashipala has argued, the historiography of Namibia, or South West Africa (SWA) as it was known under German (1884–1915) then South African rule (1915–1991), has produced an unusual disjuncture in relation to uranium. Since the value of this fissile material for nuclear energy and weapons programmes was not realised until after the rise of a colonial economy around copper, diamonds, gold, and guano, it has not been historicised in the context of this economy or its dominant geopolitics (Ashipala 2021). A driving ambition of our research is to write the history of uranium backward into the colonial period. To do so is to “de-exceptionalise” nuclear history by framing it in relation to deeper histories of imperial power and mineral extraction (Hecht 2012). In line with African historiographies of SWA, it is also to place the diverse relationships that Africans had with land and earth at the centre of these geopolitical struggles (Kinahan 2022; Wallace 2011).

This emphasis on temporal depth aligns with a “vertical geopolitics” in which the volume of a territory is taken as seriously as its surface area, from the subterranean to the aerial. The two dimensions of colonial cartography are in this respect supplemented by a third dimension of minerals, metals, vegetation, and water resources. By performing this geographical work, the agency and traditions of African actors – and non-human actors – comes alive, particularly in the context of “South West Africa,” an artificial construct that reduces the character of natural geography to an eponymous area on a map (Stals 1984). To this end, a stronger emphasis on the desert ecologies and geological formations to which the site of the Rössing mine belongs can reveal more about the history of geographical power, resistance, and co-operation in mineralised lands. Just as Robyn D’Avignon grounds gold mining in West Africa in the geographical contexts of the Birimian greenstone belt – a geological formation that underlies multiple states and territories – a similar technique needs to be considered in relation to Namibian uranium mining (D’Avignon 2022). The history of the Rössing mine lies in struggles over “vertical” configurations of land, resources, and earth; over colonial and African hierarchies of eco-resources and their role in land usage; and over the utopian imaginaries that mineralised land inspired, from the diamond fantasies of colonists and traders to African attempts to maintain pastoral land and water supplies.

The dynamics of African and European geopolitics around the historic site of Rössing were heavily shaped by the desert geographies that demarcate the contemporary state of Namibia. On the eastern side of the territory, the dunes and granite escarpments of the Namib desert hug the Atlantic coast and expand inland for about 60 kilometres, where they encompass the site of Rössing between 22°S and 23°S. Alongside perilous ocean currents and a scarcity of deep-water ports on the coast, the Namib served to delay penetration into the territory’s interior by European powers. On the western side of the territory that borders present-day Botswana, this desert geography was complemented by the Kalahari, while the “thirst belt” of the northern portion of the territory also offers a physical barrier to its mid and lower regions. It was as these mid and lower regions became increasingly open to trade from British Cape Colony to the south that reports of mineral wealth began to circulate among Europeans, even though archaeological evidence suggests that African communities had been mining and smelting copper since at least the 17th century (Kinahan 2022; Lau 1987; Wallace 2011). These mineral-rich lands belonged to a geological formation known as the Damara belt, which extends upwards into the Congo and became the object of a strategic geopolitics between mining magnates such as Adolf Lüderitz and Cecil Rhodes (Stals 1991).

This distinctive geography and geology of SWA had a series of implications for African and European struggles over mineralised lands. From the outset, the territory’s promise of mineral riches encouraged European efforts to

“envirom” this unruly territory, as demonstrated in Martin Kalb’s recent study of German schemes to gain mastery over SWA lands, people, and resources. For Kalb, this “enviroming” involved the construction of infrastructures such as borders, piers, and railroads. It was an anthropocentric project that revealed the hubris of German colonialism and scientism, with disease, famine, and physical geography demonstrating the limits of Enlightenment “man’s” control over nature (Kalb 2022; Kreike 2021). The Rössing mine was rooted in this “enviroming” or “socio-ecological reordering,” with the site of the mine and its onlooking mountain taking their names from Nonus Freiherr von Rössing, Lieutenant General of the Second Reich’s railway brigade (Ross 2017). When a rinderpest epidemic devastated the colony’s livestock and thus its primary means of transportation, a von Rössing regiment was shipped over to Swakopmund on the Atlantic coast to commence work on the territory’s first railroad. The completion of the line to Windhoek in 1903 marked a watershed in colonial state-making, enabling the Germans to move supplies and troops across the colony with unprecedented speed (Ellis 1992; *Rössing News* 1983).

