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Land, labour and capital: Small and large-scale miners in Papua New Guinea

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ABSTRACT

This paper provides the first detailed characterisation of the interface dynamics between artisanal and small-scale mining (ASM) and large-scale mining (LSM) activities in Papua New Guinea, recently termed 'ASM-LSM interfaces'. We characterise these interfaces across the project lifecycle at operational, non-operating, and future mines. Despite industry commitment to contemporary standards for social responsibility, our study shows that large-scale miners actively co-construct ASM-LSM interfaces and contribute to their intensification, which often results in violence, dispossession, and entrenched inequalities. By focussing on interfaces, we identify the influences and effects on the underlying elements that small and large-scale mining activities have in common, namely land, labour and capital. This provides the basis to chart the 'mining encounters' among the host of actors entangled in these extractive zones, and the competing interests that arise at each resource conjuncture.

1. Introduction

While it cannot be said that Papua New Guinea is a nation of small-scale miners, Papua New Guinea can certainly be regarded as a 'resource nation'. Like many other resource dependent nations, it has struggled to convert its mineral wealth into forms of economic development that can benefit the broad mass of the population (e.g. UNDP, 2014). The failure of the post-colonial state to deliver the promised levels of development has fostered widespread expectations for large-scale mining companies to fill this gap. These development failures have also pushed a good number of rural households into labour intensive and risky forms of artisanal and small-scale mining (ASM), or what is generally termed small-scale mining (SSM) throughout Papua New Guinea.[1] The link between artisanal and small-scale mining and poverty alleviation in developing countries has been firmly established in the literature (Davidson, 1993; Hilson, 2009; Lahiri-Dutt, 2018), with noticeably fewer references to Melanesia or the broader Pacific.

Papua New Guinea is one of several Melanesian states that has achieved a certain level of notoriety due to the development of numerous large-scale mining operations that have caused all sorts of social, economic, political, and environmental effects. Anthropologists and other social scientists have written a good deal about the impacts of this industry, but much less is known about the social relations of small-scale mining in this country.[2] Even less is known about the issues and impacts that arise when these small and large-scale activities occur in close proximity and the types of interface scenarios that might emerge in different contexts. Similar to many other developing countries, people engage in small-scale mining activities as a response to rural poverty to supplement meagre subsistence livelihoods. For some households, small-scale mining represents the most promising, if not the only, income opportunity.

We have found it useful to conceptualise mining arenas as 'zones of

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[1] The definition of ASM and SSM differs significantly between countries (see Lahiri-Dutt, 2018). We note that some scholars and some organisations draw a distinction between ASM (as 'informal', 'extra-legal', and entailing high levels of labour, and low levels of technology and capital) and SSM (as an economic activity that may entail reasonable levels of capitalisation and greater levels of official recognition in some jurisdictions). In Papua New Guinea alluvial and small-scale mining operations are collectively referred to as small-scale mining (SSM). Following the government regulator (the Mineral Resources Authority) and relevant legislation (*Mining Act*, 1992), we use scale-based nomenclature to distinguish between formal industrial mining activities (large-scale mining) and alluvial, informal, artisanal, and non/semi-mechanized mining activities (small-scale mining).

[2] Exceptions include Halvaksz (2008), Lynas (2018), Moretti (2006, 2007), O'Faircheallaigh et al. (2017), and Vail (1995).

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entanglement' (Bainton and Owen, 2019), which helps us to account for the multiplicity of actors, relations, interests, and interfaces that can emerge within these enclaves of extraction, as well as the spatial and temporal dimensions of these resource conjunctures. This paper provides the first detailed characterisation of the interface between small and large-scale mining (LSM) activities in Papua New Guinea, which are elsewhere termed 'ASM-LSM interfaces'. We draw upon our long-term research on the large-scale sector in the Melanesian region, and recent research on small-scale mining activities in the context of several large-scale operations. We argue that a focus on interfaces helps to identify the influences and effects on the underlying elements that small and large-scale mining activities have in common, namely land, labour and capital. In turn, this enables a better comprehension of the relations and encounters between these miners and the host of other actors entangled in these extractive zones, and the competing interests that arise at each juncture. We begin by setting out a typology of interfaces, which provides a basic framework that informs our characterisation of the relationship between small and large-scale miners during different stages of the mine lifecycle, allowing us to unearth new ways of understanding capital in these extractive contexts.

2. Interface dimensions and typologies

In this section we present an overview of the range of interface types available as a way of situating small and large-scale miners in Papua New Guinea. Following Deanna Kemp and John Owen, our focus is on disaggregating the various forms that small and large-scale mining interactions can take understanding that each form is unique (Kemp and Owen, 2019). The task of constructing a typology is challenged by the general absence of documented cases across a variety of different national contexts, where sufficient evidence is provided on the relationship between the two 'sectors' to support the development of analytical or descriptive categories.[3] Nonetheless, it is possible to identify basic criteria that give rise to different interface types. Fig. 1 provides examples of interfaces based on the minerals and metals targeted by miners and the location of these activities.

This typology prioritizes proximity to minerals and metals as the primary determinant in the development of small and large-scale mining interfaces, emphasising the centrality of land in these zones of entanglement. As we explain below, in Papua New Guinea the majority of interface cases represent examples of 'Type 3' and 'Type 4' where small and large-scale miners target gold in different areas within the mining concession or in the same location, reflecting the broader competition between companies and communities over access to land and resources. Constructing the typology so as to focus on minerals and metals within the formal legal mining concession draws attention away from points of interface in other geographic areas, and in arenas of activity where miners may not be in direct competition (or at least at the time of analysis). The purpose of the base typology is therefore not to narrowly confine exploration and analysis of interface types to a pre-defined range, but to provide the basis for categorisation and contrast using known factors that drive engagement between small and large-scale operators.

Other factors necessarily shape the dynamics of these interfaces. For instance, there are temporal and spatial dimensions to interface patterns, such as the lifecycle and the size of the project. Access to minerals and metals, which can vary over time and among different actors, is another critical axis for consideration. We can usefully consider whether minerals and metals are geologically accessible for small and large-scale miners (e.g. hard rock mining or targeting tailings), and whether these materials are geographically and socially accessible – in terms of people accessing the site for small-scale mining activities, and how access changes as large-scale projects introduce new transport infrastructure or as local social relations and in-migration patterns are transformed (e.g. Bainton and Banks, 2018). Other factors include the variability in pricing or the demand for certain types of resources. As Gavin Hilson and his colleagues have recently argued, large-scale miners tend to be more forgiving, even accommodating, of small-scale activities on their lease when prices are low, but become increasingly intolerant to other interests once prices rise (Hilson et al., 2020). And, of course, these interface moments take place within specific social, historical, cultural, and political, policy, and economic contexts that must be understood across different scales (local, regional, national). These factors have proven to be significant in shaping how small and large-scale miners conduct their activities and respond to one another. To this end, Fig. 2 presents a range of potential axis dimensions within these zones of entanglement, incorporating the matrix of competing interests and proximity to resources presented in Fig. 1.

A historical perspective in categorising interface types is essential if only for the simple observation that circumstances change, and with them, the conditions that shape interface dynamics. Land, labour and capital in these settings are almost never static. Settlement patterns evolve and disperse over time, the composition of resident groups will change, mining activities, and the industrial complex that supports it will, in all likelihood, grow. Policy frameworks may evolve with the priorities of multilateral organisations, just as their implementation is often contingent upon political interests and state capacity. Relationships between landowning groups, local and national business interests, mine employees and the mining project is likewise subject to change – and each of these present possible interface arenas in their own right. In applying the base typology to the following case examples from Papua New Guinea, we highlight areas of contestation between small and large-scale miners. Historical, social, and political context, showing the influence and effect on land, labour and capital, provide the additional means through which to ground our analysis.

