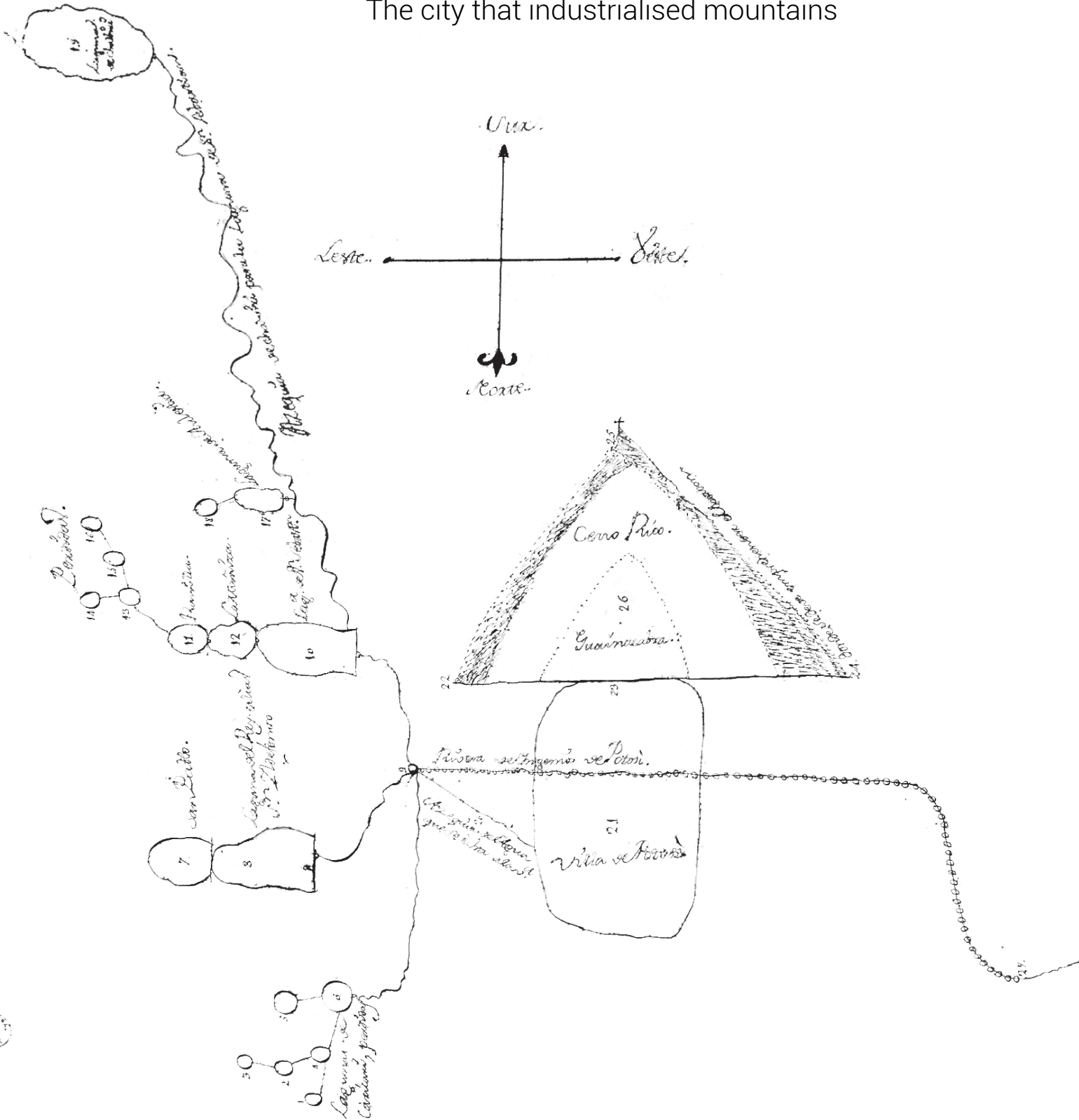


# POTOSÍ

The city that industrialised mountains



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The city that industrialised mountains

Énoncé théorique d'architecture

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Section d'architecture - Master 2019-2020  
Ecole Polytechnique Fédérale de Lausanne



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## ACKNOWLEDGMENTS

We would like to thank the people who have kindly accompanied us in the realisation of this Enoncé Théorique.

First of all, we thank Mr. Yves Pedrazzini, Maître d'enseignement et de recherche au *Laboratoire de sociologie urbaine* at EPFL. As the professor responsible for the Enoncé, he guided our work with his knowledge of Latin America.

We also thank Mr. Augustin Clément, our Maître EPFL for his collaboration, his investment throughout the semester and his precious advice. Many thanks to Bárbara Costa, for taking the time to discuss our topic and for her enthusiasm.

We would like to express our gratitude to the people we met in Potosí in September 2019, for their precious testimonies. The director of the „*Plan de Desarrollo Municipal de Potosí*“, Mr. Chaime López, has helped us greatly by sharing the cartographic documentation of the municipality. Special thanks must go to Luis Prado R., co-director of the „*Plan de Rehabilitación de las Áreas Históricas de Potosí*“ and Luis Villarpando for their interest in our subject and the precious correspondence that followed.

Finally, we deeply thank our parents and family for their unfailing support and Emeline Du for her valuable help.

## PROLOGUE

In South America, protests against corruption, social inequality and injustice, loss of credibility and abuse of authority are taking place across the continent. The protesting masses are less concerned about the political affiliation of the parties, whether left-wing or right-wing, it hits the governments equally, but much more about the political elite, the presidents and ministers in charge, whose political ideas the masses classify as outdated and not bearable for the future.

The people are dissatisfied with their socio-economic situation and blame the governments for. Since almost all states in Latin America are resource-exporting countries, the primary sector is of crucial importance within the country's economy. Therefore it is decisive how the government handles the mining policy. Is it a stable, trustworthy sector that is open to foreign investment? Is it nationalised or is it made up of state-owned, small, insecure, private businesses?

In Bolivia, Evo Morales from the party MAS (Movimiento al Socialismo), who was president until November 2019, stood for a leftist policy. Evo Morales was the first indigenous president, which is why he was received enthusiastically by the people since he was regarded as the advocate of the people's interests, hence it should be considered that two third of Bolivia's population are of indigenous origin. Indeed, he can be accounted for enormous achievements for the country.

He engaged for a social politic with democratic conditions, a better equality in the income distribution, he reduced poverty from 60 to 35 percent and drove the Bolivian country to a significant economic boom, reaching an average of five per cent per year. Morales' government even ran budget surpluses during the good years from 2006 to 2014 and used the cash flow to pay down public sector debts. However he inscribed the economic boom to the country's tradition of exporting raw materials - the same subject which paved his way to reign. Under Gonzalo Sánchez de Lozada, Bolivia's previous president with American origins, the resource sector was still privatised and he was planning for an enormous gas export project through Chile to the

USA, which would have led to poor conditions for Bolivia. Therefore the mistrust of the people resulted in the so-called „gas wars“. Through the high export amounts it was expected to propel the country's economy. But results show that contrarily at this time over 24,000% hyperinflation was happening, because the government was spending money on the production of gas and oil, which it didn't have.<sup>1 2</sup> Evo Morales claims to be a man of the indigenous people who wants to strengthen Pachamama, the mother Earth, and bring it back into the sovereignty of the indigenous tribes. Thus he explained in his inauguration speech 2016 “The time has come, the longed-for day, a historic day for Bolivia to retake absolute control of our natural resources.”<sup>3</sup>

His actual policies, however, revealed that these promises were only delusions whilst instead he was enacting concessions in order to make possible multinational large-scale resource- and energy production projects in indigenous territories. Moreover he argued that resources belong to the Bolivian people as long as they are in the earth, but once they are above ground, they can be sold to multinational corporations and exported. Accordingly, Evo Morales, like his neighbouring countries, inscribed to extractivism, a policy that can be attributed to the left wing, so-called progressive governments of South America. Likewise Venezuela and Ecuador, Bolivia's government was particularly left-oriented with the aim of creating a plurinational and communitarian state. The agenda of these governments furthermore is to re-nationalise the extractive industries, in order to maximize the state revenues by increasing the subsidy fees. The nationalisation of the oil and gas sector figured also Morales' success leading to an economic boom.<sup>4</sup>

However, this policy implies certain risks, as natural resource prices are highly dependent on the world market prices and thus it is impossible to build up a strong and stable economy.

Moreover, extractivism is indispensably linked with the repression of the development of other economic systems. This economic model suggests to be profitable due to rapidly made, relatively high revenues while not seeing the need to develop a long-term internal based market. In Bolivia minerals are still regarded as the most stable pillar of the Nation's economy and consequently they figure the most important pillar of development strategies.

Having Morales almost for 14 years at the political steak, the Bolivians strove for a change of leadership. They blamed him for political infractions, autocratic ambitions, the too long holding on power and finally for the manipulation of the 2019 October elections. Those turbulences and the neglect of the military to support Morales led to Evo's resignation the 10th November. Since then, he has been in exile and is now called for arrest as he is blamed for rebellion, terrorism and financing of terrorism. Those circumstances led Bolivia into very unstable situations, accounting for massive demonstrations, street riots and blockades. Also politically the situation was anything but

clear. After a two-day power vacuum, Jeanine Añez, who belongs to the populist right wing, declared herself interim president. The primary task of the interim government is to restore security and order between the country's mobilized groups and to establish a transparent electoral body, which will allow for new elections.<sup>5</sup> However, according to the latest evidence, the interim government does not stick to these tasks, but also settles old accounts and makes political adjustments. Thus it brought political confederates of the right wing from the eastern lowlands into the cabinet. With Añez, Luis Fernando Camacho, an entrepreneur and president of the rightist citizens' committee of Santa Cruz from the lowlands, marched into the presidential palace with the Bible in his hand and the words: „here Jesus is at home again and no longer the Pachamama.“<sup>6</sup> Accordingly, these are alarming signs for the future of Bolivia, as Camacho's action stood figuratively for the message that now again the Christian, rich bourgeoisie will rule over the indigenous population. Especially for the Indigenous, who constitute the majority of the miners, uncertain times have begun.<sup>7</sup>

Historians and politologists see the return of racism, as the unstable political situation now renders apparent the great ethnic gaps within the country. It is about far more than the banal distinction between a „poor indigenous highlands“ and a „rich white lowlands“, because the social structures are much more complex, since the country consists of 36 indigenous nations. Morales has turned the „Republic of Bolivia“ into the „Plurinational State of Bolivia“, but it is criticized that also Morales' politics did not reduce the dominance of the Andean tribes (Quechua and Aymara) amongst other indigenous people. For many, the Wiphala, the colourful flag of the Indigenous, that has become a state symbol, meant nothing - amongst the demonstrations police officers cut it out of their uniforms - a sign that further illustrates the mutual hatred. Guadalupe Pérez, from the human rights organisation „Colectivo Rebeldía“, which is based in Santa Cruz, says: „ in Santa Cruz there is a paranoid relationship with La Paz, to the highlands and the indigenous people from the highlands.“<sup>8</sup>

In the new elections, which deny a re-election of the resigned state leader Evo Morales, Luis Camacho and Marco Pumari, both members of the opposition, hope for good chances. On the side of the MAS (the party to which Morales belonged) the 29-year-old coca unionist and politologist Andrónico Rodríguez is considered as a promising candidate.<sup>9</sup>

Nevertheless, political scientists are sceptical about Bolivia's future, as according to their observations there is a lack of new ideas. It remains to be seen whether Bolivia will regain peace and political stability in order to let the economy get a foothold. Hence political sovereignty and stability is an indispensable condition for the business sector, exports and the gain of confidence of foreign investors.

## INTRODUCTION

Looking at the world market system we are currently living in, one notices an enormous disparity between the «Global North» and the «Global South».<sup>1</sup> Going back in history a concrete point can be identified where man began to divide the world into «centre» and «periphery»: with the upcoming colonialism of the 16th century. Many of those former colonies have still not escaped their fate, but continue to serve the world market as «supplier», the so-called developing countries.

Since the Spanish colonialism, Bolivia's role in the nascent world system was delegated to the peripheral supplying function for the industrialized centre, Western Europe.<sup>2</sup> Like other colonies, Bolivia was regarded as strategic base in order to sustain the expanding Spanish Empire. Given this status new settlements were created for two reasons: either to ensure political power (the administrative city) or to extract natural resources (industrial exploitation). During the time the paradigm changed from a short-term profit maximization through the expansion of the trading area to a long-term profit maximization through the expansion of the ruling area (domination of large terrains)<sup>3</sup>, therefore the role of cities as outstanding administrative, cultural, social and economic capitals got more and more important. Those capitals were mainly founded on the coastline of the American continent as furthermore they fulfilled the function of a new vehicle for shipment of agricultural and mineral goods to Europe. By 1580 Spaniards had established 225 populated cities. Contrary to them there was a huge demand for ordinary supply- cities located in the periphery.<sup>4</sup>

In the world market system the Bolivian city of Potosí, a landlocked town in the Oriental Andean chain at a height of 4.400 m a.s.l. forms a very exceptional role. Potosí would have the characteristics of an ordinary supply-city from the periphery, but it has existed for almost 500 years based on and thanks to the same resources: mineral wealth.

Indeed, it was the discovery of the rich silver reserves with the arrival of the Spanish at Cerro Rico, the hill formed by volcanic origin at the foot of the city, that made Potosí grow as an artificially created city. In the silver rush, Potosí quickly developed to a champion city showcasing an enormous population growth, and around 1650 it competed with other world cities such as London or Paris.

Potosí figured an own centre and entertained sophisticated relations with its hinterland and the international world market. It was quite «industrial» and «capital-intensive» and disposed of an enormous ingenuity, «skilled and well paid workers».<sup>5</sup>

Soon the surface silver was minted and the conditions got more and more difficult to obtain pure silver and the price of silver plummeted. This meant

several years of decadence for Potosí until 1885, when tin came on the market, replacing the export role of silver and leading to stable situations again. After another crisis, Potosi is now experiencing new growth with the processing of zinc-silver-lead polly metallics.

Looking at the city's history, it can be claimed that Potosí has always relied on- and is depended of the same principles since its foundation.

We will investigate the special preconditions and structures of Potosí, which have led to the fact that it has not only remained an ordinary mining camp, that was abandoned with the decline of the raw material prices, but that still exists today as a town with about 180,000 inhabitants despite the harsh conditions.

In order to understand Potosí's special role within the South American continent, we will analyse it under historical-social aspects as well as in its territorial context. Doing so, we try to understand the factors influencing the mining industry and the implemented territorial systems that have accounted for its current development and we will try to point out possible development deficits in order to reinterpret them as opportunities. Therefore, it is extremely important to locate Potosí in its regional and international context.

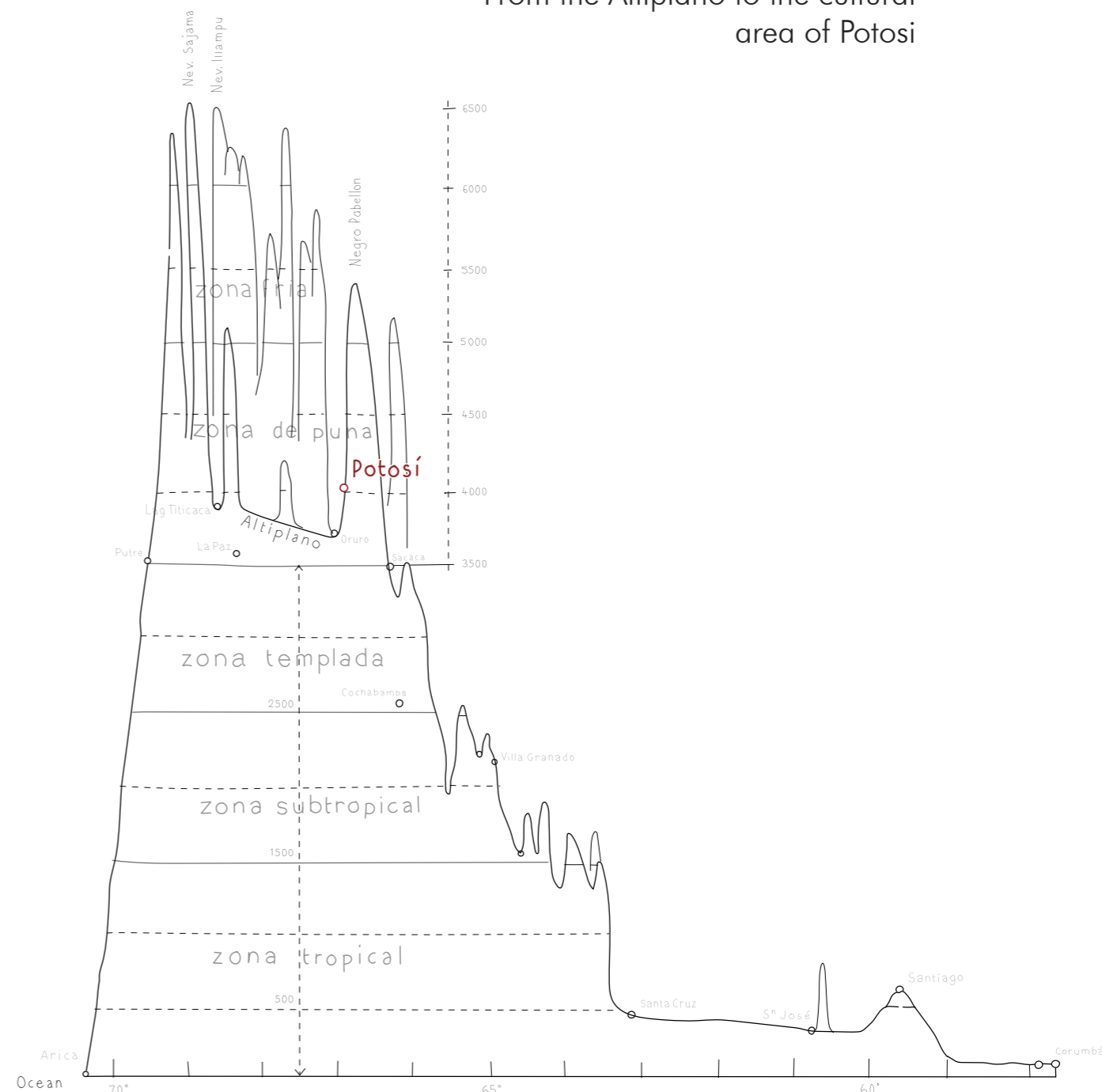
As an ambitious pillar of the Spanish economy, Potosí has not only put human but also natural-territorial resources into its service in order to rise to a capitalist industrial city. However, today its mono-industrial system does no longer appear appropriate as a future economic system. Therefore we question whether the established territorial industrial system can reinvent itself; or whether the city disposes of a much larger capital, that it has to learn to use purposefully. We are testing the city if whether it figurates a purely industrial city or whether it has the capacity to establish a new identity. Hence our hypothesis is that Potosí embodies much more complex structures than an ordinary extractive city in Latin America.

## PART I

# A STORY OF CULTURAL AND TERRITORIAL DOMINATION

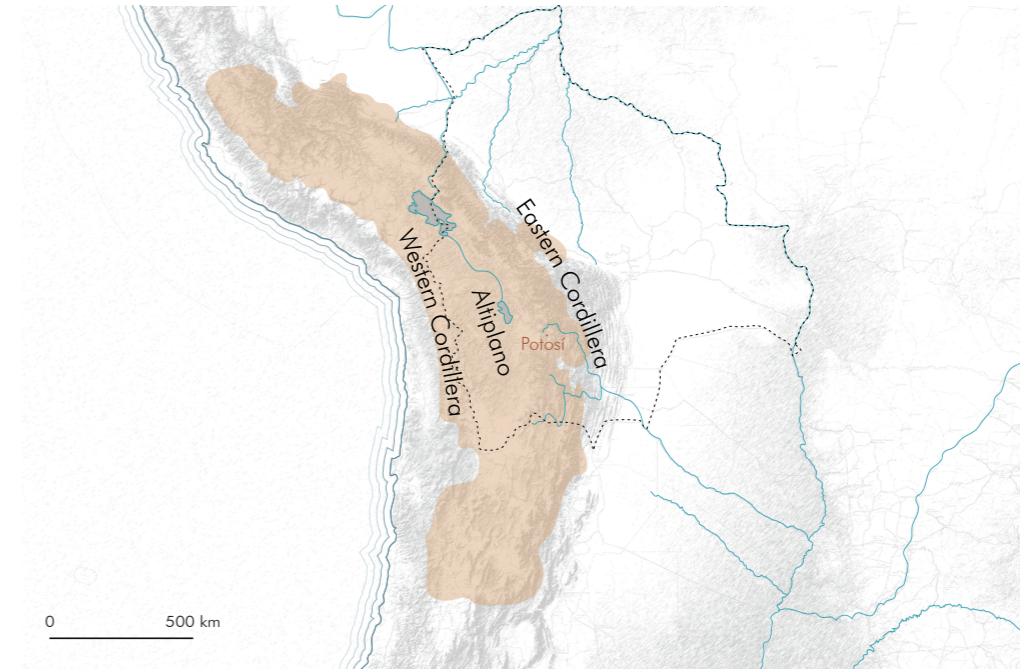
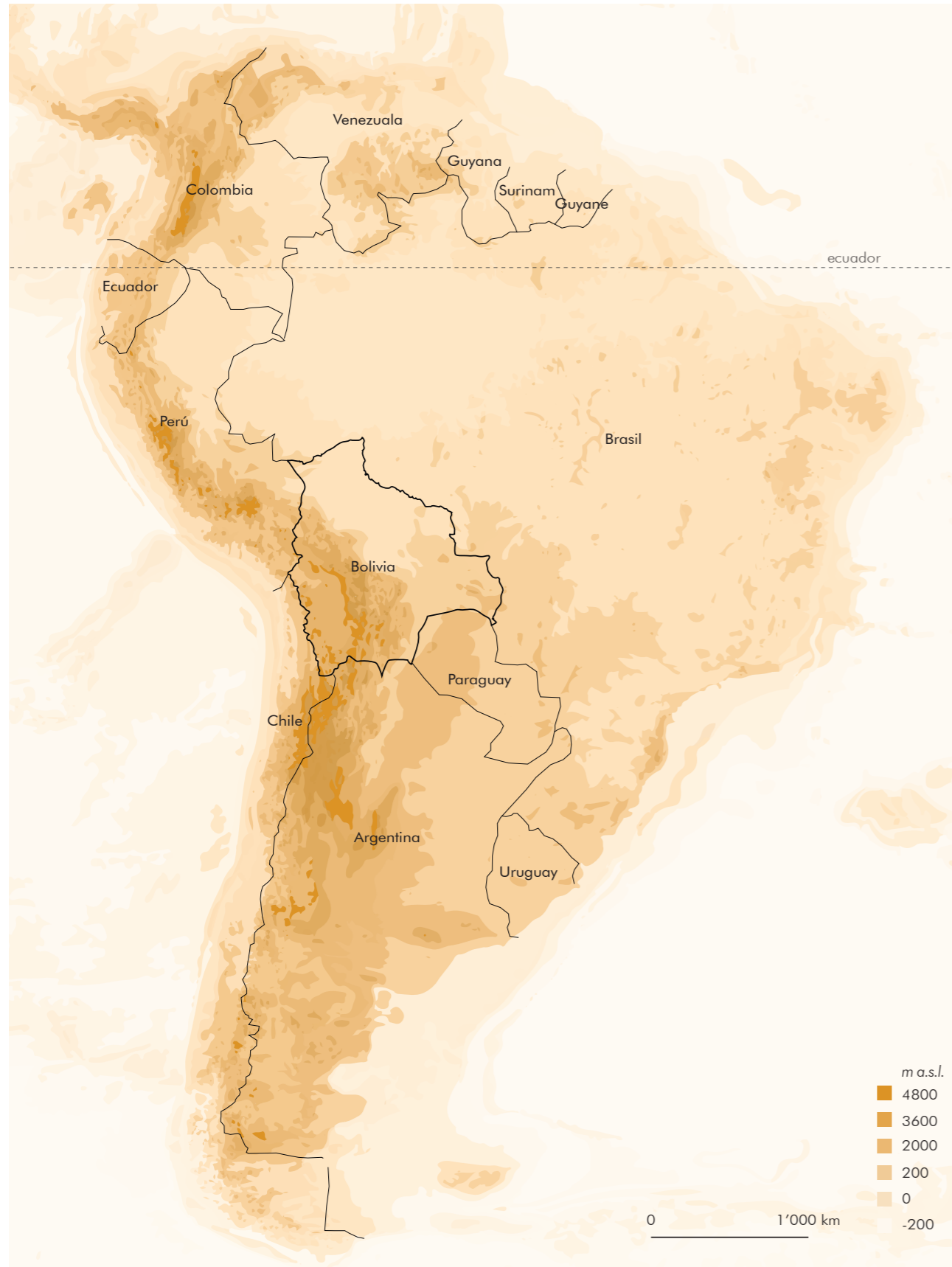
# 1. ANDEAN CULTURES

From the Altiplano to the cultural area of Potosi



**Fig.1** - Climatological zones and profile of the Bolivian territory, horiz. scale: 10'000'000 vert. scale: 50'000





facing page  
**Fig.2** - Geographical location of Bolivia and altymetry

**Fig.3** - The Altiplano highlighted in its geographic conditions in South America

The Plurinational State of Bolivia, in Aymara *Wuliwya*, in Quechua *Puliwya* and in Guaraní *Mborívia*, is a landlocked country located in the central-western region of South America. It's organized into nine departments, politically independent, and has a population of 11,383,094. Its constitutional capital is Sucre. The country is crossed by the Andes mountain range, which is home to 65% of its urban areas. Potosí, located in the heights of the Altiplano, has today more than 200,000 inhabitants. At more than 4000m above sea level, it is considered to be the highest city in the world.

**Natural and economic characteristics of the Altiplano**

The Altiplano, from Aymara and Quechua *collao*, forms the geographical region of what today is the South of Peru, Bolivia, the North of Chile and Argentina, and is as its name says a high plateau perched at a medium of 4000m over sea level in between the Western and Eastern Cordillera of the Andes. The Altiplano has its origin in plate tectonic shifts and was created as an intramontane sedimentary basin due to the endorheic sedimentary drainage from the surrounding mountains that was elevated by tectonic movements that have given rise to the Andean mountain range some 15-25 million years ago. These tectonic activities conveyed mineral resources to the surface, amongst which the most important ones are gold, silver, tin, copper, lead and mercury.

The Collao plateau is a group of endorheic watersheds among which two stand out: the system of lake Titicaca-Desaguadero-Poopó-Salar de Coipasa and the basin of the Salar de Uyuni.<sup>1</sup>

Due to its height it is characterized by a cold and dry climate, the northeastern



part being more humid than the southwestern one. The Atacama Desert, one of the driest areas on the planet, lies to the southwest of the Altiplano and to the east there is the humid Amazonas valley.

Its vegetation mainly consists of a steppe with almost permanent natural pastures that made possible the development of advanced civilisations. Extensive camelid farming and agriculture in irrigation terraces characterized their economic forms.

Today the economy in the Altiplano is characterized by mining, even though plenty of the ore deposits are already exhausted. New hope promise the rich lithium deposits of the Salar de Uyuni.

The Altiplano counts amongst the less developed regions of South America and has a poorly developed infrastructure with just a few asphalted streets.

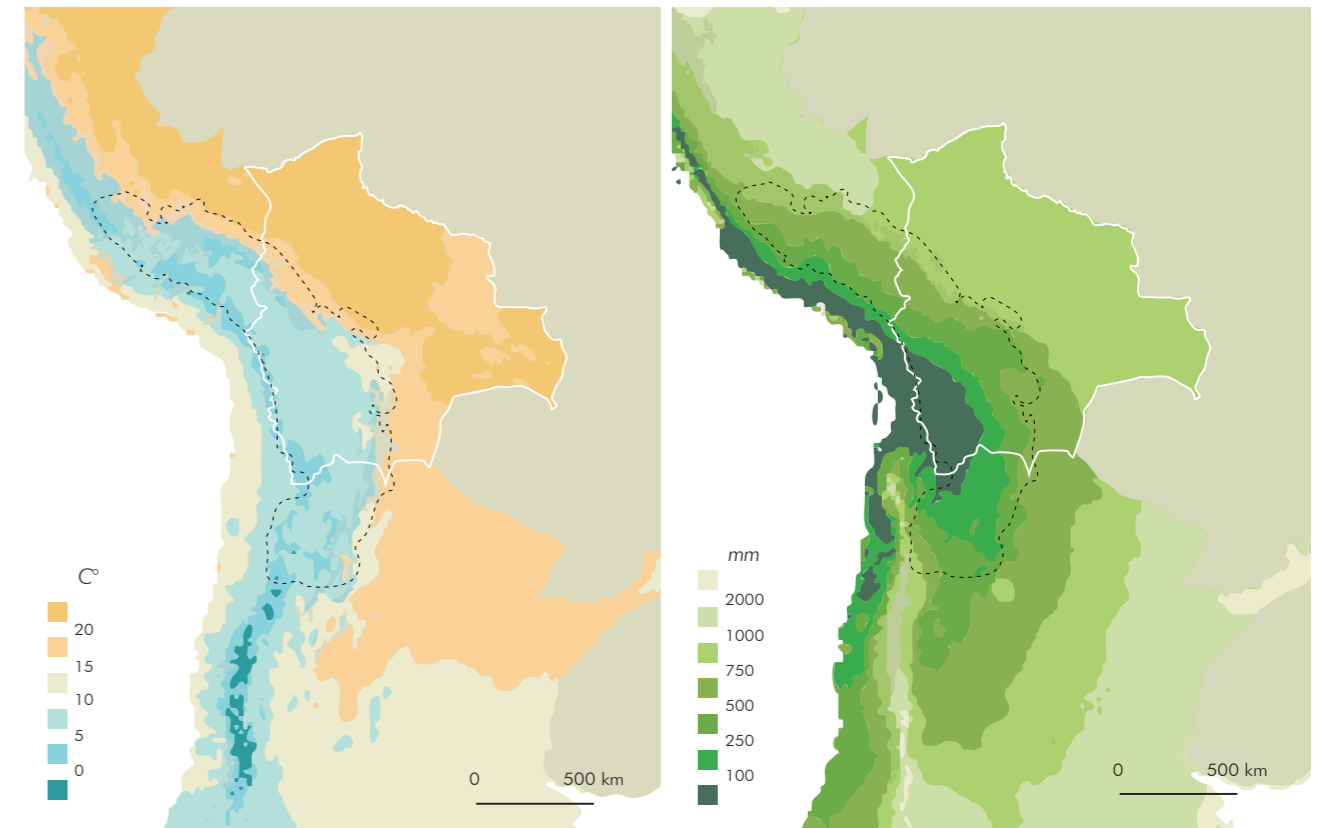
### Human inhabitation

The Altiplano has been inhabited for more than 6500 years.<sup>2</sup> The first decisive cultural change happened to be when in the strata 4000 BC the cultures made the transition from hunter-gatherers to agriculture. Historians divide the following development of Andean cultures in horizons, based on the expansion of three main cultures: the Chavin (about 1500 BC), Tiwanaku-Huari (about 900 BC until 1100 AD) and the horizon of the Inca about 1438 till the Spanish conquest starting 1534. The times in between are called intermediate periods, the early intermediate period and the late intermediate period, with the development of the Aymara kingdoms that would have a forming role for the Altiplano.

In this study we will start with the Tiwanaku civilisation as it paved important ways for the later development of the region.

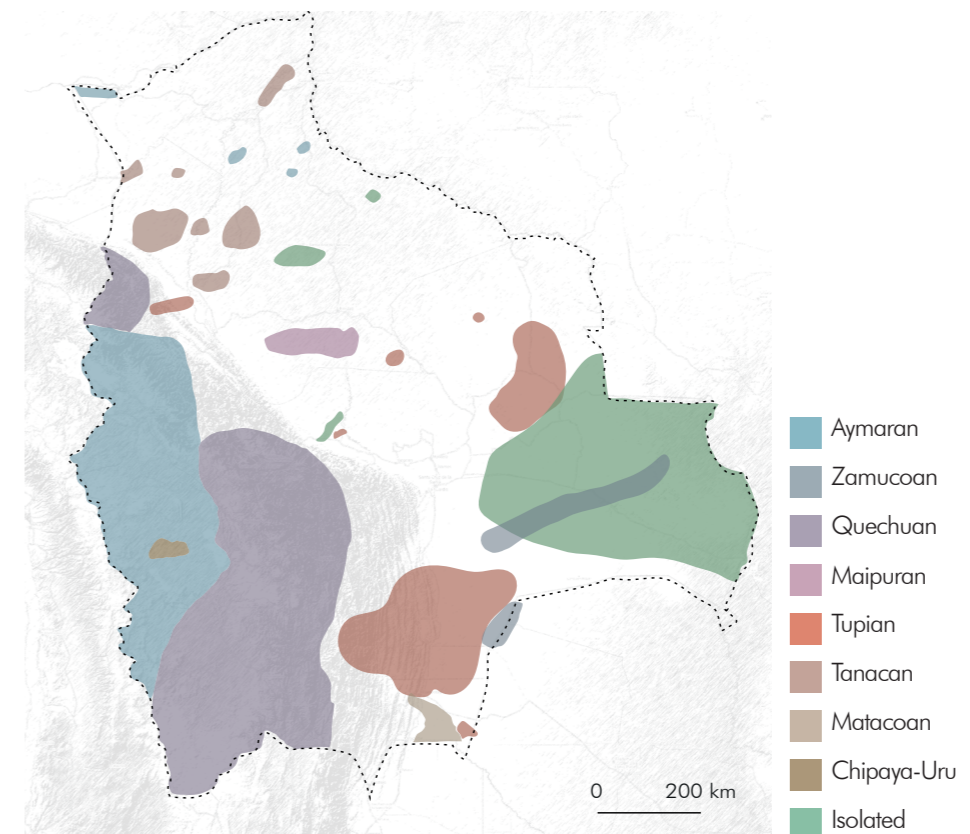
### Tiwanaku culture

The Tiwanaku culture developed in the area which today is Peru, Bolivia, the North of Chile and Argentina, the centre being located close to the Andes' most important water body, the mythical lake Titicaca. Water played an utmost role in their ideology. They believed that their ancestors were created in the lake Titicaca and then spread through interior rivers to finally come out through water resurgences. The water is the vital fluid, and so the interior of underground rivers are the blood veins of the Pachamama, mother earth, the surface rivers represent the semen and the rain its tears. Therefore water was the determining element of the establishment of all the Andean communities, called the ayllus.<sup>3</sup> Water was of on almost divine nature that is why every resurgence of water on the earth like springs, lakes, snow and therewith mountain peaks, was sacred for them. Therefore along rivers and likes, in mountains and caves they built wakas, which were places for the ritual worship of the gods. For the worship of the gods and cultural rites, the Tiwanaku fabricated brilliant jewellery from precious metals, which still today can be admired through preserved jewellery pieces. The Tiwanaku were already familiar with metallurgical technologies for the production of gold,



**Fig.4** - Mean annual temperatures in the Andes

**Fig.4b** - Mean annual precipitation in the Andes



**Fig.5** - Native people of Bolivia, classified by language families

copper, silver and bronze. Some cultures developed elaborate techniques like gilding silver or silvering copper.<sup>4</sup>

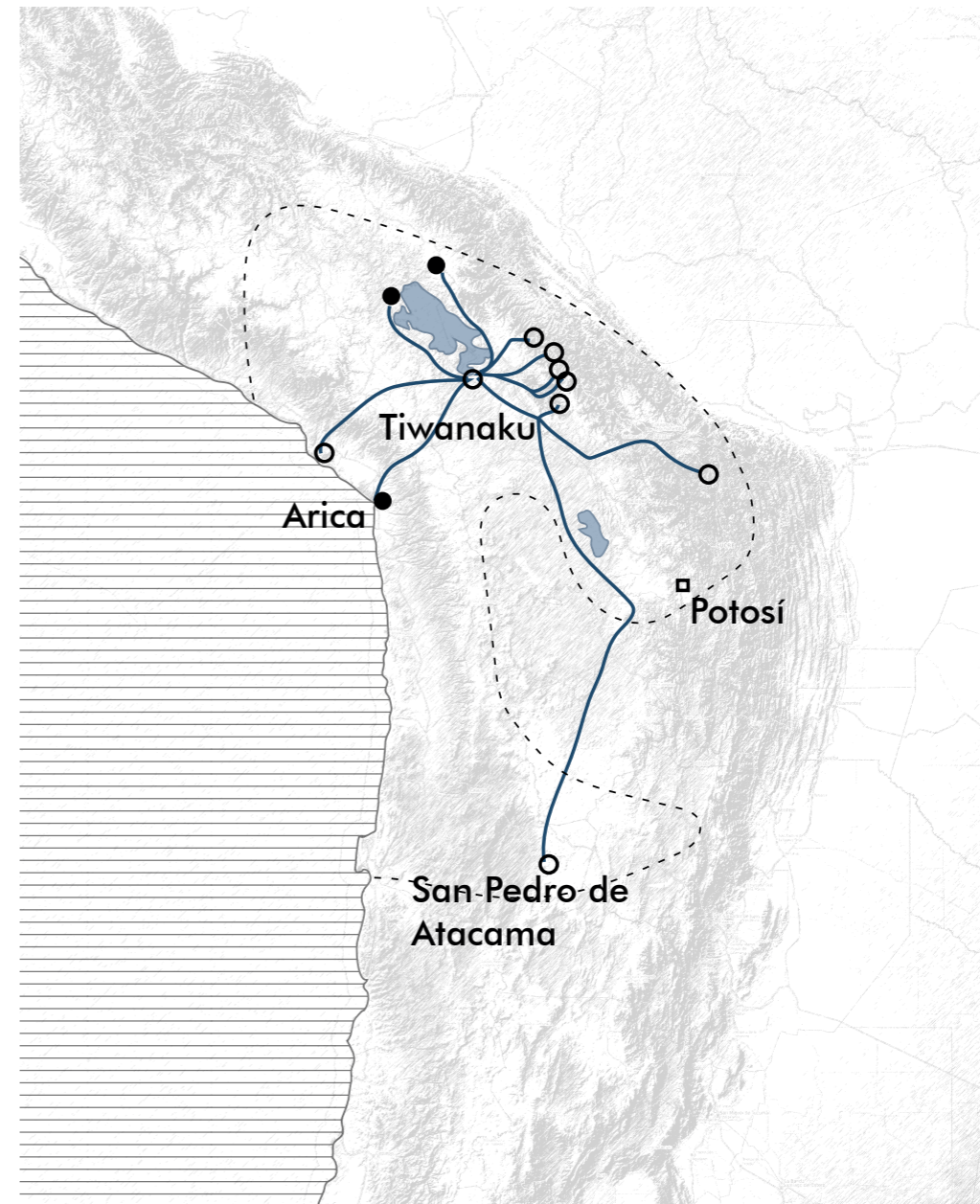
**Economic system**

Water was primordial for their existence, so it was well anchored in their belief, but beyond that the Tiwanaku engaged in employing water meaningfully in agriculture.