This “enviroming” or “reordering” of nature in SWA was motivated by enhanced European access to the territory’s mineral wealth in particular. The prospect of diamond discoveries, for example, prompted Lüderitz to orchestrate the one-sided land treaties that formed the basis for German rule. Of these, the coastal strip that encompassed the future site of Rössing was the “most dubious” of all his “dubious land acquisition treaties,” to quote Theodor Leutwein, governor of SWA from 1894 (Drechsler 1984). These tensions between geographies of land and earth were further highlighted during the imposition of direct colonial rule in 1889, which led to the separation of mineral and surface rights in the territory. The former were vested in the German Crown, while surface right owners lost their right to the minerals beneath their land (Goldblatt 1971; Kawana 1988). At this point, the German colony also began to open up to British capital, which arguably served to fuel this “reordering” of surface geographies around mineral prospects. The British South West Africa Company became particularly influential in lobbying for German military action against African groups who were seen as thwarting mining development (Lyon 2015; Voeltz 1988). Alongside other concession companies, it bore at least some responsibility for the outbreak of the Namibian War of 1904–1908, which by conservative estimates led to the deaths of around 50 and 30 percent of Otjherero- and Nama-speaking populations respectively (Wallace 2011). In the words of Marion Wallace, these events were “crucial in creating the structure of unequal, racially-determined, land ownership” that prevailed beyond Namibian independence in 1990 (Wallace 2011). Notably, their impact on labour supplies continued to be felt by the time that RUL began to recruit miners over 60 years later.

In this rendering of Namibian mineral history, the role of African groups and the significance of their perspectives can seem strikingly passive or absent – a sign, perhaps, of the particular brutishness of colonial violence in the territory, the lack of reliable documentary evidence, or possibly the tendency of African groups to prioritise other eco-assets. While further research is needed to do justice to the complex relations that African groups had with mineralised lands, it seems likely from archival fragments that traditional inhabitants around Rössing were aware of its mild radioactivity, even if they did not perceive it in such terms. As European geologists have long since noted, this natural radiation was a product of the desert eco-system, where fine mists from the Atlantic would “leach” the uranium out of the granite in which it was embedded (Backström 1970). A “ritual geology,” to use D’Avignon’s phrase, may have existed among Otjiherero-speakers in particular. According to one journalist, it had been a “Herero” tradition to see the land as possessed by an evil spirit that had powers over environmental and reproductive fertility (West 1972b). We know that Herero regarded this land as their own, since one of their leaders, Clemens Kapuoo, consulted with London-based solicitors in 1971 about prosecuting RTZ for developing the mine on their lands (*The Sunday Times* 1971).

As D’Avignon has shown in her research on West African mining, these “ritual geologies” are useful indicators of African knowledge practices around labour, ownership, and rights in mineralised lands. Since these practices long pre-dated colonial mining, they often laid down a template for European “discoveries,” despite the tendency of European engineers and geologists to deride such practices as mere superstition (D’Avignon 2022). In the case of Rössing uranium, the absence of African perspectives on mineralised lands – combined with uranium’s value being realised outside the key period of German rule – has had a silencing or warping effect on the origin stories of the Namibian uranium industry. These stories tend to elevate the role of Peter Louw, an Afrikaner settler in Swakopmund who later married Margery Burns, a British nurse trained in radiography at Guys Hospital, London. When Peter returned to the family home with black rocks from a desert outing in 1928, Margery suggested that these could contain radium, a sister-element to uranium, valuable for nuclear medicine. While it turned out that the rocks hosted uranium, not radium, the Louw family continued to invest time and resources in the site from which they had been collected. Their persistence seemed to have been rewarded in December 1955, when Anglo-American took up a prospecting option before abandoning the site eight years prior to the intervention of RTZ (Louw 2018; Rössing Uranium Limited 2022).

The symbolism of this origin story conflicts with the faint traces of a “ritual geology” in Herero tradition. The portrayal of mildly radioactive desert lands as “life-giving” and “progressive” contrasts with the fertility-draining connotations that seem to have registered in local folklore. Ironically in view of the