3. Small and large-scale mining in Papua New Guinea

Resource extraction has a long lineage in Papua New Guinea. Although gold mining was not a traditional pre-colonial activity, the original inhabitants of these islands have been extracting and utilising other mineral resources for practical and ceremonial purposes for thousands of years. Mineral resources attracted Europeans to the region, from the Spanish explorer Álvaro de Saavedra who named the islands off the north coast of New Guinea the *Islas de Oro* (Golden Islands) during his voyage across the Pacific in the late 1520s, to the European and Australian prospectors who explored Papua New Guinea throughout the colonial period (1884–1975). The alluvial gold rushes that occurred during the late 1800s and the early twentieth century (Nelson, 1976) paved the way for future large-scale developments just before the transition to independence in 1975. Recent estimates indicate that some 20,000 people are directly employed by large-scale mining companies, while a further 25,000 people are indirectly employed through contractors and local businesses servicing the industry (Bainton and Jackson, 2020). In 2018, mineral exports contributed to 84% of the total value of all exports (Bank of PNG, 2019: 14), underscoring the nation's heavy reliance upon extraction.

Unlike many other post-colonial nations, the indigenous inhabitants of Papua New Guinea have more or less retained customary ownership over their ancestral lands, which means that the vast bulk of the nation's landmass remains under customary forms of tenure. These rights have been enshrined in the constitution and reinforced through various acts of parliament. The national mineral policy framework therefore requires the identification of the customary landowners of potential project areas in order to establish who is entitled to receive specific project-related benefits. This also means that 'mine affected' communities exercise greater rights over the extractive activities occurring on their ancestral

[3] Existing literature on this topic is mainly limited to West African settings. See for example: Aubynn (2006, 2009), Bolay (2016), Katz-Lavigne (2019, 2020), Luning (2012), Smith et al. (2017), and Teschner (2013).

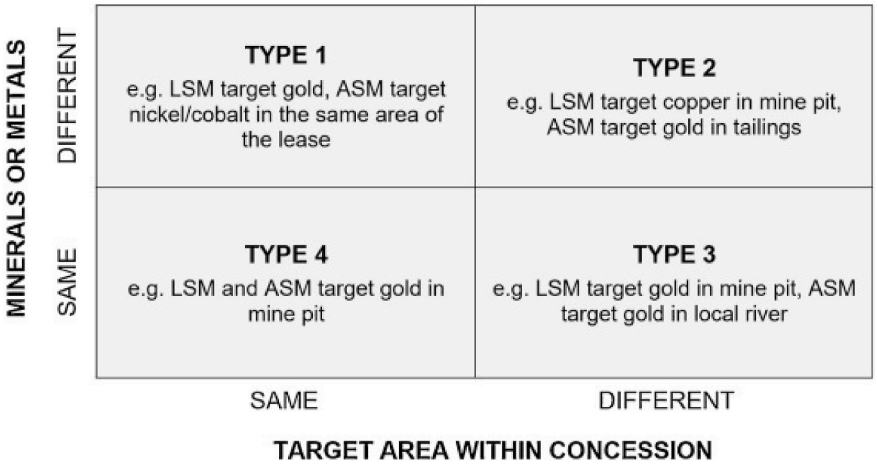

Fig. 1. A base typology of ASM-LSM interfaces (Source: Kemp and Owen, 2019).

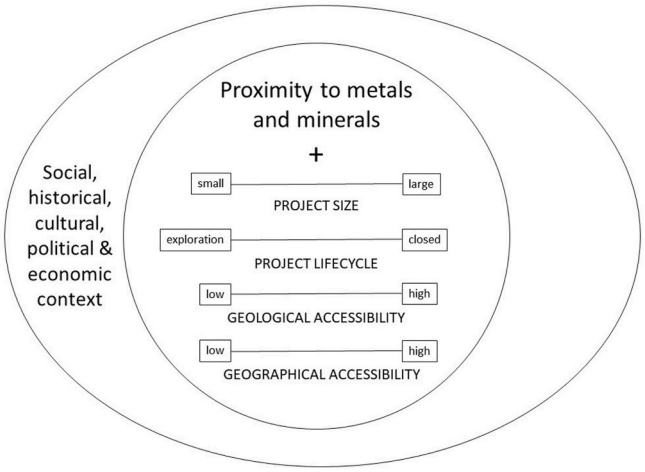

Fig. 2. Axis dimensions for characterising small and large-scale mining interfaces (Source: authors).

lands compared with indigenous groups in other countries. Under the terms of the *Mining Act* 1992, customary landowners may also undertake small-scale mining activities on their land without the need for prospecting or mining leases.

The development of the small-scale mining sector has been a relatively recent phenomenon in Papua New Guinea. Although Europeans had been mining here for some time most Papua New Guineans were only involved as labourers and did not mine for gold in their own right. It was not until the 1950s and 1960s that individual small-scale mining by Papua New Guineans really began in earnest. The Papua New Guinea Mining Cadastre Portal currently lists eight small-scale mining leases, but this hardly reflects the extent of these activities across the country.[4] Most of these mining activities occur in remote rural areas on customary land. As a result these activities are generally informal, unregulated, and untaxed. This form of work is precarious and labour intensive. Methods include panning, sluicing, dredging, and manually searching for alluvial gold. Mercury is commonly used for processing and presents a major health risk. As a result, miners and their families carry great risk – this is demanding work in unsafe conditions. In these and other mundane ways, rural poverty is inscribed upon the bodies of rural people.

No systematic evaluation of the small-scale mining sector has been made since the start of the millennium when 50,000–80,000 miners were believed to have been working in Papua New Guinea (Susapu and Crispin, 2001). Recent estimates converge on 60,000 people and about 4 tonnes of gold annually.[5] Although it is possible to update these figures to account for population growth, the availability of gold and people's access to it (geologically, geographically and socially) are much greater determining factors in calculating the total amount recovered.[6] Compared to other countries, especially throughout sub-Saharan Africa where governments and multilateral organisations have worked to 'formalise' this sector (Hilson et al., 2017), in Papua New Guinea there has been very limited institutional or policy support for small-scale mining. Using funds from the European Union, in 2009 the Mineral Resources Authority established a Small-Scale Mining Training Centre at Wau in Morobe Province, which has been the site of almost continuous small-scale and semi-mechanized mining activities since the 1920s. However, these training services remain inaccessible for the vast majority of impoverished miners throughout the country.

While the small-scale mining sector remains relatively undeveloped, the large-scale mining sector has steadily expanded through a succession of projects that have caused numerous controversies, conflicts, and disasters (see Fig. 3 and Table 1 below). The first large-scale mining operation in Papua New Guinea was the Panguna copper mine on the island of Bougainville. The development of this mine in 1972 provided the economic base to support the transition to independence and played a major role in the de-colonisation process. Within a number of years, the social and environmental impacts of the mine had sparked a local resistance movement, which eventually resulted in the forced closure of the mine in 1989. The violence then escalated into a decade-long secessionist conflict between the Bougainville Revolutionary Army and the state of Papua New Guinea. In 2019 a referendum was held to determine whether Bougainville should become an independent nation, to which the majority of Bougainvilleans voted 'yes'. But as we shall discuss below, these political developments have been inseparable from the persistent question of whether or not the Panguna mine should be re-opened.