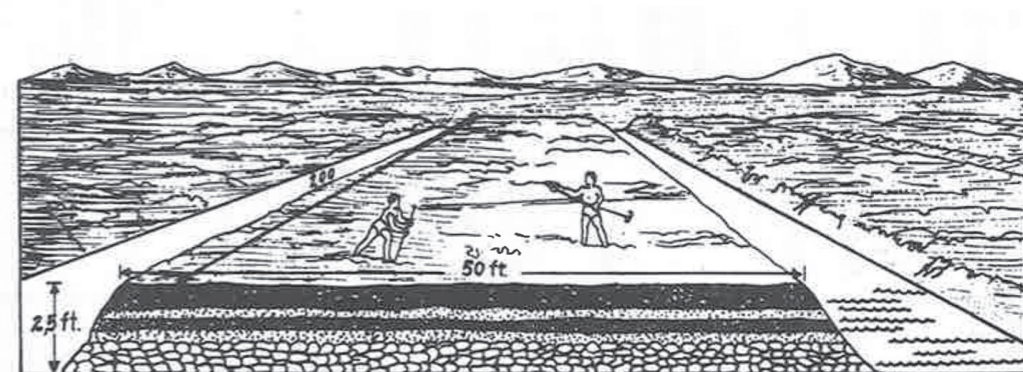
Therefore they used the technique of the Waru Waru system, which consists of connected irrigation channels dug into the ground in order to drain extensive plains. It was apt for inundated areas where the soil from the excavated channels was used to create elevated cultivation beds in which the crops were grown. Thanks to the capillary conduction from the canal to the bed the roots of the plants were directed downwards which allowed for a very narrow positioning of the plants. Mainly, they grew potatoes upon which they employed a special dehydration technique, providing the so-called tunta or chuño, which could be stored for a long time and grains like quinoa. Moreover they developed an ingenious water system of interconnected water conducts that linked the arid lands of the Atacama Desert to the Titicaca mythological center. They built large scale territorial projects with aqueducts to ensure for a water supply. The water system was also used as important communication routes for trading and the transportation of goods. This system was complemented by land trails which would ensure the large scale bartering with outer regions in order to be able to dispose of a great variety of goods throughout the empire.

Furthermore they engaged in the farming of camelids like the llama that is used for its wool, meat and as means of transportation, vicuña or alpaca, which is supposed to be a hybridisation of the llama and vicuña, whose wool was highly appreciated in Andean cultures. The conejillo de Indias was - and is - also grown for its meat.

In order to be able to farm their cattle in the hostile environment of the Altiplano they lived according to a form of a half-nomadism. Indeed, this economic system developed in very early epochs and probably had its origin in the transhumance or temporary migrations.<sup>5</sup> Transhumance from Latin 'trans' meaning 'the other site' and 'humus' 'land', describes a life-form of the periodic migration of livestock from higher summer to lower and warmer winter pastures. In those valleys normally the herders have their permanent home. Generally, only the herds travel with a limited number of people necessary to tend them, while the rest of the tribe rests at their agricultural fields. This system thus describes a nomadic life existence, combined with a fixed residence and yet differs from pure nomadism. Transhumance occurred with the domestication of livestock, when man with his livestock imitated the routes the cattle went once undomesticated, in liberty searching for fresh pastures. The domesticated herds will always take the same route, which is why these paths got an enormous importance and would later be turned into roads. At the time of the established road system, it was of the utmost



**Fig.6** - The cultural area of the Tiwanaku: the lake Titicaca and its environs



**Fig.7** - the agricultural system of the waru waru forming terrasses and drainage channels



importance to protect grazing privileges and to guarantee the farming infrastructure.<sup>6</sup>

### Aymara kingdoms

After the collapse of the Tiwanaku empire around 1100 AD the Altiplano rested fragmented in various lordships, which are formed by different ethnic groups, but have the same language, Aymara, and a common culture. They didn't form an imperium, but rather small states or kingdoms, why they are classified under the denomination «Aymara kingdoms». In the North, close to Cuzco, there lived the Canas and Canchis, around the lake Titicaca the Collas, Lupacas and Pacajes, which built the nuclear area of the Collasuyo. In the South there was the confederation of the Charcas being composed by four people: the Charcas, Chuis, Chicas and Caracaras, which are the ones who settled in the area of Potosí. To the West there lived the Carangas.

With the figurative water-body: lake Titicaca - Rio Desaguadero - lake Poopó - Lakajuahuirá and los Salares- their territorial area was divided into two political parts the Urcosuyo, upper region reaching from the upper part of the lake to the sea, and the Umasuyo, downer region stretching along the oriental part to the fertile yunga lands. Many interpretations suggest that «urco» signifies the masculin, and «oma» the feminin hinting to the connotation of the fertile, fecund with the feminin always standing for the Pachamama, mother earth. For a quatripartite division they introduced another axis creating the Alaayunca and Manccayunca, the coastal area and the zone of the valley.

Those Aymara tribes are products of a migration coming from the Southwest aiming for the Titicaca lake and passing by the departments of Oruro and Potosí. With their invasion they mingled with the tribes already living there, who unlike the invaders were not of an agrarian culture but were hunters and gatherers. As a result one can observe a hybridisation of their two ways of live, which would lead to a Half-Nomadism.

Political-economical system of «ecologic floors» and «vertical control»

Ever since the Andean space has represented a very difficult territory to inhabit, as it is not easily to cultivate, which is why already the early cultures developed a sophisticated economical system to ensure their survival. J. Murra designated this agricultural system as system of «ecological floors» existing in a non-continuous territory.<sup>7</sup>

This means that man strived to make best profitable his habitat by analysing which plant would best grow on the different height levels, forming so fertile «islands» called the «ecological floors».

Those «archipelagos» of food-crops were spread over the territory in the distinct geographical environments - from the highlands to the fruitful valleys and warm lands.

The designed method makes evident the emergence of the Andean economic system of reciprocity and redistribution, as the so achieved highly diversified

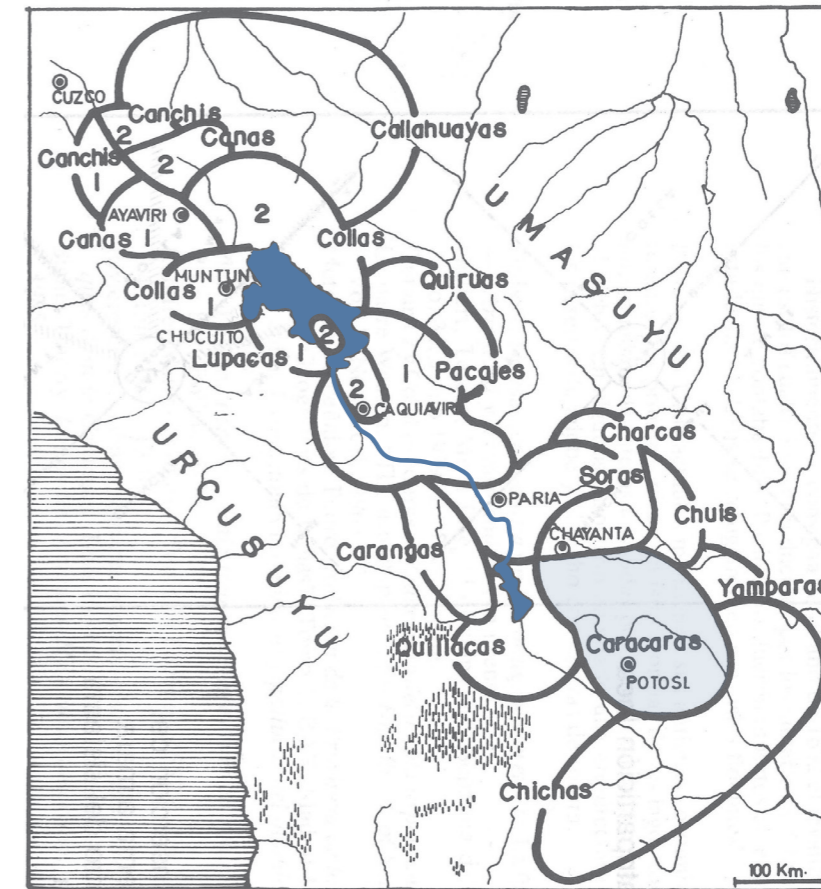


Fig.8 - Reins of the Aymara kingdoms, 11-14th century, the Caracaras being the ones at Potosí

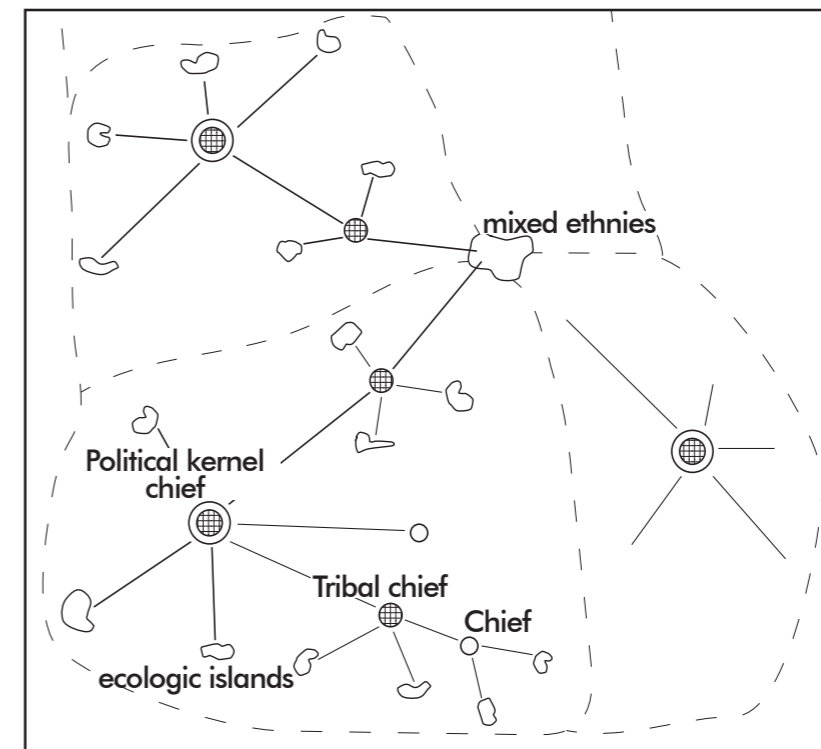


Fig.9 - Scheme political system of the vertical control over spatial ecological islands



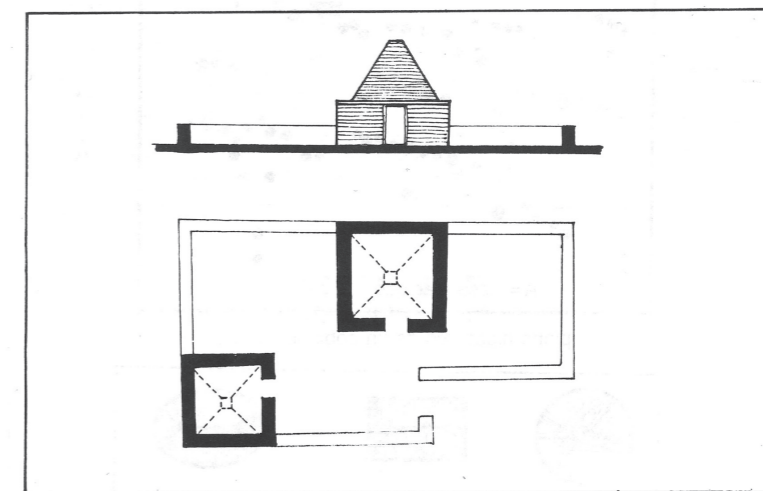
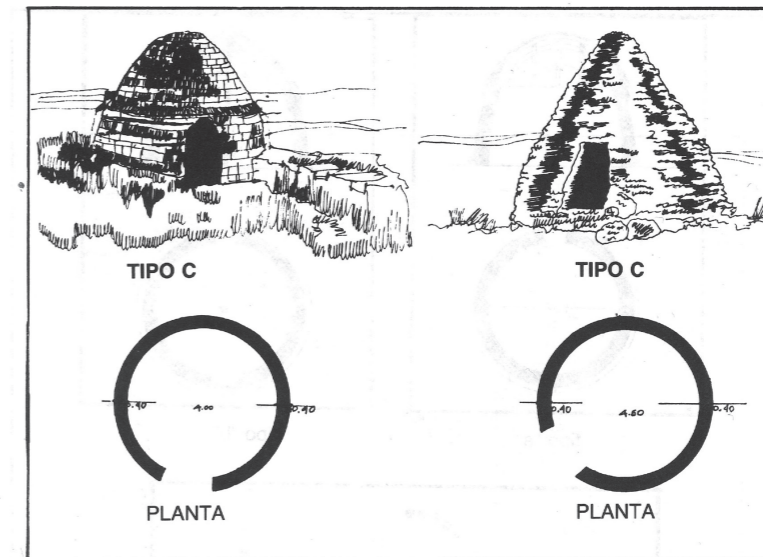
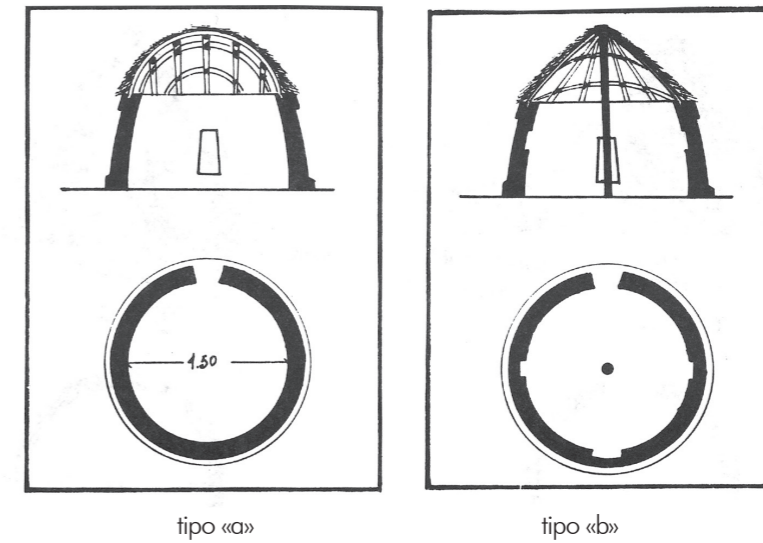
**Fig.10** - Poblacion Cañaviri (dept. de La Paz) with the mixture of a round and rectangular typology

crop yield had to be interchanged by trade communications. This reason demonstrates once again that the Aymara cultures relied strongly on an engineered infrastructure network.

In order to be able to control their lordships, which consisted of non continuous territories, the Aymara kingdoms developed the political system of the «vertical control». This is to say that the Aymara chiefs exercised their political power in the high-lands, where they built political kernels while having control over several «islands» seen as colonies in the fertile «ecological floors». In the Altiplano there existed several political centres, each one of them being under the rule of one chief. The latter also had authority over a certain territory. Within this territory he had up to several hamlets directly under his rule, but could also have other tribal chiefs under his rule, who in turn had sub-dependencies and possessions. The chief of an allyu sent colonizers to the «ecological islands» who would engage for the agricultural production to ensure the provision of food crops for the kingdom. This is to say that the colonizers were controlled by the political centre but at the same time they maintained their ethnic identity with the kernel as well as their right to lands from the central zone. Many times the colonies were of a multiethnic character as different kernels sent their people to the fertile regions. The designed social system of vertical power was the most efficient one for the Altiplano, which is why it even stayed valid with a state-driven expansion. It was continued under the Incan centralism, which demanded a vertical control of the tribes as well as under the control of the Spanish when it got pushed to become an economic production with the creation of the *reducciones*.

**Spatial organisation**

The Aymara cultures not only inherited their cultural beliefs, economic system and way of life to their descendants but also influenced the spatial organisation and the housing typology of the Andean cultures, which in some cases still can

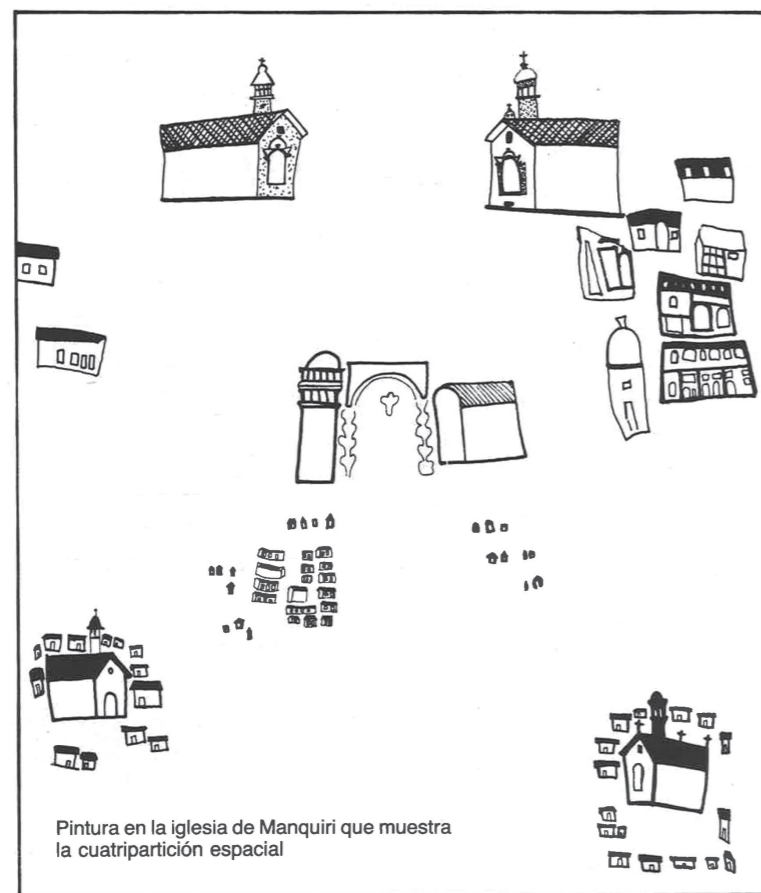


**Fig.11** - Housing typology of the Aymaras: unicelular round plan showing variations of the vaulting and the orientation of the entrance

**Fig.12** - Rectangular typology, so-called putucos



be observed today. In many parts the Incan ideology was not able to penetrate into the strongly established cultural elements of the Aymara civilisation. Their housing typology was based on a round plan being closed by a simple vault. It was an unicellular habitat being arranged freely in the space. The outer area was of a paramount importance as communication space and part of the architectural ensemble. In the whole of a village layout, they didn't build plazas, but esplanades dividing the settlement into two parts. This spatial conception reflected their social structure of Anansaya, the preliminary race, and Urinsaya, the secondary race. Having a territorial duality and a social duality, this concept superposed resulted in a quatripartition of the urban space. When under the Spanish colony those tribes came together it could be seen, that they settled according to their ideology in spatially separated areas, see therefore Fig.13.



**Fig.13-** Native tribes settling around Spanish churches. The spatial divergence in four parts reflects the classical organisation of society

### Inca Empire

The Incas were a Quechua culture that spread south departing from Cuzco. Under Inca Pachacuti (1438-1463) and Tupac Yupanqui the conquest of the Aymara kingdoms took place. However, the Aymara tribes were resistant, and fled to the river Pilcomayo, where heavy battles broke out since the Aymara tribes were not willing to integrate into the new empire. The river Pilcomayo, which runs not far from Potosí, was by and large the limit of the Inca Empire in its southeast extension. Therefore, the area around Potosí is still strongly marked by

the influence of the Aymara. In their centralized empire, the Incas respected and benefited from the established system of the ecological floors, but nevertheless carried out large population resettlements and new territorial divisions. This meant a restructuring of the conquered society, which integrated itself partially, but in many areas preserved its culture, as can be seen, for example, in the language (Aymara) or the architecture. The occupation of the Incas proceeded very quickly and briefly, which is why the Spaniards, when they arrived, did not encounter a completely Quechuaised country, but still found important traces of the Aymara culture.

The Inca empire was divided into four administrative parts that emerged from the centre of Cuzco, the Chinchaysuyo, Antisuyo, Contisuyo and Collasuyo, the region of Bolivia. Together they formed the Tahuantinsuyo. In addition, they established some control cities in the Collasuyo, located at strategic points to better control the valleys. The map Mapa Mundi of Poma de Ayala summarizes well the existing world view: Cuzco in the dominating centre, the division of the four realms, and other important centres are shown, amongst them Potosí. At that time, cartographic documents were particularly important because they represented both the knowledge about a region as well as the property relations, or to which regions the Indigenous had the right of access and use. Later they were used in order to reclaim Indigenous territories.

The Inca were an organized, hierarchized society who subjected the Aymara tribes so that they would work for them. Therefore they introduced the system of the mita, in Quechua meaning «work shift, working time», or also «season», which is a system of tribute through work. It was used for major state projects, such as the construction of roads, military services or the work in the mines.

Under the Incas, the mining of precious metals gained a new status, as can be seen in the Coricancha temple, the main sanctuary in honour of the god of the sun, in Cuzco, whose walls were made of gold-plated stone blocks. For greater efficiency, they organized mining according to strictly hierarchical methods and used the subjected Aymara tribes as miners through the mita. The work was carried out rationally, they categorized exploration and mining periods, extraction and processing as well as smelting activities. Mining areas were demarcated and some of the extraction was carried out on a large scale. To ensure the transport of the resources, they extended the road network to the ore deposits. On the roads they built so-called tambos, stations that served as rest houses or storehouses in order to provide supply on the paths for travellers.<sup>8</sup>

### Conclusion: Culture forming the environment

Decisive for the Tiwanaku hegemony as well as the Aymara kingdoms was that the different tribes lived under one common ideology. They believed in the reciprocity function of the society, which made it possible, that the different groups of a distinct origin could coexist beside each other. Simultaneously the principle of reciprocity demanded for a great interaction and communication apparatus between the distinct cultures. This interaction was the basis of the Andean economic system. In order to make the economic production the most



Fig.14- Mapa Mundi of Guamán Poma de Ayala, ca. 1615 representing the world view of the Incas. Cuzco as the centre of the world and other important towns are represented, amongst them Potosí



efficient together the neighbouring tribes undertook large-scale works such as sophisticated hydraulic systems that were set in place to irrigate the arid areas of the Atacama Desert with water from the Titicaca mythological centre. The case of the Tiwanaku culture shows the hybridisation of beliefs and the economy. The communities lived from being Nomads, moving cyclically around with their livestock and cultivating potatoes and other food crops in the dispersed fertile archipelagos. Therefore circuits and roads played an utmost role in the Andean culture, which is why sanctuaries to worship Pachamama and the gods were ritual installations along the treks. Also for the large scale trade and communication relations the Andean cultures set in place an ingenious road system. Those works not only strengthened the relations between ethnics but also contributed to counteract possible territorial violations.

So one can conclude that the territorial works reflect the socio-political system at stake. Till the Aymara times they were of a neutral character, serving the common sense of communication. The Incan Empire that relied mainly on the same political system changed the administration of the roads and introduced a strongly hierarchized sense. The Spanish later would use the same road system for their conquest. Another decisive role would be attributed in the 16th century when they served the transport of precious metals, the silver coins in treasury boxes and the mercury used for the amalgamation process. Although introducing a mercantilist notion to the streets, which demanded even more administrative expense, the Spanish committed the transportation task to the Andean societies as they lacked of the exhaustive knowledge about the territory and its trajectory.<sup>9</sup> Even today most of the Andean societies rely on those sparsely routes, which meanwhile have been paved but which still remain under the control of Indigenous people, as recently can be experienced through street blockades that are undertaken by demonstrating people.

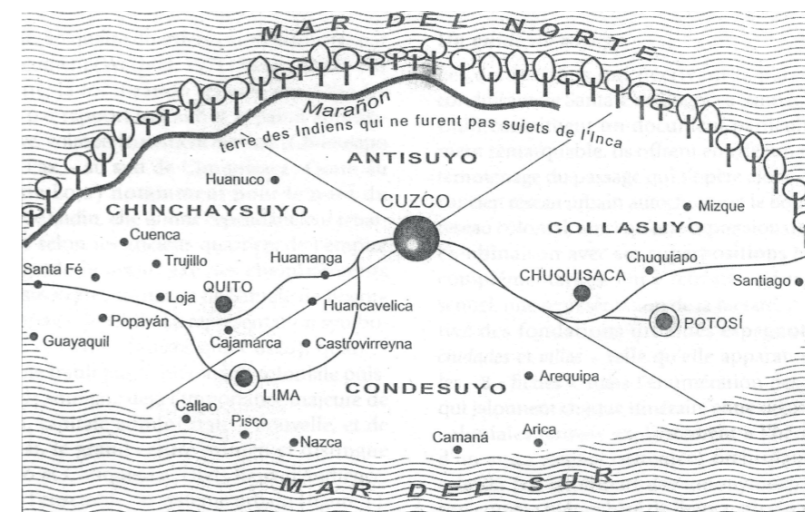


Fig.15- Interpretation showing the division of the Tawantinsuyu in four political parts, main communication axis passing by Potosí. Jean-Paul Deler, 2008

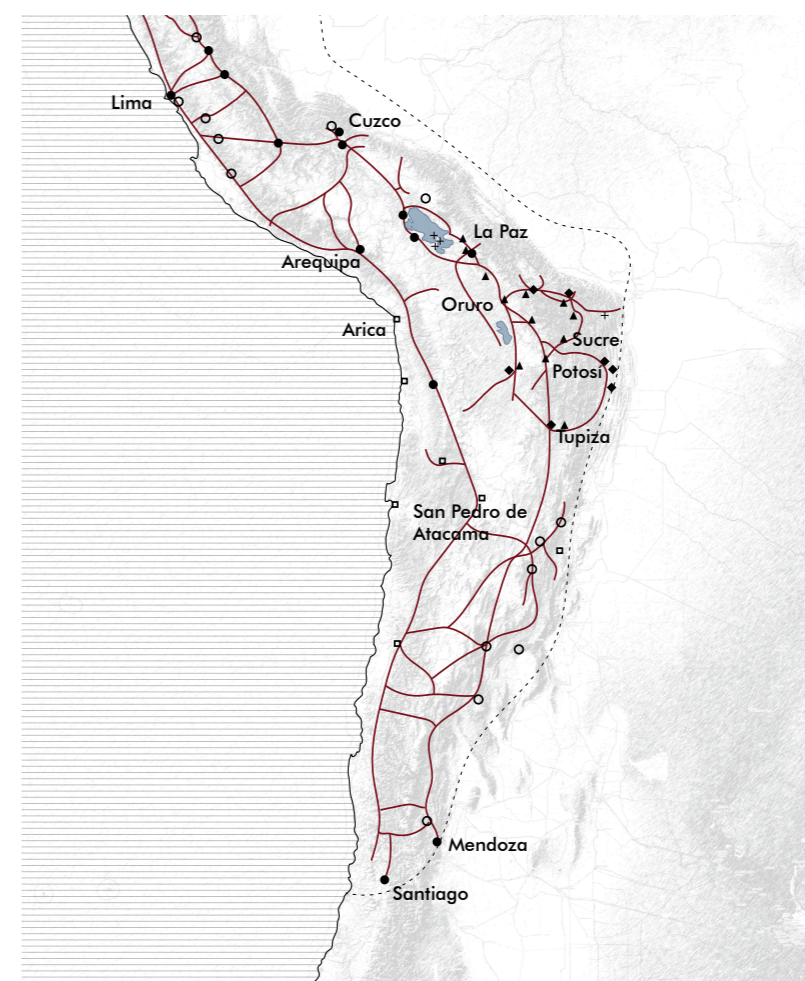
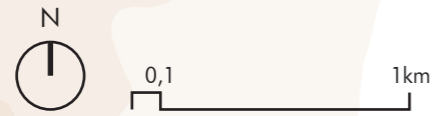
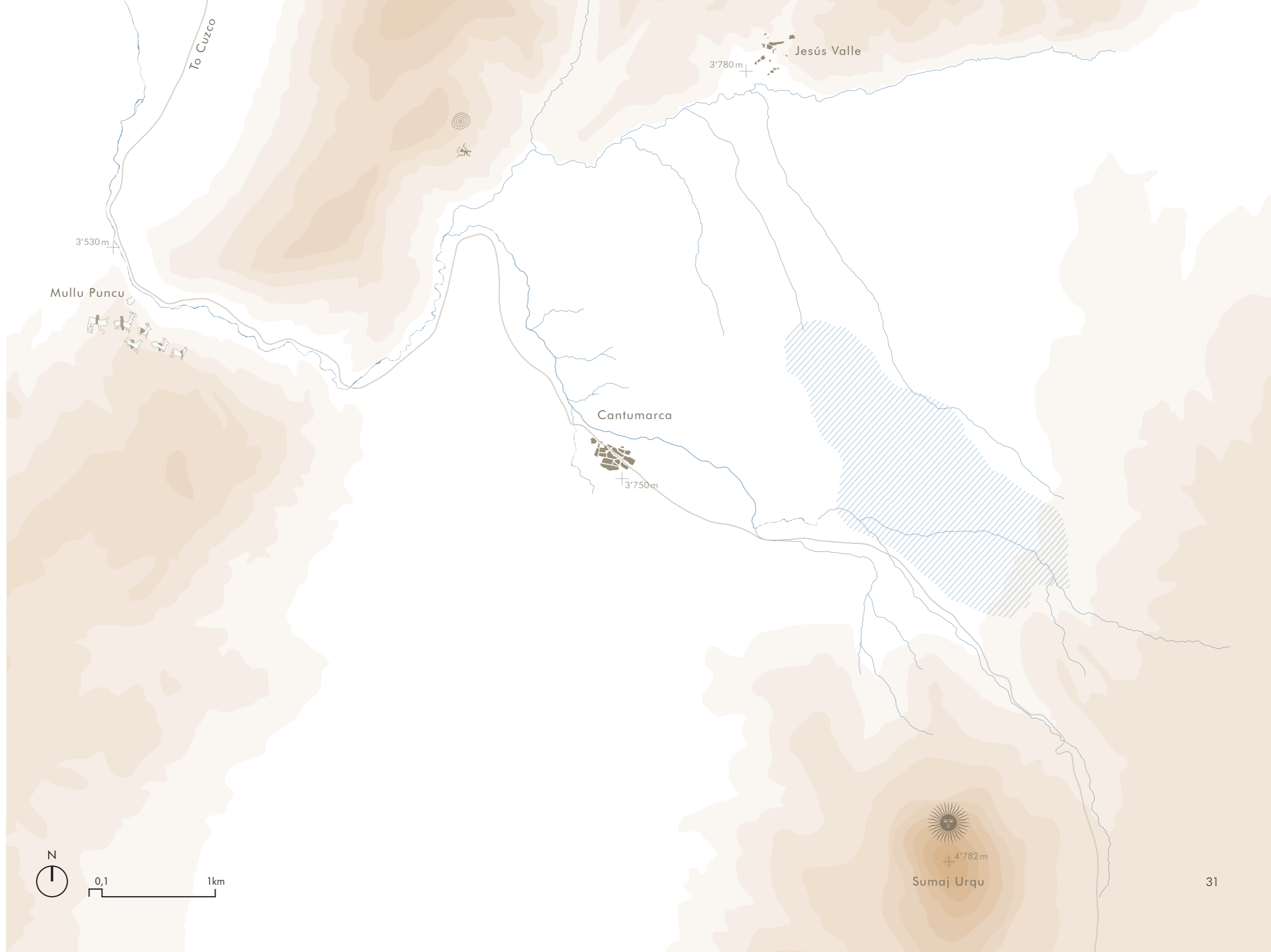


Fig.16- The Incan road net as nervous system through the territory and depicting the cultural area around Potosí

- Inca trails
- + sanctuary
- ▲ tomb
- ◆ fortress (administrative city)
- cities with continuity till today
- cities under Inca
- later built city
- - limit of Tiwanaku empire

Area of Potosí  
Early 15<sup>th</sup> century

-  Indigenous settlements
-  Wetland
-  Inca roads
-  Geoglyphs
-  Geoglyphs
-  Cave paintings
-  Inti cult





## The cultural area of Potosí

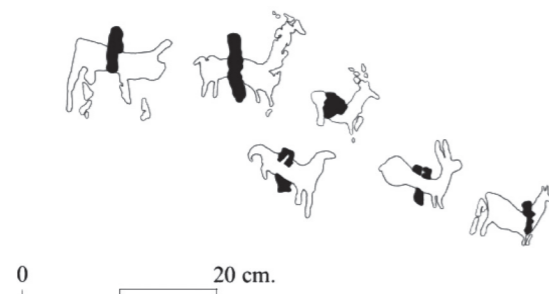
The region of Potosí is often presented as a deserted and arid area, which had never been explored by man before the arrival of the Spaniards and the exploitation of the Cerro Rico. This version of history is contradicted by evidences of settlements in the region of Potosí dating back to the Tiwanaku culture and even to earlier horizons.<sup>10</sup> The place had also a continuity of population during the reign of Aymara tribes with the Caracas.

According to Abott and Wolfe there are proves for worshiping places at Cerro Rico as well as that the Andean tribes already minted the surface silver of the hill to produce jewellery to honour their gods since the Intermediate period, before the Tiwanaku. Nevertheless this knowledge about the silver resources got lost in the following epochs.

There are theories that during the Aymara kingdoms this knowledge got lost because of weaker policies. Another explanation would be the expansion of the Incan Empire : the Indigenous tribes tried to hide those silver deposits fearing that the Inca would not only exploit the silver but also force them to work for the metal gain.

Moreover the hill ever since had a mystical conception, it was a divinity of Pachamama for the Andean cultures, which they tried to protect from the purely material interests of wealth. Nevertheless the mines of Porco, that lie 50 km to the southwest of Potosí, were well known to the Inca, which is why it soon became the flourishing centre for the Empire's silver exploitation. As the silver ores lay close to the surface, they were easily to be mined.

During the time of the Incan Empire the zone got populated by Quechua tribes, who didn't find out about the richness of Cerro Rico and settled in areas nearby like Cantumarca, where metallurgic works under the Incas are proved, as well as Jesús Valle, and nearby hamlets.<sup>11</sup> Like explained before, the indigenous tribes already disposed of a sophisticated system between capitals and supply-cities. In this way, Jesús Valle served Cantumarca as a supplier of maize, and the beverage Chicha obtained from it, as well as other commodities to satisfy the daily needs. These places know an important traffic, being on one of the main Inca roads.



To the east of Cantumarca, on the Inca road leading to Cuzco, there is a deep and narrow gorge where the Ribera flows between two reddish-coloured mountain ranges. It is called Wayq'u Puncu (from Quechua, «Gate of the gorge»). This natural corridor shelters a cave, the Mullu Puncu. Cave paintings, mainly depictions of

Fig.17- Representations of llama caravans in the Mullu Puncu cave.

caravans of loaded llamas, attest to the intense pre-Hispanic traffic that this natural corridor experienced. It linked regions as far away as the vicinity of Lake Titicaca and northern Chile to Potosi.

The name «puncu» (gate), refers to rugged landscape reliefs that mark a transition between different ecological regions, landscapes or paths, and are often considered places where the saqra powers of the underworld are concentrated. The cave is indeed one of the most important pre-Hispanic places of worship known in the vicinity of Potosi. It is part of a network of cultural places that draw a true pre-Hispanic sacred geography around Cerro Rico.

The cave of Mullu Puncu is perceived as a space of communication with the underworld: the entrails of Cerro Rico, the nearby sanctuary of Manquiri or even hell itself. Thus the term «Mullu» can refer to the notion of soul for pre-Hispanic cultures, the part of man that survives after death. The concept of the gate takes on another meaning: the gorge leads the dead to their final resting place.

For these caravan cultures, souls have to travel one last time through the Andean territory and the sacred natural elements (the waqu'as) guide them. They are necessary to those who have never travelled through Potosi during their lifetime and may get lost. For the inhabitants of Cantumarca, the souls follow the Ribera before finishing their journey in the Mullu Puncu cave. Although there are several hells and maps of the journey of the dead, the Mullu Puncu occupies a privileged place in the regional funeral geography.<sup>12</sup>

An explanation of this importance is the geographical configuration of the area. Indeed it is there that the gorge changes direction, and when you come from the north it suddenly reveals the Cerro Rico in all its majesty. The cave would be thus the first stage of the rituals dedicated to the Cerro Rico.