masculine profile of uranium mining in Namibia, this juxtaposition between the life-giving and the infertile revolved around womanhood: the Rössing prospect was initially known as the “Margery Louw deposit” (Boulton 2021; Rio Tinto Management Services 1975). Such symbolic conflicts point towards disjunctures in African and European assessments of nature: the role of radium and uranium as prized eco-assets at the dawn of the nuclear age on the one hand, and the foreboding of black rocks for pastoral-life and water ecologies on the other. In this regard, the history of the Rössing mine corresponds with Traci Brynn Voyles’s notion of “wastelanding,” where white settlers denigrated Diné farming in order to portray the land as barren and suitable for a toxic activity such as uranium mining (Voyles 2015). At Rössing, a similar logic was at play: white settler extraction of nuclear benefits was pursued against geological customs that forewarned of toxic earth (Leddy 2021). The importance of such customs as safeguards for the desert environment has been highlighted by the current need to import water into Namibian towns as a result of uranium mining demands (SAIEA 2010). The origin story of major mines like Rössing matters if the purview of nuclear geography is to encompass the environmental concerns and knowledge of traditional landowners.

3. Global Convergence

The creation and eventual success of the Rössing mine stood at a crossroads in RTZ’s trajectory as a global mining giant. From one perspective, the mine was only made possible as a result of the multinational’s distinctive geopolitical and operational structures, its multi-mineral business models, and its comparative knowledge systems across geological regions and the world of mining technology. This global repertoire was brought to bear on the site of Rössing in 1966, representing a convergence of geopolitical, business, and technological power that would have transformative effects for the Namibian economy and make the mine accountable for one-fifth of the state’s gross domestic product by the end of Apartheid (Jones 1986). From another perspective, the emergence of Rössing as the world’s largest uranium mine put RTZ at the helm of market politics around the global uranium trade, a fact reflected by its founding membership of a price-fixing cartel in 1970 alongside Australia, Canada, France, and South Africa (Bron 2021; Department of Energy 1976). By the end of the Cold War, the multinational’s portfolio of complementary industrial assets was staggering, with RTZ mines producing among other metals and minerals around 11 percent of the world’s aluminium, 15 percent of its copper, 8 percent of its iron ore, and 11 percent of its uranium (Moody 1992).

In this light, the development of a “nuclear” geography around the Rössing mine cannot simply be mapped vertically within the territorial parameters of

SWA; it also must be mapped transnationally through the history of RTZ. While the origins of RTZ go back to 1874 – when Hugh Matheson founded “Rio Tinto” to exploit copper deposits in Spain – it was an operational overhaul after 1945 that made the mining conglomerate an ideal vehicle to develop the Rössing deposit. The role of the uranium trade in this overhaul was pivotal, with Rio Tinto executives carefully shadowing American, British, and Canadian attempts to locate uranium deposits from the Second World War. From 1944, these attempts were coordinated through the Combined Development Trust, or Agency (CDA), which undertook extensive exploration programmes in both third party states and the historic territories of the British Commonwealth and Empire (Gowing 1974; Helmreich 1986). Since uranium was seen as a critical resource in the context of the Second World War and Cold War, an emphasis was placed upon heightened cooperation between states that belonged to what might be termed the “Angloworld”: “a politically divided but culturally and economically united intercontinental system” (Belich 2009). In this Angloworld of uranium exploration, the British dominion countries – Australia, Canada, and South Africa in particular – occupied an unrivalled position, not only because they were already centres of global mining capital, but because they also possessed substantial uranium deposits within their borders.

From the appointment of John Norman Valette (“Val”) Duncan as Managing Director in 1951, the operational strategy of RTZ became heavily shaped around this Angloworld framework. Duncan, a talented businessman hitherto employed by both the British Foreign and Commonwealth Office (FCO) and National Coal Board, had in his own words “spent all his business life [...] forging links between Commonwealth countries by means of resource developments.” Not only did he believe in the “enduring value of the Commonwealth concept”; he also believed that multinationals should fill in the void left over by British decolonisation, a recommendation he made as chair of the FCO’s Review Committee on Overseas Representation (Duncan 1969; West 1972a). As Managing Director of Rio Tinto, it was Duncan’s mission “to create a [...] company in each of the principal mining countries,” which in turn would control operations locally, invest equity in overseas partners and projects, and receive full backing from the headquarters of the RTZ group in London (Moody 1992).