Against the background of this evolving crisis, the government has strengthened its commitment to extractive-led development. In 1981,

[4] The portal is hosted by the government regulator for the mining industry, the Mineral Resources Authority. The portal can be accessed on the MRA website: www.mra.gov.pg.

[5] See for example Papua New Guinea Investment Promotion Authority website (accessed 30 June 2020): https://www.ipa.gov.pg/agriculture/mining/.

[6] The 5.3 million people counted at the 2000 census will have grown to 9.3 million in mid-2019 at the National Statistical Office-quoted rate of 2.7% p.a., or by 1.75 times. An update of Susapu and Crispin's estimate solely on the basis of population growth is therefore 88,000–175,000 people and 7 tonnes of gold annually.

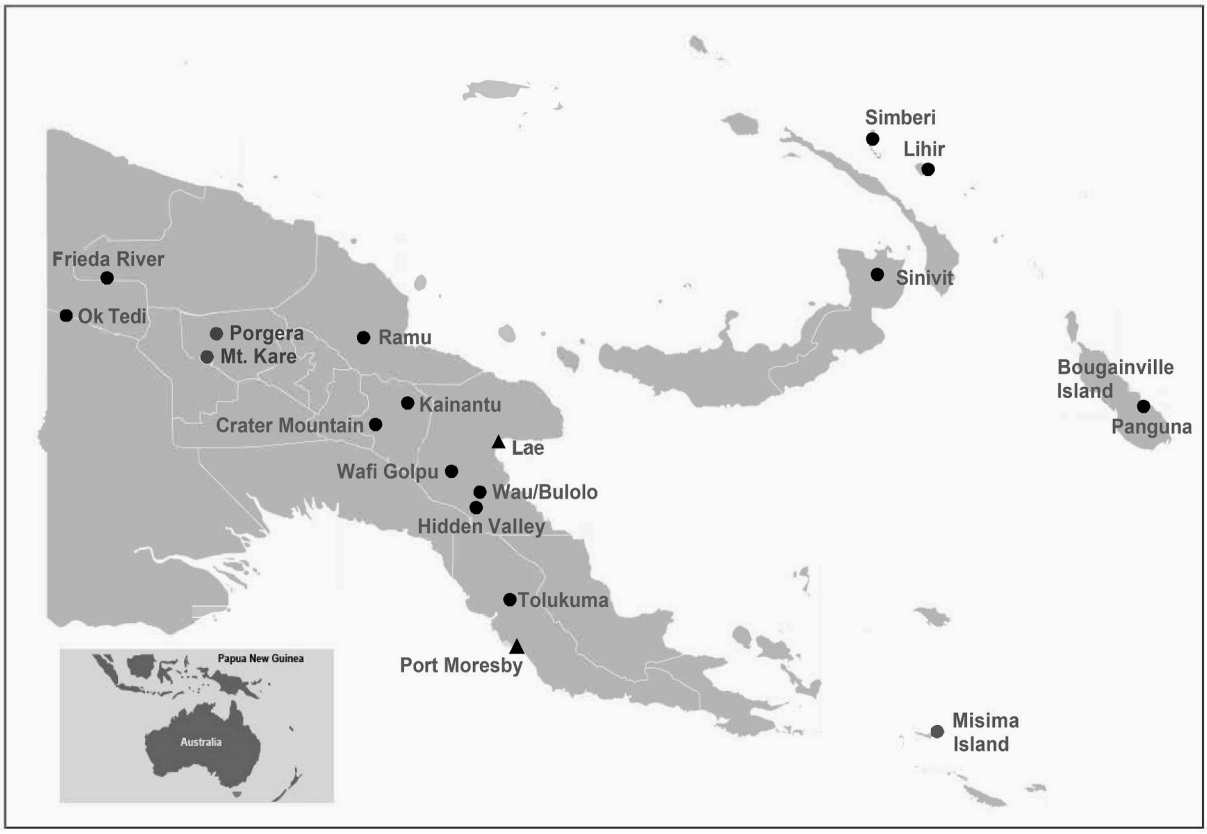

Fig. 3. Large-scale mining projects in Papua New Guinea.

Table 1
LSM-ASM interfaces across three categories and according to 'type' (based on Fig. 1).

Category	Mining project	Provincial Location	ASM-LSM interface	Interface type (proximity to metals)
Operating	Ok Tedi	Western	Yes	Type 2
	Porgera	Enga	Yes	Type 3 & 4
	Lihir	New Ireland	No	–
	Hidden Valley	Morobe	Yes	Type 3
	Ramu Nickel Mine	Madang	No	–
	Simberi	New Ireland	No	–
	Kainantu	Eastern Highlands	Yes	Type 3
	Crater Mountain	Eastern Highlands	Yes	Type 3
Non-operating	Panguna	Bougainville	Yes	Type 3 & 4
	Misima	Milne Bay	Yes	Type 3
	Tolukuma	Central	Yes	Type 3
	Sinivit	East New Britain	Yes	Type 3
Future	Frieda River	Sandaun	Yes	Type 3 & 4
	Wafi-Golpu	Morobe	Yes	Type 3

the giant Ok Tedi gold and copper mine opened on the opposite side of the country in the remote Star Mountains in Western Province. When the mine operator failed to develop a tailings dam, the state endorsed decisions to dispose of mine waste in the Fly River, creating an unprecedented environmental disaster. The affected communities living downstream from the mine then launched court proceedings in Australia against BHP as the operator of the mine, eventually forcing the company to walk away and hand the operation to the state in 2002 (Banks and Ballard, 1997). Before this 'slow motion' environmental disaster had fully unfolded (Kirsch, 2014), negotiations were already underway to develop a gold mine on Misima Island in Milne Bay Province, and at Porgera in Enga Province in the highlands. The Misima mine opened in 1989. It generated fewer ecological impacts compared to Ok Tedi, but the period of operation was notably shorter, and the mine closed in 2004 due to the low price of gold at the beginning of the millennium. Several junior companies have since explored the option of re-opening the mine, but local communities have mixed feelings about these prospects, caught between their desire for renewed economic development and their fear of recurring social and environmental impacts. Meanwhile the Porgera gold mine, which opened in 1990, has generated a profound legacy of harm through ecological destruction (Jacka, 2015), the uneven distribution of mining benefits (Golub, 2014), uncontrolled in-migration to local project area communities, resettlement failures (Kemp and Owen, 2015), and escalating conflict and human rights abuses (Burton, 2014).

Several years after operations began in Porgera, an agreement was reached to develop a large-scale gold mine on the main island in the Lihir Group, located off the east coast of New Ireland (see Bainton, 2010). Operations commenced in 1997, and are now set to continue until at least 2045. These large-scale mines were accompanied by the development of numerous medium-sized mines, including the Tolukuma

gold mine, which was developed in 1994 and then subsequently closed in 2013 following a series of environmental and operational failures. In one way or another, each of these projects have produced complex social and environmental legacies that undermine any positive contribution that these mines might provide to local communities or the nation as a whole. Despite the harm generated by these industrial activities, the state has remained committed to extractive capitalism as a pathway to development. Several prospective projects are in the advanced stages of exploration, and two are now advancing towards the final planning and permitting phases. The proposed Wafi-Golpu mine in Morobe province, which is also home to the Hidden Valley mine and the historic Wau-Bulolo mining district, will be the first large-scale underground mine in the country. Drilling campaigns and landowner negotiations have been ongoing since the CRA mining company was awarded an exploration licence in 1980, although European miners have been prospecting in this area since the early 1900s. Further north in Sandaun Province, exploration activities have been taking place at Frieda River for more than 50 years, with several previously failed attempts to develop this large low-grade copper deposit (Skrzypek, 2020). Both of these projects have recently released their environmental impact statements for public review, however, both ventures are currently advancing slowly due to social and political factors, including the rather difficult question of what to do about the scores of small-scale miners living and working in close proximity to these project sites.