With the arrival of the Spaniards and the implantation of the mita, the cave took on yet another meaning, symbolizing for the laborers the first gate of the mine and the beginning of a dangerous activity, both physically and spiritually.<sup>13</sup>



Fig.18- First view of the Cerro Rico from the Quebrada



„For the salvation of the souls it is necessary that they live together.“

Christian legitimization of the population resettlement

„[The city] has to be traced [...] for its cuadras, and in each cuadra four solares, with its wide streets and the square in the middle.“

Rules for the city planning from the Gobierno del Perú de Matienzo, Spanish magistrate of the Audiencia de Charcas

## 2. THE SPANISH SETTLEMENT POLICY

From city planning to the foundation of the Villa Imperial de Potosí



Fig.19 - Guamán Poma de Ayala, The Villa rica of Potocchi, ca.1615.

The end of the prehispanic period is determined by the Spanish conquest and the consequent re-organization of the territory according to the European rationalism of the modern era. The Spanish were influenced by the utopic ideas of the renaissance, which were hard to compile with the Andean traditions. To make possible the coexistence of two cultures in the American policies the strict separation between Spaniards and indigenous peoples was codified in, creating two „republics“ that shared one „habitat.“<sup>14</sup>

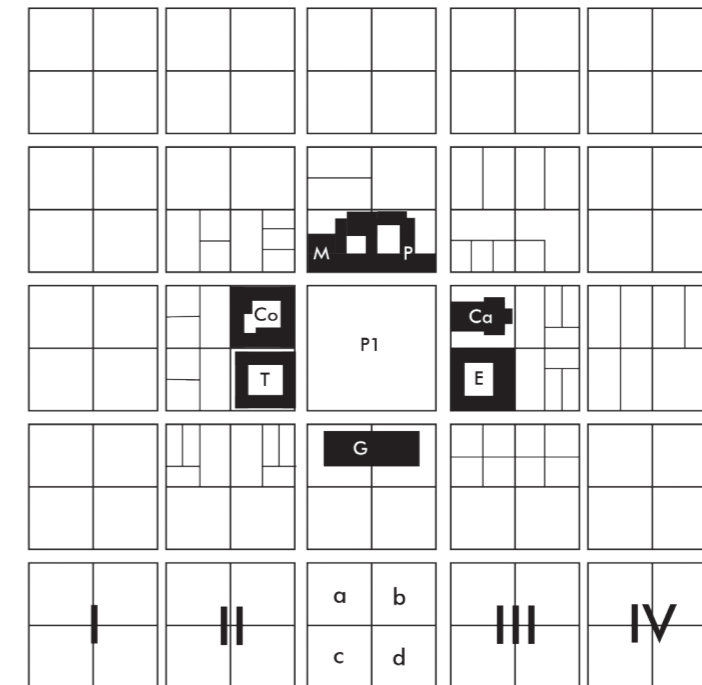
On the one hand, this meant that the Spanish established European political centres, harbour towns for trade-relations with the mother country Spain and inland relay cities on the way to the harbour. The most important restructuring, however, was the concentration of the formerly dispersed living population into new settlements, the *reducciones*, which were created for the purposes of political and economic control. They served both for the exploitation of resources such as minerals and to ensure for the basic food supply with agricultural products. The political system responsible for the territorial nucleation was the *encomienda*, which was introduced in 1503 by the Spanish Crown for means of social control. In the broader sense, a feudal system in which the conquistador was entrusted with a piece of land that he had to control and pacify. His mission was to evangelize the people and provide them protection. Equally the subjected tribes were obliged to pay tribute and work for the landowner.<sup>15</sup>

### 1. Political centres - administrative towns

The European centres served both political control and the prospect of seizing power into new areas, which is why they were located at strategic points. Often where the Andean cultures have already built their centres, such as Cuzco, La Paz, Quito, Bogotá, or Mexico City. This fact also conditioned their continental location: a decision to symbolically point out to the identity and continuity of the centre. These capitals were kernels of political, religious and military power. The conquistadors realised the ideal concept of humanism, in which the outstanding status of the city in antiquity was recalled, thus reorienting to the Greco-Roman ideal of the city, which was based on square blocks and the system of the *cardo-decumanus* in their new foundations.<sup>16</sup>

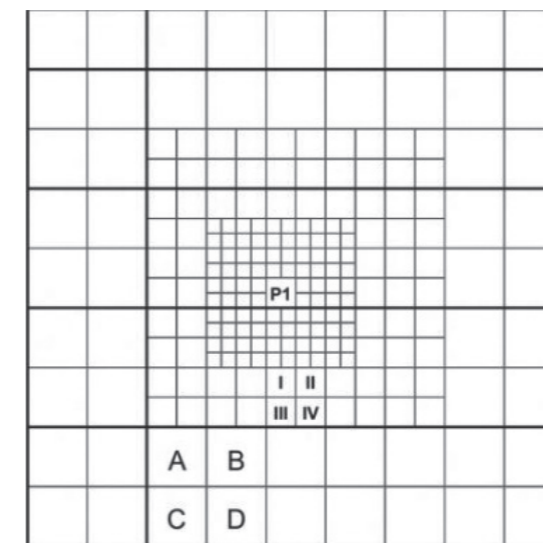
#### Characteristics

The Plaza Mayor was attributed a key function and therefore was located in the centre of the city's foundation. Directly around the most important hierarchical functions were located: the instances of church and political power, which were closely linked and mutually dependent on each other, as well as police and juridical court. It was the religious-monarchical authority which exerted its power over the assigned peripheral conglomerates: *encomiendas* and *reducciones*. Furthermore, the church played a key role in attributing the city coherence, order and the daily and annual rhythm, which was based on Christian feasts. The adjacent building blocks were intended as residences for Spanish families.



P1: Plaza Mayor      G: Gouvernment      a-d: solares  
M: Major hall      E: School      I- IV: cuadras  
Co: Convent      Ca: Cathedral  
T: Tribunal      P: Police

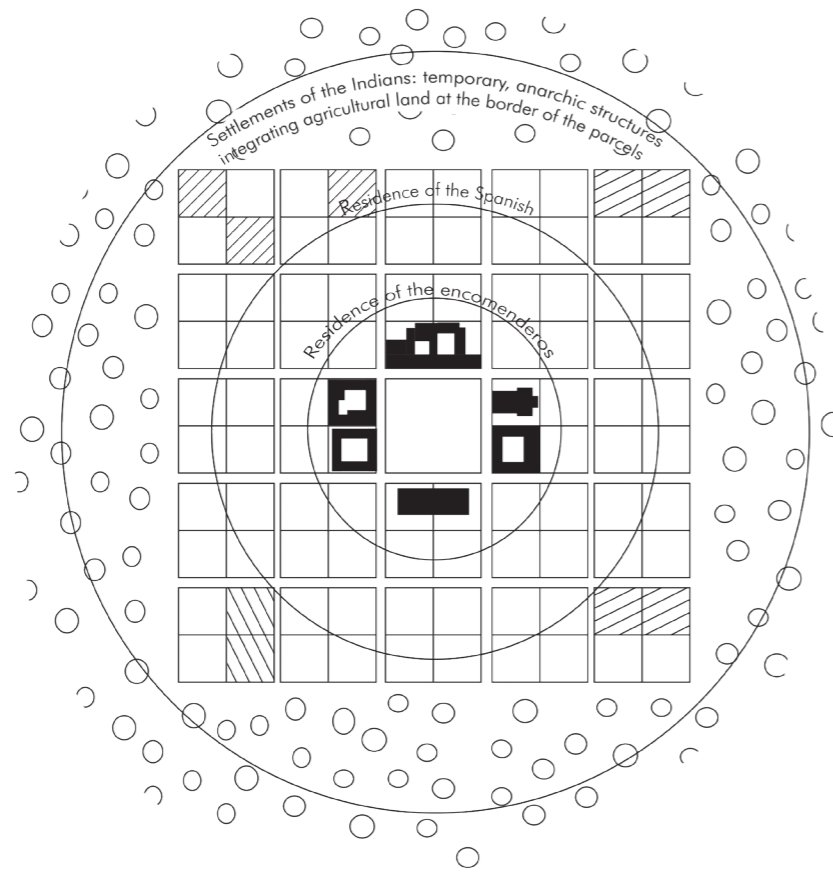
Fig.20 - Idealistic scheme of the colonial centre, after Wilhelmy & Borsdorf, 1984: 58



P1: Plaza Mayor      A- D: quintas (community land)  
I- IV: cuadras

Fig.21 - Smaller scale of the of the city, showing its community land outwards, from Wilhelmy & Borsdorf, 1984: 58

**Fig.22** - The real inhabitation of the city, showing Indigenous settling around the Spanish core, after Lockhart & Schwartz, 1990:70

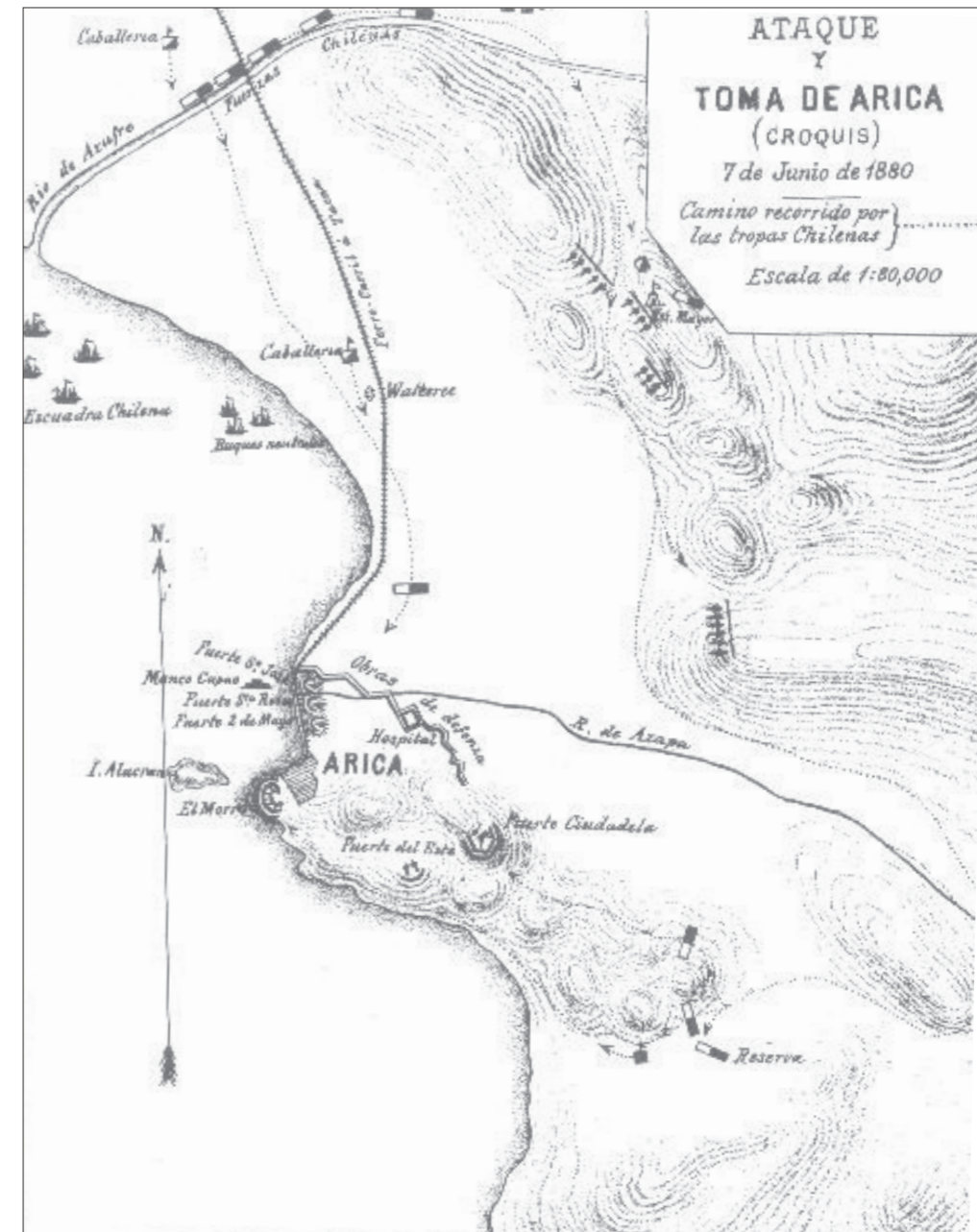


The building blocks, cuadras, had a length of about 100 meters and were later divided into four more equally sized plots, solares. The urban area was surrounded by the common land, ejido, which consisted of undivided cuadras and served as pasture for cattle or as gardening land. The communal land formed the land reserve of the city and was partitioned as soon as the inner city solares were fully populated. To the outside followed the four times larger charcas, where Indians used to farm for urban landowners.

Not represented in the utopian concept of the city, because not foreseen, are the settlements of the Indios that emerged spontaneously as satellite aggregations around the core city. These remain in the traditional rural style of urbanization, it is to say of an organic nature, and were only adapted to the European checkerboard trace after the 18th century.<sup>17</sup>

### Harbour - and relay cities

Likewise any other new, Spanish city foundation harbour and relay towns based on the checkerboard plan and the urbanisation criteria described above. The Spanish set of rules „Gobierno del Perú“ mandates only to orient the Main Plaza towards the port in the case of a harbour town.



**Fig.23** - The harbour town Arica, which was the closest link for Potosí to the sea - Oleo del heroe de Arica, coronel Francisco Bolognesi, obra del pintor Daniel Hernandez

## 2. Reducciones

Reducciones served the better political and economic control of the Indigenous people in concentrated Indian settlements. They were located in the periphery and functioned as hinterland to maintain the vibrant Spanish city life. Typically, they were agricultural settlements. In the three early years from 1564-1567, for example, 573 scattered Indigenous hamlets were reduced to 40 colonial settlements. This population resettlement was legitimized as a Christian act: „For the salvation of the souls it is necessary that they live together.“<sup>18</sup> Since the Spaniards believed they came in the Christian mission, the aim was to found the new reducciones far away from the old huacas (sanctuaries), so that the Indians



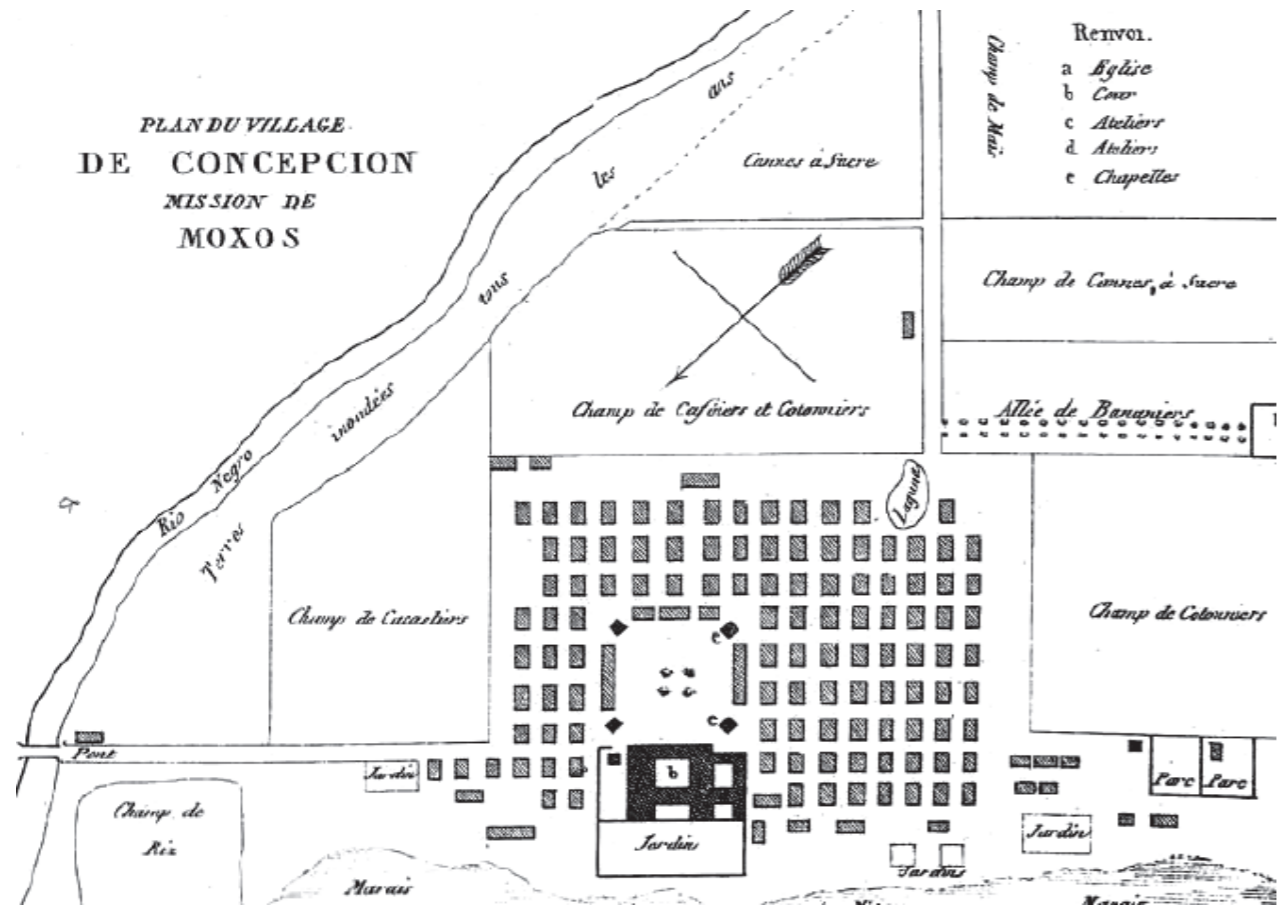


Fig. 24 - Plan of the Jesuit reduction 'Mission de Moxos' showing the productive areas around 1832, Alcide d'Orbigny

Fig. 25 - Mining enclaves in the Spanish Empire, 1885

could not fall back to their pagan faith. In addition, the Spaniards demonstrated the aspiration to govern of the new world by imposing the checkerboard as an instrument of urbanization aiming for better control. In reality, however, it turns out that this was only the ideal concept, which was not always respected. Sometimes reducciones were created over an old Inca settlement, or the rectangular ground plan could not be complied and site-specific divergences developed. Others readopted the vernacular organic urban morphology over time. Jaun de Matienzo, Spanish magistrate and judge of the Audiencia de Charcas, presented in 1563 with the „Recopilación de las Leyes de Indias“ precise rules of reducciones for the Spanish crown. Thus he described that a settlement must consist of no more than 500 family-chiefs (2,500 persons). If the number of reduced families exceeded this limit, two or three hamlets should be created and they should be divided according to their race anansaya - urinsaya. He also prescribed the urbanization structure, arranging the main functions at the main square. In theory he aimed for a governmental system, in which the indigenous would participate, but their real participation was very relative.

With the time there was a huge abomination of the feudal system, which is why Jesuits and Franciscans often promoted reducciones in order to protect the indigenous population from excesses of monarchical power. The aim of

Fig. 134.—MINES OF PERU.

Scale 1 : 20,000,000.



the Jesuits reducciones, which were mainly spread in the lowlands, was to exist as autonomous settlements. Therefore they disposed of agricultural lands and manufacturing areas.<sup>19</sup>

### 3. Mining enclaves

The category rural settlements includes alongside agricultural hamlets mining enclaves as well. The thirst for the rich mineral resources was the reason for the colonisation of many remote regions. Yet, their muleteer trails, which had existed since the early cultures, linked the whole country and developed into the ruta de la plata, the silver route, figured the most important, vertebral axis of the country's communication routes. The caminos reales were the only connections to the often difficult accessible mining enclaves in the Andean region. Due to their very peripheral location, they never managed to build up their own economy or to become a factor for population development, as they lacked access

to infrastructures such as metallurgy complexes or sales markets. Therefore they remained merely mining towns of minerals. Their population was characterized by the indigenous peasant community, which continued the traditional principle of rural agriculture. Therefore, no permanent settlements were founded and the life cycle of these mining enclaves was constantly uncertain, in the same as the life cycle of the mineral veins was unpredictable. Nevertheless, some small mining villages have managed to survive for a relatively long time as separated conglomerations.<sup>20</sup>

### 4. Agroindustrial cities

Agroindustrial cities of the lowlands served as a kind of transitional form towards autonomous cities. They were able to develop their own industries such as grain mills, textile and glass industries, and were thus economically relatively autonomous. Their social structure, however, was based on the same principle as that of the reducciones, which means that the population consisted of controlled Indians.

### 5. Mining cities - reales de minas

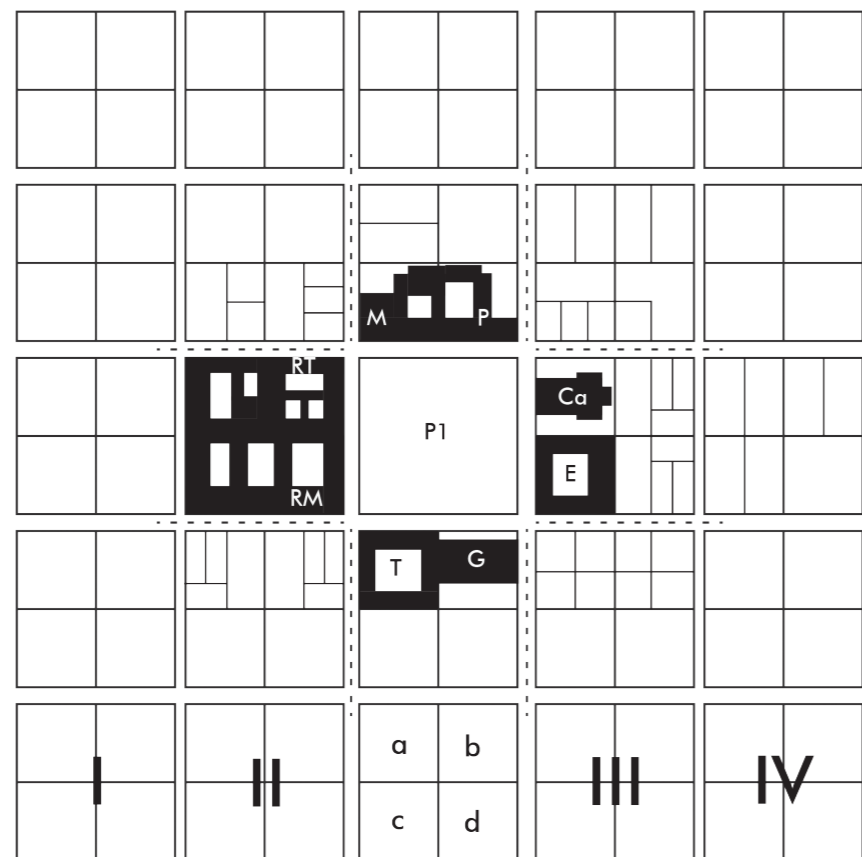
Mining towns constituted a special role as they gained relative autonomy over the economic and social fabric of the surrounding area. They were characterized by the mixture of Spanish and Indigenous culture. Often mining towns arose above the Inca ruins, as in the case of Porco (department Potosí), which already supplied the silver for Cuzco during the Inca Empire, others were newly founded like Potosí or Oruro.

These mining towns showed in space special forms of relations between economic activity, social structure and territory.<sup>21</sup> Due to their particular position of being able to build up their own economy, they were no longer hinterland, but formed a small centre themselves, which in turn set up a hinterland. The mining towns incited other small industries related to the mining industry, such as metallurgic plants, smith guilds, as well as satellite economies, such as agriculture and livestock farming in the surroundings. The mining centres thus led to a territorial integration of the region. Many of these centres still exist today and have achieved a structural change towards trade and service oriented regional capitals, such as Oruro, capital of the equally named department Oruro.

#### Characteristics

The colonial mining towns became melting pots of Spanish and indigenous population, hence it was the Spanish Crown's highest concern to control the precious mineral resources, why it sent several deputies to these towns. At the

Fig.26 - Idealistic scheme of a mining town



- P1: Plaza Mayor
- M: Major hall
- RT: Royal Treasury
- RM: Royal Mint
- T: Tribunal
- G: Government
- E: School
- Ca: Cathedral
- P: Police, Prison
- - - streets of commerce and guilds
- a-d: solares
- I- IV: cuadras



same time it was the city of the Indians, as they constituted the labour force. In the city's layout, the royal mints, as the most important economic-political organ, represent the centre of the city. They are arranged around the Plaza Mayor, alongside the usual political and religious authorities. In the mining centres the power of the Spanish state apparatus becomes apparent as in no other part of colonial society. It had control over the royal treasuries, claimed the duty of the mining taxes, supervised the operation of the mint, exercised social control over the Indian workers who were obliged to work within the mita, took care of the slave traffic with Africa and maintained the trade relations of the precious metals and mercury, which was necessary for the extraction of silver. In the surrounding area located were trade and handicraft quarters, which developed in relation to the mining activity such as silversmiths, saddlers, tailors and so on. According to Rodríguez, the origin of the settlements can be identified from the main plaza: in the close environment there are the mine entrances, metallurgic plants and mastery workshops, all of them are surrounding the settlement, and sprawling up the hills.<sup>22</sup>

Next to them, separated from the centre and characterised by an organic, anarchic urbanisation trace, there are the residential areas of the Indian workers. These are, in contrast to the city centre, space of the cultural mingling of Indigenous, Black and Mestizos and of the survival of Andean mining rites and traditions. Due to the evidence that they kept living with their extended families, it can be observed that when the man was called by the mita, normally the whole family migrated together. Doing so, it allowed the families to have continuity with their community and culture of their origin.

Moreover, the reales de minas, like no other place, are scene of magnificent architecture, jewellery, objects and religious painting. It is here that the conquistadors' ideal of humanism, with its initial exuberant Baroque lifestyle and expression, and its later Classicist and Rococo features, could best be realised thanks to the rich resources. At the same time, these manifestations show the extent to which Spanish culture has penetrated the colonial way of life.

It should always be considered that this was a space of hybridization, the coexistence of two cultures that gradually assimilated each other, or even used the same techniques and forms of representation, but in fact understood something completely different. For example, for a Spaniard a siren stood for the world of humanism with its Greco-Roman origins, whereas the Indigenous person saw the mermaids of Lake Titicaca in this image.<sup>23</sup>

## 6. Territorial consequences of the reorganisation of the land

As it can be seen in the scheme to the right, the Spanish resettlement policy meant enormous changes for the territory and people living on it, as it engendered the immense nucleation of Indigenous rural people into the newly founded *reducciones*. Nevertheless they repeated the same principles the Indigenous civilisations relied on with their vertical control. The Indigenous had centres and sub centres, being controlled by the chief of the allyu and tribal chiefs,

which themselves had dependant areas.<sup>24</sup> The Spanish just optimized this model into an economically very efficient one, being able to control the Indigenous population with very few administrative centres and eliminating the sub centres.

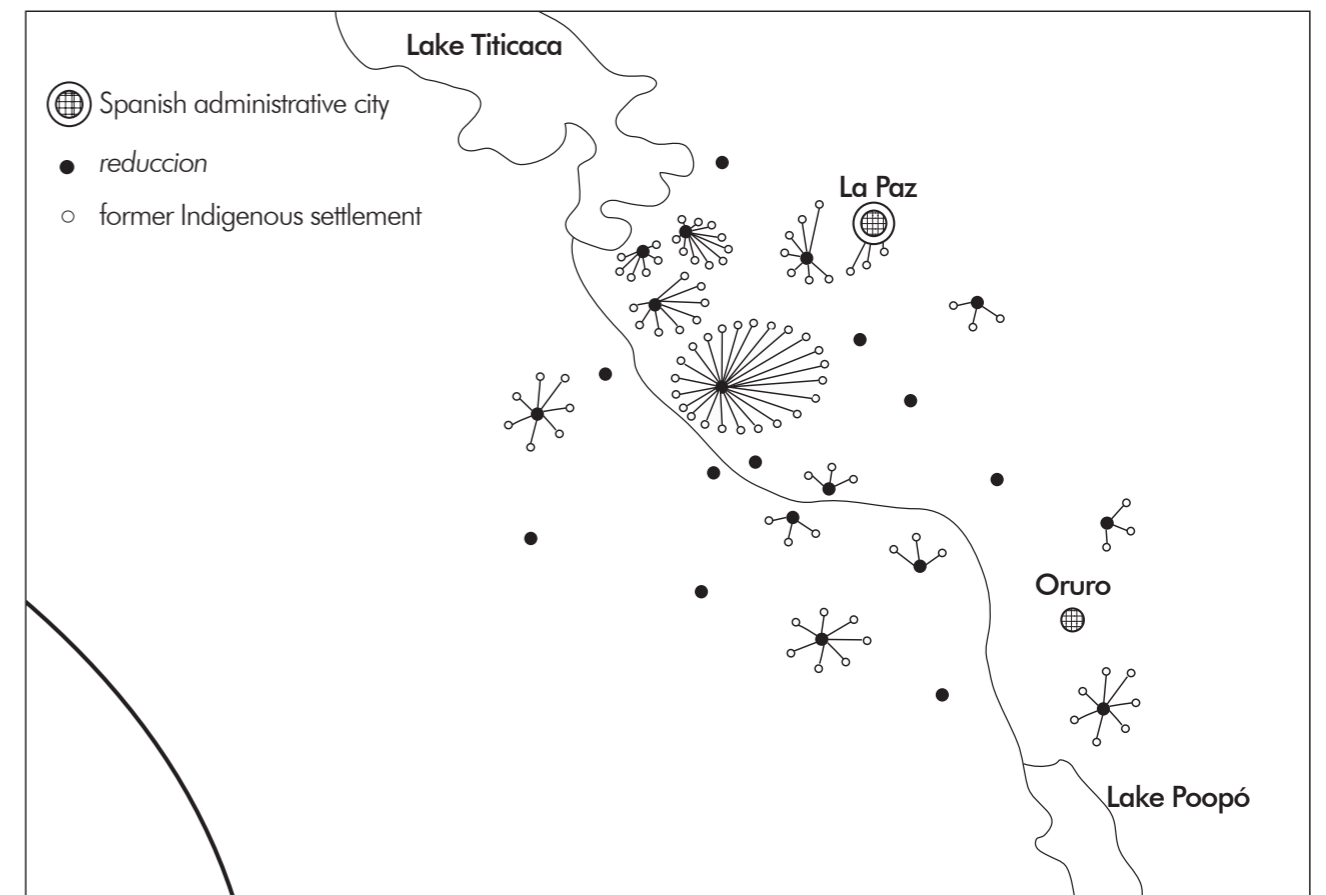


Fig.27 - Scheme of how the Spanish reorganised the territory between Lake Titicaca and Lake Poopó through *reducciones*

The foundation of Potosí  
Late 15<sup>th</sup> century

La Puerta  
3'490 m

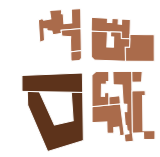
To Arica

To Chuquisaca

3'780 m

Cerro Rico  
4'782 m

To Buenos Aires



Church and colonial grid



Church and indigenous fabric



Drained wetland



Inca roads





**Fig.28** - A montane and barren landscape as departing point for Potosí's creation - two horsemen just above the city

In 1532 the Spanish conquest started under Francisco Pizarro and Diego de Almagro coming from the northern parts of Latin America, Ecuador, and advancing to the south. Their conquest happened quite fast and relentlessly as in the Inca Imperium there happened to be an era of a power vacuum due to internal wars. 1534 the Spanish started another expedition from Cuzco aiming for the south but as they didn't find any major Incan towns this region stayed quite uninteresting for them. The district of Potosí was the encomienda of Gonzalo Pizarro, who undertook several expeditions searching for mineral resources, but stayed without success. According to legends it was the Indian Diego Hullapa, an experienced miner from Cuzco, who made the silver findings in April 1544.

Meanwhile the zone rapidly got famous, first by the locals of Chuquisaca and Porco, Spaniards as well as Indians, who were the first to arrive at Cerro Rico to mine the silver of the hill. But as they suffered from the harsh conditions and the cold they didn't had the aspirations to settle there more than one month. This explains why they didn't built their own houses, instead sized the ranches of the Indians in the nearby Cantumarca and other sites the closest possible to Cerro Rico.<sup>25</sup>

Soon Cerro Rico's fame got known amongst the whole Altiplano and even in father circles so that people from around the world were attracted by its promising wealth.

At the first time Indigenous and Spanish lived in a peaceful conviviality and the Andean cultures were even grateful that the Spanish came to conquer the



**Fig.29** - Abandoned ruins (after the flood from 1626) in the close environment of Potosí

territory as they saw in them the liberators from the Incan supremacy.

The Spanish undertook friendly relations with the chiefs of the indigenous tribes and made contracts with them in order to have an Indigenous tribe mining the silver for them. Thus the Indigenous people were free and they were obliged to handle the minted silver as tributes to the Spanish conquistadores. It was a principle based on mutual confidence, which means that the Indigenous were not controlled. Therefore they used this opportunity to make money themselves as they guarded a part of the minted ores, which is why the silver mining was a lucrative business also for Indians. Nevertheless after a while the Spanish demanded for bigger quantities of tributes and a higher amount of work, which was not compatible with the agricultural living of the Indians who cyclically returned to their fields in the valleys to cultivate their potatoes and maize. According to the chronicle of Arzans the first conflict between Spanish and Indigenous happened when the Spaniards started to oblige the Indians by the force of poles to fabricate bricks and to build them houses.<sup>26</sup> As a response the Indigenous fled the high territories and left their ranches and village of Cantumarca deserted. Meanwhile the Spanish quickly occupied their houses to find refuge from the inherent cold. Arzans further claims that when those infrastructures already were saturated by the big mass of rapidly inflowing people all forces of the newcomers were put together and the city of Potosí was founded within four days in the month of December 1545 in order to escape the inherent cold.<sup>27</sup>



## Foundation of the City

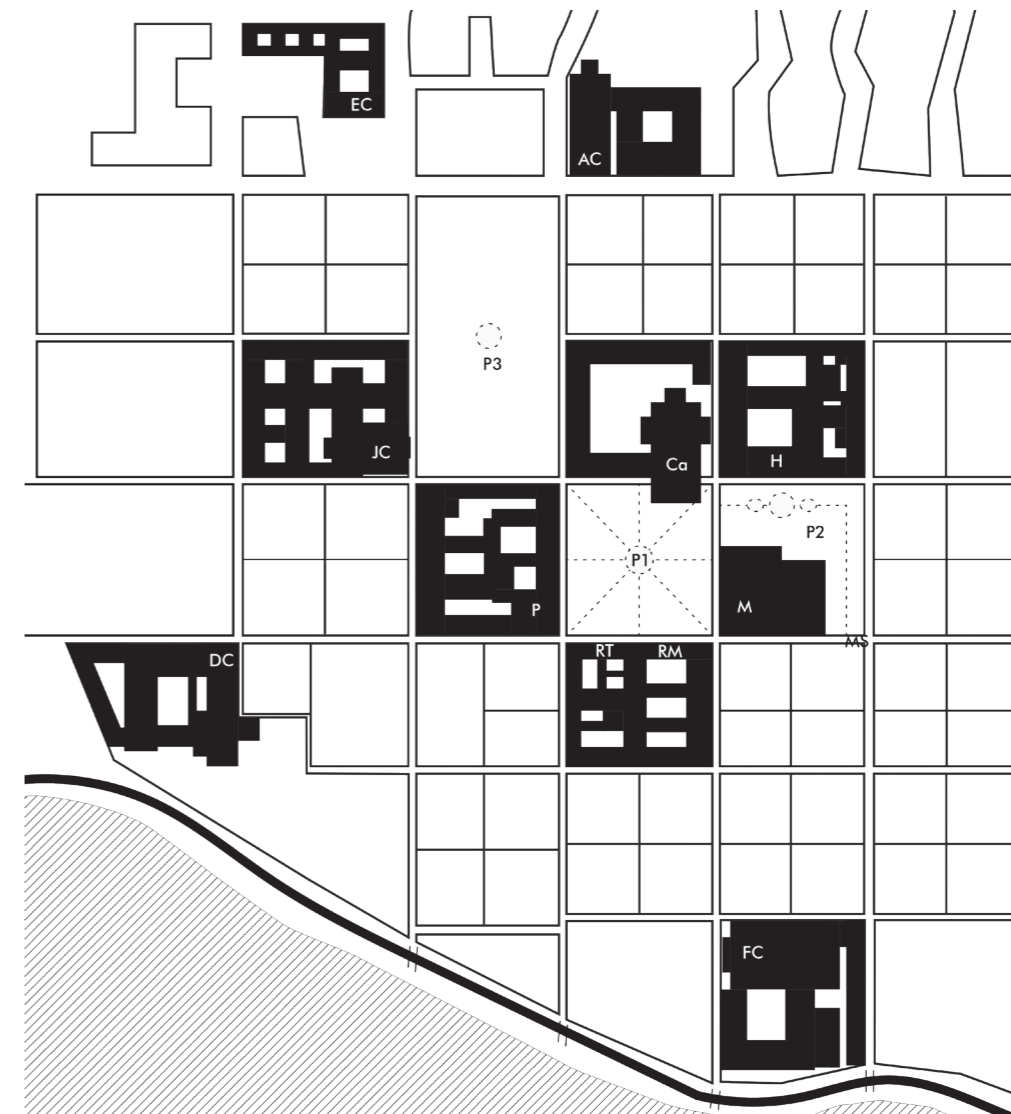
Although the city of Potosí was officially founded by the Spanish in April 1545, commonly it is claimed that the origins of the city of Potosí are not corresponding to a planned foundation of the Spaniards, but much more that the city arose from an unplanned mining settlement.

As we have seen, it was of course the incredible spell of silver that attracted people of all races, and that they settled there purely for the sake of profit in disordered structures originally designed for a short time. However, it can be observed that the city still has continuity of settlement till today.