In the 1950s, Duncan therefore masterminded the re-structuring of Rio Tinto’s operations from politically-precarious territories such as Northern Rhodesia and Spain to more stable ones such as Australia, Canada, and South Africa. This transition took place in part through investments in uranium mining: ones that capitalised on the incentive schemes of Commonwealth states. Duncan’s Angloworld strategy began to materialise from 1953, when Rio Algom was formed as a subsidiary out of the acquisition of three uranium mining companies around Elliot Lake in Ontario, Canada. In the same year,

Rio Tinto was granted permission by South Africa to survey the Palabora Igneous Complex, which became the site of one of the largest open-cast copper mines in the world and also a producer of uranium. Two years later, Rio Tinto acquired a controlling interest in the Mary Kathleen uranium deposit in Queensland, Australia (Stevens 1955a; Hibberd 1955). The first managing director of Mary Kathleen Uranium, as the Australian subsidiary became known, was recruited from Consolidated Zinc Ltd, thus pre-empting a merger between the two mining groups under the name Rio Tinto Zinc in 1962 (Moody 1992). As one industry journal put it, this merger “formed the basis of, and provided the impetus for, RTZ’s subsequent development into an international mining giant” (Moody 1992).

This re-structuring of Rio Tinto around the Commonwealth was only possible with the active support of mining and political interests in Angloworld states. In Canada, the rise of Rio Algom was secured by the complex ways in which it could arrange its assets to minimise taxation – often with the political support of Eldorado Nuclear as the nationalised sales agent. As one Canadian politician argued in a Cabinet meeting, the government could “be accused of discriminating in favour of Rio Tinto” because its suggested tax model “was not, in practice, one which other producers could adopt” (Cabinet Committee on Uranium 1959). The Australians also encouraged the entry of Rio Tinto into the uranium market. Jack Stevens, the chairman of the Australian Atomic Energy Agency (AAEC), described to a Treasury official how Rio Tinto was “a large and competent mining organisation and if it does decide to come here it will want to come in a big way”: “the entry into our uranium mining field of this organisation with its overseas capital would be [...] welcome” (Stevens 1955b). Conzinc, which had received 10 years’ worth of capital from the CDA as Australia’s designated uranium contractor, were also preparing for Rio Tinto’s move long before the 1962 merger. In the mid-fifties, the group shared with Rio Tinto confidential information about pricing so that it could gain an upper-hand in negotiations over deposits at Mary Kathleen and South Alligator River in the Northern Territory (Australian Atomic Energy Commission 1955).

Despite tactics such as these, Rio Tinto enjoyed major state-level backing, with the UK Atomic Energy Agency (AEA) agreeing to loan the group £5 million to proceed with works at South Alligator River (Plowden 1955). The multinational’s ability to build close partnerships with state-level authorities in Canada and Australia was also evident in South Africa. Its work at Palabora was supported by a loan from the Industrial Development Corporation (IDC), the Apartheid state investment branch that later became a major shareholder in Rössing. In contrast to elsewhere in South Africa, the uranium produced at Palabora was the only uranium that was not marketed and sold through the Nuclear Fuels Corporation of South Africa (Nufcor), which had been established in 1967. The career of G.A. Macmillan, who became head of Rio Tinto

South Africa, highlights the intimacy of regional links between RTZ and the South African state. He had been recruited to RTZ Tinto from the IDC, was a board member of Rössing Uranium Ltd, and was appointed to the Atomic Energy Corporation of South Africa in 1983 (Moody 1992).

By the time that RTZ purchased the rights to Rössing in 1966, then, a powerful extractive bloc had emerged across the Angloworld, born in part out of informal partnerships between private and state interests over uranium. This bloc, itself plugged into the dense business, political, and scientific networks of the Commonwealth, provided opportunities for chemists, engineers, and geologists to apply, learn from, and transfer extractive techniques across borders. Nowhere was this most evident than in Palabora, the ancient African copper mine in South Africa's Limpopo province, described by Rio Tinto South Africa as an entire "minerals complex" (Palabora Mining Company 1987). It was at Palabora that RTZ was able to devise with South African Atomic Energy Board's Extraction Metallurgy Division a process to separate almost impossibly low-grade ore, producing just over 150 tons of U_3O_8 out of 22,000 tons a day. This process, where nitric acids were employed to leach uranium from copper, was the technology that made the development of the Rössing deposit possible, where uranium would be worked instead as the principal commodity (Rogers 1975; Hansford 1973).