4. Dilemmas at the interface

At almost every mining project in Papua New Guinea there is some type of interface with small-scale miners. The dynamics of these interfaces vary with project size, geology, and social context (as reflected in Fig. 2 above). They also vary over time from the exploration phase through to the post-closure era. For the sake of convenience, we can group these mines into three basic categories: operating mines, non-operating mines, and future mines. There are some overlaps between the last two categories, when interests arise to reopen or redevelop 'closed', 'non-operational' or 'abandoned' mining projects. Table 1 groups individual mining projects in Papua New Guinea according to these basic categories, and situates them in relation to the different interface 'typologies' (based on proximity to minerals and metals) presented in Fig. 1. In this section, we describe and characterise the interface between small and large-scale miners across these three categories. The cases we describe are illustrative of the broader set of interface dilemmas encountered throughout the country.

We begin with the relationship between small and large-scale miners at the Porgera gold mine, which represents a kind of 'elementary' interface typology in Papua New Guinea, owing to the violent convergence of interests between the company and the community in both the mining pit and other parts of the concession. Indeed, in some circles, the 'Porgera interface' has attained an almost mythical status, reflecting the complex entanglements between land, labour and capital. This justifies slightly more attention to this case, followed by shorter examples from Misima and Bougainville, and finally the Frieda River project.

4.1. Operating mines (Porgera)

A milestone in Papua New Guinea's legal history was set when a local villager, Puluku Poke, copied the Australian miners who held alluvial leases at Porgera and began mining for himself on the Lower Porgera River. In the 1950s, the area was still deemed 'uncontrolled'[7] and Puluku famously walked 50 km out of the area to a government station where, on May 27, 1958, he declared a parcel of gold and received £225 for it (approximately AUD 3470 in 2019).[8] The Department of Mines suspected him of mining on the lease of an Australian miner – an early 'informal small-scale mining'-'formal small-scale mining' entanglement – but in court in 1959 Puluku proved that he was working on his own land. Once the colonial authorities had recovered from the shock of discovering what Jerry Jacka calls 'uncontrolled natives with bank accounts' (Jacka, 2015: 68) it became an established principle that customary landowners were free to do alluvial mining on their land without holding leases.[9]

By 1988, as Placer Dome sought to develop a hard rock mine at Porgera, a report written for the company estimated that 75% of able-bodied males spent some of their time working alluvial gold (cited in Jacka, 2018: 124). Small-scale mining was particularly important to people in the Lower Porgera area where Puluku was still an active figure (Jacka, 2007, Fig. 2). However, the national government was troubled by environmental impacts at two existing large-scale operations. At Ok Tedi in Western Province, the consortium partners were wavering about the viability of following the agreed mining plan, which included completing a tailings dam, prompting the government to order the mine closed for some weeks, allowing it to re-open only after a commitment to build additional infrastructure, including the dam (Canberra Times, 1985, March 21). On Bougainville, militant landowners began a campaign of sabotage against the infrastructure of Rio Tinto's Panguna mine on November 26, 1988, citing environmental damage (partly as a result of riverine tailings disposal) and making a demand of PGK 10 billion (USD 11.6 billion in 1988) in reparations. As a result, the Minister for Environment and Conservation, Jim Yer Waim, pushed for a dam to be built at the next mine, Porgera, over which he would have jurisdiction[10]:

> I hereby reject the company's preferred option disposal of treated tailings direct in the river and will require the construction of an impoundment dam. (Jim Yer Waim to Placer General Manager, November 29, 1988).

In the end, the tailings dam was never built. However, what impacted alluvial miners at Porgera was not initially tailings from the process plant. After construction was approved, faulty geotechnical assumptions saw a waste rock dump fail. A seven million cubic metre 'mud glacier' descended 4.5 km down Maiapam Creek into the Porgera River between 1989 and 1992, destroying gardens as it advanced and burying the alluvial gold targeted by local miners under metres of sediment (PJV, 2002, Fig. 2.1; Jacka, 2018, Fig. 5.2). In pre-project documentation, sediment run-off from the rock dump had been predicted to be slight and to have 'negligible long-term negative impacts' (Porgera Environmental Plan, cited in Sullivan et al., 1992: 3). After the fact, though, it became known as the 'Anawe Erodible Dump' (e.g. PJV, 2002, Fig. 2.1; MMSD, 2002: I-8). When the regulators showed no signs of holding the company accountable for this engineering failure, local activists led by Opis Papo, a geology graduate, and the aforementioned Puluku Poke formed the Porgera River Alluvial Miners Association (PRAMA) to press their case for compensation. Four factors make what seems on first sight to be a straightforward case of a large-scale mine affecting a pre-existing small-scale mining economy far more complex.

Firstly, inequalities engendered by the development of the mine has led to conflict in the local community. For 30 years, people in the Lower

[7] The Australian Administration only permitted its own patrol officers to enter the area and barred access to the area to outsiders such as traders, missionaries etc.

[8] At the labourers' standard rate of £1/10 per month, Puluku's gold, earned in about three months, was worth more than a labourer could earn in 12 years.

[9] This is now formalised in the *Mining Act* 1992, §9(2) as 'any natural person who is a citizen may carry out non-mechanized mining of alluvial minerals on land owned by that natural person' (see Golub, 2001: 205–209; Biersack, 2006; Jacka, 2015: 64–68).

[10] The two mines were subject to national legislation passed in 1967 and 1976. The *Environmental Planning Act* 1978, Papua New Guinea's first environmental legislation, was not retrofitted to either mine.

Table 2
Growth in the population of Porgera (Sources: Banks, 1997; Burton, 1992; NSO, 2014).

Year	Method	Population	National growth rate	Actual growth rate	Migrants(estimate)
1957	Patrol Census	2020	–	–	<10
1980	National Census	5029	–	–	<200
1990	National Census	10,405	+2.7%/year	+7.5%/year	~3840
2000	National Census	22,809	+2.7%/year	+7.8%/year	~9230
2011	National Census	45,111	+3.0%/year	+6.4%/year	~13,540

Porgera area had the better access to alluvial gold-bearing deposits, and their consistently higher incomes from small-scale mining enabled them to establish a dominant position in local politics. However, when mine benefits began to flow in 1988, a new set of actors in the Upper Porgera area received the lion's share, causing reversals of fortune (e.g. Golub, 2014; Jacka, 2015: 75–76). This can be quantified at about USD 40 million in land compensation and royalty payments over the first five years.[11] This became even more concentrated from 1997 when dividends from the 2.5% local equity in the project, originally intended to be spread across a wide area, went only to the Porgera Development Authority (PDA)[12] and the landowners of the Special Mining Lease (SML).