In Potosí there is a duality of anarchically grown structures and a city planned on a checkerboard. At the same time, Potosí is a lively place of hybridization between the culture of the Andean and Spanish people. In contrast to 'normal' Spanish cities, Indians and Spaniards lived directly together in the early days, as they were looking for the same location advantages such as already existing infrastructure or dry areas and were spatially not separated. In the course of the urbanization efforts of the Spaniards, the clear division of the population emerged later: the Spanish city was planned on the north side of the Río de la Ribera, while the Indians settled separately on the south side of the river, near the mineral deposits.

Since the urban area of the Villa Imperial de Potosí was located on a large swamp, the Spanish firstly engaged to drain this area. Thus the artificially formed river de la Ribera was created as a drainage channel, whereupon the city planning reached its northernmost limits. With the arrival of the first Franciscan religious order in 1547, the city began to take shape for the first time. Three other orders were to follow, and in 1555 the Hospital Real, which helped to determine the main road axis that cross at the boundaries of the Plaza Mayor accordingly to the system of cardo-decumanus. Moreover at the main plaza important functions, such as the Royal Mint, the Royal treasuries, the major hall and prison established. Therefore Potosí corresponds very well to the criteria of the planned urban development. As Rodriguez describes it in the model of mining cities, see Chapter 2.1, the reason for the city's existence can be identified directly from the main plaza: the Cerro Rico with its mine entrances as well as the sites for further processing in the immediate vicinity.

In contrast, until the beginning of the 18th century, the habitational area of the Indios was characterized by unicellular houses on a circular plan, covered with thatched roofs. The kitchen was located outside and chickens and other farm animals directly shared the outer space with them. According to numerous descriptions of the chroniclers, the living situation in these areas was precarious: «the houses of the Indians have no apartments, they are of 20 feet in length and 100 feet in width; others are round, where they live like the biggest piece of crap in the world; they never sweep; they all live together, fathers, mothers, chickens,



- |                       |                      |                               |
|-----------------------|----------------------|-------------------------------|
| P1: Plaza Mayor       | RT: Royal Treasury   | P2: Trade square              |
| M: Major hall         | RM: Royal Mint       | MS: Merchants' Street         |
| Ca: Cathedral         | H: Hospital          | P3: Indigenous market 'qhatu' |
| P: Prison             | JC: Jesuit Church    | EC: Encarnación Church        |
| FC: Franciscan Church | DC: Dominican Church | AC: Augustinian Church        |

**Fig.30** - Scheme of Potosí's city centre with its most important functions, ca.1603 after Lane, 2019: 39





**Fig.31** - Traces in the urban tisse still remind of the traditional round typology of the Natives (to the right) here already beeein quite mixed

pigs, dogs, cats and rats.»<sup>28</sup> Arzans adds that 20 to 30 people lived together in one of those little spaces. Bakewell concludes that these precarious situations have made it impossible to establish roots or develop the sense of private or collective ownership. The city has always remained in the spirit of a camp.<sup>29</sup>

This behaviour can be easily understood from the figures Arzans provides. Thus he describes the population share from 1546 being 94% Indians to 6% Spaniards. Within this year the population has also increased from 3,170 to 14,000 within six months, which means a quadrupling.<sup>30</sup>

Further, the chronicler Cañete states for the year 1598:»Potosí already embraced the area of two leguas containing 954 streets out of which 268 were regular and proportionate where the Spaniards lived, while the remaining streets where the Indians lived, or the twists and turns that they represented, more than streets resembled the labyrinth of Crete built by Daedalus. In total there were 16,000 houses, and when in 1611 the head of the Royal Audience of Charcas, Bejarano, took a meticulous census, it turned out that in the Villa there were 66 thousand Indians of both sexes, 40 thousand foreigners from the kingdoms of Spain and other foreigners, 3 thousand Spaniards born in Potosi, 45 Creole Spaniards from all the kingdoms of the Indies and 6 thousand blacks, mulattos and zambos, accounting for a total of 160 thousand inhabitants, when Buenos Aires that was founded long before Potosi, just in 1810 had barely sixty thousand inhabitants.»<sup>31</sup>

Just in the 18th century the urban trace happened to be consolidated, following the Spanish patron of the quadricular, but with an irregular layout. Straight, bigger

streets were traced and the round housing plans got replaced by rectangular ones. However the importance of the outer space as integrated inhabited area still stayed valid.<sup>32</sup>

Potosí won the title of the 'Villa Imperial' which meant that it got a special recognition by the Spanish Monarch Phillip II, in 1561, after helping its motherland Spain out of a deep financial bankrupt in 1557.<sup>33</sup>

**Fig.32** - General plan of the Villa Yimperial de Potosi, Atlas of Sea Charts - lightening the separation between Spanish and Indigenous people by the means of circle (indigenous) and rectangular (Spanish)





### 3. POTOSÍ, THE FIRST INDUSTRIAL CITY

From the territorial machine to a global city

*„We now know that Potosí silver did not tarry long in London, Paris, or Amsterdam, much less in Lisbon or Seville; the lion’s share was traded away to Asia.“*

Kris Lane, 2018



Fig.33 - Potosí «piece of eight» or *perso de a ocho* that irrigated the world in the 17th century





Fig.34 - «El Cerro Rico y la Villa Imperial», Gaspar Miguel Barrio, 1758



## A territorial machine

The viceroy Francisco de Toledo was sent 1569 to Perú in order to pacify the Spanish government realm. Thereby one of his main missions was to increase Potosí's profits and efficiency, since the Spanish Crown was getting more and more indebted due to its territorial expansion policy and expensive trade relations. Therefore Potosí's mines had to yield the missing amounts.

Toledo fulfilled these aspirations by carrying out important urban and territorial measures. Thus, he initiated the creation of the Ribera de los Ingenios, which had previously flowed through the city as a spontaneous spring, and at the same time he introduced the new metallurgical separation process with the help of the Ingenios. These were small factories that used hydraulic energy to grind the minerals and separate them using the amalgamation process with mercury. This was also a newly introduced process, which became necessary as from 1566 onwards the surface deposits of pure silver were exhausted and so mixed ores had to be mined, which then had to be separated. In order to establish the system of the Ingenios for a large-scale silver production, an enormous engineering effort was needed, as well as an exact study of the surrounding territory. In order to ensure a constant water supply for the running of the water wheels, Toledo commissioned the construction of artificial lagoons in the nearby caldera, which would serve as a reservoir for the precipitation fall accumulated over the winter.



Fig.35 - Viceroy Francisco de Toledo, Felipe Guaman de Alaya, 1615

By 1621, 32 artificial lagoons had been created in their full extent, all of which were connected to each other by an elaborate system of canals, tunnels and aqueducts.<sup>34</sup> These fed the water into the Ribera de los Ingenios, where until 132 Ingenios settled over a length of 15km. These were all connected in series as a huge territorial machine, which meant that the upper Ingenio always had to pass the water to the one below, as they all depended on water energy. As a result all the Ingenios were connected to each other by aqueducts.

Berrio's painting shown on the previous page describes very clearly the different elements of the system. The lagoons, dams and canals are on the left side of

the painting and the Ingenios connected by the aqueducts run from one side to the other. Berrio was able to capture the effervescence that prevailed in Potosí at that time, with its markets, processions and ethnic diversity.

In the map that conclude the Part I, the different elements that compose the territorial machine are represented in blue: the lagunas of Kari Kari to the east, the Ribera crossing the city and the Ingenios settling on its banks. Together with the Cerro Rico, they form the «mining triangle» of Potosí, which since the 16th century has ensured the economic future of the city and irrigated the whole world. Each element of the mining triangle, between persistence and mutation, will be developed in Part II.

## A control over people

As another great deed that would bring a long-term social restructuring to the country, Toledo introduced the system of mita. This signified a duty for the indigenous population to work. The system itself was taken over from the Incas, but its conditions were tightened. As a result, all men between the ages of 18-50 from the surrounding 16 provinces were obliged to work for Potosí for a minimum wage for one year. In theory, they were assigned to work in a cycle every 7 years. They were used in the mines and Ingenios as well as for the execution of infrastructure projects, such as new roads or the construction of the artificial lagunas and their canal systems. In 1573, with the first concession, 2,308 Indians were assigned to the Ingenios, 1,403 to the mines and 762 to other tasks. When a man was called up for duty, he usually migrated with his entire family, which had far-reaching consequences for the people's areas of origin; these were left as almost deserted regions. By the 18th century, 95,000 people had been subjected to compulsory work.<sup>35</sup>

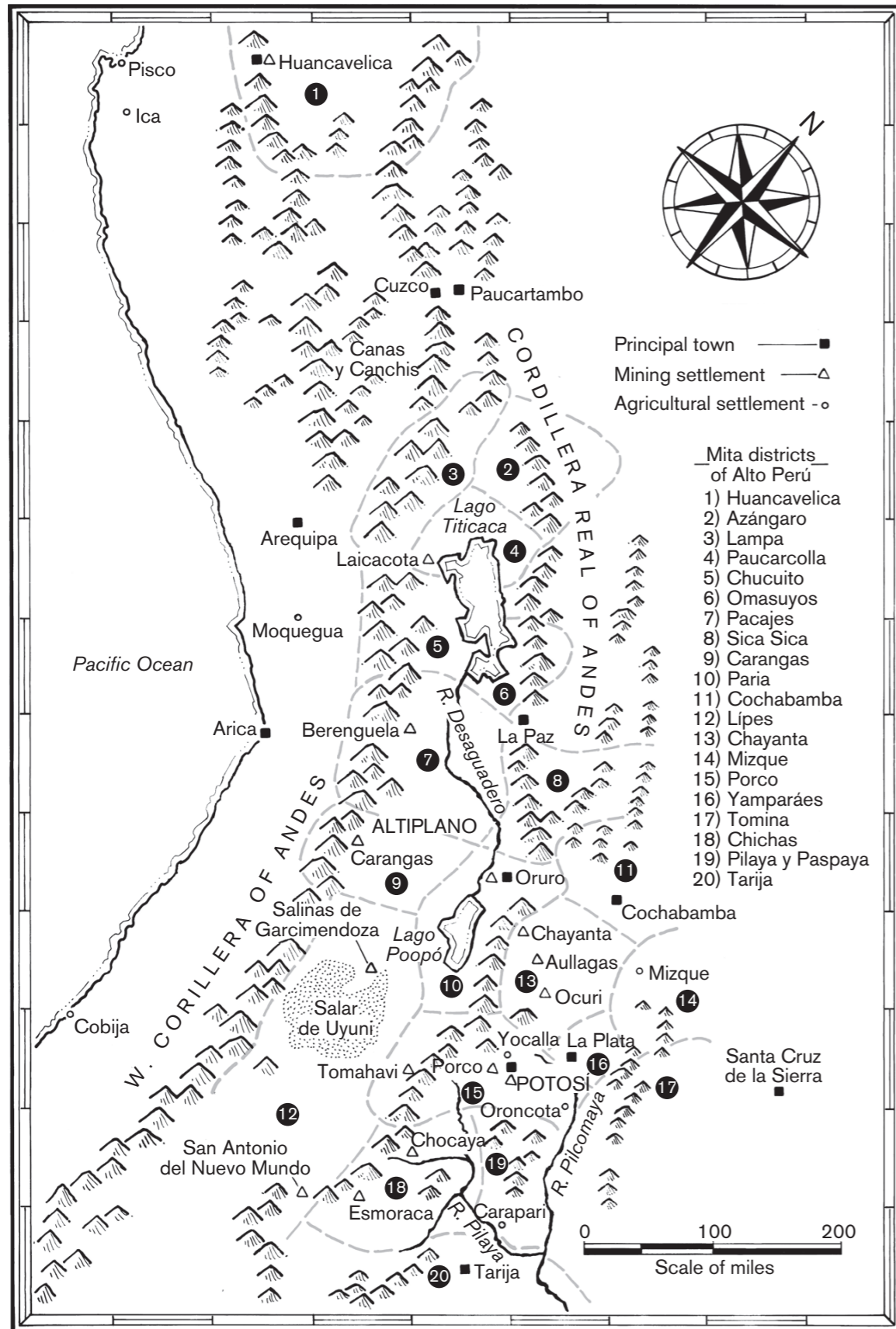
Beyond political and military domination, the emergence of power also has to do with the control of the supernatural.

A legend well known to the inhabitants of Potosí is particularly revealing of the methods of evangelization employed during the Colony. It tells how Saint Bartholomew locked the devil in a cave in the outskirts of Potosí: the *Mullu Puncu* Cave, a pre-Hispanic place of worship that we have already mentioned.

In Christian mythology, the victories of the saints over the devils often symbolize attempts to evangelize pagan cults. Saint Bartholomew is no exception to the rule.<sup>36</sup>

For the Jesuits of the 16th century, obsessed with the existence of the devil, indigenous cults could only be a sign of Satan's influence. One finds this idea in the whole colonial process of evangelization of the Andes.

The Spaniards undertook the reorganization of the religious landscape of the natives according to the dichotomy of heaven and hell by marginalizing the old cults. Certain entities considered less subversive can be incorporated into Catholic rites. This is the case of the rapprochement of the Pachamama with the Virgin Mary. Others, too diabolical, are eradicated. Thus, the term *supay*, which

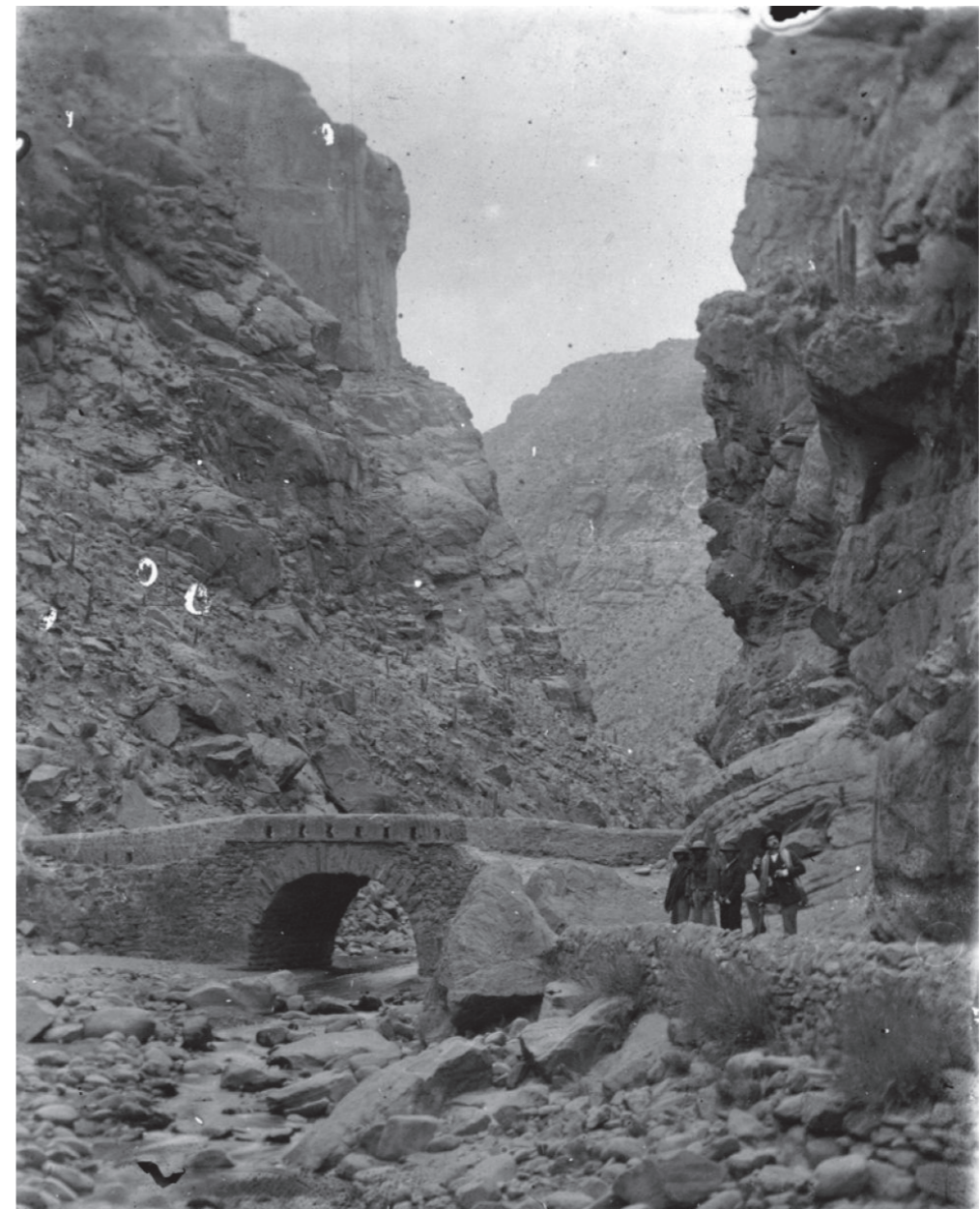


would have meant the souls of the dead and the ancestors in pre-Hispanic times, was chosen by the missionaries to incarnate the devil in the Andes.

The Wak'as were relegated to the sphere of the *Ukhupacha* (infraworld in Quechua) chosen by the evangelists to translate the concept of hell. The latter is opposed to the *Hananpacha* (world above) where the evangelists place God, the Virgin and the saints.

Pre-Hispanic rituals are forbidden but continue underground. The Ukhupacha becomes the space of secrecy for the Indians, associated with the past, in opposition to the world above, guaranteed by the new colonial order.

In Potosí, the cults of Mullu Puncu and Cerro Rico are attacked by Evangelists during the XVIth century.<sup>37</sup>



facing page  
**Fig.36** - Potosí's Mita districts and satellite mining camps

**Fig.37** - Quebrada de San Bartolomé, 20th century



According to legend, the devil had taken up residence in the cave of the gorge to the west of Potosí. He could command the mountains to close in on the unfortunate travelers who tried to cross the narrow passage. Saint Bartholomew, moved by the martyrdom of the inhabitants of the place, would have appeared in the gorge, whose evil rocks he was sifting. Then he settled himself in the cave. The devil had fled and a chapel was built to welcome the saint a little further down the Ribera. But he refused to settle there and always preferred to return to the «devil's cave» until he was forced to do so by force, sealing the entrance to the cave. From then on, he returned to the chapel and did not move.

This desire of the saint to return to the cave, as if he had been perverted by the devil or was in the process of becoming one himself, is a rather convincing metaphor of the long process of Christianization that the Indians were to undergo, constantly forced to deny their past cults although they were always trying to find them again.

During the colonial period, Potosí never formally recognized a veneration of San Bartolomé, which only began later in the 18th century. The cult turned into a celebration, which grew particularly strong under the Republic. On 24 August, Saint Bartholomew's Day, the people of Potosí celebrated the saint's victory over the devil. Today, however, the celebration has been replaced by a festivity copied from the Oruro carnival in order to accommodate the demands of Bolivian mestizo identity and tourism.

The names of the places that witnessed these events are significant: the gorge took the name of the saint «*Quebrada de San Bartolomé*», while the nearest municipality where the chapel dedicated to the saint was built is called «*la Puerta*».

The Mullu Puncu, today sealed with a gate, owes its fame only to this late colonial episode in its history, as any pre-Hispanic cult was forgotten by the inhabitants of the area.<sup>38</sup>

### A global city

In the colonial times Potosí was a flourishing city, entertaining extended trading relations, not only with other South American countries and Europe, but also with Asia. Of whole Latin America, in the Villa Imperial de Potosí there arose the biggest market.

The Imperial Villa was sterile apart from its wealth of silver, so everything necessary for life and work had to come from far away.

Although the times show a fierce technological struggle, there was also a phenomenal influx of basic and luxury goods from all over the world, all bought with raw silver. Even the indigenous inhabitants ended up adopting European and Asian consumption habits.

From the neighbouring and tropical valleys, but also from Chile fruit, corn, meat, pack animals and various agricultural and industrial products were imported. Thus for example the cronists kept records of the ananas supply to Potosí. French and English merchants imported luxury goods from Europe to Potosí and with

Asia there was a big market for expensive cloth like silk and oriental spices.<sup>39</sup>

Another important connection, that developed was the route to Huancavelica, in the north of Perú, about 1,000km distanced from Potosí, as it deposed of the greatest mercury deposits that were necessary for the amalgamation process. At first this route was done by land, till in the 17th century by sea. Still it remained an elaborate trip. From Huancavelica the mercury was transported with lama caravans over the Andean cordillera to the Peruvian port Chíncha, by boat to Arica, and again with lama caravans to Potosí. The Spanish Crown introduced the trade with mercury as a state monopoly in order to have full regulation of the prices.

It is to say that all of those freight transports just were possible thanks to the by Andean populations preset conditions. It were the roads emerging since the Tiwanaku empire and having been accomplished under the Inca that the Spanish relied still upon. And the nomadic way of life, that is anchored in the Andean culture providing the demanded knowledge, that made possible those intensive trading relations. Since the Andean cultures had the habit of moving through the country with their camelid herds, they had a great knowledge about the territory, knew about their supply and also possessed of the sufficient, appropriate means for their journeys: the llamas. For this reason, the Spaniards handed over the responsibility for transports to the indigenous people from the beginning.

Within the travel routes, the connection Potosí's via the Río de la Plata with Buenos Aires became especially interesting, as it is the shortest way to Europe. This route, however, was a very dangerous one, as brigands could be hiding in the hinterland, which is why oftenly it was decided to take the longer sea route via Arica to Panama and from there to Europe.<sup>40</sup>

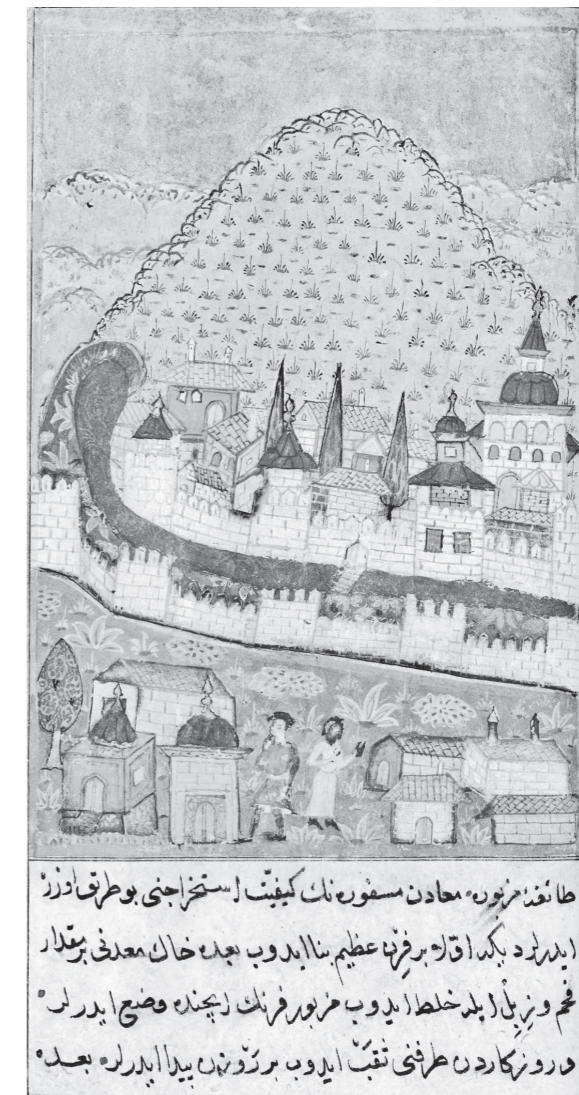
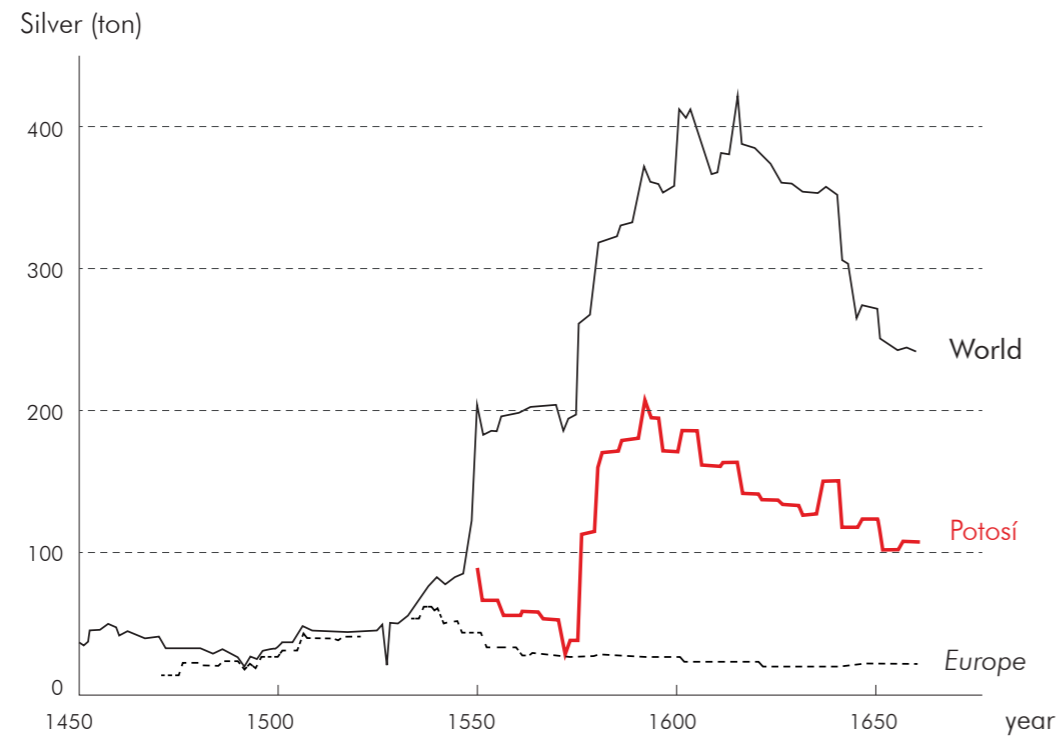


Fig.38 - The Cerro Rico of Potosí, Tarih-I Hind-I Garbi manuscript, ca. 1582

Potosi quickly became the most populated city on the American continent, and rivaled the largest capitals in the world, reaching 160,000 inhabitants in 1650.

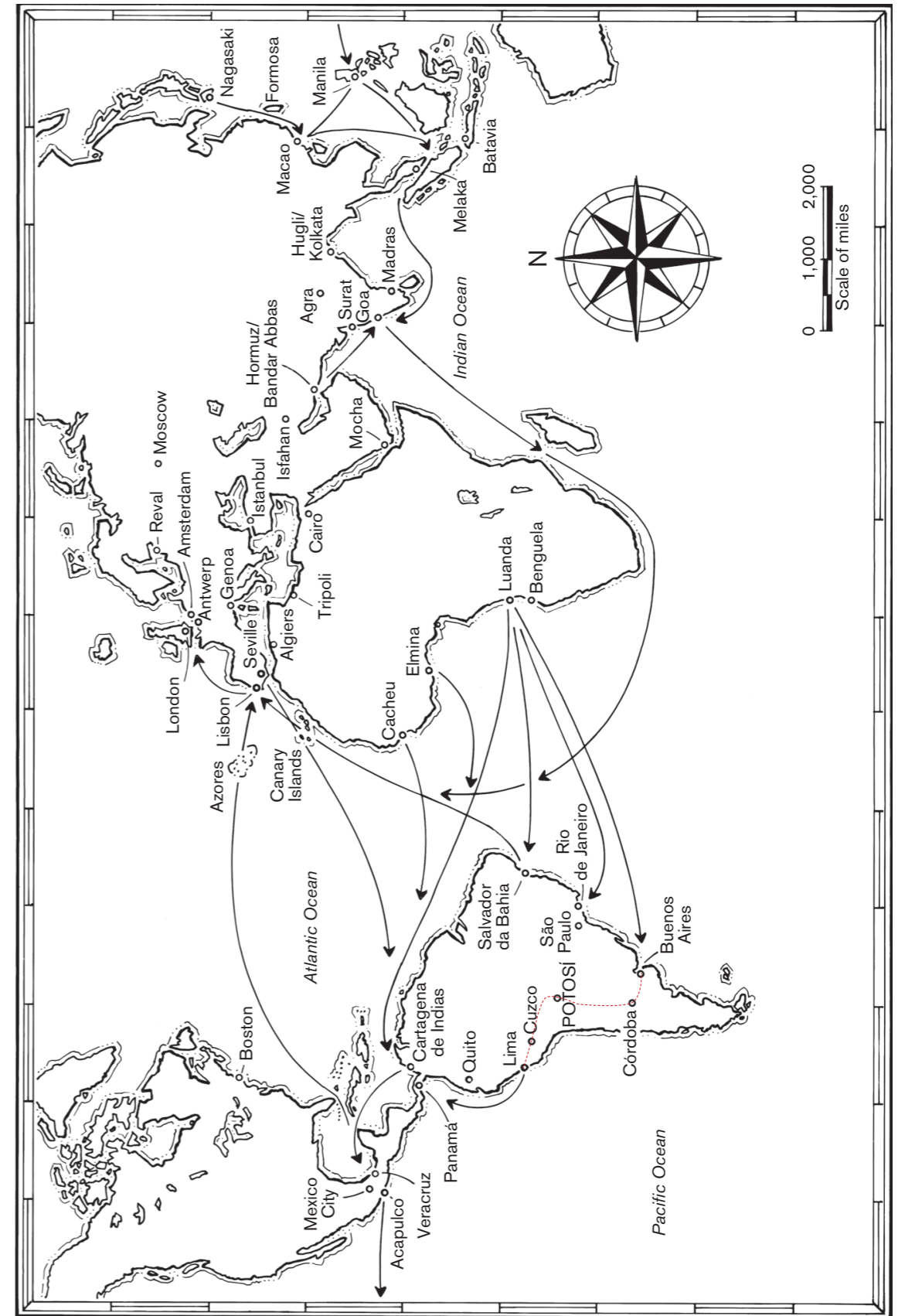
The demand for workforce created by the Ingenios is impressive: in 1603, there were more than 19,000 Indian workers, representing one third of the total Indian population.

It is important to specify that only 1/12th of them were mitayos. When Viceroy Toledo arrived to revolutionize the mining and refining sectors of Potosí, it was the largely independent Andean natives who mined and refined most of the silver in the Cerro Rico, not the Spaniards who held the monopoly, as the history often tends to be told.



**Fig.39** - The evolution of silver production in Europe, Potosí and the world from the 15th to the 17th century

-facing page  
**Fig.40** - Global maritime trade routes in the Age of Potosi silver and the roads to Potosi

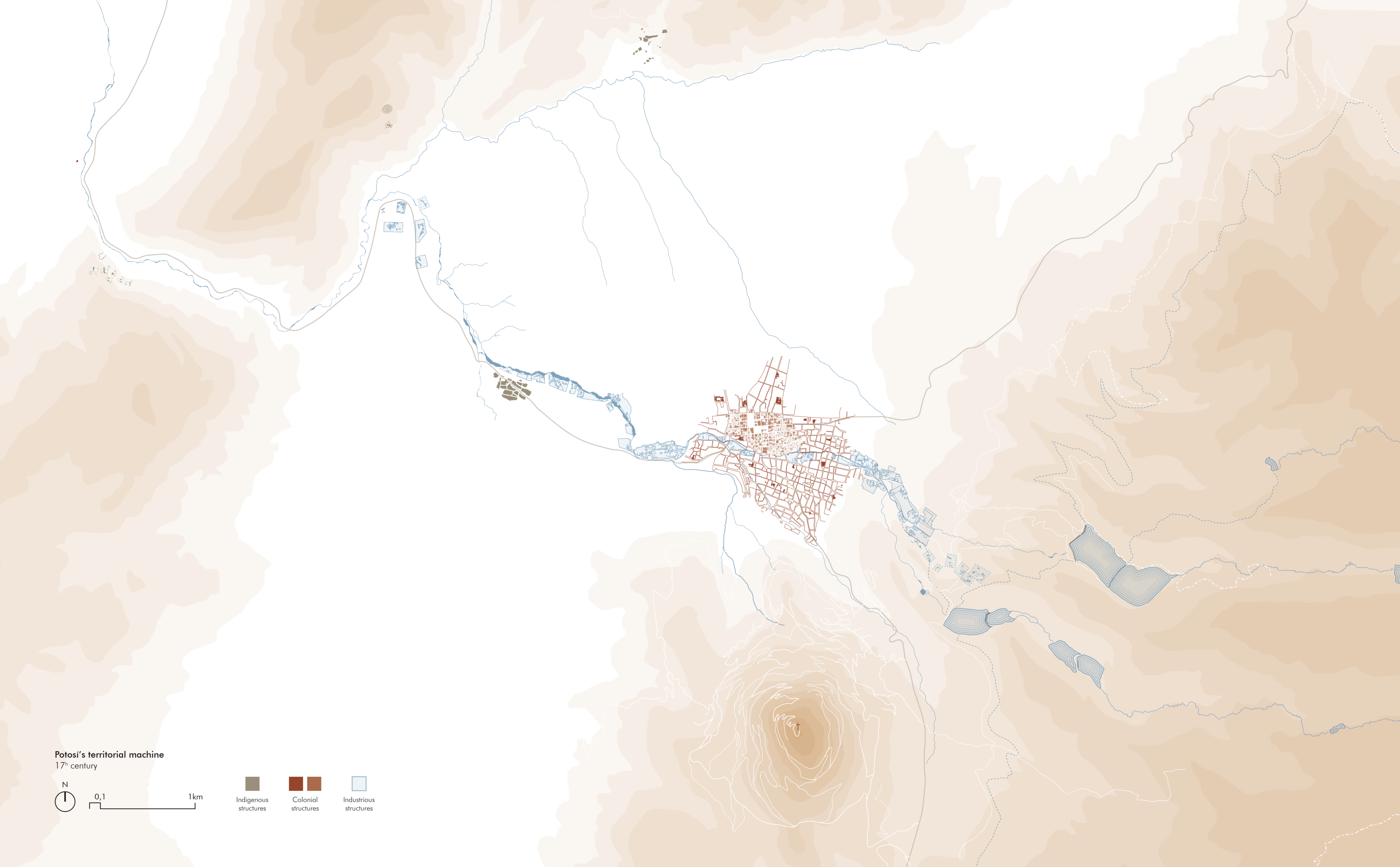




Potosí's territorial machine  
17<sup>th</sup> century



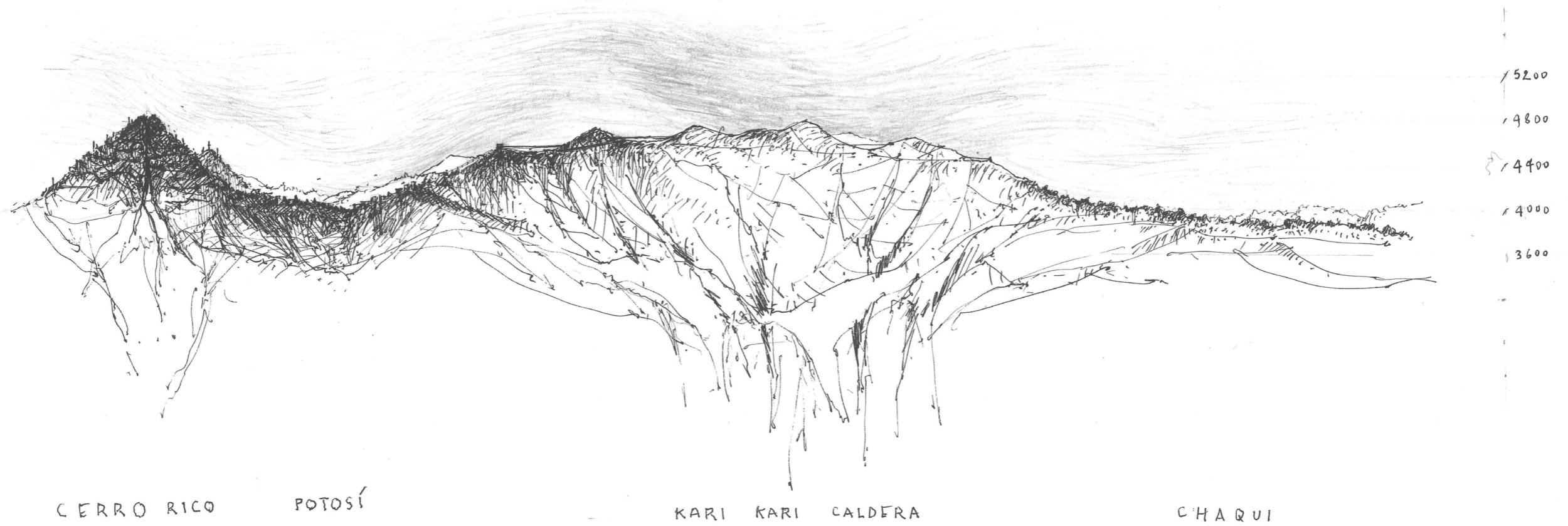
- Indigenous structures
- Colonial structures
- Industrious structures



## PART II

# THE MINING TRIANGLE





TERRITORIAL SECTION OF POTOSÍ .