4. Shareholder Geographies

In July 1969, Rössing Uranium Limited (RUL), the subsidiary through which RTZ exploited Namibian uranium, was established. By focusing on the creation and development of equity positions in this company, it is possible to paint a picture of nuclear geographies and their patterns internationally – what we refer to in this section as "shareholder geographies." In this regard, the corporate makeup of RUL resembled a nuclear order in microcosm: one that reveals how nuclear politics were negotiated around the business of Namibian uranium. The international interests enshrined in RUL were moulded in particular by RTZ's "one-third equity and two-thirds loans" strategy, with RTZ's controlling share declining from a peak of around 55 percent as new partners were brought into the fold (Daniel 1995; Jepson 1975). In exchange for sales contracts for uranium and often a stake in RUL, the mining house relied on its international partners to generate loan finance for exploration and construction of the mine. Whereas RUL's founding partners came from states most complicit in the historic and ongoing colonisation of Namibia – South Africa, West Germany, and the UK – this transformed with the globalisation of the uranium trade in the 1970s and 80s. The rise of RUL as an international company – and Rössing uranium as a global commodity – was nonetheless indebted to these colonial origins.

In seeking finance and support for the Rössing prospect, it was predictable that RTZ should turn to the UK and West Germany for its founding agreements. The mining house had strong ties to – and was essentially a product of – the British ruling class; it could also tap into German networks of engineering expertise that had remained in Namibia since the colonial period (Roberts 1980; Macrae 1970). The earliest agreements between RTZ and the UK AEA should be read in this context: an official endorsement, in effect, of RTZ's plans to proceed with the mine. While these advance purchase agreements enabled RTZ to appeal for further finance, the West German agreement of 1969 was even more significant in that it provided an immediate financial stimulus (Rogers 1975). This agreement, signed with Urangesellschaft mbH & Co., formed a “package deal covering exploration, feasibility studies, financing and supply of U_3O_8 ” (Heads of Agreement 1969; Wright 1973). The deal was instrumental to the studies that proved the feasibility of the mine, while Urangesellschaft's commitment to purchase 6,000 tonnes of uranium further bolstered the economic credibility of RTZ's proposals (Urangesellschaft mbH 1969). Even though political pressure prevented Urangesellschaft from openly taking up 10 percent equity in RUL, the West German company and the Federal Republic's Science Ministry were keen to maintain links and purchase options with RUL going forward (Lambert 1971).

Having demonstrated the economic and technical promise of the mine, the task facing RTZ remained twofold: to consolidate financial and political support from Apartheid South Africa as the occupying power in Namibia, and to sell off equity positions in RUL in the absence of direct participation from the UK and West Germany. To this end, the multinational entered into discussions with the IDC, which could negotiate on behalf of the Apartheid state the loan finance required to bring the mine into production. At an estimated total of £30 million, the loan finance furnished by the IDC to RUL represented a bold investment, particularly in view of the mine's location in an internationally disputed territory (Brockway 1975). In return, the IDC took up 13.2 percent equity in RUL, which also included the majority of “preference” shares (Hecht 2012). In accordance with the Atomic Energy Act of South Africa, this gave the IDC overall voting control of the RUL board, while also enabling RTZ to retain a “beneficial interest” in the company (Lethbridge 1969). The provision of additional loan financing by General Mining, which took up a 6.8 percent holding in RUL, also cemented connections between RUL and South Africa's leading uranium producer (Moody 1992). At this point, the act of buying uranium from or investing in RUL became firmly locked into the nuclear geopolitics of Apartheid South Africa, including its ongoing occupation of Namibian territory.

From a backdrop of Apartheid and historical colonialism, the negotiation of equity and long-term sales contracts with RUL proceeded as a form of “nuclear ordering,” where equity and sales were negotiated with suitable

partners across the world (Hecht 2012). The internationalisation of RUL seemed to revolve around three overlapping geographical axes in particular: the Commonwealth circuits inherent in the operational structure of RTZ, the market demands of the uranium cartel, and the diplomatic needs of state-level representatives in the UN General Assembly and Security Council. The involvement in RUL of Rio Algom, RTZ's Canadian subsidiary, provides an illustration of how RTZ drew upon its Commonwealth business dynamics. Having taken up a ten percent equity option in RUL as part of the UK AEA's initial agreement for Rössing uranium, the Canadian subsidiary went on to provide a loan of US\$ 7.5 million to Rössing in July 1977 (United Nations 1985). In a similar manner, the onboarding of *Total Compagnie Minière et Nucleaire* was also valuable to the international profile of RUL, ensuring that the company could rely on both British and French backing in the UN Security Council (Daniel 1995). Along with South Africa and RTZ as members of the uranium cartel, both Canada and France had a vested interest in making sure that the world's largest uranium mine was not subject to boycott or meaningful sanctions (Moody 1992).