The social organisation of all the people of the Porgera Valley does not fit the long-standing national doctrine that Papua New Guinea's 'customary landowners'[13] are determinable as discrete groups of people who can be mapped, one-to-one, onto bounded land parcels, as assumed by the *Lands Act* 1996 and its predecessors and expressed by the PNG Law Reform Commission in the statement: 'all automatic citizen Papua New Guineans are born *into one clan* or such other social unit' (CLRC, 2008: xi; emphasis added). In Porgera, though, people are free to derive land rights from any ancestor they can show they are descended from (Burton, 1992; Golub, 2007, 2014). The net result was that a precondition for inequality was created when seven fixed 'clans' and twenty-three 'subclans' – in reality lines of descent with no corporate existence – gained recognition. The vehicle for inequality itself was the consequent nomination of twenty-three individuals to be 'agents' for the lower-level lines of descent, which made them representatives of others they rarely encountered. In advice to the then Department of Environment and Conservation, Colin Filer categorised this as the 'stratification' effect, where mine development gives rise to 'new forms of inequality, division and conflict within the community' (Filer, 1992: 6) and later it prompted Alex Golub to say that the Special Mining Lease landowners were 'hung on a hook' to make the Porgera agreements possible (Golub, 2007: 80).

The process of consolidating fluid, negotiated systems of rights into rigid structures in the 'desire to standardise the social organisation of customary landowners' (Filer, 2007), a process which Thomas Ernst (1999) termed 'entification', has been discussed by anthropologists working all over Papua New Guinea. In many of the cases presented, the creation of inequality has generally been raised in respect of outlying groups who stand to be marginalised by exclusion.[14] In Porgera, though, both the included *and* the excluded are caught up in conflicts generated by entification. Conflict has never been far from the surface in Porgera; indeed, Jacka quotes a Porgeran as saying 'war is wealth' (*yanda takame*) (2015: 220). But since 1990, cash flows from the mine, which pass from the direct recipients to their relatives at one remove from the leases,[15] have escalated into dangerous gun-fighting (Wiessner, 2010), with the deaths of a hundred people occurring in eastern Porgera alone between 2004 and 2012 (Jacka, 2016).

Adjacent to the mine, the 'Lower Maipangi' conflict of 2005–2006 was triggered by an argument among closely related families over the distribution of compensation (Post-Courier, 2005; Jacka, 2015: 225). While tribal fighting is normally difficult to research directly, the priest-researcher Philip Gibbs was passing through Porgera Station in 2006 and gave a graphic eye-witness account (pers. comm. to Burton). After the conflict had caused damage to property valued at PGK 3 million and led to the gunshot deaths of at least 27 people, local leaders called for a state of emergency to be declared (Post-Courier, 2006; cf. Burton, 2018a).

Secondly, the perception that Porgera is a place of wealth leads directly to the topic of migrant small-scale miners (Bainton and Banks, 2018). A short sketch of the changing demography of Porgera is necessary to show the scale of the influx (Table 2). The first census was conducted in 1957 by a visiting Australian patrol (Banks, 1997: 65) and may be treated as a good estimate for the time. The first nationwide census was in 1980 when there may have been less than 200 outsiders present, in the form of mission staff, teachers, and the pre-mine exploration workforce (Banks, 1997: 83).

The rate of growth, and after taking into account the resident mine workforce, is far in excess of national intercensal growth rates and, with reservations about the quality of the 2011 census, some 10,000 migrants were likely to have been living in Porgera by 2011. They were drawn from areas beyond the Porgera Valley, notably from Laiagam and Paiela in Enga Province and from Tari in Hela Province. Their principal means of livelihood was what Barrick Gold (then owner of the Porgera mine) has termed 'illegal mining'.

For the last fifteen years, and perhaps longer, small-scale mining in the mining lease itself has taken several forms. A clearly illegal form is when young men climb through or over the security fence to hide in concealed locations within the exclusion zone during blasting, such as in disused tunnels in the pit wall, and scramble to gather gold-bearing material before guards can secure the pit again. Images circulating on social media show hundreds of men descending upon the freshly blasted material to quickly grab 'free' gold. The rock is then taken away in bags to be crushed and mixed with mercury in the settlements, and the gold recovered by 'cooking' gold amalgam using basic household utensils. A second method, only slightly less dangerous due to the need to evade security patrols, is to steal material from the various stockpiles at night. A last, arguably not illegal, method is small-scale panning below the decant pipe of the mine (see Fig. 4).

Conflict between locals and migrants was previously uncommon, as migrants depend on the goodwill of their hosts for permission to live in Porgera. A new development was when the resettlement village of Apalaka (Burton, 2014, Fig. 2) – wholly within the mining lease and where John Burton counted 1260 residents in 2007 – was burnt down in

[11] At prevailing rates per Bank of PNG. Much more has been paid since 1994 (Johnson, 2012).

[12] Filer (2004) gives an account of the PDA. Intended to catalyse development in Porgera, by 2010 it could not account for the expenditure of at least PGK 240 million received since 1990 and had lost any capacity to implement infrastructure projects (Johnson, 2012: 75). In 2018, a new chairman said the PDA was 'not functioning' (LoopPNG, 2018).

[13] Term used 33 times in the *Lands Act* 1996.

[14] See, for example: Jorgensen (1997); Wesch (2008); and Dwyer and Minnegal (2018).

[15] Early in the mine life, Glenn Banks reported that 40–55% of compensation money was passed to secondary recipients. Banks, 1993. *Economic Modelling Project. Porgera Social Monitoring Programme Report No. 1*. Canberra and Port Moresby: Unisearch PNG Pty Ltd for PJV, pp 27.

Fig. 4. Women panning for residual gold in tailings at the Porgera gold mine. Courtesy of Human Rights Watch (2010, Cover image). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

August 2017, with loss of life, during a conflict between migrants and locals over the theft of alluvial gold. John Owen was able to overfly the devastated area a few days later and to witness the scale of destruction at first hand. Conflict between the mining company and trespassers entering the pit has at times overwhelmed the mine's ability to cope, most recently in December 2019 when 'armed warring factions of illegal miners, believed to be from Tari' fought running gun battles in the pit itself (PJV, 2019, December 19).

Thirdly, a different dimension of the relationship between Barrick and small-scale miners in the local community concerns the bashing and sexual abuse of women attempting to gain a livelihood from gold panning by security guards (e.g. Harvard Law School, 2009; Human Rights Watch, 2010; Amnesty International, 2010). After several years of denial, Barrick reversed its position and accepted that security guards, whether on its own staff or employed by its contractors, had indeed committed abuses. It promised to retrain its security force and to make amends through a 'Remedy Framework' (PJV, 2014).[16] Victims were typically marginalised women, whether Porgerans, migrant women married to Porgerans, or 'free' migrants, driven to very low-technology small-scale mining to earn enough to provide for themselves and their children. This speaks to broader failures of rural development in Papua New Guinea as seen elsewhere globally (e.g. Hilson, 2009; Hilson and Garforth, 2012).