Fig.1 - Section of the Cerro Rico, the Kari Kari caldera and rural lands in Potosí





Fig.2 - Entering the  
mines of Cerro Rico,  
2019

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CERRO RICO

## 1. CERRO RICO

Sacred and exploited underworld

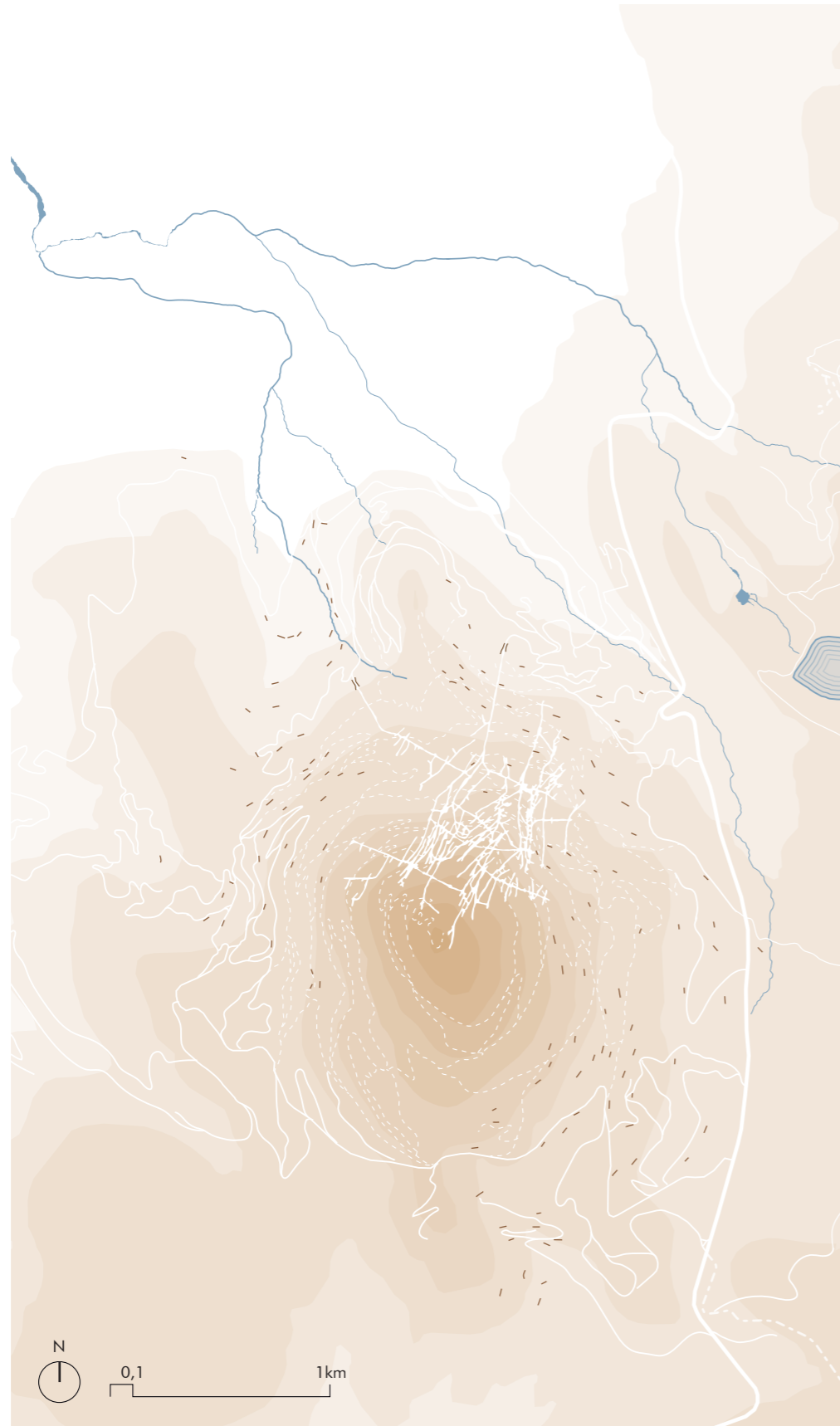
*„This wealth is not for you, it is for  
others who come from afar.“*

Indian legend implemented  
by the Spaniards, 16<sup>th</sup> century

*“Esta es la octava maravilla del mundo y la  
mayor de todas; pues es todo este cerro de  
plata.”*

Fray Diego de Ocaña, 1605





**Fig.3** - Paths, mine entrances and Pailaviri Mine level 0



**Fig.4** - Cerro Rico, aerial view



## Geology

Cerro Rico is located in the highly mineralized Eastern Cordillera of the Bolivian Andes, one of the rocky mountain ranges that rise to the east of the great Altiplano. The Red Mountain of Potosí, arguably the richest silver deposit in the world, has been producing silver, tin, zinc, lead and other metals discontinuously since 1545.<sup>1</sup>

It is estimated that more than 45 thousand tons of ore were extracted from the mountain (as a comparison, it represents the mass of the Titanic). According to geologists, similar quantities of resources would still be exploitable in the Cerro, but dispersed at depth and would require sophisticated processing.

The Cerro Rico, nearly 4,800 metres high, is a silica-rich volcanic dome about 14 million years old that was internally fractured over the following millennia. The fractures became ore veins, mineralized by rich hydrothermal fluids and magmatic steam rising from below.

Metal veins often contain quartz, and its high silica content has been the curse of indigenous miners since colonial times. Silicosis, a lung disease caused by inhalation of these tiny particles, remains the main cause of death among miners.<sup>2</sup>



Fig.5 - View from the hillside, 2019

The rich silver veins of Cerro Rico have an average width of about one meter, but several larger veins were mined in colonial times, leaving behind wide and dangerous galleries.

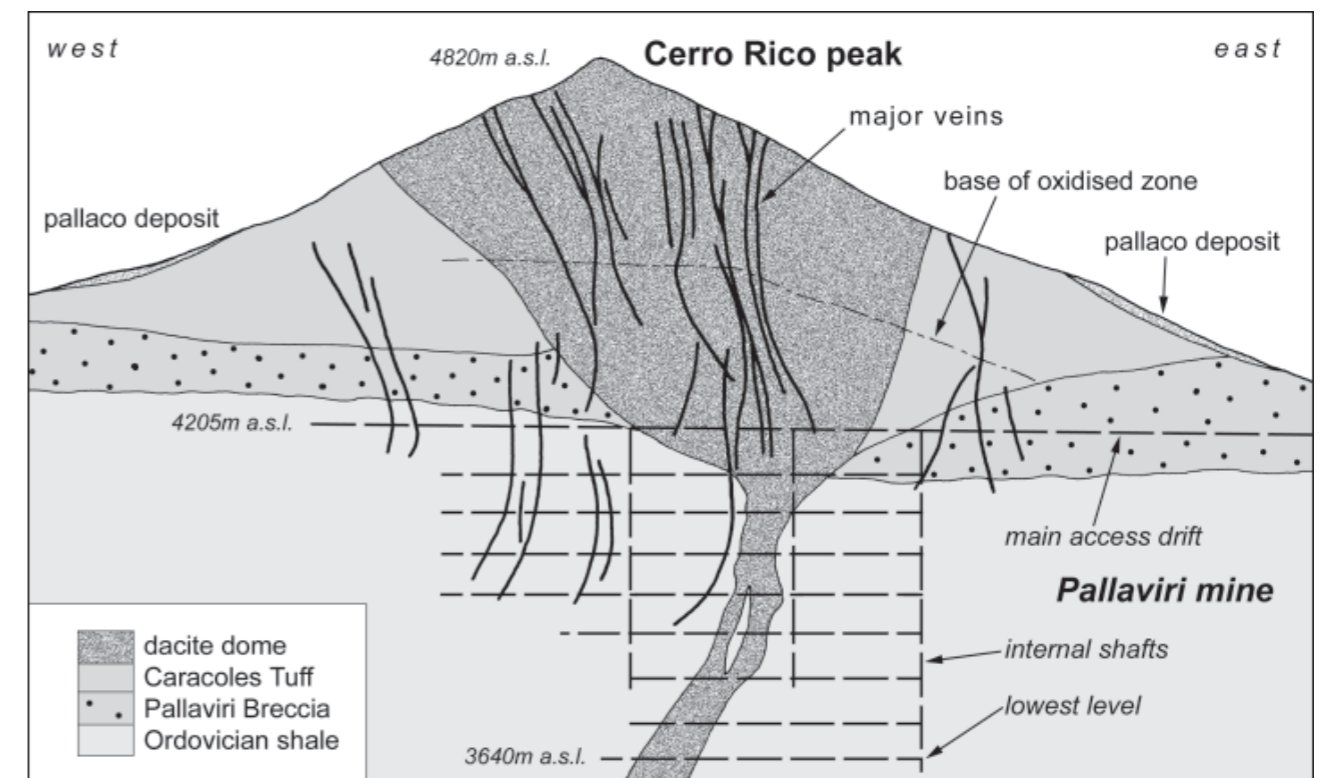
The deepest level mined in modern times, Level 16, is 1'150 meters below the top.<sup>3</sup>

The characteristic red colour of the Cerro Rico comes from the surface oxidation of iron and other metallic compounds, which is at the origin of the initial boom in Potosí.

Most of the veins plunge abruptly into the mountain from the surface to the northeast. The ores in the upper zone were richer due to what is called supergene oxidation, and some pieces of pure silver were found. At depth, the ores tend to be lower grade.

The map on the previous page shows the access roads to Cerro Rico and the plan of level 0 of the Pallaviri mine, one of the largest currently in operation. It is estimated that the mine entrances, shown in brown, are more than 150 on the slopes of the hill today.<sup>4</sup>

Fig.6 - Geological section of the Cerro Rico





### A sacred mountain

Did the pre-Inca peoples extract silver in Potosí? As explained in the part I, according to the scientists Abott and Wolfe , there is evidence that the Cerro Rico was mined, not only in Inca times but long before: at least in the year 1000 AD, well over 500 years before the arrival of the Spaniards.

If the exploitation of the Cerro by pre-Hispanic peoples is not entirely established, its sacred dimension is certain. Today many rituals and offerings made to the mining deities persist on the slopes of the mountain as far as the interior of the mines. They attest to the meeting between the pre-Hispanic religious universe and the beliefs of the Spanish colonizers.<sup>5</sup>

### Indian beliefs

The Devil's Cave or *Mullu Puncu* discussed in the previous chapter has an undeniable link to the mountain. It would be a doorway, „the entrance to Potosí“, leading to an even more important place of worship: the *Wak'a P'utuxi*, the Cerro Rico and its summit, the *Sumaj Urqu* in Quechua. They are part of a vast territorial system of *Waka's* which includes *Guaina Potosi* (son of Cerro Rico) and Porco, among others.

As mentioned above, the vision of *Mullu Puncu* as a doorway was reinforced with the introduction of the *mita* by the Spaniards, *Mullu Puncu* symbolically becoming the first entrance to the mine for the *mitayos* coming from the north.

The mines, *Waka's* inside the mountains, were not simply holes in the ground from which wealth was extracted; they were sacred areas or portals to the underworld.<sup>6</sup>

Nombre	Referencias culto	Localización
Potosi, Potocchi, Potocsi	Santuario, adoratorio del sol, Capac Ique	<b>Potosi</b> (Potosí), <b>Potosi</b> (Chuquisaca), <b>Potosi</b> (Huanuco) <b>Potosi</b> (La Paz), <b>Potocsi</b> (Arequipa), <b>Potocchi</b> (Puno)
Huayna Potosí Huayna Potochi	Hijo del cerro Rico <i>Apu</i> , santuario (La Paz)	<b>Huayna Potosi</b> (Potosí), <b>Huayna Potosi</b> (La Paz), <b>Huayna Potosi</b> (Potosí-Quijarro), <b>Huayna Potocchi</b> (Puno)
Tanga Tanga	<i>Huaca</i> (tres en uno y uno en tres)	<b>Tangatanga</b> (Potosí), <b>Tanca Tanca</b> (Puno), <b>Tanga Tanga</b> (Arequipa)
Caltama	<i>Huaca</i> de Porco	<b>Caltama</b> (Potosí), <b>Caltama</b> (Yonza, D. Campos)
Quiquijana Apoquiquixana	Santuario, adoratorio Gran Señor Quiquixana	<b>Quiquijana</b> (Chuquisaca), <b>Quiquijana</b> (Cusco) <b>Quiquijana</b> (Apolo, La Paz)
Choquechampi	Santuario, adoratorio	<b>Choquechambi</b> (Chuquisaca), <b>Choquechambi</b> (Cusco) <b>Choquechambi</b> (Arequipa)
Aquillani	Santuario, adoratorio	<b>Aquillani</b> (Chuquisaca), <b>Aquillani</b> (Cusco)
Illimani	<i>Apu</i> , santuario	<b>Illimani</b> (La Paz), <b>Illimani</b> (Potosí), <b>Illimani</b> (Chuquisaca)
Sabaya	Tata Sabaya, <i>Apu</i>	<b>Sabaya</b> (Carangas, Oruro), <b>Sabaya</b> (Moquegua)

Fig.7 - Correspondence of cerros with similar names across Latin America

### A religious syncretism

The arrival of the Spaniards and the massive exploitation of the Cerro Rico marked the banishment of Indian cults, and particularly the *Waka's*, considered to be satanic. With legends such as that of the Devil's Cave, the Spaniards gradually managed to make the Indians forget the sacred nature of *Sumaj Urqu*. The Cerro is thus dedicated to Saint Bartholomew, exorcist of the demons, who becomes the Patron Saint of the city. However, after half a century of exploitation of the hill, the Indians still came to this place for ritual purposes.

This persistence can be explained by the continuous exchanges between the mining and agricultural environments. Indeed, there is a strong analogy between the beliefs of miners and Andean peasants, who associate the underground with the wild forces of the world, wealth and danger.<sup>7</sup>

According to the chroniclers, torments of the souls of unfaithful Indians are added to the inhuman conditions of underground mining. This is what gives the mines (and the whole city by extension) its dimension of „*mouth of hell*“, the name that has designated it throughout the colonial period. More than anywhere else, the infernal *Ukhupacha* had found its place in the mining galleries.

The Spaniards tried to erase the diabolical dimension of the mines by associating the Cerro Rico with the Virgin Mary. The Indians appreciated the similarities between the Virgin, mother of mankind, and the *Pachamama*. An artistic current is born from this religious syncretism: the Spanish-American Baroque, perfectly represented by the painting „*La Virgen del Cerro*“. In the centre, the Virgin Mary is crowned by the Eternal Father and her son Jesus.

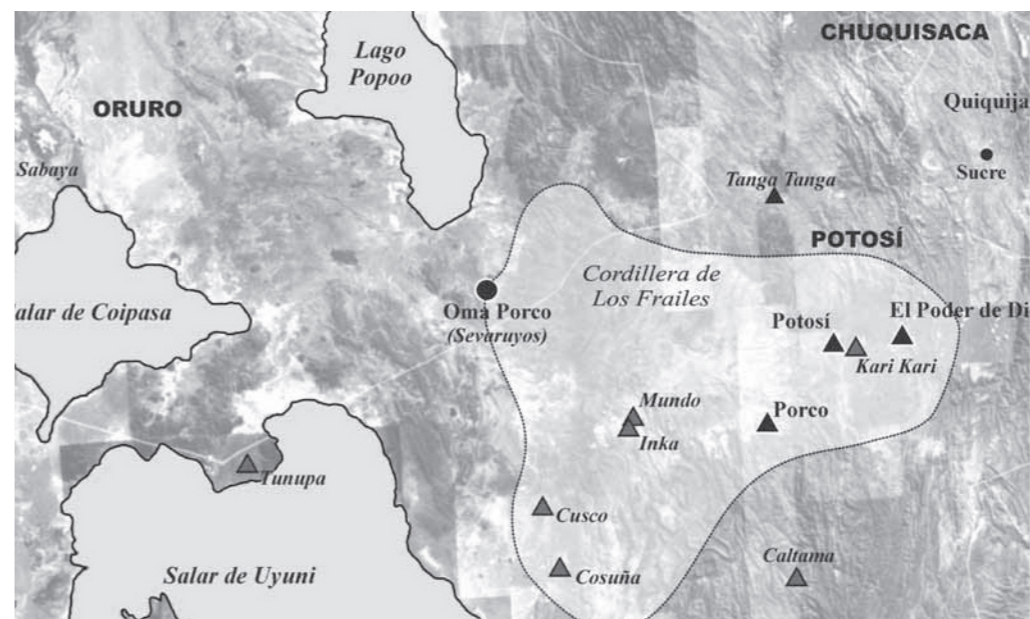


Fig.8 - Sacred Cerros across the region





Her mantle, triangular in shape, merges with the Cerro Rico, whose summit reaches the divine skies. On either side of the mountain there are two major Inca deities: *Inti* (the sun) and *Quilla* (the moon).<sup>8</sup>

However, infernal forces cannot be eradicated so simply and the figure of *el Tio* takes on the role of master of the underworld. Half devil, half protector, he is responsible for the appearance and vanishing of the silver veins, and is the real owner of the mines.

Various stories can explain his origin: he would be a pre-Hispanic deity of the mountain buried by the Spaniards, the soul of the mythical dead of the mine, or ironically the devil of *Mullu Puncu* exiled by God in the underground, reappearing where the Spaniards did not expect him.

Today, the Cerro no longer appears directly in the rites of the miners. Its figure has been replaced by the *Tio*, the *Pachamama* and the *Virgin*, each one playing a specific role. The *Pachamama* gives birth to minerals. The *tios*, whose presence is materialized in each mine by a statue, control them and await offerings and sacrifices from the miners, otherwise they will be punished by the disappearance of the veins, illnesses or even fatal accidents. Finally, virgins and crosses guard the entrances to the mines to protect the safety of the miners.

It is surprising to note that for the miners, the *Pachamama* is both the *Virgin Mary* and the wife of the *Tio*, who impregnates her to give birth to the metal veins.<sup>9</sup>



facing page  
**Fig.9** - «La Virgen del Cerro», ca.1701-1800.

**Fig.10** - El Tio, guardian of the underworld



## The age of wind

Ore processing in Potosi first began on the slopes of the Cerro.

A significant contribution of the Incas to metallurgy (and particularly to the foundry) is the use of wind ovens called *gayras* (*wayra* meaning wind in Quechua). This is an ingenious technology that requires relatively little fuel and virtually no capital investment. The *gayras* are operated by Indian experts, the *Yanaconas*.

When settlers began to exploit the Cerro Rico, starting in 1573, this technology was widely practiced. It is then the natives who hold the monopoly of the metallurgical industry, the Spaniards taking little part in the refining of metals. The truth is that many chroniclers have neglected the question of the transfer of native technology to the Spanish.

The ores extracted from the mines are taken to the surface, more precisely to the *bocaminas*. From there the materials are sorted by the *palliris*, who break up the ores with *combos* (miners' hammers). At that time „*palliris*“ meant any person, regardless of gender, who worked the metal aggregates before refining. Today this role persists, but is entirely devolved to women.

The Andean windmill oven is capable of producing fine silver after a series of controlled steps. The silver is first melted on the slopes of the Cerro in the *gayras*. These are placed on pedestals to catch more wind. The product that comes out is a „lead paste“ which is then recovered and refined by the natives in their homes with other types of ovens. The process is repeated two or three times to get rid of the lead and obtain the purest silver possible, with a purity of about 93%.

Before 1582, more than 6,000 *gayras* were growing all around Cerro Rico. According to Luis Capoche, a chronicler of the 16th century : „The *gairas* are placed on the peaks and flanks of the mountains and hills within sight and walking distance of this town, which makes the spectacle pleasant in the darkness of the night.“<sup>9</sup>

From the beginning of the 17th century, the number of *gayras* declined significantly due to the introduction of the *Ingenios* and the amalgamation technique.

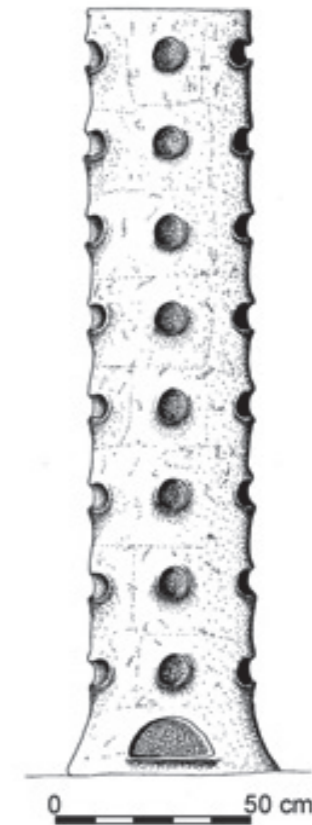


Fig.11 - Graphic reconstruction of a Guayra

Fig.12 - «Estos yndios estan guayrando», ca. 1603









### Mining deeper

A few decades after the discovery, colonial miners reached the water table and with it unoxidized or sulphidized ores at a depth of about 400 metres or more.

These could be quite rich, but were difficult to smelt with the technologies of the time, the *guyaras*. It would be in 1572 that the problem would be solved with the introduction of mercury smelting, adapted to the conditions of high altitude and the particular chemistry of the ores of Potosí. Although the miners wanted to believe that the great silver veins of Potosí widened and became richer as they descended, this was false most of the time.

Beyond an enriched zone near the water table, the silver ores would decrease in quality or become more refractory, and sometimes the veins would disappear completely.

When the mines on Cerro Rico deepened and reached the water table, they had to be put on bail or abandoned.

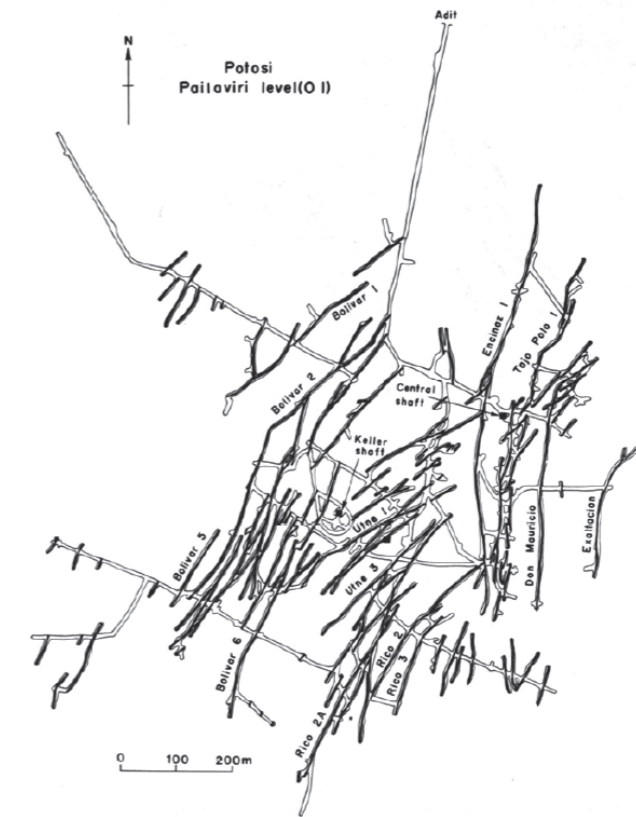
The hillsides were then perforated with adits - horizontal tunnels called *socavones* in Spanish.

In the absence of explosives, introduced only in the 1670s, digging these tunnels required a lot of energy, time and money.

The work became more dusty and dangerous and the climb up became more difficult as the mines deepened. Potosí then experienced its first crisis, its silver production dropped considerably.

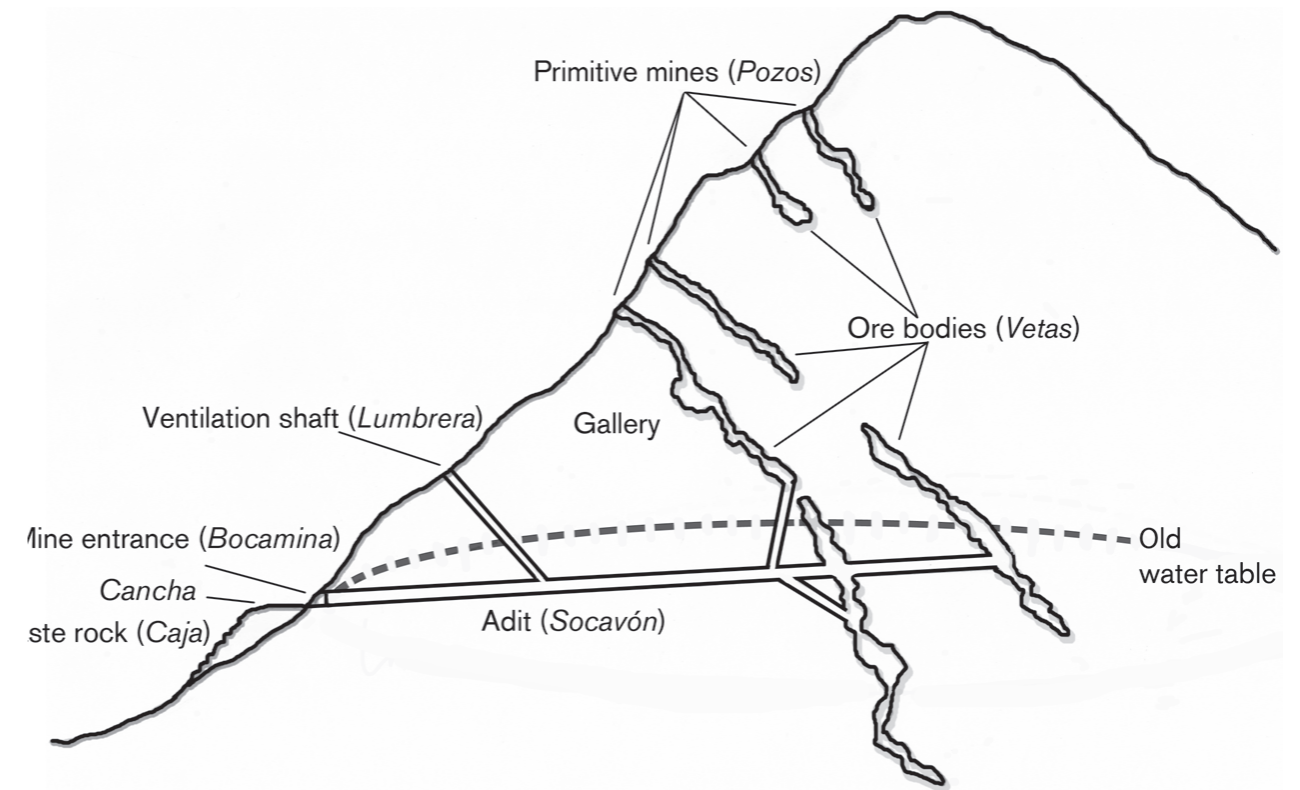
In order to compensate for the decline in the purity of the silver ores extracted from the Cerro, Viceroy Toledo set up the territorial system of the lagoons and the Ingenios at the end of the 16th century, which triggered the second boom in Potosí, the most productive ever achieved. The Ingenios de la Ribera will continue to evolve over time to adapt to the metallurgical history of Cerro Rico.<sup>13</sup>

During the colonial period, it is estimated that 8 million Indians died inside the mountain, earning it the nickname of „man-eater“, which it continues to bear today. And unfortunately with good reason: on average 3 miners perish every month in one of its dark bowels.



**Fig.15** - Potosí Pailiviri Mine level 0 and vein arrangement

**Fig.16** - Cerro Rico mines and drainage adit





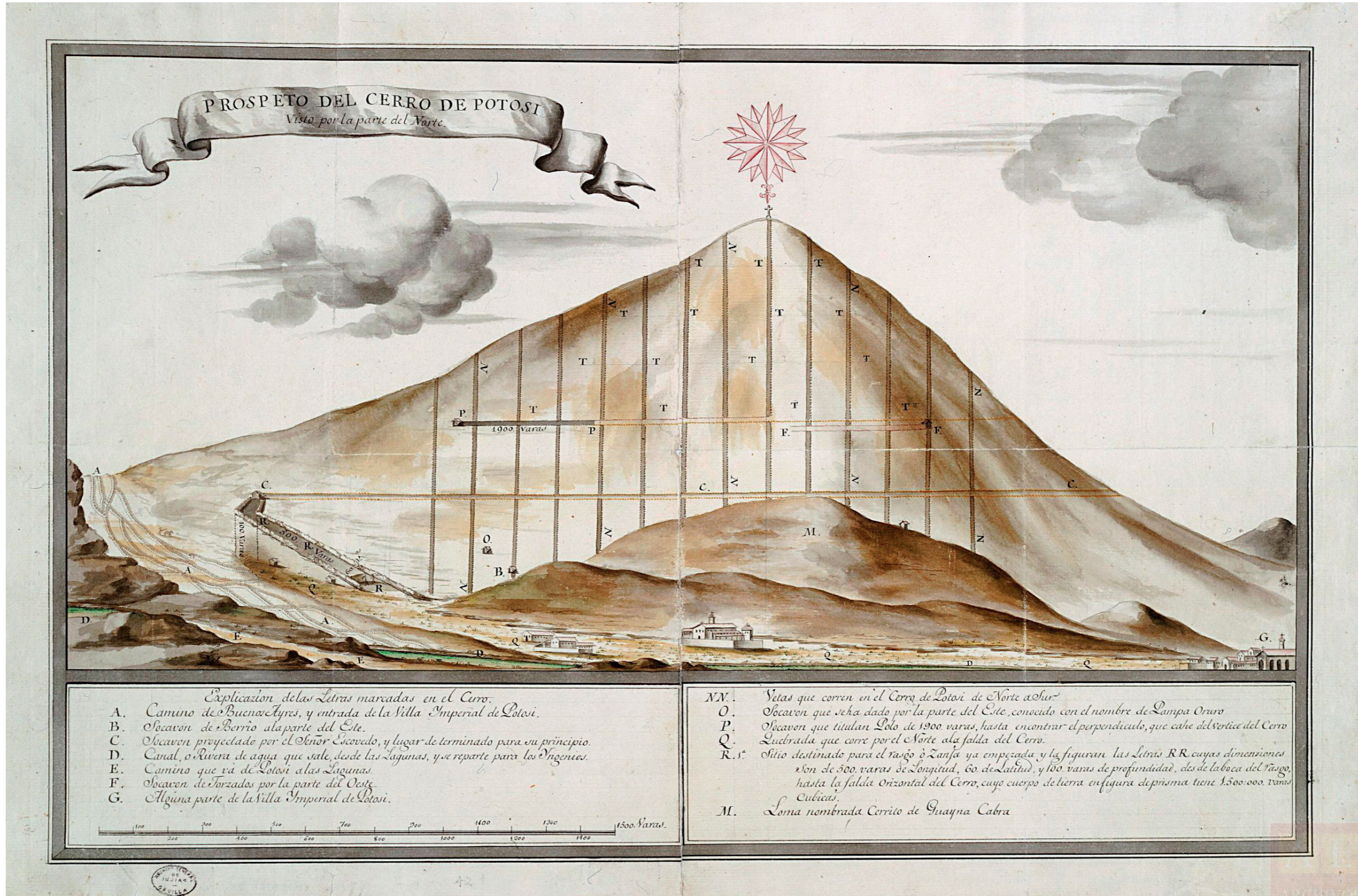


Fig.17 - «View of the Cerro de Potosi», ca. 1779



### Booms and depressions

The extraction of material from Cerro ríco has been uninterrupted for 475 years now. Its history is a succession of mining booms and depressions, as in most large non-ferrous deposits, depending on global supply and demand. Three main periods in Cerro Rico's metallurgical history can be identified, each corresponding to a mining boom:

From 1573 to 1885, silver mining, with a boom from the late 16th to early 17th century.

From 1885 to 1985, exploitation of tin with a boom at the end of the 19th and beginning of the 20th century

From 1985 to today, zinc-silver-lead polymetallic mining with a contemporary boom since the 2000s.

This new boom is driven largely by demand from the rapidly industrialising countries of South-East Asia.<sup>14</sup>

The extraction techniques employed and the working conditions of the miners are almost identical to the times of the colony. Although there have been attempts to improve mining methods, the medieval techniques practiced in the colony are still in use.<sup>15</sup>

Today, between 9,000 and 12,000 miners work in the bowels of the Cerro. The average income of a miner is much higher than the average Bolivian income: 2000 bolivianos per month compared to 200.

It is estimated that 8000 children are sent to the mines each year.

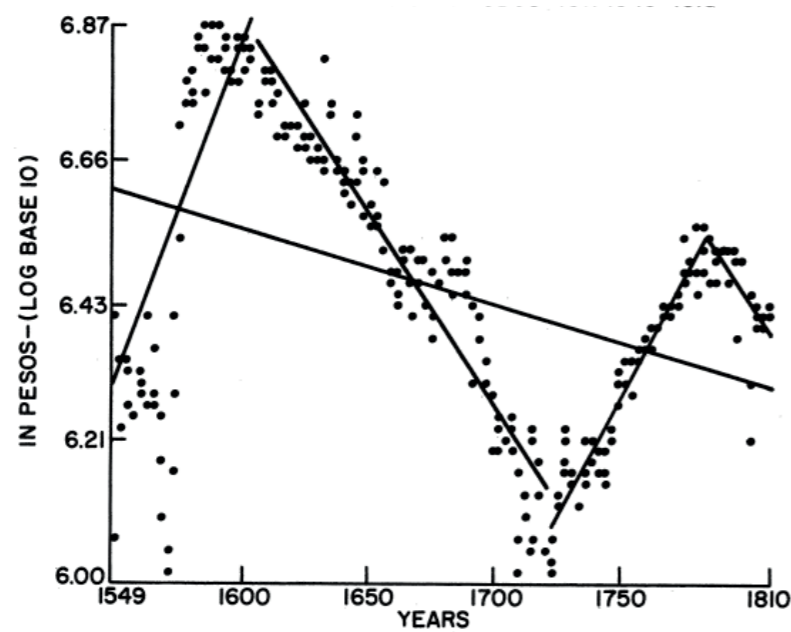


Fig.18 - Total Potosi silver production, between 1549 and 1810

The major disruptions in Bolivia (mainly the War of Independence from 1809 to 1825) ruined mining, disrupting production circuits. This leads to a strong decline of the city but never its disappearance and today the mining exploitation of Potosi still constitutes an important part of the national GDP. One of the major turning points for the mines of Cerro and its workers was the revolution of 1952: all the mines were nationalized. At that time they belonged to the „tin barons“ who became immensely wealthy during the Second World War.

As a consequence of the nationalization of large mining companies, the COMIBOL (Bolivian Mining Cooperative) was created. The objective of this corporation is to centralize all mining administration subject to the process of return to the State. Miners and their unions began to play an important role in national politics. However, the collapse of the tin price on the world market in 1985 brought Potosi into a new cycle of depression and bankrupted COMIBOL. It sold its mines to the two other mining groups which remain

Fig.19 - Miners working on Cerro Rico, 2011





today: the private sector and cooperatives. The latter are by far the largest group of miners, but are far less efficient than the private sector. According to the government, cooperatives employ 90% of the workforce (120,000 workers in Bolivia) and contribute only 17% of production. A „dualist“ mining industry has thus developed between a high-productivity private sector and a sector of rudimentary cooperatives.<sup>16</sup>

The cooperatives work the veins of the Cerro in an empirical and disorderly way. This has dramatic consequences on the Cerro that no one is unaware of. It has been listed as a UNESCO World Heritage Site in Danger since 2014.

Current supporters of the dug mountain recently filled a giant hole that had opened up near the ridge with a concrete plug, then with factory waste, but it continues to sink. A small stone tower maintains the official altitude of Cerro Rico.