The internationalisation of RUL through equity offers and sales contracts also occurred at a time when nuclear energy programmes were proliferating worldwide. RUL's boardroom became a place where an entrenched, quasi-colonial order increasingly merged with representatives of states whose nuclear aspirations were in their infancy. At no point, however, did RUL purposefully break from the broad model of western-alliance building on which it was based: equity offers and sales contracts were a device for diplomacy as much as business. Relations between RUL and Japan provide a prime example, with Kansai Electric's initial purchase of 8,200 tonnes of uranium marking a watershed in the early development of RUL and the growth of an American-backed Japanese nuclear industry. The Taiwan Power Company also became another notable "western" customer, purchasing 4,400 tonnes of uranium from RUL in October 1983 – a transaction that would be seemingly impossible in the current context of Chinese control of RUL (Uranium Sale Agreement 1983). Perhaps the most striking example of nuclear ordering by RUL came in 1975, when Mohammad Reza Shah's Atomic Energy Agency of Iran (AEAI) negotiated the last combined equity and sales agreement in the company (Bailey and Bhatia 1987; Daniel 1995). The subsequent overthrow of the Shah and his replacement by Ayatollah Khomeini's Islamic Republic brought the pro-western business strategy of RUL into disarray. How to manage the AEA's shareholding in the company – and whether to proceed with uranium sales to Iran – became a recurrent concern for RUL throughout the 1980s and 90s.

While the management of equity in RUL was a means by which geographies of nuclear energy could be constructed, it was also possible for opponents of the Rössing mine to mobilise counter-geographies by buying ordinary shares

in its parent company, RTZ. This tactic was pioneered by two groups in the UK in particular: the Campaign against Namibian Uranium Contracts, which sought to influence UK policy on Namibian investments as part of the Namibia Support Committee, and People against Rio Tinto and its Subsidiaries (Partizans), which specialised in shareholder-based action and was formed in 1978 at the request of Indigenous communities from North Queensland, Australia (Moody 1991). As the origins of CANUC and Partizans suggest, these groups mirrored and exposed the international geographies of Apartheid and extraction on which RTZ relied, where possible co-ordinating affected communities across borders, mobilising sympathetic organisations, and organising resistance. Such action was vital in heightening awareness of Namibian uranium mining, “bringing knowledge to the local level, making connections to movements elsewhere, mobilising extra-local resources for local action, and acting at different scales, turning local conflicts into glocal conflicts” (Conde and Kallis 2012). At RTZ annual general meetings, protest shareholders asked awkward questions about labour conditions and health hazards at the Rössing mine (Vale 1972). Through tactics such as these, a Namibian-powered “geography of nuclear energy” became imaginable, for the first time placing black miners of Namibian uranium and western consumers of nuclear energy into a single analytic frame.

5. Distribution Geographies

In exploring the link between Namibian uranium mining and geographies of nuclear energy, it is necessary to finally reflect on both where Namibian uranium went and at what point it was designated as “nuclear.” As “Follow the Yellowcake Road” suggests, this is not a simple task: a whole range of secretive measures were instituted to conceal the movement of uranium from the Rössing mine. These became more sophisticated as opposition to the mine mounted: not only through protest groups such as CANUC and Partizans, but also through sanctions imposed by the UN and, more meaningfully, the USA. The nuclear geography of this uranium was further complicated by the absence of end-use restrictions and its production in basic oxide form. For recipients of Namibian uranium with further enrichment facilities – principally the UK, France, West Germany, and the Netherlands – this opened up a world of industrial possibilities: one in which Rössing uranium could be converted into hexafluoride form and the final buyer need never discover the origins of the primary material. The absence of end-use restrictions was also useful for nuclear weapons states such as the UK, whose original reactors had been constructed with the overriding purpose of producing plutonium for the nuclear weapons programme: Namibian uranium was a pliable resource in this plutonium economy. Following the “yellowcake road,” then, is an undertaking

beset by the chimerical qualities of uranium from the African continent in this period. As Gabrielle Hecht has noted, it could be said that African U_3O_8 has only been “nuclear” when western policymakers have needed it to be (Hecht 2012).