Fourthly, returning to the burial of alluvials under the 'mud glacier' in the early part of the mine life, this had political ramifications well beyond simple equations about loss of livelihoods. The issue came to a head in 1994–95 as the Porgera Joint Venture was seeking a permit for its proposed Stage 4B mine expansion, designed to increase the mill throughput from 7000 tonnes/day to 17,800 tonnes/day. Obviously, this would intensify river damage, not rectify the damage already done. At the Stage 4B Water Use Permit Hearing in July 1995, PRAMA supporters packed the meeting hall and threw the PJV representatives to the floor, kicking and beating them. Opis Papo wrote to the company afterwards, saying, 'If you point finger [sic] and say that criminal elements have disrupted the meeting, we will have no option to point out the same to your company'. In the *Post-Courier,* one of the country's daily newspapers, he was quoted as saying that the PJV were 'thieves and were stealing gold', at which point the company launched a short-lived lawsuit against him for defamation. Lawyers acting for PRAMA had demanded PGK 24 million in compensation for the lost alluvials and a period of stand-off ensued after the State Solicitor pointed out that under Section 154(4) (b) of the *Mining Act* 1992 no-one needed to pay compensation to landowners for the loss of alluvial gold deposits because all minerals belonged to the state. The Stage 4B expansion was approved late in 1995 with no resolution of PRAMA's issues in sight. This was solved in January 1996 when the Minister of Environment and Conservation, Paul Mambei, made a 'Ministerial Determination' under the *Water Resources Act* 1986 whereby PGK 15.2 million[17] would be paid to the aggrieved landowners over a period of years.

PRAMA began to fragment after this. Breakaway landowners formed the Lower Porgera Independent Landowner Group (LPILG), demanding to be paid directly by PJV as they did not trust PRAMA to distribute the money fairly. Nonetheless, Opis Papo was elected as the MP for Lagaip-Porgera at the 1997 national elections, serving one five-year term as a member of the newly-formed People's Resource Awareness Party (PRAP). Both PRAMA and PRAP still exist, and as recently as mid-2019 PJV responded to PRAMA's claims that there were still outstanding amounts due under the 1996 Ministerial Determination. In response, PJV said it had actually paid out PGK 48 million and all back payments were up to date (PJV, 2019, June 20).

In summary, the loss of the riverine alluvials, which took away the livelihoods of Porgera's historic small-scale miners of the Lower Porgera area and diminished the influence of men like Puluku Poke, coincided with a sudden flush of wealth, and the rise of multi-million kina business interests, in the Upper Porgera area. This was the key disruptive effect for local Porgerans in the first fifteen years of mine operations. The build-up of inequalities, compounded by grievances arising with the complexity of land rights in Porgera, generated a high level of internal conflict throughout Porgera. An extraordinary homicide rate prevailed in Porgera for sustained periods – estimated at 103/100,000 head of population 2002–2006 (Burton, 2014, Table 1) – and shaded the 'orthodox' problem of small and large-scale mining interfaces. In the second fifteen years, overcrowding in the Special Mining Lease, made acute by the in-migration of some 10,000 people from neighbouring areas and the company's problems with resettlement, and its failure to safeguard women has layered new kinds of conflict over the top of existing grievances simmering in the mine area communities.

4.2. Non-operating mines (Panguna and Misima)

When large-scale mining operations cease this can create new opportunities for engaging in small-scale mining as previously inaccessible areas or resources within the mining concession are 'opened up' and as lease area boundaries are no longer enforced. At the same time, poor forward planning to manage the economic transition away from industrial-led development can also result in situations where local mine affected communities are forced to revert to subsistence agriculture and other precarious livelihood activities, like small-scale mining, in order to survive.

On Bougainville and Misima Island a thriving small-scale mining economy has emerged in the post-mining era. The origin and closure of the Misima and Panguna mines are, of course, characterised by different historical moments. The Misima gold mine is the first mine in Papua New Guinea to complete the full project lifecycle from exploration to planned decommissioning and environmental rehabilitation of the site. However, the 'social aspects of mine closure' (Bainton and Holcombe, 2018) were insufficiently incorporated into the closure process, which is now reflected in the near total collapse of the economy and service provision on the island. Similar to Bougainville, people have turned to small-scale mining in response to rural impoverishment. As one Misiman miner remarked to Simon Kenema in 2019, alluvial mining is now their 'daily bread and butter'.

Misima has had a much longer and continuous experience of small-

[16] It remains in question as to whether this has been successful (Aftab et al., 2016).

[17] The equivalent of USD 11.4 million at the time.

scale mining that stretches back to the late 1800s, which meant that by the time large-scale mining commenced in 1989 local residents were already very familiar with resource extraction. Whereas on Bougainville, small-scale mining was non-existent before the conflict in terms of its current scale and ubiquity. Small-scale activities emerged within the context of a war-ravaged economy, and the total abandonment of the Panguna mine site after Rio Tinto was forced to leave the island in 1989. Despite the historical presence of colonial miners in Kupei and Panguna in the 1930s (O'Faircheallaigh et al., 2016), the emergence and salience of post-war small-scale mining activities can be regarded as an entirely novel phenomenon. Contemporary small-scale mining in Bougainville can be traced to the spontaneous burst of panning activity in the Panguna mine tailings along Kawerong and Jaba Rivers in the late 1990s. The activity reached its zenith in the early 2000s as thousands of Bougainvilleans and other Papua New Guineans were attracted to Panguna by the prospect of an income. With the discovery of other deposits outside of Panguna small-scale mining activities soon spread to other regions on the island. By the time the Autonomous Bougainville Government passed its mining legislation in 2015 (*Bougainville Mining Act*, 2015), which contained provisions for community-based regulation, small-scale mining had expanded from an obscure activity localised in Panguna into a major economic undertaking occurring across the island.

In both cases local miners have developed sophisticated mining techniques. On Misima, miners use a combination of hydro-sluicing, hard rock mining, dredging, mechanical pumps, sluice boxes and panning, and hoppers and strainers. Hydro-sluicing appears to be the favoured method, and some miners have invested a good deal of money in piping supplies to ensure a continuous flow of water to help expose new extraction sites. The net result of these activities is intense competition over access to water sources, evidenced through the commonly used Tok Pisin expression '*yu gat wara, yu gat moni*' (literally, 'if you have water, you have money'). On Bougainville, particularly in the Kieta and Panguna areas, local miners have developed semi-mechanized methods for extracting and processing gold using derelict equipment from the Panguna mine. This innovation can be attributed to the peculiar materiality of sudden mine closure, and the local reclamation of a post-industrial landscape.

The capacity of local governments to regulate small-scale mining and its social and environmental effects remains limited at best. While there is at least a policy focus in Bougainville to manage small-scale mining through community-based regulation and the establishment of 'designated areas' (Corbett, O'Faircheallaigh and Regan, 2017), there have been many difficulties surrounding the implementation of this policy (O'Faircheallaigh et al., 2017). Local efforts are largely directed at managing access to sites and the division of labour. Similar challenges have arisen in Mimisa, and there is evidence that unregulated mining activities are causing increased erosion and sedimentation of local waterways. There have been various attempts to designate specific areas for small-scale mining. However, unlike Bougainville, these efforts have mainly been promulgated at the local level with the support of the Misima Alluvial Miners Cooperative, which notionally represents the interests of small-scale miners on the island. This endeavour has been partly driven by concerns about the return of large-scale mining and the risk of future displacement.

4.2.1. *The politics of access*

Debates about re-opening the Panguna mine or the development of other deposits in Bougainville are couched within the larger set of debates occurring on the island about the need for an economic base to support future autonomy or independence. These debates are complicated by the legacies of the Panguna mine and the conflict, and as a result there is little consensus among Bougainvilleans as to whether large-scale mining should be permitted in the future. Some landowners vehemently oppose mining of any kind, while others consider reopening the Panguna mine as the most realistic pathway to fiscal self-reliance. In between these poles there are a variety of positions, including those who think that small-scale mining is the most appropriate economic road to maintain local sovereignty over land and resources. Although Rio Tinto may have walked away from its environmental and social responsibilities in Bougainville and evidently has no desire to re-open the Panguna mine, a host of other small and medium-sized mining firms have expressed their interest in this project. Many of these companies have entered into complex arrangements with local landowners – several of whom operate their own small-scale mining ventures – in the hope of securing rights to Panguna and other deposits. These foreign interests have added several layers of complexity to an already fluid and dynamic mining landscape on the island (Regan, 2017: 390–402).