„The fact that Cerro Rico still exists today is a small miracle,“ writes Kris Lane in his book *Potosi: the silver city that changed the world*. „In most countries, a mountain this rich in ore would have been leveled and turned into a pit long ago.“<sup>17</sup>

	COMIBOL	Secteur privé	Coopératives	Total
<b>Production 2005</b> en tonnes métriques		182 000 62,75%	108 000 37,25%	290 000 100%
<b>Production 2013</b> en tonnes métriques	27 000 3,68%	581 000 79,37%	124 000 16,94%	732 000 100%
<b>Valeur 2005</b> en millions de dollars		347 55%	283 45%	630 100%
<b>Valeur 2013</b> en millions de dollars	292 8,60%	2 112 62,4%	982 29%	3 386 100%
<b>Redevances 2005</b> en millions de dollars		10 71,4%	4 28,6%	14 100%
<b>Redevances 2013</b> en millions de dollars	13 9,40%	94 68,1%	31 22,5%	138 100%
<b>Nombre de travailleurs en 2005</b>	117 0,2%	5 450 9,80%	50 150 90%	55 717 100%
<b>Nombre de travailleurs en 2013</b>	7 902 5,8%	8 110 6%	119 340 88,2%	135 352 100%

Fig.20 - Comparison of the three Bolivian mining groups



Fig.21 - A Pailiri, 1990



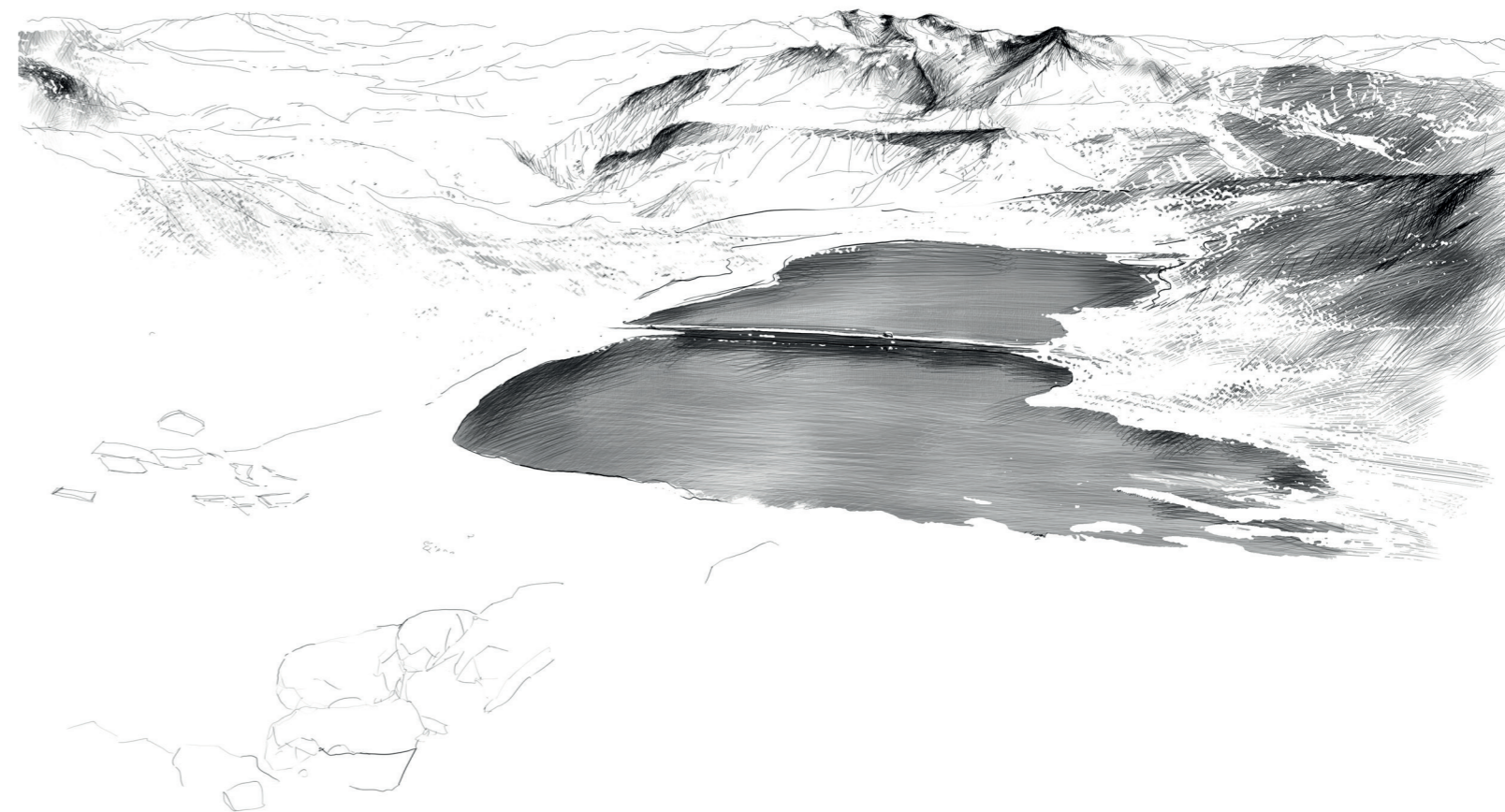
## 2. LAGUNAS DEL KARI KARI

Water reservoir

*„The walls were wide enough for six horses and their riders to walk upon them. It is the most important engineering works to be undertaken on the American continent in the 16th century.“*

William E. Rudolph, 1936

**Fig.22** - Laguna San Idelfonso, 2019





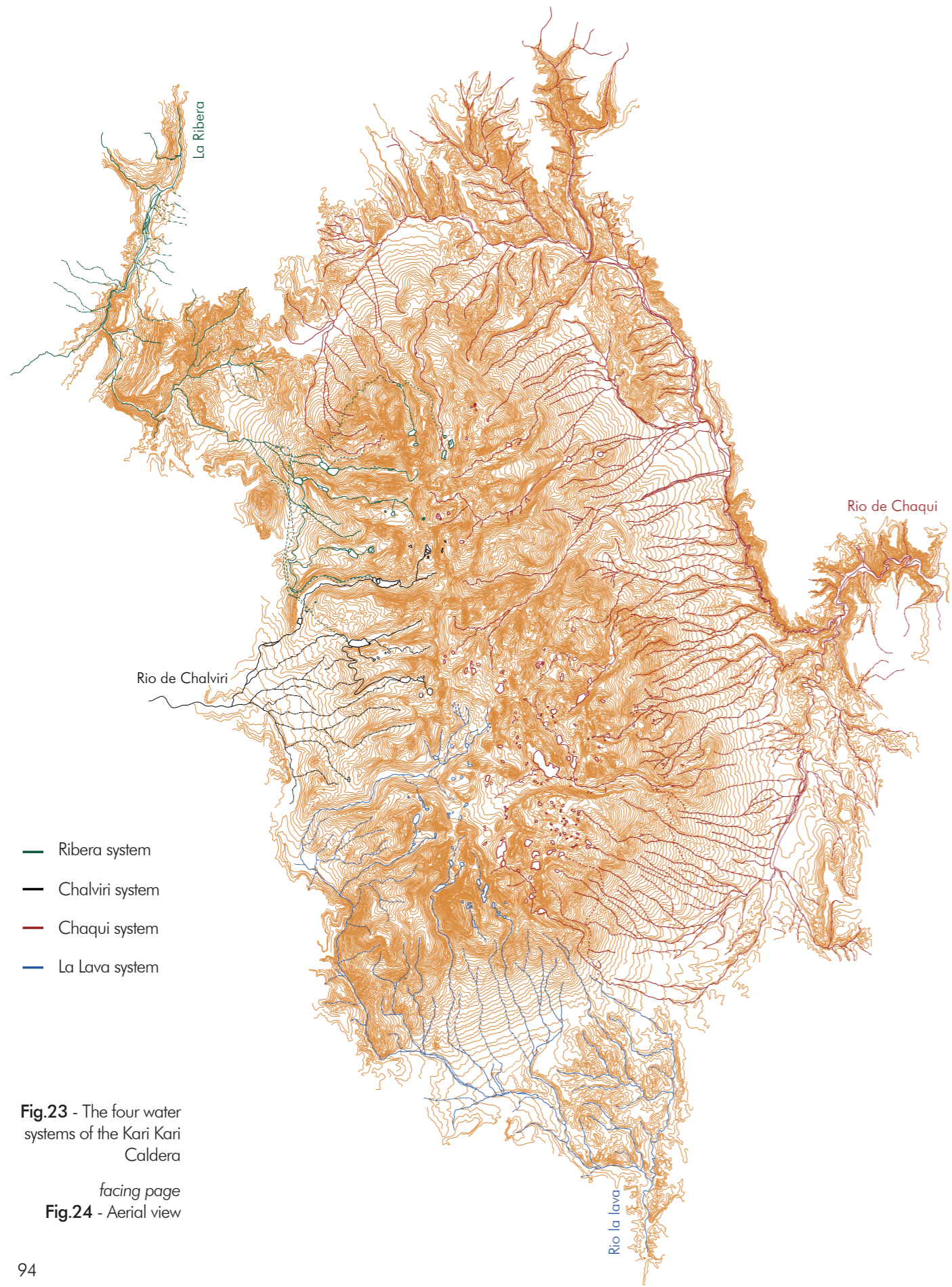
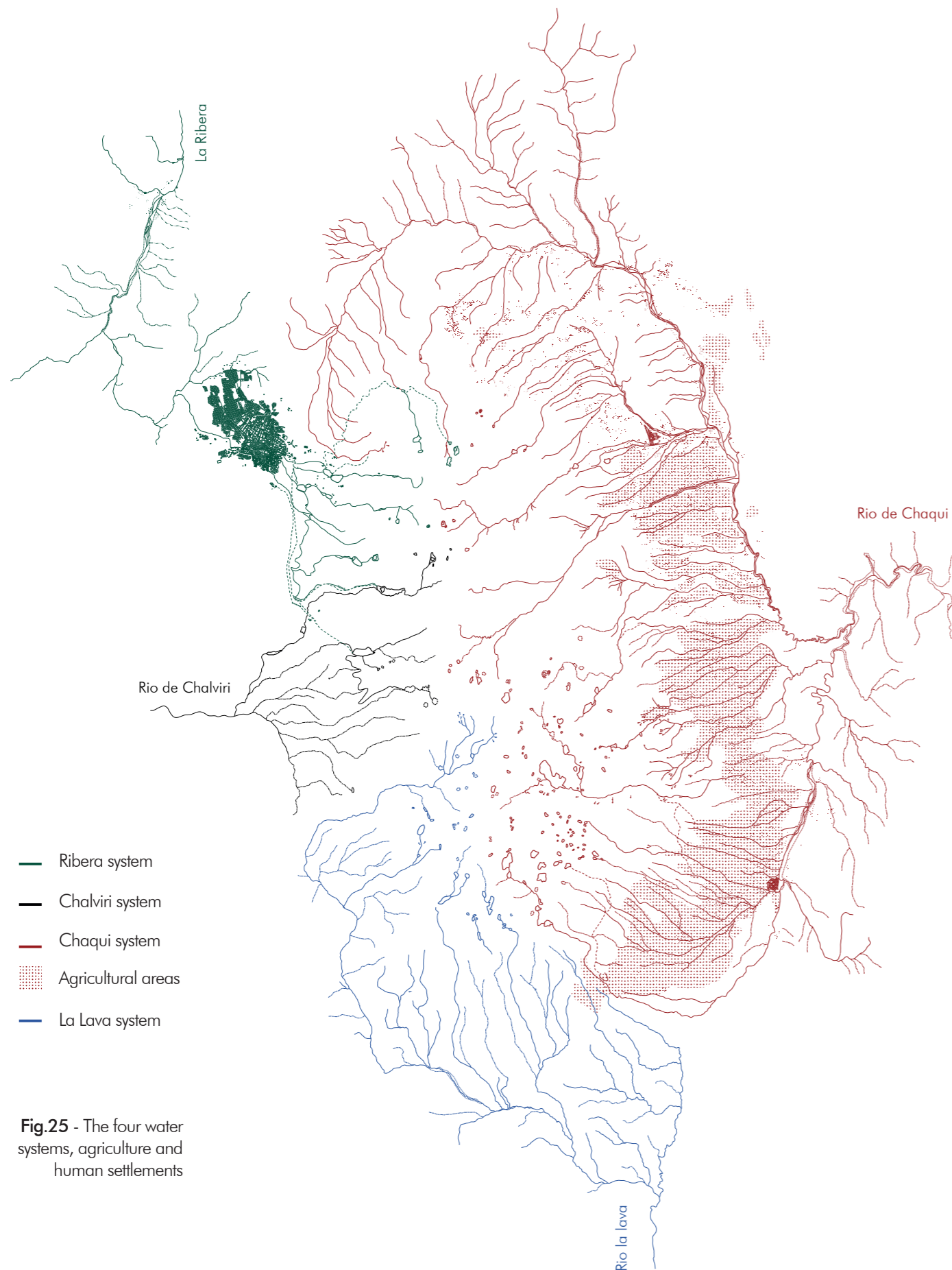


Fig.23 - The four water systems of the Kari Kari Caldera

facing page  
Fig.24 - Aerial view







**Fig.25** - The four water systems, agriculture and human settlements

The *Lagunas of Kari Kari*, situated at a height between 4.350 - 4.700m, reside in the Oriental Bolivian Andean Range.

Divided into 6 valleys, which cover 65km<sup>2</sup>, the dams store all the water in a natural basin of 20km<sup>2</sup>, which groups together the intermittent drainage of the six small valleys.

The large lagoons measure more than 1km in circumference and have a depth of 50m in their centre.

The climate is dry and cold, it disposes of 635mm precipitation a year, which manifests in snow and hail during the three raining month from October to December, whilst having a relatively high evaporation of about 1350mm. Some low vegetation plants extend sparsely over the volcanic rocks and only domesticated mammals like llamas have adapted to this harsh climate.<sup>18</sup>

### Geology

Geologically the lakes were formed during the late Tertiary 20.8 million years ago and built part of the Kari Kari Caldera, which was constituted by a huge batholith beneath a surface perhaps two kilometers higher than at present. Subsequently to the eruption of the batholith and its regression, rock faults remained, standing in their environment like single men, as what the word „Q’ari Q’ari“ in Quechua signifies. In those faults eight glacial troughs established glaciation, which formed the basins for small natural lakes.

As can be seen on the map on the left, the water flowing from the lagoons forms four rivers on the four sides of the caldera, each one being used for a specific purpose. The *Ribera system*, connected to the *Chalviri system* by aqueducts, crosses Potosi and is used for industrial and potable purposes. The *Chaqui system* irrigates all agriculture east of the Caldera. The *la Lava system* goes south and is not used by Potosi.

### Industrial use

By 1572 the city’s four most influential miners, Captains Illanes and Iñigo de Mendoza, Sebastián de Arlés, and Villafranca, started to invest into an amazing work of engineering, which should reflect the city’s rise and fall over the next centuries. The lakes initially being built out of economical interest - to create hydraulic power for the mineral separation plants - nowadays constitute 44% of the people’s household water.

The first lake, Chalviri, was established by the workforce of 20 000 dependant Indians erecting a dam of 12m width at the outpourings of the glacial pit formations. Due to its success, 32 lakes were established over half a century. The Spaniards took advantage of the topography of the Kari Kari Mountain Range and joined all the artificial lagoons in a vast network of canals, aqueducts, waterfalls and tunnels.

In the first decades, the waters flowed into Lake Chalviri, which then supplied hydraulic power to the first ingenio built directly on its flanks. This industrial





**Fig.26** - «Villa Imperial de Potosí y Cerro Rico con 21 lagunas» ca. 1755-75, Francisco Javier Mendizabal

complex, surrounded by a dry-stone wall, seemed to consist of small agrarian farms scattered on the mountain peak, living in self-sufficiency by exploiting the surface watershed.

However, the industrial activities in the mountain heights, directly linked to the lagoons, were quickly abandoned, as the transport of minerals was not profitable. The Ingenios had to be close to Cerro Rico and the city for maximum efficiency. The ideal location was the Ribera de la Vera Cruz, along which 132 ingenios were built over a length of 15 km in the following years. Most of the water for the ingenios comes from the San Sebastian lagoon, to which most of the reservoirs are connected.<sup>19</sup>

On May 15, 1626, the dam of the lagoon of San Idelfonso broke, causing the death of more than 2000 inhabitants and the destruction of 126 of the 132 ingenios - 79 of them irreparably. However, the city quickly recovered from this disaster, quickly rebuilding the factories.

The technologies for refining the minerals used in the ingenios have changed since colonial times, but their need for water is still very important. There are 28 of them still in operation today.

#### Potable use

Additionally the water is channeled towards the city to ensure the population's potable water coverage, with 44% being taken from the Kari Kari water system and 56% from the system of the river San Juan, which was set in place in 1999.<sup>20</sup>

Furthermore there are emergency plants and tanks in times of water shortage, such as the Palca, San Antonio and Paranturi system, which lie under the level of Potosí and therefore need water pumps to ensure the population's supply, which makes them a costly affair. This case underlines once more the ingenious functioning of the economical Kari Kari system, which in the 16th century served already the city area : the water stored in the San Idelfonso lagoon supplied the city's 286 fountains, which were distributed by the Casa del Agua in the upper city.

At the end of the 19th century, the water of the lagunas was used additionally to the underground nappes. Nevertheless because of the mixture of potable and grey water in the underground nappes, they could no longer be used in



**Fig.27** - Lagunas San Sebastian and Planilla, 1997



the 20th century and the Kari Kari system became the onliest water resource.

In 1930, six lagoons were still feeding Potosi, which then had 35,000 inhabitants (a fifth of the population at its peak). Despite this, it was decided to restore the reservoirs for the needs of the population and the metallurgy.<sup>21</sup> Between 1935 and 1936 the American hydraulic engineer and historian William Rudolph restored with 800 workers the cascading lagoon system inherited from the Spaniards. He was hired by one of the tin barons, Mauricio Hochschild, owner of the Compagnie Minière Unificada del Cerro de Potosi.

### Agricultural use

A vast agricultural land of 200km<sup>2</sup> following the river to the east of the caldera is irrigated by the lagoons. At the beginning of the 17th century, this area became very important for the food supply of the rapidly growing population of Potosi.

The farms that developed around the caldera produced large quantities of green beans, potatoes, barley, etc. The region is also rich in forest resources (eucalyptus, conifers, willows, poplars, thola, churqui, quehuiña). The two main towns in this rural world are Chaqui and Puna, whose names evoke their main activities. In fact, Puna reflects the environment to which the region belongs, which means „zone of altitude“ in Quechua, and Chaqui directly refers to an emblematic agricultural tool of the Andes: the *Chaqui-Taccla*, the „foot plough“.



Fig.28 - «Peasant using the chaquitacla», Felipe Guamán Poma de Ayala, 1616

The lagoons of the colonial period, restored, continue today to supply the population, the metallurgical industry and the agricultural areas. A new industrial park, replacing the Ribera, is being created behind the Cerro Rico, to limit urban pollution. The park nevertheless remains dependent on the water resources of the lagoons, which it will of course make use of.

However, at a time of ecological crisis and with a growing population, the resources provided by the Caldera are beginning to become insufficient and Potosi is facing a water crisis.<sup>22</sup>

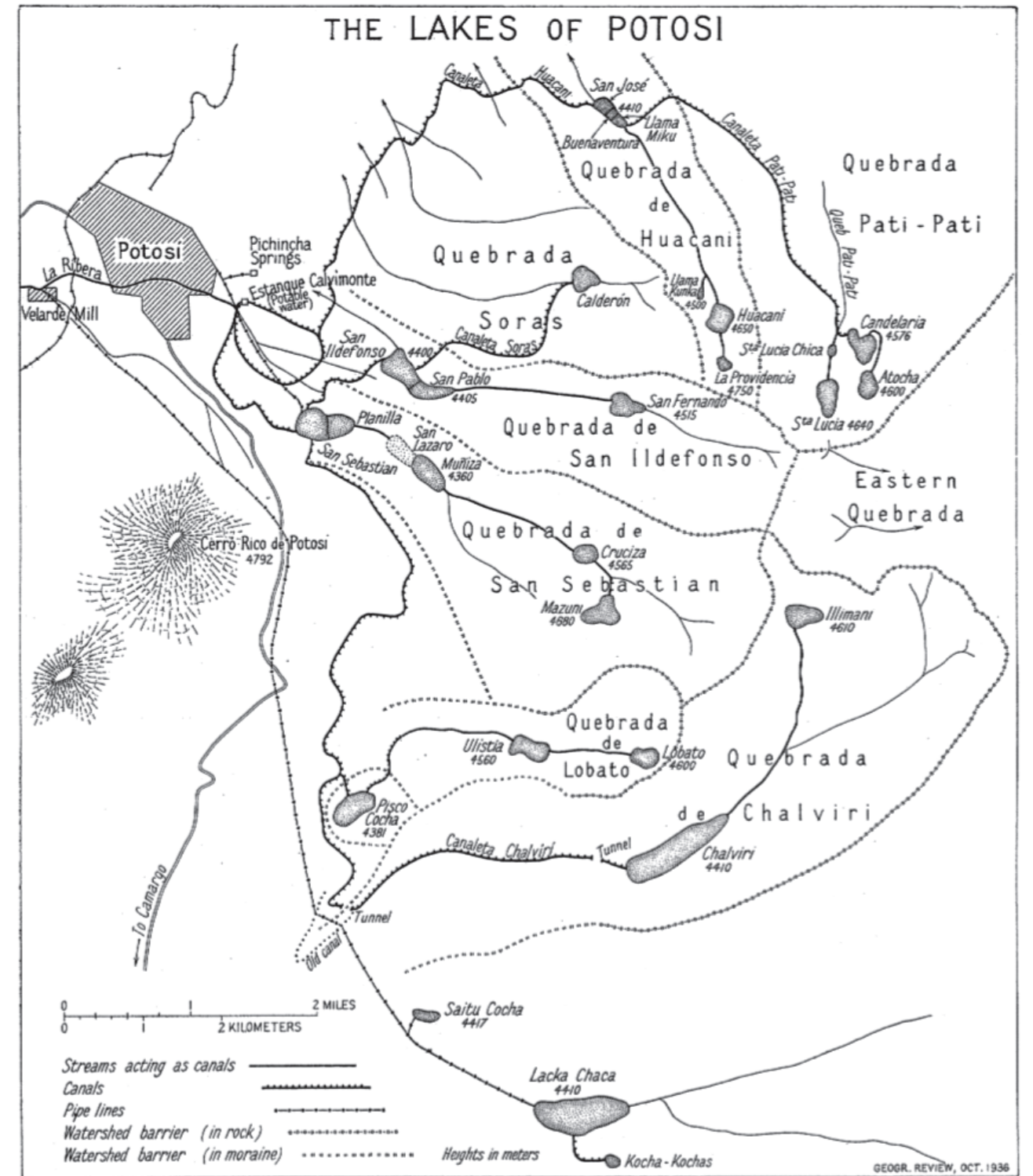


Fig.29 - The reservoirs and aqueducts of Kari Kari Range

*„The factories on the banks of the Ribera were already in the 17th century true workers' towns, with the main services, which concentrated the workforce very intensively.“*

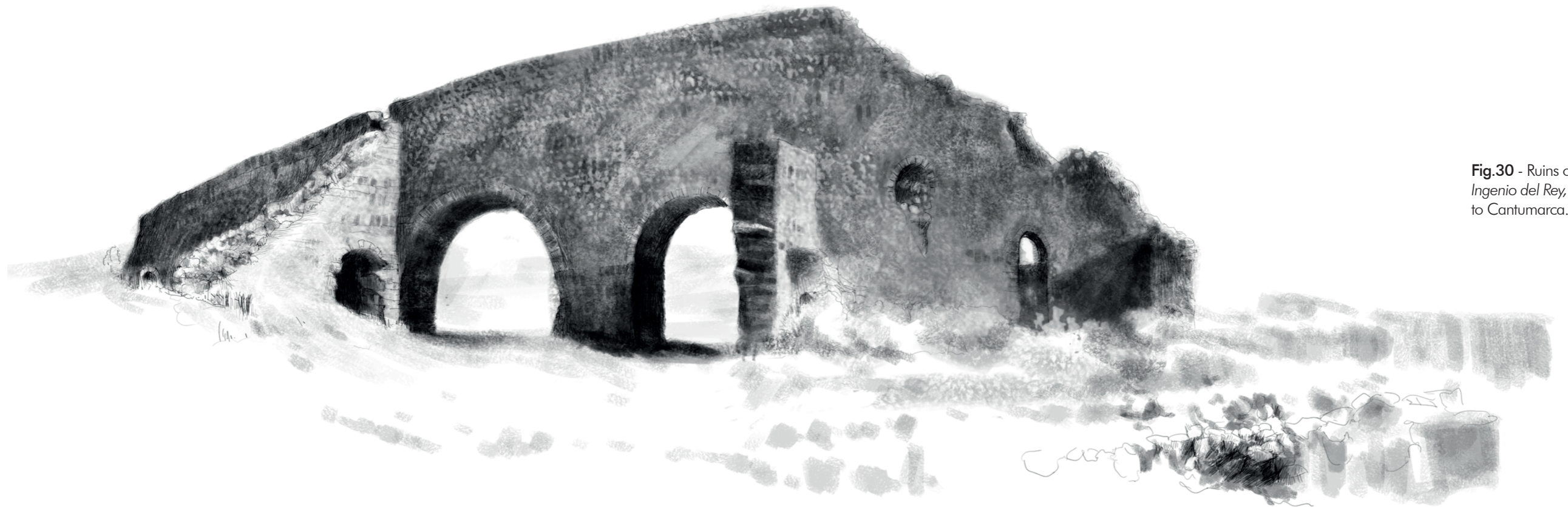
Alain Gioda, 1998

*„The Ribera was where two cultures met. It achieved to usufruct interculturality.“*

Ing. Carlos Serrano, 1980

### 3. LA RIBERA DE LOS INGENIOS

The chain of factories



**Fig.30** - Ruins of the Ingenio del Rey, close to Cantamarca. 2019





Fig.31 - La Ribera de los Ingenios  
 Fig.32 - Aerial view





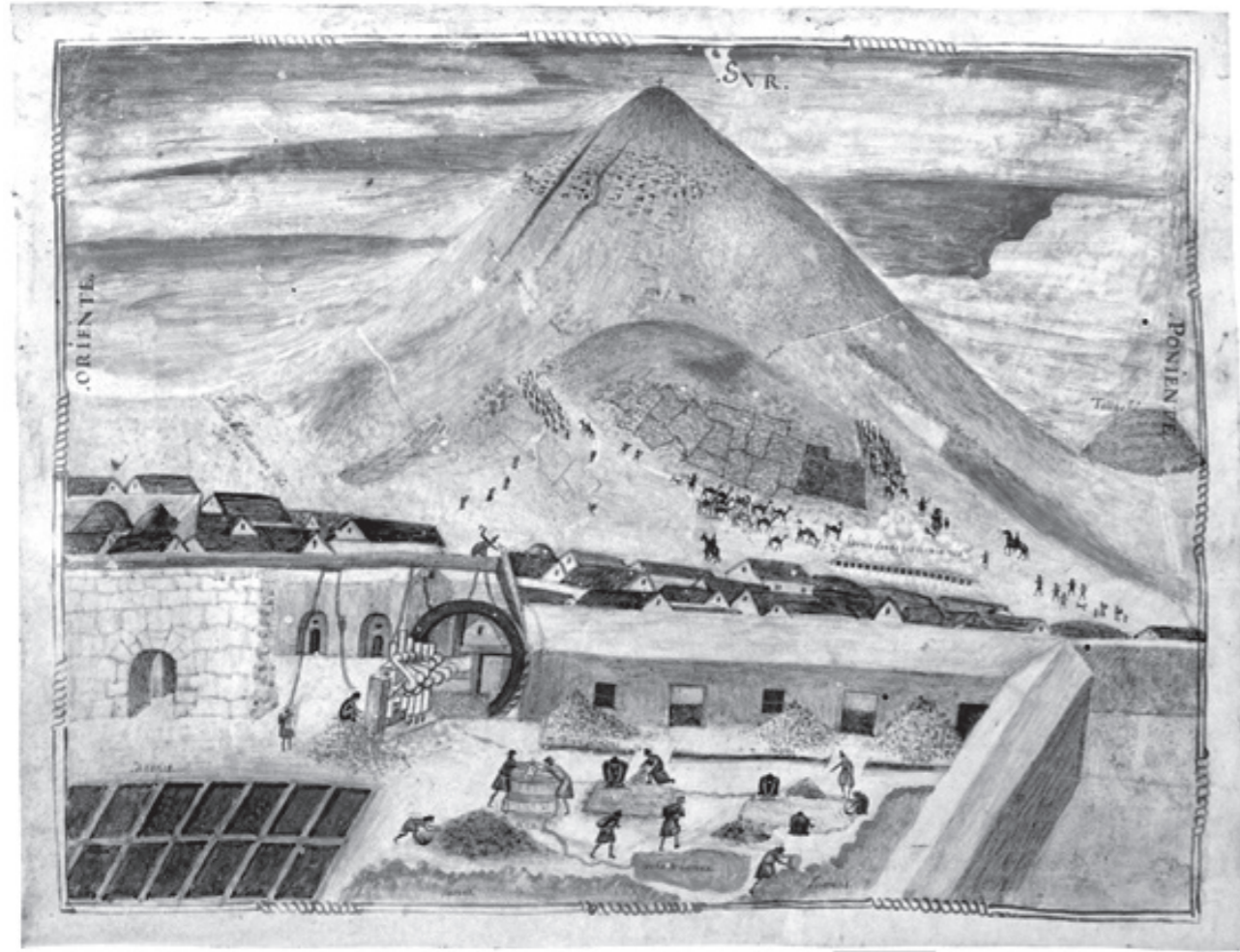


Fig.33 - Cerro Rico and silver refinery, ca. 1603

### Potosi's ingenuity

At the end of the 16th century, the Spaniards noticed a decline in the silver content of the ores extracted from the Cerro, which the Huaras are unable to refine properly. The introduction of a new processing method will revolutionise the metallurgical industry in Potosi. The latter requires the establishment of a vast hydraulic system that has its source in the Kari Kari Lagunas. A canal was dug through the city of Potosi, following the bed of an intermittent stream. It is later called the Ribera de ingenios de Vera Cruz.<sup>23</sup>

The mining policies in Potosi are the result of the meeting of two cultures, although there is a tendency among some chroniclers to minimize the contributions and role of the natives throughout history. Interculturality in the practices of exploration, processing and smelting of raw materials is materialized along the Ribera in the form of the Ingenios.

These processing plants, initially powered by hydraulic energy, take their name from the wheel that crushes the materials, a particularly innovative

infrastructure for the time. They stand along the Ribera for some fifteen kilometres, connected by a series of aqueducts and canals. The number of Ingenios installed on the riverbank and in the areas surrounding the town varied according to the volume of production of the Cerro Rico mines and the content of minerals in its veins.<sup>24</sup>

There are three main periods in the metallurgical history that takes place along the ribera, the main industrial area where different processing and smelting practices took place from the 16th to the 21st century:

1544-1825 (Colony) and 1825-1885 (Republic): Silver processing

1885-1985: Tin Processing

1985 to the present day: Zinc-silver-lead polymetallic processing

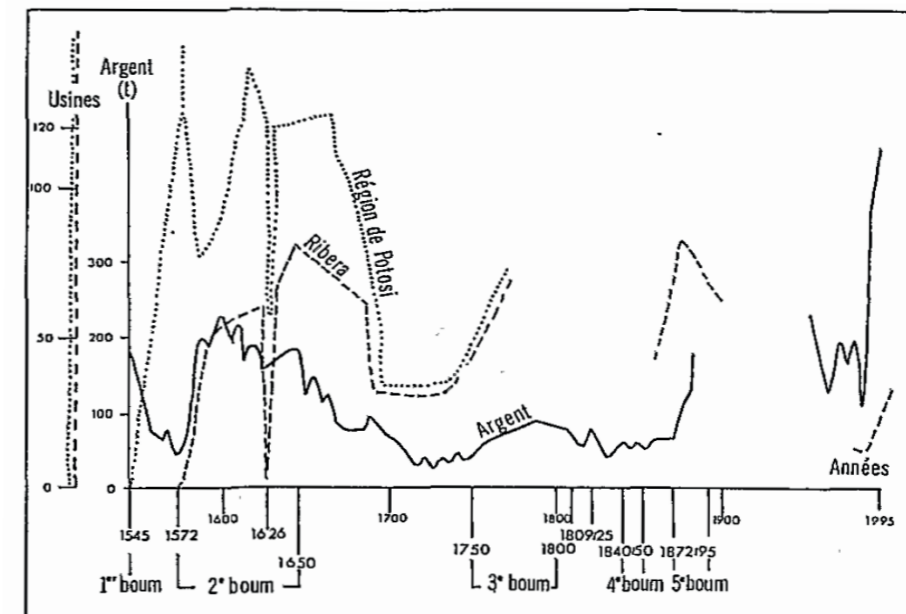


Fig.34 - Evolution of silver production and the number of ingenios on the Ribera in the region of Potosi

### Geology

The river, which begins in the upper part of the San Ildefonso and San Sebastian valleys at 4440m, descends abruptly to 4170m, where a continuous stream of water is formed. The valley narrows and crosses the bofedal, joining the Huayna Mayu River at 3934m.

From there, the ravine widens to Cantumarca at 3840m. The difference in level is 560 meters over a distance of 10 km.

The recent Quaternary materials come from the crystalline rocks of the Kari Kari mountain range. The surface layer of the soil in the Ingenios de la Ribera region is generally very thin, 10 to 15 cm. In some small depressions, accumulations can reach 1.3 m deep. The composition of the surface soil corresponds to a dark brown silty sand, moderately rich in organic matter,



under which there is a 30 cm layer of calcareous clay.<sup>25</sup>

### The Age of water

The golden age of silver mining lasted from 1573 to 1650 and was ensured by the use of the amalgamation process powered by hydraulic energy. The latter was widely used until 1872, when electricity and steam were introduced in Potosi.

For a long period, the Yanaconas (specialized Indians) held a monopoly over the Spaniards in the management and processing of minerals. Before the construction of the Kari Kari reservoirs, the ingenios settled in the surroundings of the city, on the rivers Cayara, Mataka and Chaqui. In order to avoid transporting the minerals too far, the Spaniards built dikes (diques) closer to the Silver Mountain and dug the Ribera canal.

The work began in December 1574 and was completed in March 1577 (6 months after the end of the construction of the first lagoons, in the quebradas of San Ildefonso and San Sebastian). The flow of the Ribera was then of the order of 160-250 litres per second. The disaster of San Ildefonso in 1626, which we have already mentioned, shows the city's capacity to overcome the difficulties: a few years after the dam ruptured, destroying a good part of the industrial park, there are more Ingenios than before along the Ribera.<sup>26</sup>

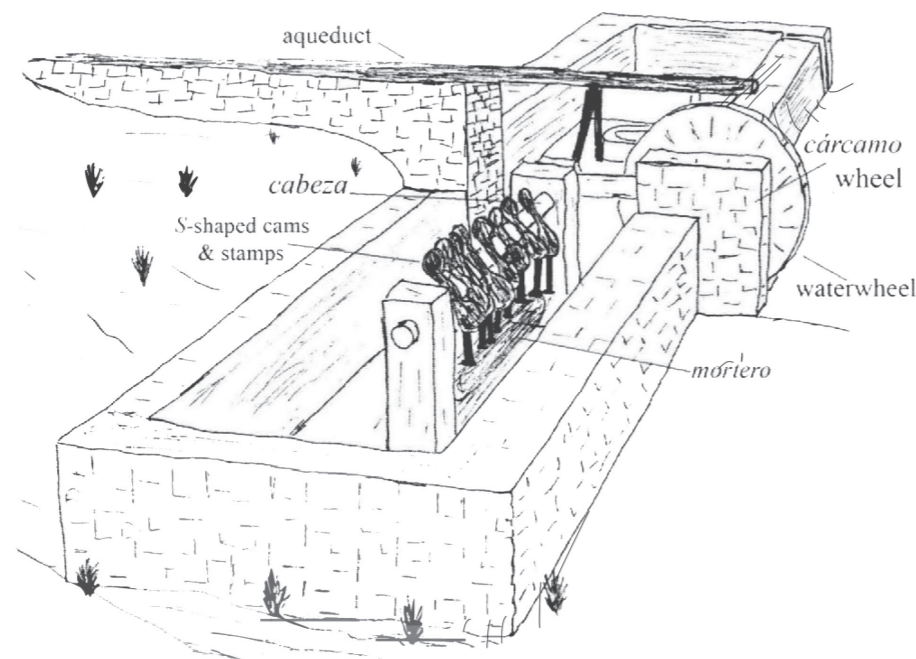


Fig.35 - Reconstructive sketch of the watermill and walled patio of an ingenio

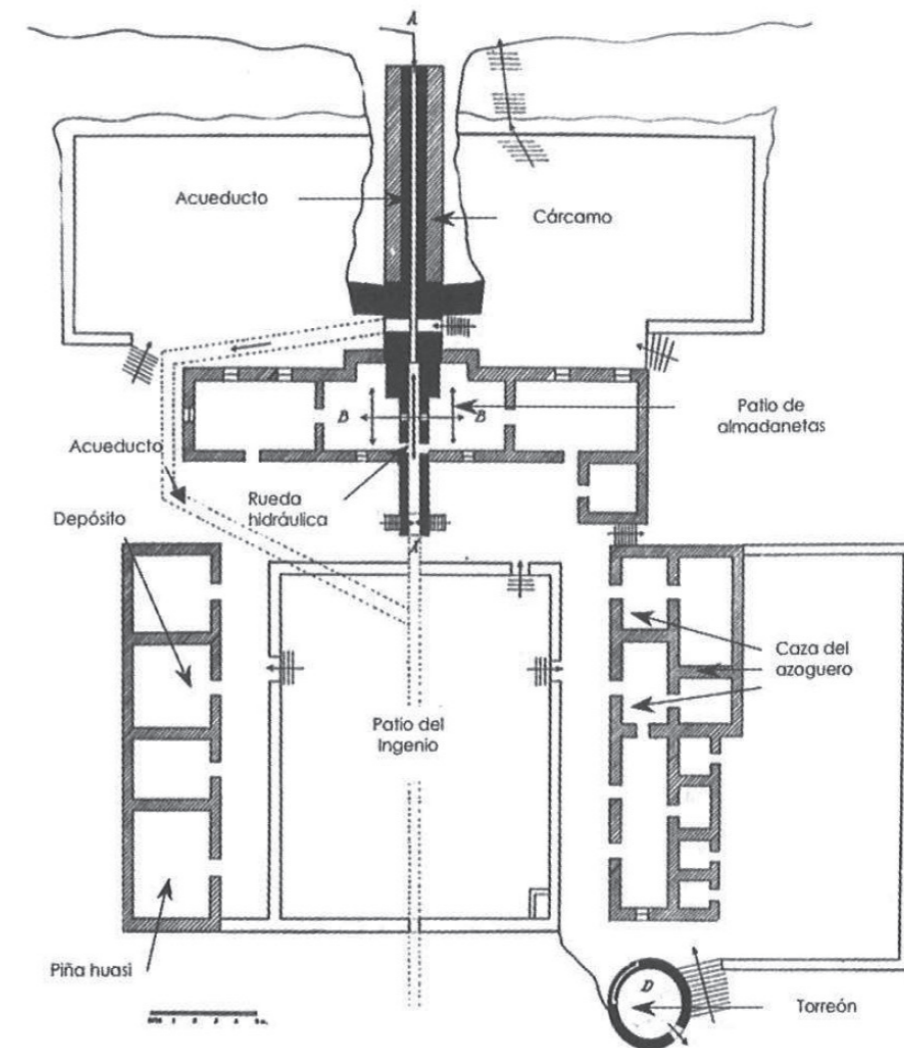


Fig.36 - Reconstruction of the plan of an ingenio

### The amalgamation process

Amalgamation is an enrichment process for the recuperation of metals, particularly gold and silver, using mercury. In 1556, more than half a century after the Conquest, a revolutionary industrial process was introduced in Pachuca, in present-day Mexico: the amalgamation of silver ores using the cold „patio“ or Medina process. 17 years later, Pedro Fernandez de Velasco transferred the technology to Potosi. Today, controversy persists as to whether this process comes from Europe or was discovered in America. In any case, it was in Potosi that it reached its most sophisticated form.<sup>27</sup>

### Description of an Ingenio, based on Arzans Orsúa y Vela's drawing (fig.37)

The water enters the Ingenio from another one, located upstream, in the upper left corner and falls on the first waterwheel with one milling assembly,



the „cabeza de ingenio“. [1] (see fig. 38)

It flows along an aqueduct and then falls onto a water wheel, which moves two six-mesh heads on either side. [2]

The entire facility is surrounded by a masonry wall. Inside the enclosure there are many dwellings and places for different purposes, like a small workers' city :

- [3] Warehouses for the storage of the ores extracted from the Cerro mines
- [4] Patios where the Indians mix the ores in boxes
- [5] Warehouses for mercury, salt, copper sulphates, llama manure (used as fuel) and other supplies
- [6] Residential areas of the owner or administrator of the ingenio (called *azoguero*)
- [7] Chapel

In each of them they worked nearly or more than 100 indigenous people, among men, women, but also children and the elderly.<sup>28</sup>

### The different stages of silver processing

The ore is first crushed using the *pisones* driven by the waterwheel. When it has the appropriate grain size, it is humidified and channelled through canals to collecting tanks, where the finest aggregates are removed.