Since Rössing entered production two years after the UN’s Decree No. 1 – the ruling that prohibited the extraction and removal of natural resources from Namibia – the need for secrecy around uranium deliveries was imperative (UN Council for Namibia 1985; Daniel 1995). The UK government, for example, advised RTZ to take “discrete steps” to prevent the “serious embarrassment” of a ship being “arrested [...] and its cargo confiscated in the name of the UN Council [for Namibia]” (Reith 1975). Unlike uranium supplies from other states, which were shipped into Liverpool en route to England’s “nuclear north west,” the UK government ruled out direct deliveries of Namibian uranium. While RTZ noted “considerable advantages in airlifting the product from a security and political point of view,” these were fraught with risks, particularly in view of the no-fly zone imposed on South African flights over the African continent (Daniel 1995). On one occasion, a South African Airways plane loaded with Rössing uranium was even shot down by an Angolan MIG-21 near the Namibian-Angola border. This border territory had become a key region in geographies of resistance to Apartheid, having historically evolved beyond spheres of colonial control and as a space of Communist infiltration in the Cold War. For these reasons, the region formed an ideal defensive base for SWAPO, yet it also served, ironically, as a labour pool for migrant workers who could be tempted southwards into mining, including in the service of RUL. In view of the protest geographies they faced – from blockades in Europe to military retaliation in Africa – it became necessary for RTZ to periodically switch between French and South African airline routes and shipping (CANUC 1985).

After delivery, the onward journey of Namibian uranium and its “nuclearity” depended on a complex range of techno-political factors, most of which revolved around the specifications of nuclear reactors, the regulatory regimes of different states, and the volume of their pre-existing uranium stockpiles. While it was possible, for example, to directly feed certain reactors with Namibian U_3O_8 , the majority of reactors would require the uranium to be further enriched or modified. For most purchasers of Rössing uranium, then, it was necessary to make arrangements for enrichment before receipt of the original product. This meant that states with enrichment facilities were often powerbrokers of nuclearity, occupying a position above the original suppliers of uranium in the contested process of nuclear ordering. The majority of Rössing uranium received by the UK, for example, was intended not for its own nuclear programme, but for enrichment and re-distribution to other customers of the mine. As described by one UK official in April 1982, uranium imports for Britain’s programme were “dwarfed by the large quantities

processed here on behalf of foreign customers” (Kirkman 1982). This lucrative business also provided a platform for European collaboration. As signatories of the Treaty of Almelo on 4 March 1970, the UK, the Netherlands, and West Germany agreed to invest in Urenco: a new enrichment consortium with plants at Almelo, the Netherlands, and Capenhurst, UK.

The mediating role that European enrichment plants played in the lifecycle of Rössing uranium was capable of producing quite unusual geographies of nuclear power. In 1976, for example, a number of British agreements to enrich Namibian uranium had been made with purchasers who already planned to sell the final product on to the Soviet Union (Stanley 1976).

While this Namibian U_3O_8 entered the UK without end-use restrictions, it would leave, theoretically, having been brought in line with Euratom and Non-Proliferation Treaty safeguards by which the UK had agreed to abide. When the final destination of this UF_6 was located in the Soviet Union, a coordinating committee would also negotiate the return of uranium tailings (Stanley 1976). Despite these precautions, it is tempting to wonder whether European-converted Namibian uranium ever made it back to South Africa’s weapons grade enrichment plant in Pelindaba, which began production in 1977 and required uranium hexafluoride for its feed (Albright 2015). Such an arrangement does not seem inconceivable in light of the close relations shared between the atomic energy establishments of the UK and South Africa in the 1970s. The UK AEA had historically enriched U_3O_8 from South Africa into UF_6 for customers of South Africa’s Nufcor, which would then replace the U_3O_8 in the UK’s stockpile. In the words of one official, “the AEA find this traffic pleasantly rewarding” (Clarke 1969b).

Distribution geographies were also shaped by measures taken against Rössing uranium, which ranged from UN legal action against Urenco to US pressure on South Africa through the Comprehensive Anti-Apartheid Act of 1986. In December 1983, the UN Council for Namibia called upon Urenco to remove enrichment of Namibian uranium from the Treaty of Almelo (Kenyon 1984). Seven months later, it initiated legal action through Dutch courts, largely on the basis that, unlike the other two states in the Urenco “troika,” the Netherlands recognised the validity of the UN’s Decree No.1 and did not deny that Rössing uranium was being enriched in Urenco plants (Schrijver 1984). Whereas this case was outpaced by negotiations for Namibian independence, the passing of the Comprehensive Anti-Apartheid Act in the US proved far more challenging. Even RTZ, with its powerful lobbyists and political connections in Washington, D.C., could not persuade the legislation’s sponsors to remove Namibian U_3O_8 from the list of imports proscribed by the Act. Senator Mitch McConnell’s last-ditch effort to amend the Act – claiming that a US boycott on Namibian U_3O_8 could harm the Paducah gaseous diffusion plant in his state of Kentucky – was unsuccessful: only supplies of UF_6

from South Africa would be permitted into the US henceforth (*Nucleonic Week* 1986).