Any future large-scale resource development on Bougainville will have to confront the legacies of the conflict, and it seems highly unlikely that the kinds of benefit sharing packages that have been negotiated elsewhere in Papua New Guinea will be sufficient to gain local support for new developments. In addition to these challenges, future projects will also have to contend with the competing rights and interests of small-scale miners working within the old Panguna concession and beyond. The Panguna area is fiercely contested, with a kaleidoscopic mix of foreign mining interests and competing landowner factions jostling for control. One of the more notable examples involves the Perth-based Australian junior mining company RTG Mining Incorporated that claims to be the 'landowner's developer of choice' for redeveloping the Panguna mine.[18] This company has supposedly entered into a joint venture with the Special Mining Lease Osikaiyang Landowners Association, a newly constituted entity purporting to represent the interests of the Special Mining Lease communities from Panguna. In another case that reflects the coalescence of competing interests, in the mid-2000s a local company called Jaba Industries was established with the support of landowners from the Jaba mine tailings area to secure alluvial mining rights over the Jaba tailings. The company was funded by a Chinese national, but the joint venture shut down in 2013 when disgruntled landowners set the gold processing equipment and mining camp on fire. The tensions and sensitivities surrounding mining – large and small-scale – have continued to escalate. In 2019, and again in early 2020, outraged landowners murdered two geologists (a Papua New Guinean and an expatriate) who were undertaking exploration activities in Bougainville at the invitation of local companies.

On Misima the situation is less convoluted and antagonistic. At present there is only one foreign company courting local landowners. In 2017 the Australian junior mining firm, Kingston Resources, acquired a 70 per cent stake in the Misima project and has since been conducting exploration activities and seeking investor support to develop a large-scale gold mine on the island. Most of the local small-scale mining activities are currently conducted within the exploration concession, but for the most part this has not directly impinged upon the interests of the company, resulting in far fewer tensions over access to land and resources. This moment of peaceful cohabitation will no doubt change if the project develops and the company secures its area of interest. A good number of individuals have expressed a preference for small-scale mining because it supposedly generates fewer impacts, and allows for greater community participation, which in their view, ensures that mining income is more widely distributed. When the original negotiations were underway to open the Misima and Panguna mines there was little need to consider small-scale mining interests. This will doubtless be a major point of contention and potential conflict in any future negotiations for large-scale mining.

4.3. *Future mines (Frieda River)*

Large-scale miners often encounter small-scale miners during the exploration phase. The presence of small-scale miners can sometimes provide large-scale miners with an indication or a 'map' of where to

[18] See: https://www.rtgmining.com/panguna/.

explore (Luning, 2014). But as the above examples show, large-scale miners soon find themselves entangled in negotiations with local miners and landowners for access to these areas, and there are plenty of cases around the world where explorations activities have been suspended or abandoned because they were 'over-run' by small-scale miners. In the case of the Frieda River project, early exploration activities precipitated local involvement in small-scale mining. Geologists working for Highlands Pacific detected gold in the Nena and Amosai Rivers and advised local residents of the gold in 1991. The geologists also explained how to identify and find gold. Although alluvial mining was not totally unknown to these communities, local residents apparently adopted alluvial mining methods rather quickly once the cash returns became apparent, and as a result, gold continues to be mined in these areas. In 1995, gold was discovered in the Ok Binai River and at Daptem in 2003, which led to a local gold rush that lasted for approximately five years.

Over the past 30 years, a lucrative small-scale mining economy has developed in this area, which provides the majority of households in Ok Isai and Wabia village, and various nearby communities, with an important source of income in the absence of any other economic opportunities. The combined resident population of Ok Isai and Wabia was less than 1000 people in 2019. However, the total number of people involved in the local small-scale mining economy is significantly greater owing to the high levels of in-migration to nearby alluvial working sites, and the involvement of surrounding communities in local trading networks, the provision of mining labour, and the supply of foodstuffs, material goods, and fuel.

Current plans for the development of the Frieda River copper mine include the construction of open pits and mine processing facilities. Mine waste, including tailings and waste rock, will be stored subaqueously in an 'integrated storage facility' (a dam) located on the Frieda, Nena, and Niar Rivers downstream of the mine site. This facility, referred to as the Frieda River Hydroelectric Project, will also be used to generate hydroelectric power for the mining project, and it is proposed that this will provide a source of energy for the wider rural region. Crucially, inundation following the establishment of the storage facility will mean that the villages of Ok Isai and Wabia will have to be relocated. This also means that substantial alluvial gold resources will be 'sterilised', closing off a major source of income to the local population.

The base socio-economic conditions in the province and the project area communities have been documented in a number of project commissioned studies (Frieda River Limited, 2018). On the surface, the people of Ok Isai and Wabia appear well off. In material terms, they have a higher standard of living compared with many other rural communities in Papua New Guinea (e.g. Burton, 2018b). The local gold trade has been central to improvements in these villages, and without it, food, security, transport, and access to health and education services would be greatly diminished. Local residents describe small-scale mining working sites as their 'ATM' or their 'bank', demonstrating their everyday reliance upon alluvial resources and the ease with which household members can engage in these activities when they need to access cash. Community members claim that life was very difficult prior to the development of the small-scale mining economy – it was considerably harder to access food, these places were more remote, and there was a greater absence of services. At the same time, this image of relative rural affluence threatens to mask the poverty risks and multi-dimensional forms of vulnerability that currently exist within this setting, local dependence upon small-scale mining to survive, and their heavy reliance upon the Frieda River project for very basic services including emergency medical airlifts.

The Frieda River project has been re-branded as the 'Sepik Development Project' to emphasise the social and economic development that will supposedly arise from this resource extraction venture. However, public commentary on the environmental impact statement for the mine indicates, among other things, that there has been insufficient attention to resettlement and livelihood restoration risks threatening those communities who will be displaced by this 'development project'. [19] Given that many households are thoroughly dependent upon incomes derived from small-scale mining, the loss of this income stream will have severe effects at the household level. A primary concern for local communities and the company is the issue of 'compensation' for loss of access to alluvial gold sites and related incomes – and this is likely to be a determining factor in the community consent process for the mine. While some community members expect to be compensated for this loss into perpetuity – reflecting the view that the alluvial resources would have provided them with a livelihood for generations to come – the Mining Act prohibits the payment of compensation for alluvial resources. Even if this payment is reframed and incorporated into the livelihood restoration strategies for resettlement, the difficulty of determining the value of artisanal-mined resources will present a major barrier to providing 'fair compensation'. Arriving at an agreed estimated value of the geological resource raises a range of technical and political issues. While there are established models for calculating the value of land-based assets, such as crops and houses, there is no equivalent for alluvial resources. And although the developers and the national government remain optimistic about the potential for this project to transform the regional economy, the experience at every other mining project in the country indicates that pre-existing vulnerabilities will be amplified for many local households and mining-related impacts will not be 'offset' by mining-related benefits.