In the patio are formed the *tortas*, which are then mixed and homogenised. The material is ready for incorporation, which consists of throwing the mercury onto the *torta*. The mercury is placed on a cloth through which small drops pass.

The patios were large (100m long), with well-jointed tiles to prevent the mercury from leaking, and with a slight slope so that rainwater could easily pass through, but without dragging the fine material from the *tortas*.

The mixture is then washed in tanks to separate the heavy material (the amalgam) from the lighter ones. The amalgam is pressed with rags to recover the mercury, which is reused in the process.

Finally, the silver is melted in ovens to form bars of pure silver for the Casa de la Moneda.

During this period, the production of silver increases in proportion to the flow of water used, which frequently requires the construction of new lagunas. The Ingenios system, which is very efficient and requires relatively little maintenance (the wooden wheels and pistons are the few elements that require regular replacement), is one of the causes of the industrial backwardness of the city, which was probably the first industrial city in the world.

Steam and electricity were introduced in 1872 (causing the 5th Potosi boom). Hydraulic power was no longer the only driving force behind mining activity, but the colonial system was maintained. There were still some processing facilities on the Ribera, but the machinery was becoming obsolete. At the end of the 19th century, only 17 ingenious hydraulic machines remained.<sup>29</sup>

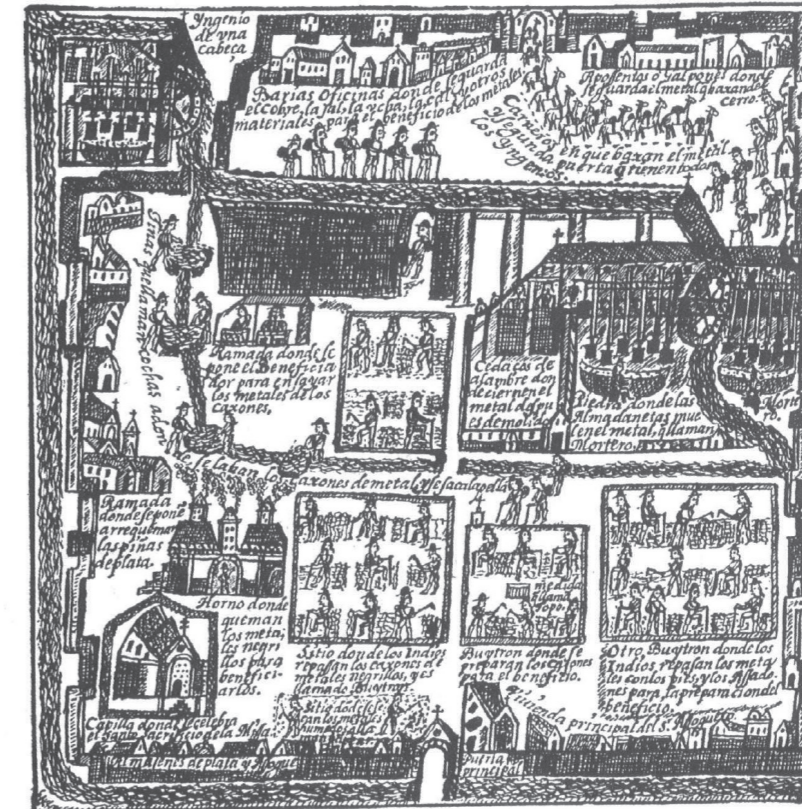


Fig.37 - The activities within an Ingenio, Arzans Orsúa y Vela, 18th century

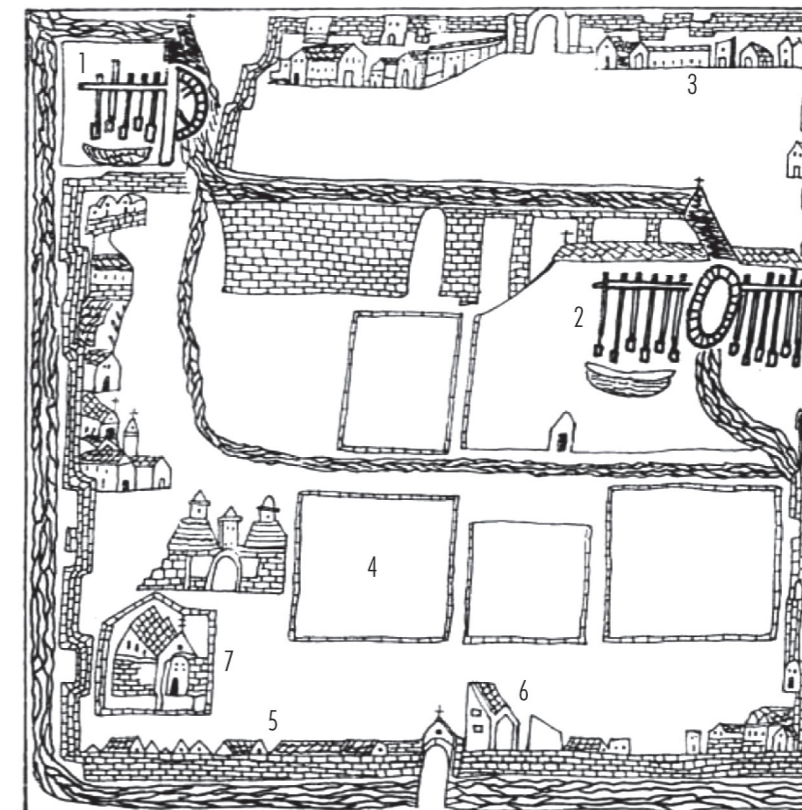


Fig.38 - Simplified drawing



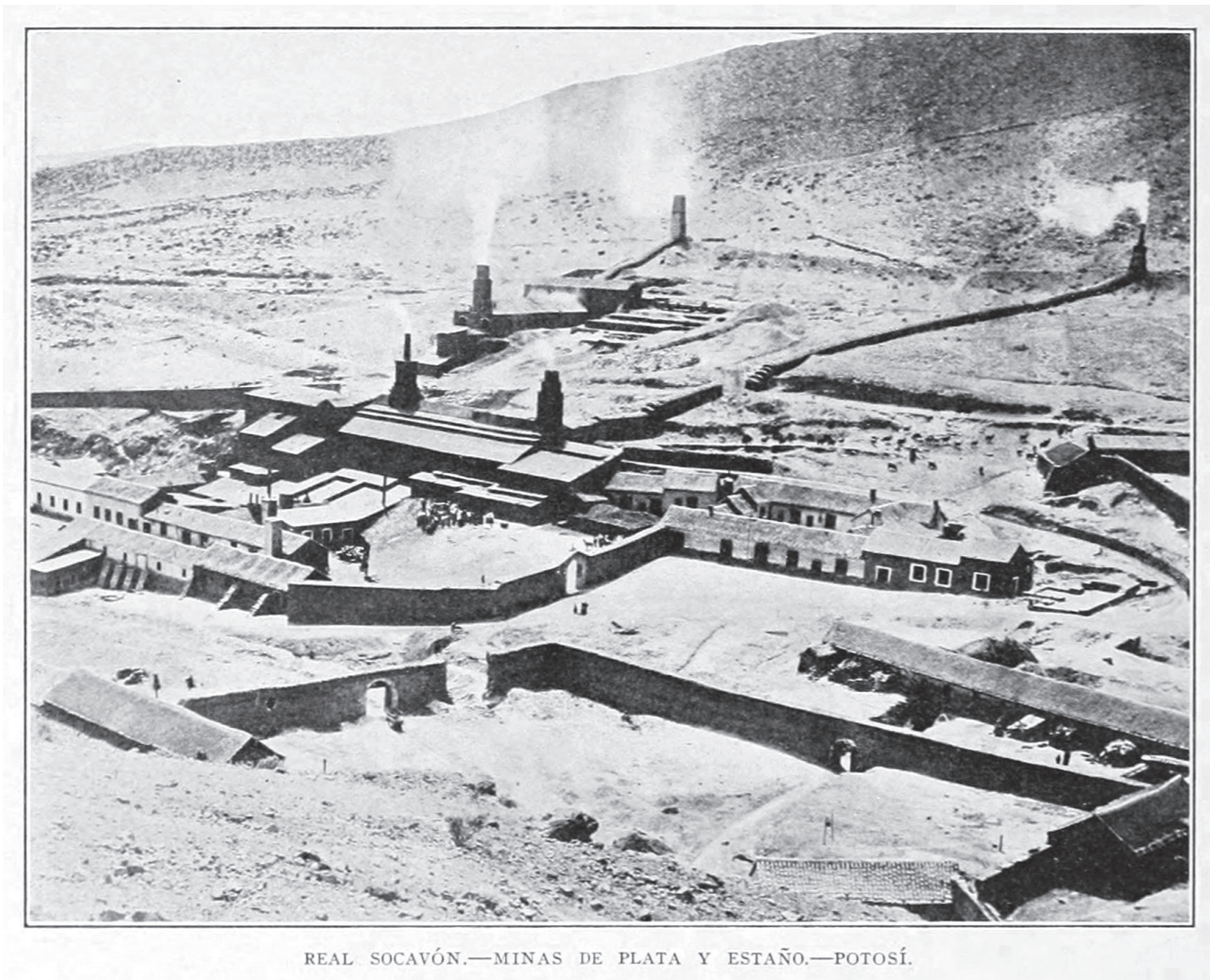


Fig.39 - Real Socavon,  
early 20th century

### Infrastructures between evolution and persistence

With the arrival of new energy and new materials to exploit, Ingenios has transformed itself to adapt to the new metallurgical requirements, although it will never again be at the forefront of global technological progress as in the past.

Industrial equipment powered by steam or electricity has been imported since the end of the 19th century, mainly from the United States or Germany. The ageing processes employed are increasing the technology gap.

Two main technologies are used in Ingenios for the treatment of tin first, and more recently of complex zinc-lead-silver metals: concentration and flotation. In both cases, the materials are transported from the Cerro Rico and then crushed and ground in the Ingenios as in the colonial period. The waterwheel was only replaced by machines: the trituradora of mandibulas for the big aggregates and the molino of bolas for the finest ones.

Water is an essential element in the treatment of materials for both of these techniques, which is why the proximity of the Ingenios to the Ribera remains a significant advantage.<sup>30</sup>

### Concentration

Concentration is achieved by means of cyclones (gravimetric concentration) or concentration tables (concentration by flotation).

Cyclones are devices that accelerate natural sedimentation by subjecting suspended solids to a rapid rotational movement (centrifugal force).

When the tin particles are smaller than 1 mm, concentration tables are used. Each table concentrates minerals of a specific size. The tin concentrates are placed in decantation basins, where they are separated from the remaining waste by gravity.

The final production is divided into clear water, waste and tin dioxide concentrates, which are transported to a washing platform before being shipped for export.

### Floating

The flotation process is based on the hydrophilic and hydrophobic properties of the solids to be separated. It is essentially a phenomenon of solid behaviour in relation to water.

The minerals in a low density peat are placed in a flotation cell and agitated to maintain a state of suspension. Air bubbles are passed through this aqueous paste. Hydrophobic particles adhere to the air bubbles and pass into the foam that forms above, while hydrophilic particles fall to the bottom of the flotation machine. The concentrated component present in the foam is collected while the residue at the bottom of the machine is removed.



Fig.40 - A modern  
Ingenio, 2019



### **A technological superposition**

An interesting turnaround occurred at the end of the 19th century, which marked the beginning of the era of tin mining. The small national companies, whose mines were catalogued as secondary, silver mines, later turned out to possess rich deposits of tin.

Their ores had to be processed and for this purpose the existing infrastructure of the Ribera was used for the erection of mills. Thus there was a technological superposition, which lasted until the last century.

The plants were well assembled, that is to say, with technical criteria and this meant that they occupied little specialised labour.

Today there are still 28 ingenios in activity along the Ribera. The flotation plants are located very close to the shore on the site of the former gravimetric plants, where the smelters used to operate.

However, it is very difficult to recognize the three eras of mining activity in Potosi in many of them.<sup>31</sup>

### **Pollution**

The Ribera industrial site has been in operation since March 1577 to the present day; that is more than 440 years of continuous work.

It has suffered the effects of all kinds of pollution: water, earth, air and noise. The inhabitants of La Ribera, at different times, have been victims of mercurial vapours, they have been affected by the fumes from the tin smelter, their waters have received mercury, salts of gravimetric concentration and various chemical reagents (many of which are toxic) used in the flotation. The river also receives wastewater from a large part of the city.

### **Heritage and measures**

On 11 December 1987, UNESCO approved the World Heritage title for the city of Potosi, for its urban and architectural ensemble which is historically the prototype of the colonial cities of Latin America.

The riverside area has undergone some restructuring and rehabilitation since 1987, particularly where the archaeological infrastructure is present. But the deplorable state of some of the ruins and the inaction of the public authorities did not prevent UNESCO from declaring it a World Heritage Site in Danger in 2014.<sup>32</sup>

A project to close and relocate the industrial park in the south of Cerro Rico is underway.

**Fig.41** - Ruins of the Ingenio Ichuni, 2010





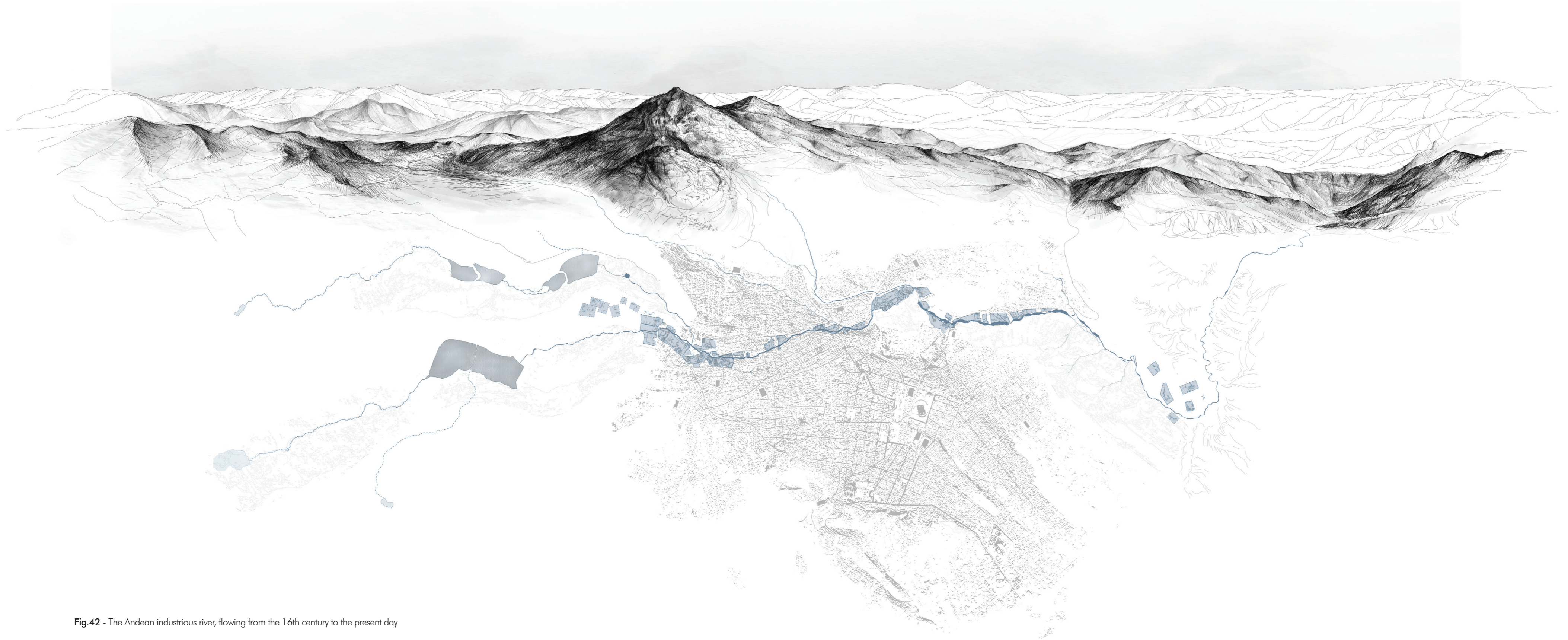


Fig.42 - The Andean industrious river, flowing from the 16th century to the present day



**PART III**

**THE CAMP CITY**



## 1. AN INDUSTRY BASED ON EXTRACTIVISM

*„50 percent of Potosí’s population lives of the mining activity.“*

according to studies carried out by *Sociedad Potosina de Ecología*, the university and other institutions

*„Even though it is not easy to relocate the mills, the entrepreneurs are convinced that they have to close down their activities in the city.“*

Mayor René Joaquino, 2013



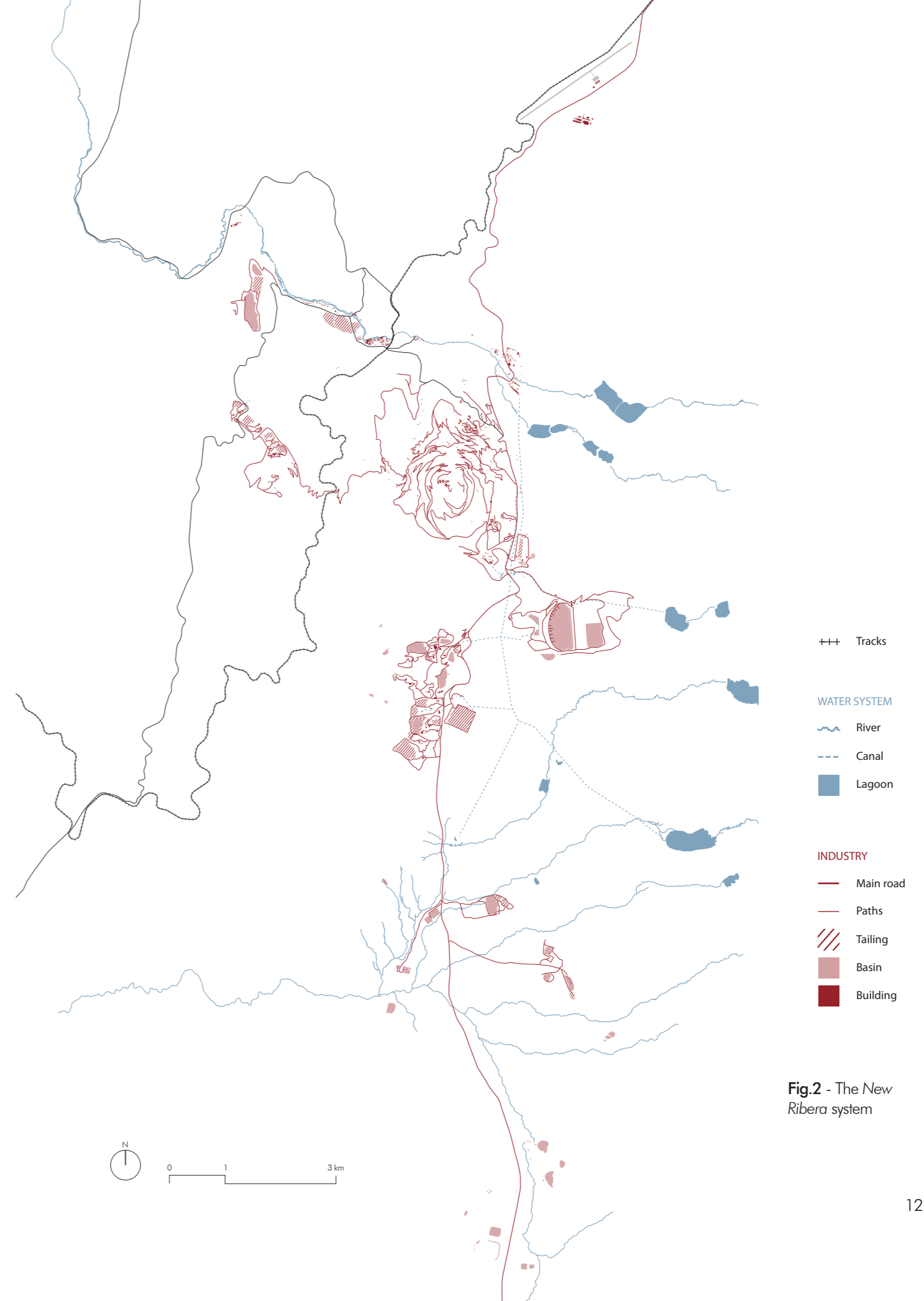
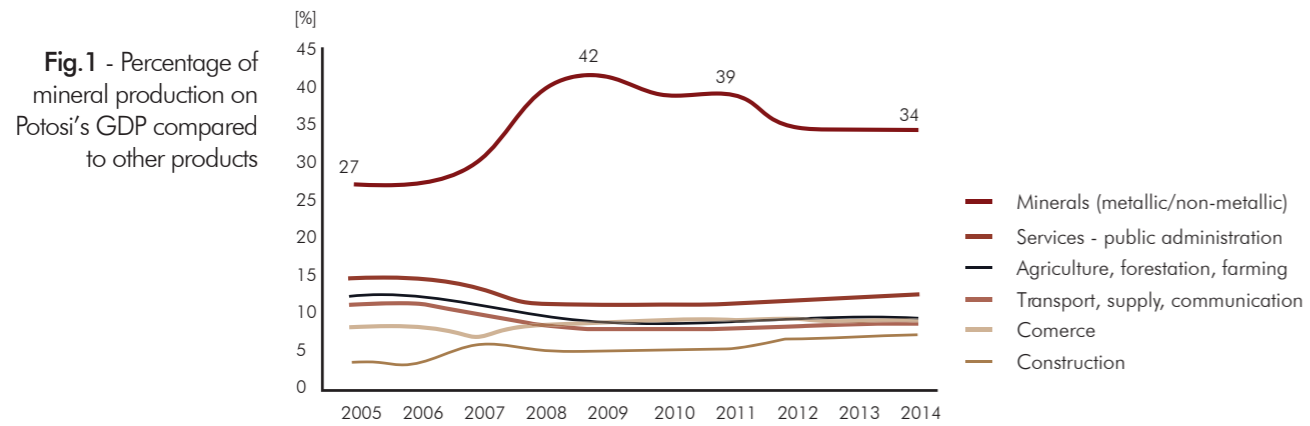
**Fig.1** - Reflection of the Cerro Rico in a tailings deposit



## The new Ribera

As throughout history, Potosi's economy relies and depends on the profitable returns from its resources. As can be seen in Fig.1 the percentage of mineral exportations on Potosi's GDP has always surpassed the 25% mark and at economically good times even sustained the 42% of the departments GDB over the last 15 years. Mining therefore seems to be indispensably linked to the future of Potosi. At the same time, however, it represents considerable environmental pollution and health risks. For this reason, affected residents have been demanding measures to alleviate these precarious situations since 1985. Among these measures are, for example, the entire removal of the Ingenios from the urban area, as they represent a considerable noise, air and water pollution. Along the Huayna Mayu tributary to the Ribera de los Ingenios, 30,846 people are affected in the urban area. Along the Ribera, 19,074 people are affected in parts of the old town, Cantumarca and San Juan. The problem lies in the solid waste that is discharged into the river, which carries about 1,700 tonnes a day. Furthermore, demonstrators advocate a stronger industrialization, to merge several small businesses into a big one and above all to switch to new technologies. Hence the current ones are completely inefficient with a maximum capacity of around 720 tonnes of processed materials by 11 Ingenios a day; this output could be achieved by one single Ingenio.<sup>1</sup>

Recently, a spatial shift of the Ingenios towards the South of Cerro Rico, along the valley of the Caldera can be noticed. New plants are installing there and the so-called colas, seepage basins, in order to filtrate and reuse the water from the separation process. They rely on the same territorial system as the colonial Ribera de los Ingenios, being located in the catchment area of the Caldera's water system and taking the water that is accumulated in lagoons. In their full extension, they end up 30 km south until the Caldera forms a ring with the agricultural lands to its East.







**Fig.3-** Empresa Minera Manquiri, the tanks are used to store the processing water

**Fig.4 -** Orthophoto of the San Bartolomé Mine with its colas, the tailings

As a result of these restructuring measures, there arise cleared up areas in the urban tissue, which have been converted into public infrastructure projects, in the form of an urban park with football and tennis courts and a swimming pool. This is the case of Pampa Ingenio, which opened its doors to new functions in 2016. This industrial restructuring process means a high potentiality for the city of Potosí to upgrade urban areas.

### The circuit of the materials

#### The example of Empresa Minera Manquiri

Along the factories that are processing the ores into more refined products than just the pulverised, separated minerals the enterprise Minera Manquiri stacks out, as it has its own foundry in order to be able to produce silver ingots. It was connected to the San Bartolomé mine which lies on the south side of the Cerro Rico and according to the its north American mother company Coeur Mining figures amongst the world's largest mines of pure silver and the second largest of Bolivia. It was engaged in processing superficial silver deposits from surface pockets of ore bodies or the remains from already processed minerals to silver ingots. As any other Ingenio the Manquiri plant uses the flotation process in order to separate the ores. The Manquiri enterprise has the specialty, that it is connected to its own water filtration basin. These are big basins, often made by piled up residues or as concrete basins. After the filtration process, when the valuable ores have already been recovered, the mixture of water and waste ores is discharged into those basins. They serve to recover the water, which will be gained through a longer filtration time, so that the water can be reused in the production process. In the tailings, ground ores without economic value are left as residue. Whilst on the surface shallow lagoons are built containing acid wa





ters. These represent a risky environmental impact due to their high content of ecotoxic metals. Although the situation is of course difficult to assess, the tailings already represent an improvement on the previous situation, where the solid wastes were discharged directly into the Ribera river.<sup>2</sup>

The other separation plants normally just serve the separation of the ores and the pulverised minerals that are gained directly after the floatation process are sold to the international markets. So their value creation takes place abroad, where the minerals are first melted and then processed into other products or product components. Even the existing environmental regulations, a lot of those firms illegally pure the solid wastes directly into the Ribera. Therefore in San Antonio, 4 km west of Potosí, the effluent of the Ribera, the seepage basin cola de Laguna Pampa I and II was built in 2007. Daily it accommodated about 4,200 tons of water and mineral discharges of 32 Ingenios, located along the Ribera. Nevertheless since 2015 it has reached its maximum capacity and end of its operational life. Therefore the question about the recycling of the residues produced by those 32 intra-urban Ingenios remains a problem. As a solution the creation of a new industrial park to the South of Cerro Rico, about 15 km away from the city, where various little processing plants already have initiated to settle, is envisioned by the government.<sup>3</sup>

## Transportation

### Railway

In 1905, the era of tin, Potosí got its train station and therefore connected to the uprising vast network of the Ferrocarril de Antofagasta a Bolivia. It was a transnational railway route, connecting important mining sites with the harbour Antofagasta in Chile from where the minerals could be shipped overseas. Once the biggest extension was from Antofagasta, over Oruro till La Paz. After 1964 however, when the firm was nationalised, the maintenance of the lines became too expensive, and important main connections like Oruro–La Paz, Guaqui–La Paz and Arica–La Paz were closed, which meant the collapse of this system.<sup>4</sup> Even though the section Potosí–Sucre is preserved, the railroad resembles more a railbus and just serves passenger services. However, it remains uncertain whether a railbus will pass, since the railway system is very unreliable and disruptions occur repeatedly, which can lead to months without service.

### Airport

In 1990 the airport, which lies 6 kilometres to the northeast of Potosí, was opened. It came out of the needs of a military base and never got extended to a flight hub. In 2015, the first national, daily running flight connections were established. According to the flight index, there is daily one flight from and to Cochabamba, and one flight from La Paz via Potosí to Santa Cruz. In 2019 finally a contract for the extension of the airport was signed, in order that it could become an important tourist destination.<sup>5</sup>



**Fig.5** - Train station in Potosí, 1990



**Fig.6** - An old lokomotive train, once forming part of the Ferrocarril de Antofagasta a Bolivia brigade, now resting at the train cemetery in Uyuni, 2016



## 2. A MORPHOLOGICAL AND SOCIALLY FRACTIONED CITY

*„The inhabitants of this Villa and its riverbank are made up of outsiders who come and go, of all classes of folk.“*

Concolorcorvo in *El Lazarillo de Ciegos Caminantes*, 1773

*„The right moment must be seized by the municipality of Potosí to change the mentality of its population from a camp town to a perennial town with a future“*

Chaime C. López, director of the PDM, *Plan of the Municipal Development of Potosí*, 2007

**Fig.7** - Potosí seen from Cerro Rico, the main church marking the central plaza





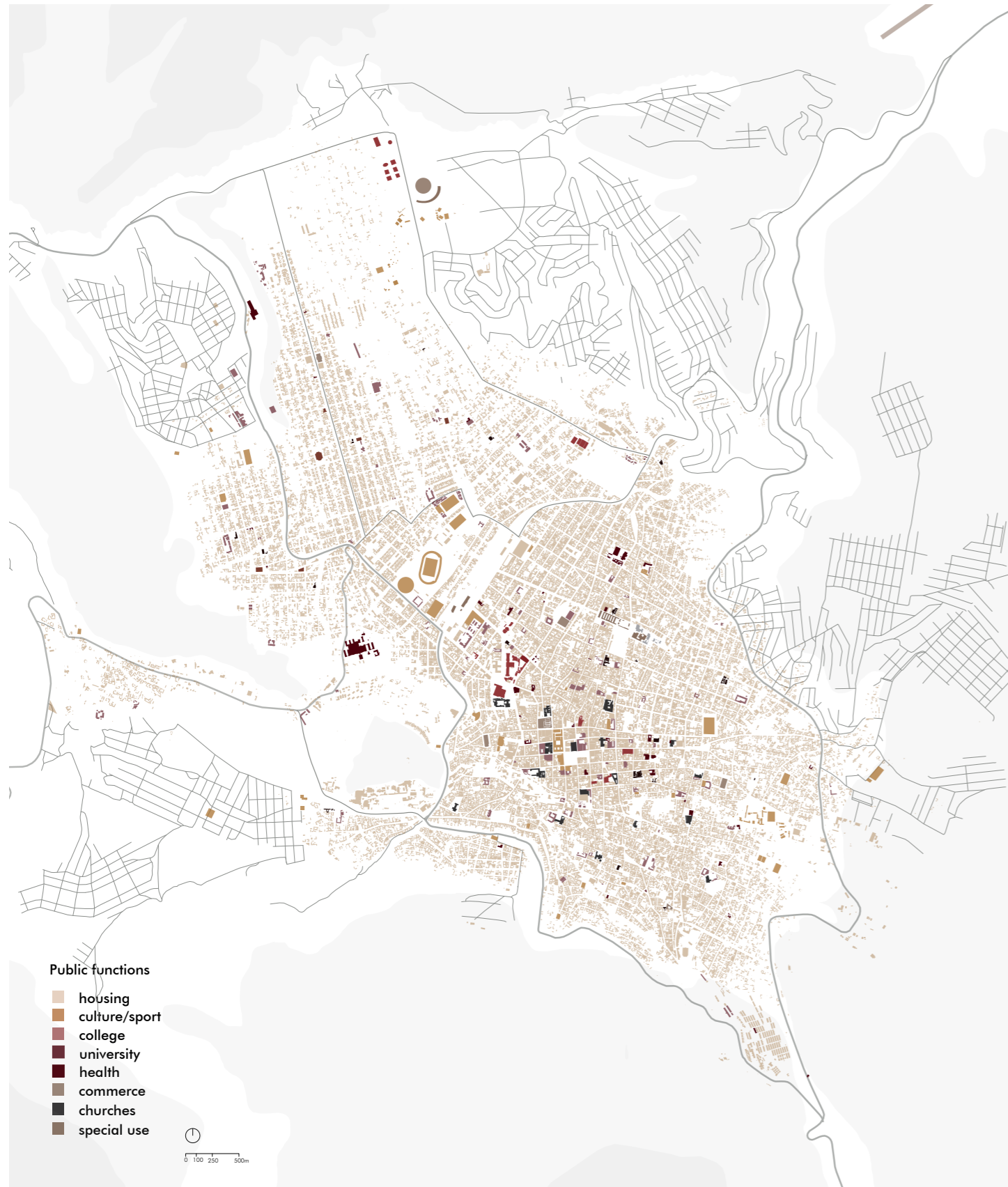


Fig.9 - The actif colonial centre and its extensions



Fig.10 - Aerial view



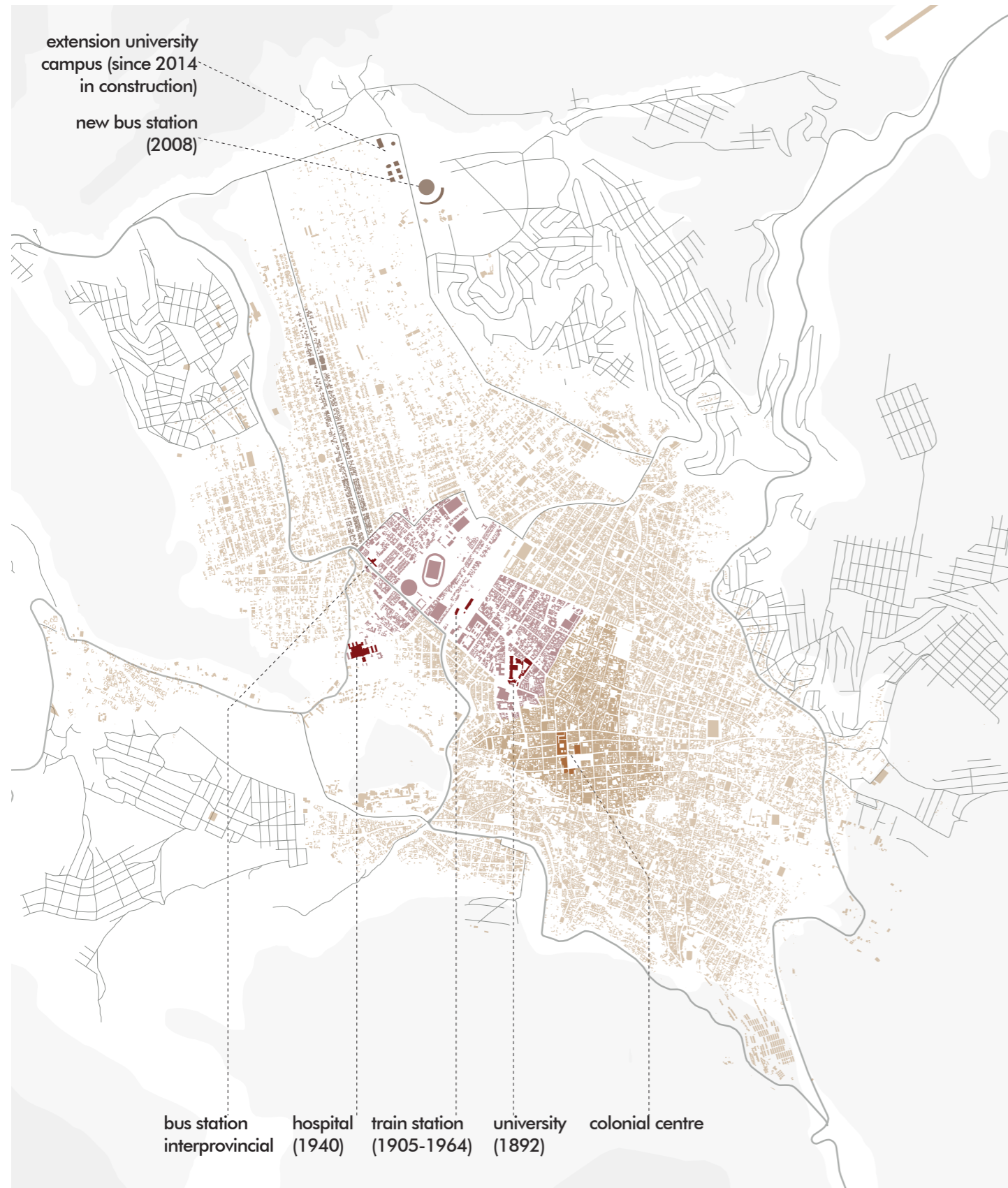


Fig.11 - Main public amenities determining the urban extension

### Diverging urban tissues

In the constitution of the urban tissue one can clearly observe different phases of development, all following their own logic. In general there happened a planned urban sprawl from the centralized colonial centre, having the Plaza Mayor in its middle towards the northwest in the 1940s, consolidating the zone of the university, the train station and the hospital. Nowadays this part can be regarded as second, "young" centre as it builds an important pole for young people with the university and unites essential functions of the Potosinan everyday life. With its morphology of a gentle grid turned about 60 degrees to the colonial one, it can also be considered as transition area to the strict housing grid, which was annexed in the 1970s more to the west. This part of the urban tissue rests a linear aggregation, in which just the main middle axis is equipped. Determining elements of this extension area are the new interregional bus station, which was opened 2008 and the university citadel whose construction have begun in 2014. Contrary to those planned extensions, the first informal occupancies were to happen since the origins of the city in the 17th century and constantly growing to the southeast, searching the proximity to the Cerro Rico. The city's issue for urban planning has always been its topography, which is limiting its urban sprawl to all senses. Therefore one can observe that little urban pockets are forming at the perimeter of the city, all following in an organic way the site's own logic. Their access often is provided by just one route and generally they miss all forms of equipment, be it the connection to basic services or public facilities such as kindergartens or schools.