That trade in Rössing uranium continued almost unabated is testimony to the dark arts of RTZ and its partners. Prior to the Comprehensive Anti-Apartheid Act, for example, it was reported that a “yellowcake flotilla” headed to the US with 10,000 metric tons of Namibian and South African U_3O_8 , all waiting to be enriched (*Nucleonic Week* 1986). Yet the practice of concealing Namibia’s “yellowcake road” was well-established even before anti-Apartheid legislation and legal proceedings. From the 1980s, it had become routine for RTZ to market all Namibian uranium through RTZ Mineral Services, a Swiss-based subsidiary that enabled the multinational to hide the uranium’s country of origin (Moody 1992). Louis Francois Durreet, vice-president of Comurhex, France’s enrichment plant, also claimed that US sanctions only accelerated “flag-swapping,” where country of origin labels were switched in uranium stockpiles. According to Durreet, the total amount of uranium subject to flag-swapping in Europe amounted to around 1000 metric tonnes a year, with Swiss and West German utility companies having been particularly active in this market (*Nucleonic Week* 1986). In September 1987, over a year and a half into US sanctions, the public relations manager for Rössing, Clive Algar, could report that most of Rössing’s clients “had managed to find facilities elsewhere. No contracts had been broken and production was carrying on at planned levels” (Hawkins 1987).

6. Conclusion

By following the “yellowcake road” from the origins of the Rössing mine to its role as a uranium producer, it has been possible to think about nuclear power through a range of geographical categories. From these, it is clear that nuclear geographies, if their spatial patterns and processes are to be fully understood, need to be first of all linked back to non-nuclear themes of land usage and wider regimes of mineral extraction. This re-tracing of nuclear geography into the colonial and pre-colonial past often necessitates other forms of historical and geographical expertise, typically in the broadly-defined fields of anthropology and imperial history. While such work can be highly specialised, it is invaluable in revealing the relationship between nuclear geography and older formations of colonial power or pre-colonial environmental politics. In the case of the Rössing mine, this can be seen by the leading roles of Germany, South Africa, and Britain in both the colonisation of “South West Africa” and the creation of the mine. From one perspective, these colonial underpinnings were pivotal for the nuclear ordering that took place through equity investments and sales contracts. From another, they also produced tensions in Namibian nationalism and resistance, with uranium

mining both conflicting with traditional values around land use, yet also offering a potential revenue stream for an independent, postcolonial Namibia.

The development and opening of the Rössing mine also sat at a geopolitical crossroads in the world uranium trade, which in this period went from being a secretive preserve of a Cold War elite to a rapidly globalising marketplace. How a mining house like RTZ responded to this period of transition, providing an interface between the strategic interests of leading states and the rising marketplace for new nuclear power, is a major factor in the development of nuclear geography. In this regard, the history of the Rössing mine is also the history of how RTZ built operational capacity and political trust in key mining regions and states, as well as how it was able to bring this wealth of multi-business, multi-mineral expertise to bear on the lunar landscape of Rössing. In our examination of RUL's formation and the distribution patterns of the uranium from the mine, we have also been able to show how the uranium business in Namibia had been fundamental to the articulation of nuclear geographies. These geographies were constructed first of all by the organisation of equity in RUL, a strategic process in which a company or state's nuclear and political profile was of vital importance. Although equity in RUL gave nuclear states enhanced access to Namibian U_3O_8 on favourable terms, their receipt of this uranium was not necessarily the point at which a "nuclear" geography was formed: the U_3O_8 tended to require further enrichment for "nuclearity" to be attained. This made European clients of RUL key brokers of nuclear geography through the uranium trade since they possessed the enrichment facilities to turn U_3O_8 into UF_6 . While enrichment marked the stage at which Rössing uranium became nuclear, it also transformed the technological properties of that uranium by adding international safeguards. For this reason, it was initial access to Namibian U_3O_8 that was most prized. Particularly for states with established nuclear industries, the receipt of this form of uranium empowered them to shape the structure and spread of nuclear geographies.

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Geographies of Nuclear Energy. An Introduction.

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