5. Discussion and conclusion

Several patterns now begin to emerge from these cases and our grouping of these interfaces. For the most part, the interface between small and large-scale miners is characterised by competition over the same resource type (gold) across numerous spaces of mutual interest within the formal concession. Even in the case of the Frieda River project, where the company is ultimately targeting copper, it has a principal interest in the alluvial gold resources that it must first unearth or displace in order to reach the copper resources. Although each interface moment plays out under unique circumstances, they share a common dimension: land, and the resources contained on and underneath the surface, provides the primary pivot for these moments of articulation between capital and labour.

These interface scenarios (or dilemmas) also draw attention to the dynamics of capital accumulation and the 'extractive relations' (Owen and Kemp, 2017) that constitute these settings. In each instance, we find an ensemble of relations characterised by the unequal ownership of the means of production (land and capital), struggles over the control of these things, attempts to use capital and land to generate profits under competitive conditions, the uneven distribution of the burdens and benefits of extraction, and groups of people engaging in precarious livelihood activities or forced to sell their labour to survive (or both). As the situation at the Frieda River project and the Porgera mine demonstrates, large-scale miners have little to offer people who become landless, or who lose their access to critical livelihood resources, in development contexts where there simply aren't enough jobs or business contracts that provide a living wage. These extractive relations set the conditions by which profound inequalities will emerge and become cumulative, leaving some people stranded with 'no land, no work, no welfare, and no allies' (Li, 2014: 177).

These inequalities emerge as the interactions and entanglements between large and small-scale miners, and local landowners, reveal 'hidden' forms of value that are then unevenly distributed. As large-scale miners conduct their exploration activities, drilling hundreds of meters

[19] In 2020, the Australian based 'Environmental Defenders Office' coordinated a series of independent expert peer reviews of the Frieda River Environmental Impact Statement. The reports are hosted on the 'Save the Sepik' website: https://savethesepik.org/expert-review-eis-high-level-summary/.

into the ground, they unearth or 'discover' resources that were previously hidden from view. This 'discovered value' can take many forms – metallic resources, aquifers, or sources of energy – but in most cases value disproportionately accrues with large-scale miners at the expense of small-scale miners and local landowning communities. For example, at the Lihir gold mine, which is one of the few projects in Papua New Guinea where there is no interface between large and small-scale miners, the mining company has 'unlocked' the value contained in the geothermal field within the Special Mining Lease. What was once a 'common' resource in the form of hot springs, which community members used for a variety of purposes, has become a source capital accumulation for the company. By converting the geothermal steam into a source of energy, the company has reduced its reliance on heavy fuel to power the processing plant. These corporate 'cost-savings' are not passed on to the community in any form. While customary landowners for that specific parcel of land are compensated for the destruction of the surface of the ground, at present there is no legislation in Papua New Guinea to allow for the payment of geothermal royalties. Just as the discovered value of sub-surface metallic resources overwhelmingly accrues with large-scale miners, in Lihir, the company has captured the value of this geothermal resource. As a general point, we can therefore say that these conjunctures generate new expressions of inequality and extend the uneven accumulation of wealth.

Across these cases, the social relations of extraction are further complicated by demographic changes as migrants are attracted to these sites by the prospect of engaging in small-scale mining and the potential to make a living. At Porgera, in-migration has compounded the changes and challenges that landowning communities face as a result of large-scale mining, and in-migration will certainly create profound disruptions at the Frieda River project if the mine is built. The effects on land, water and environment are aggravated as the population grows, squatter settlements spring up with poor, cramped living conditions and environmental health issues, and, as 'local' identities and access to revenue streams become increasingly contested and spark violent confrontations (Bainton and Banks, 2018: 455).

These interfaces also entail a scalar dimension. At the smaller scale, the entanglement of resource rights, labouring bodies, economic flows, and livelihood risks generates a complex set of interests and issues, or what we can understand as the social relations of artisanal production. For the most part, these complexities and conflicts are managed as part of a 'coherent' system within these specific zones of small-scale extraction, characterised by a certain mutual understanding between landowners and miners, traders and brokers. At the most basic level, surface and subsurface rights are not distinguished in ways that alienate resource rights or disrupt the existing relationship between people and the environment, or radically transform what Marx would call the 'metabolic' relationship between humans and nature. On the other hand, at the larger scale we find a process of simplification that creates inconsistent cleavages between land, labour and capital. This process obscures the social relations of small-scale production and the rights and interests that exist within these settings. As we find at Porgera, these processes of simplification result in extreme forms of dispossession.

In addition to our main objective to expand the characterisation of these mining interfaces beyond the simple binary choice between pathfinders at prospecting and illegals during operations, our work also reveals important insights about how the respective sectors construct or respond to notions of risk in response to the other. While it appears that some enlightened mining companies understand the types of interface dilemmas that we have described, our findings demonstrate a curious relationship between 'interface type' and 'risk appetite'. Widespread corporate endorsement of contemporary standards in the international sphere, such as the Voluntary Principles on Security and Human Rights, would strongly suggest that mining companies are moving away from interface dynamics such as those represented in our study. Indeed, this may be the preference of many mining companies, to operate as the sole miner on a resource concession, but our review of the historical and currently operating mining projects in Papua New Guinea shows that companies are not only active in co-constructing interfaces with small-scale miners, but that they also contribute to their intensification through perverse sets of incentives. In long-life operations, such as Ok Tedi and Porgera, the current owners could be said to have inherited the circumstances that they presently operate under. It is worth noting, for Porgera at least, one of the current owners, Zijin, has only recently bought into the joint venture – and whoever develops the resources on Misima and Bougainville will 'acquire' existing legacies and social risks. The two most immediate large undeveloped resource projects, Wafi-Golpu and Frieda River, both have active small-scale mining economies within the proposed special mining lease and lease for mining purposes area. Moreover, one of the proponents of the Wafi-Golpu joint venture, Newcrest Mining Limited, is a recently minted member of the International Council for Mining and Metals, and after operating the Gosowong project in Indonesia (which has been inundated with small-scale miners), is acutely aware of the likely risks associated with forming an interface in such near proximity to their resource. Our point here is that while some of the interface risks contained in these projects is historic and, in some ways 'grandfathered' into the cost of doing business, companies continue to pursue projects with known interface dynamics, despite signalling to the market an intention to avoid the risks of doing so.

Our concluding remarks relate to the connections between land, labour and capital. Interfaces form principally on land and in their raw expression as human exchanges between labour as an endeavour to advance at different scales, and with different motives, the interests of capital. Studying small and large-scale mining interfaces as sites of exchange between two (or more) scales of mining activity introduces novel opportunities for deconstructing long held notions fashioned around an otherwise singular hold on the meaning, and interests of 'capital'. A renewed interpretation of capital is warranted, not merely because these interfaces contain clearly distinguishable classes of interest, but because these interests are intrinsically bound up in complex sets of land and labour relations that function differently at scale. The phraseology, 'the interests of capital', holds no explanatory value in these interfaces unless we are prepared to painstakingly unpick each interest and at each juncture. Case studies of the kind we have presented have the potential to become the new normal in the supply of future commodities, and when viewed from this vantage point, they represent what we call 'supply interfaces' – or in other words the ground level conditions from which metals and minerals enter the global supply chain. To the extent that these perspectives add complexity to the study of small and large-scale interactions, they also confer legitimacy to the small-scale miner as commodity producers and through that – their land, their labour and their capital.

CRediT authorship contribution statement

Nicholas Bainton: Conceptualization, Writing - original draft. **John R. Owen:** Conceptualization, Writing - original draft. **Simon Kenema:** Data curation, Writing - original draft. **John Burton:** Data curation, Writing - original draft.

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