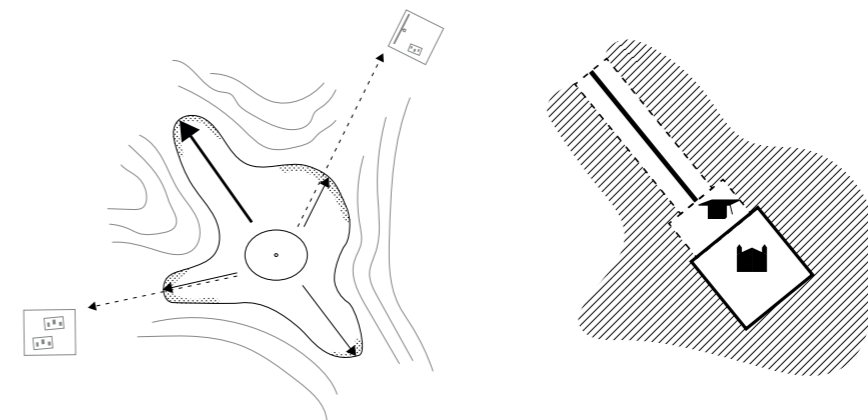


Fig.12 - Scheme urban sprawl along the four axis, reaching the industrial hubs at their extremities

Fig.13 - Scheme urban morphology. One colonial compact centre with adjacent modern centre developing in a linear way, dwelling belt around

In general one can observe an urban sprawl from the city centre to the periphery along four main axis, constantly pushing outwards. Commonly, the peripheral areas are deserted of all forms of public functions, which remain concentrated in the colonial centre. Due to this mixity of functions, of commercial, administrative, cultural and residential nature, the centre still deposes of the highest lot prices. The first development axis is going northwest-southeast, consolidating the most dense and poorest part of the population on its south side, in proximity to the



Urban development

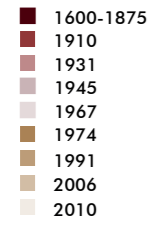
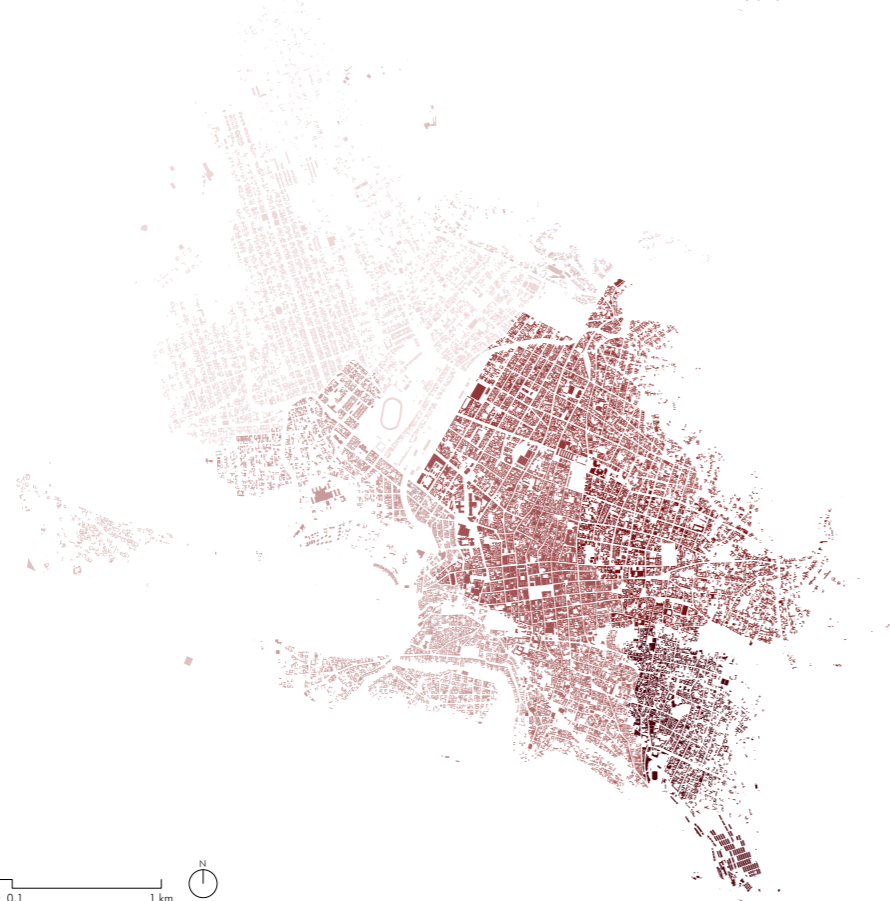


Fig.14 - From concentric to linear development



Densities

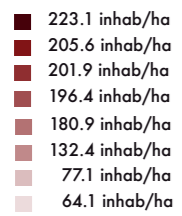
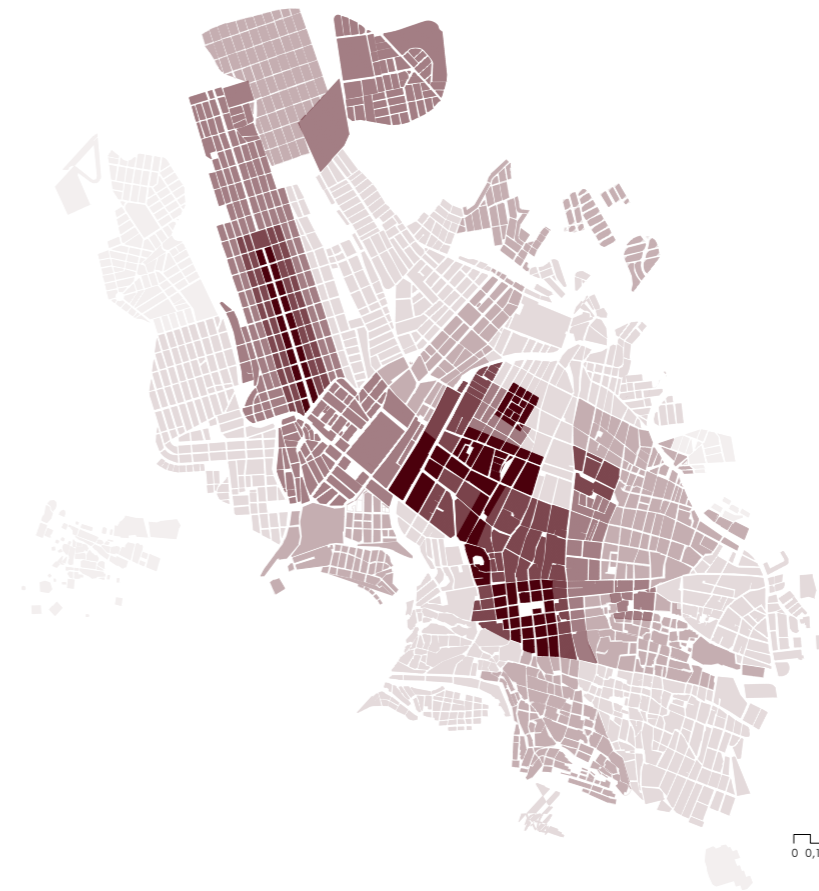


Fig.15 - A bipolar density



Price/m<sup>2</sup> in US-\$

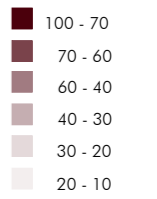


Fig.16 - Valuable extended centre



Public service, access to:

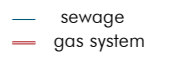


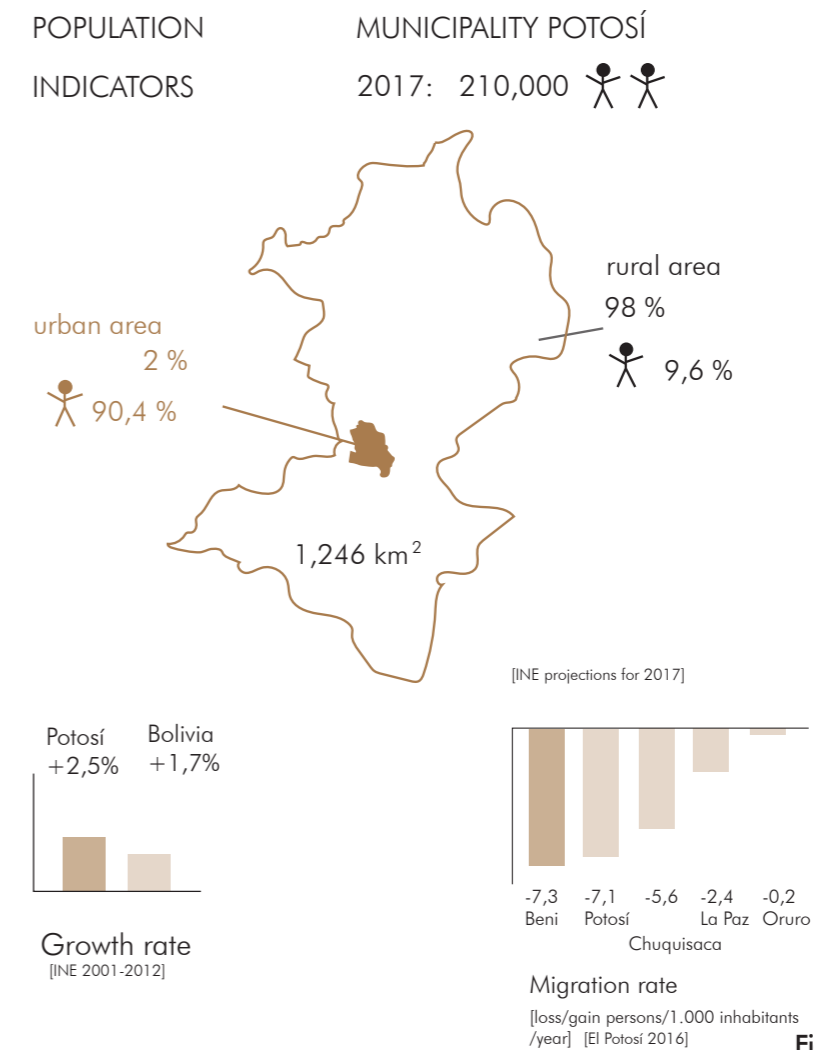
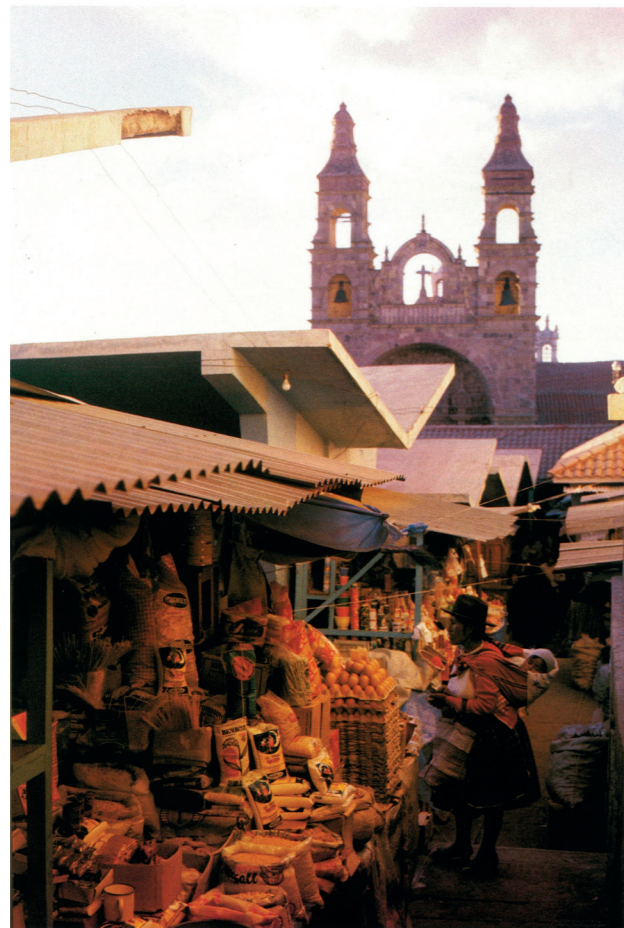
Fig.17 - The deserted periphery





Cerro Rico. It is this part, where the young rural population arrives first in order to seek work in the mines. Thus one can notice a special age composition of the population: it is the quartier the closest to Cerro Rico, which disposes of the highest rate of 19 - 29 years-old. Simultaneously they live under precarious conditions: the lack of water, gas or a connection to the sewage system. Because these are the quartiers existing since colonial times, they possess of the colonial parishes that once served as agglutination point for the different people. Mirrored to the other extend, there is the checkerboard extension of the 1970s. This zone is considered to be a consolidated one, of little density with single-family houses on their parcel, which is reflected in the price of the lots. Regarding the actual conditions however, one observes that only the main axis is well developed while the fringes rest deserted of public services. Another axis can be deduced from the industrial evolution. It goes to the northeast, where in 1990 the airport and after 2017 the cement factory settled, as well as to the southwest along the river de la Ribera, in outer districts like Cantumarca or San Antonio, where new processing plants and water treatment plants are developing. It is estimated that the area, which will have the greatest urban development, will be Cantumarca, as on the one hand it is connected to the industries and on the other hand it still offers quite a big zone of good, flat terrain to be urbanised.<sup>6</sup>

**Fig.18** - Vendors at the central market, Potosí's main church, Our Lady of Peace, in the background, 1990



**Fig.19**

### A young and unrooted population

The Municipality Potosí is divided into an urban and a rural area, with the urban area making up just 2% of the Municipality. Potosí has a rather young population. Especially in the rural part the birth rate is still very high, as the children are traditionally used for pension provision. But this is exactly where the problem lies: the area offers too few incentives for young people, so that the young population between 20 and 25 years of age who are willing to work emigrates. Be it to other municipalities of Bolivia, such as Cochabamba, Santa Cruz, Oruro, where the migration rate is -0.2 (unlike Potosí -7.3%) or even to other countries.<sup>3</sup> Argentina is the largest destination country. In the countryside, this behaviour leads to dramatic effects, the ageing of the population. But also in the city, a significant break can be seen from the age of 18, where young people move away for a better education. For Potosí one can speak of a «brain drain», since it also loses the 25 year olds who have finished their studies. At the same time, it remains striking that Potosí, as a mining town, still attracts



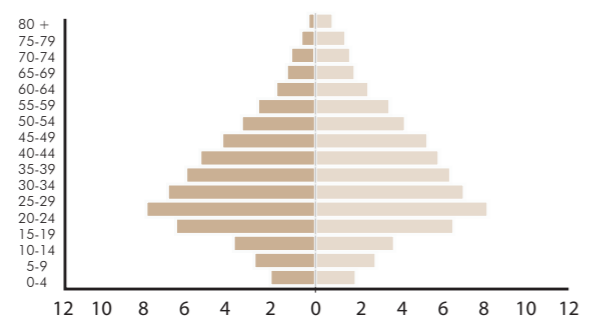
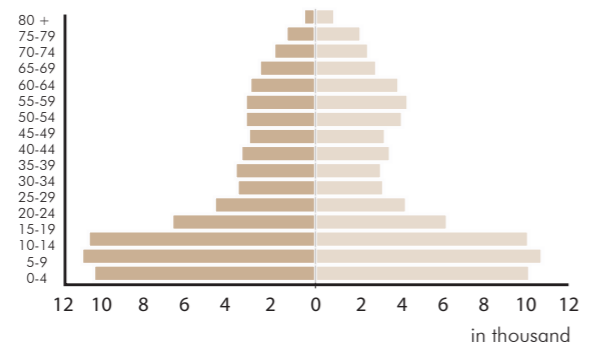
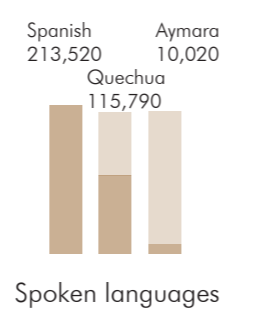
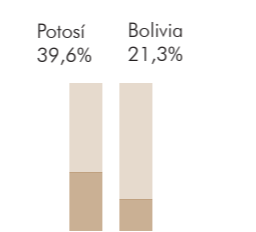
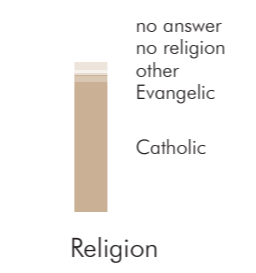
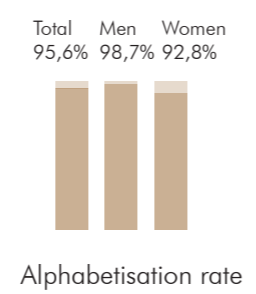


Fig.20 [INE 2001-2012]

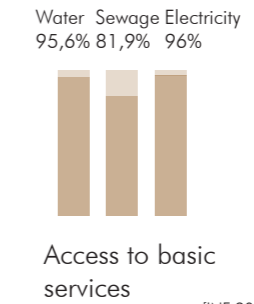
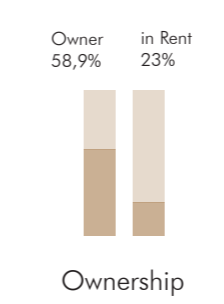
SOCIAL FACTORS



parts of the population to work in the mines. These are mostly young people from rural areas with a low level of education. They settle in the immediate vicinity of the workplaces (the Cerro Rico), whereby the accommodation must be cheap. This leads to the prevailing situation of precarious situations in the typical mining districts, San Cristobal, San Pedro and San Benito, which have existed since colonial times. They are particularly densely populated (22% of the whole urban population lives in these 3 districts) and in many places don't dispose of an adequate infrastructure: the lack of water, gas or a connection to the sewage system. The situation is even more acute for those who settle directly at the Cerro Rico, in the sheds that store the working material. They are often widowed women with their children who work as pailaris for the mining industry. According to Cepromin, an organisation that was created in 1979 in last moments of the military dictatorship, when the miners fought for democracy and an organ for their political formation, in 2011 13,000 children were working in the mines. Compare to the governmental counts, which are more than three times less with 3.800.<sup>7</sup>

The idea to change the miners' social situation has existed for a long time, yet the anarchic conditions haven't really improved. Cecilia Molina, director of the Cepromin sees her role as followed: «to prepare leaders, with the idea, that the benefices of mining musn't continue outgoing to foreign countries, but contrary for the first time in history for the own good of the country.»<sup>8</sup>

HOUSING SITUATION



[INE 2001-2012]

Fig.21



### 3. POTOSI'S POPULATION AND ACTIVITIES ON THE UPSWING

*„In the first examination period for 2018 admissions we had 7,085 7,085 applicants, out of which approximately the half was admitted in the first postulation period.“*

Vicedirector University Tomas Frías Adrián Montoya,  
2019

*„Agriculture, cattle farming, tourism and industry in the department of Potosí together with mining are the five pillars on which we will build the development in the next five years.“*

Potosí's ministry Nélide Sifuentes, 2019



### Potosí's population and activities on the upswing

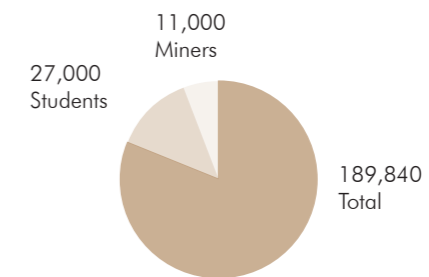
The biggest problems for Potosí's development today are its own history. Economists and sociologists say that Potosí has always had to postpone its own development for other interests.<sup>9</sup> Thus, in the colonial time, it was designed to achieve the greatest possible economic profit for Spain. Finally, the flourishing market led to a long-term settlement of the colonisers, both Spanish and Indigenous. However, there was never any interest in developing an economically sustainable city. This also conditioned the system of the *encomienda*: the interest of the Spaniards was only to make profits for the mother country Spain. Since the human capital of the Indios, who were obliged to work by the *mita*, was sufficient, the Spaniards did not try to use more efficient systems but maintained the same anarchic methods. For the indigenous population there was also no need to build an economic backbone since the whole economy was under Spanish control. This way of thinking continued after the independence in 1825, when mine ownership fell into oligarchic hands. Unfortunately, until this day, Potosí's situation has not changed much, as it represents a sovereign role to the outside, which it can gain thanks to the high mineral prices it is able to recover from the world market.

Compare to Fig. 23, which reflects the overall economic performance of Bolivia on Potosí's GDP. Are there fluctuations in the mine yields, direct consequences can be seen in the country's whole GDP. At good times Bolivia's market yield goes raised straight up, in the times of crisis however a depression is noticeable, but can be alleviated by other factors. In 2016, Potosí generated with 1,807,833,685 million dollars, the second strongest GDP after Santa Cruz. What is not taken into account, however, is that the contribution to the GDP consists of purely primary goods, which means a complete absence of a secondary sector. For the whole of Bolivia, Potosí represents a strong economic

pillar, and so it was in the later history that with the help of Potosí's resources, first Sucre, La Paz and, after the revolution of 1952, the Bolivian East (Santa Cruz, Cochabamba) were built as economically strong cities, while Potosí had to renounce its own growth. With the vision of good results obtained by Potosí, in the eyes of the government Potosí is doing well, although the city is neglected on a national level. Thus, there is no evidence of this wealth on the streets: the industry is not diversified, there is a lack of technology, productive innovation, or incentives for regional production, which therefore results in a human and capital flight. Therefore a structural change is the primordial condition to overcome these drawbacks and the centripetal place of natural resources in Bolivia's economy.

### URBAN POPULATION

The potentiality of a young population - an academic one and one having the work force



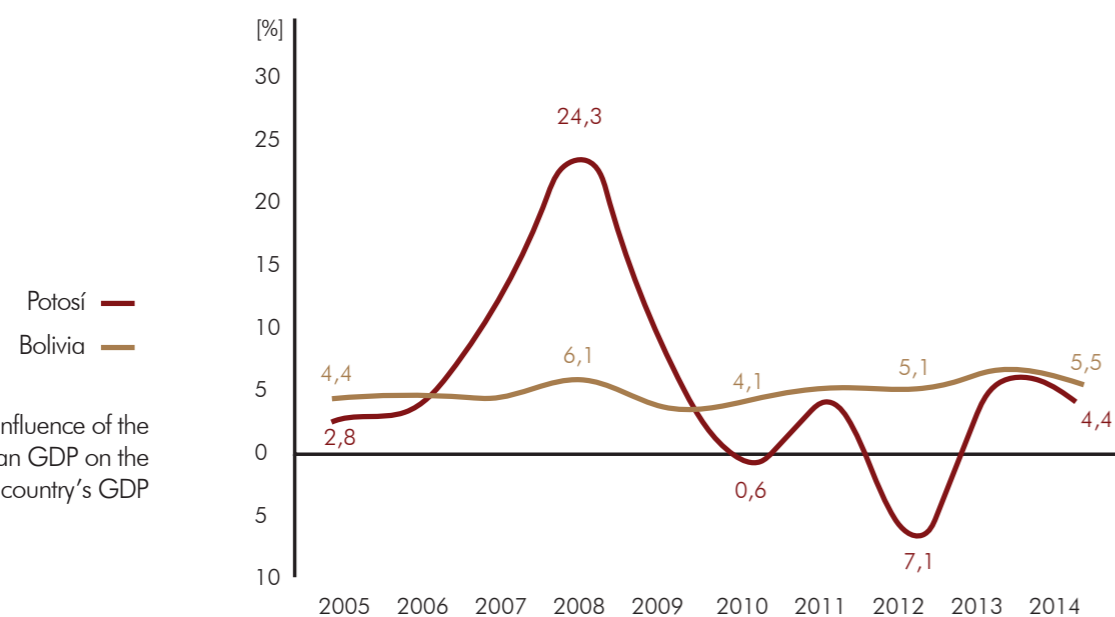
Ratio of young population - Fig. 24

### The educational pole

As already described the university Tomás Frías has an extraordinary role, not only in the city's morphology as connector between colonial urban tissue and recent expansion, but also as development motor for the future. It was established in 1892 and in 2018 it could gather a community of 27,000 students. Yearly there are applying more than 7,085 young people for admission, out of which in 2018 about the half was granted admission. These numbers show the high potentiality Potosí would have out of their students, but as the offer for providing a study place is not adequate, a lot of young people are forced to move abroad in order to be able to study. This is a first reason why Potosí has such a high rate of negative migration. The offer includes 34 branches, covering almost all scientific fields, from social and humanist studies, over economies and administration, to medicine, arts, they offer besides the traditional engineering careers technological engineering and two branches for mining engineering. Implementing those specialized branches Potosí is responding to its territorial conditioning.<sup>10</sup>

The aim is to form educated locals who will later be able to take over leading functions and guide the mining industry in a sustainable direction.

Fig.23 -Influence of the Potosinan GDP on the country's GDP





## Touristic attraction

If we look at the numbers of visiting tourists of the whole municipality of Potosí, in 2016 it was the third most visited after Santa Cruz and La Paz. From 2016 to 2017 there was a growth rate of +24%, which is a good sign for the region of Potosí. It is to remark that almost the half of inflowing tourist was visiting the Salar de Uyuni, the worlds highest salt flat to the south of Potosí.<sup>11</sup> Most of the tourists normally come seeking for the environmental beauty, whereas heritage site tourism, such as in Perú with the Machu Picchu is almost not existent in Bolivia. For the city of Potosí in order to better profit from the touristic influx there would be a high potential to promote cultural tourism. Many tourists have already discovered the attractivity of visiting active mines, but for the other cultural heritage, such as the Ribera de los Ingenios, which once built the first industrial machine, Potosí stays completely unknown. This is due to the fact that there is no valorisation done for its patrimony.

### TOURISM

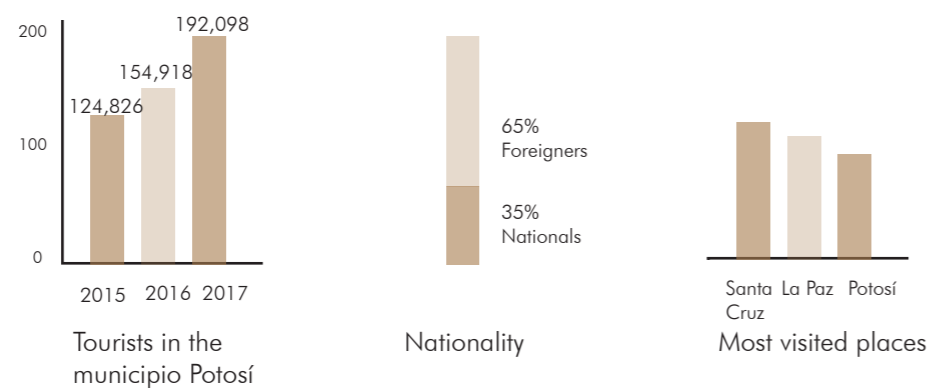


Fig.25 [El Potosí, 2016]

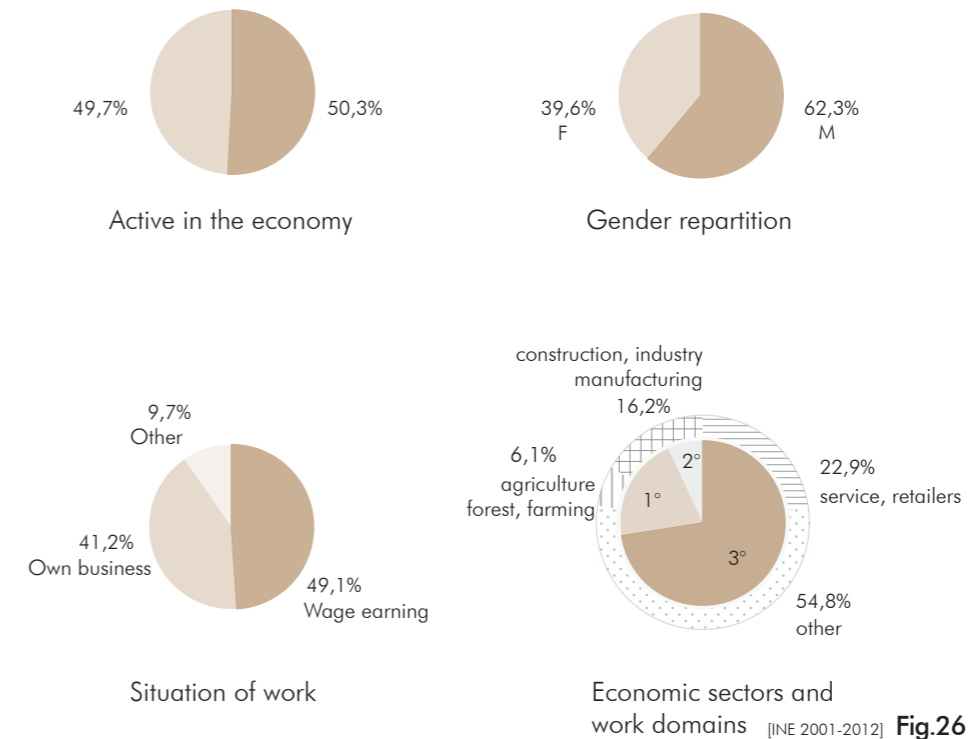
## Towards the diversification of the economy

Potosí's ministry Nélide Sifuentes already announced in 2019 that «agriculture, cattle farming, tourism and industry in the department of Potosí together with mining are the five pillars on which we will build the development in the next five years.»<sup>12</sup> Indeed, there would be a potential in developing the agricultural sector with the production of quinoa, beans or farming of camelids, sheep, goats, or also in the development of regional handicrafts, or the textile industry, which is almost inexistent.

For Potosí of particular interest however, would be to develop an own refining and production process of the raw materials, since by processing the materials a three times higher price could be achieved.

First advances towards an own refinery process can be observed with the contract for the new cement factory, 7 km to the northeast, next to the airport.

## ECONOMIC FACTORS



It is a project worth 241 million dollars, which will be the largest of its kind in Bolivia. A production of 1.3 million tonnes of cement a year, as well as a clinker line with the capacity for 3,000 tonnes per day is envisioned.<sup>13</sup>

## Lithium

Another enormous potential for Potosí are the lithium deposits from the Salar de Uyuni, about 200km to the southwest. With ten million tonnes these are the largest in the world, while extraction has not yet begun. This means that should production begin, which is quite likely to happen in the near future, a well developed control and administration centre will be needed to carry out this enormous logistical task. Potosí, as the capital of the province and generally as the closest major city, could overtake the task of an administrative headquarters. As the lithium sector will be newly established in Bolivia's economy, Bolivia has the unique opportunity to establish the further processing of the lithium reserves in its own country since the beginning. It could thus emerge from the fatal cycle of a pure «supplier» role in the world market system. However, this must be politically regulated from the outset in order to grant the Bolivian industrial sector a monopoly on lithium mining and processing. So that for the first time raw materials represent a development factor and do not leave the country unprocessed as before. Thus the lithium would be a generator of jobs. Not only for the purely logistical tasks of mining it will need specialists, but if the industrial sector was to be born, it would lead to many other tasks in the service sector. In addition, an influx of the academic population could be expected, which





**Fig.28** - The exploitation of Lithium in the Salt flat at a height of 3.600 m

could have further positive effects for the establishment of a specialized market in Potosí. This could lead to valuable synergy effects with the local knowledge, since the university Tomás Frías offers two courses of studies specialized in mining. In addition, classical scientists in chemistry, physics and mathematics would be available in order to establish a local pole of specialists.

Lithium is regarded as the new natural gas, the key raw material of the 21st century, as it is used in batteries. Batteries, which are expected to have a major impact on climate change, as they serve as the engine for the electric car. For instance, the price of lithium per ton has doubled since 2016 to well over 13,000 dollars.<sup>14</sup>



**Fig.27** - Potosí as the closest administrative city

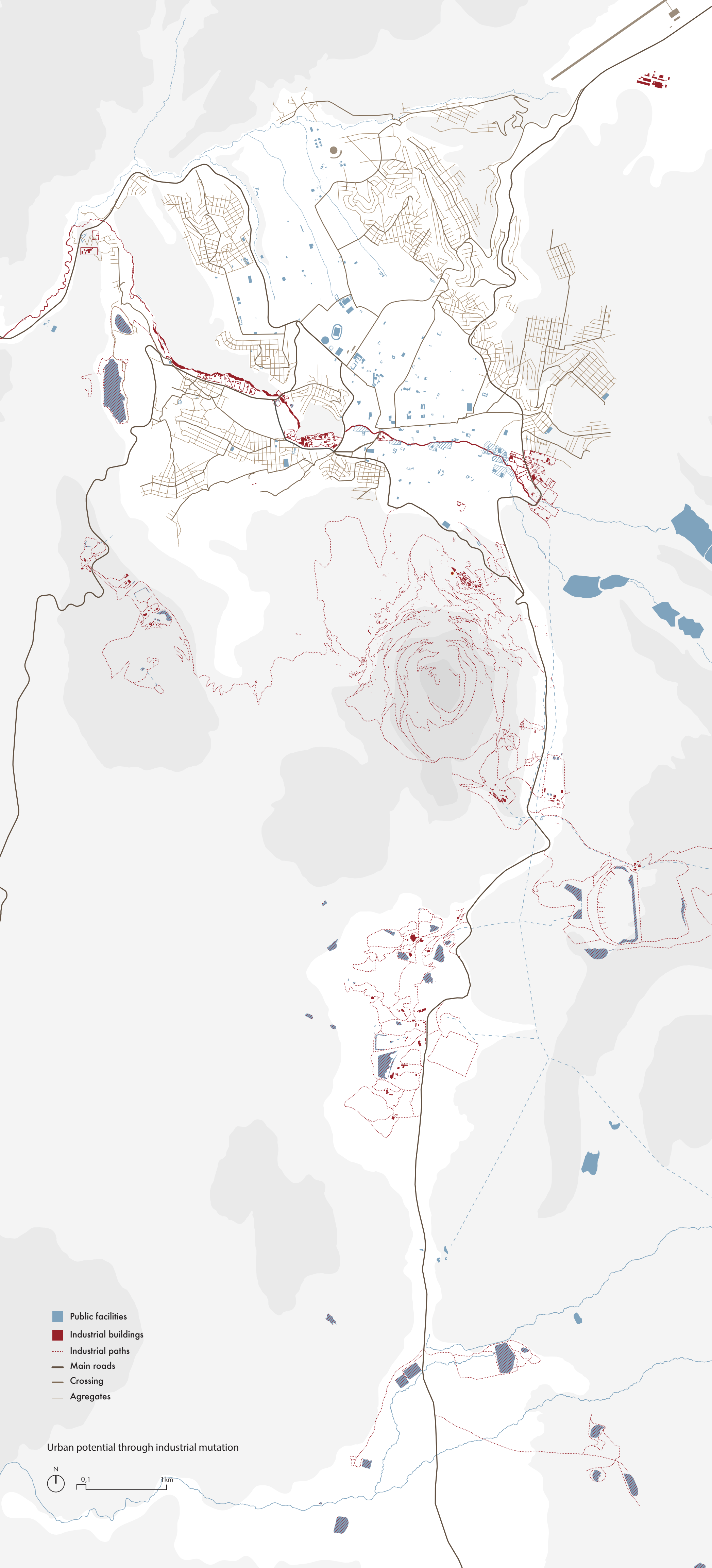
This is why the global struggle to secure Bolivia's raw materials has already begun. Thus a Chinese company already owns a huge potassium chloride plant for fertilizers with a production volume of 350,000 tons per year, there are further contracts with India for the mining of lithium and contracts with Germany for a joint venture project that was to run for 70 years. Contracts

had been negotiated in which the Bolivian state company Yacimientos de Lito Bolivianos (YLB) was to retain 51% of the production shares, while the remaining 49% went to the German company. The German government has also agreed to provide up to one billion euros for research for battery cell production, as well as to build three battery factories, which should create up to 1,000 jobs. So it was a win-win situation for both parties, as Germany gained access to raw materials whilst Bolivia retained full control over its deposits and at the same time could attract foreign investment. Hence it could not master such projects on its own. From 2021 on, some 40,000 to 50,000 tons of lithium hydroxide and lithium carbonate should have been extracted annually. However, in November 2019, Morales cancelled the project unexpectedly.

From the point of view of environmentalists this was a good sign, as they fear a threat for the ecosystem with far-reaching consequences. It takes two million litres of water to produce one ton of lithium carbonate. Hence lithium is not available in its pure form, but must first be freed from boron and magnesium by a floating process using sodium carbonate. This leads to a drop in the groundwater level in the Atacama Desert, so that some rivers have dried up and the indigenous population no longer has access to water. The tourism sector also raises concerns, as the natural beauty of the virgin, vast salt lake is the country's main tourist attraction, which they see as endangered by industrial operations.<sup>15</sup>

The immense conflict of interests of the different actors to this piece of land is already visible, and only the future will show how Bolivia will bring this situation under control.





- Public facilities
- Industrial buildings
- Industrial paths
- Main roads
- Crossing
- Agregates

Urban potential through industrial mutation





## EPILOGUE

“If I were to pay you, Sancho,” responded Don Quixote, “according to what the greatness and nobility of this remedy deserve, the treasure of Venice and the mines of Potosí would not be enough.”<sup>1</sup>

It is difficult to talk about Potosí without using superlatives, as Potosí is the city of excess. And Don Quixote doesn't stop there: he is at the origin of the expression „*Vale un Potosí*“ (it's worth a Potosi) synonymous of countless wealth, still used in Spain today. There it is, finally, the Eldorado that the conquistadors were so desperate for: a mountain made of silver. After a long slump, the mining industry in Potosi has been experiencing a revival since the beginning of the 21st century, thanks to the strong demand from Asian economies: China in the lead, followed by South Korea and India. The miners are regaining some of the influence they had lost on politics, and it was thanks to their strong support that Evo Morales was elected in 2005. However, their relations did not remain cordial, as Morales tried to attract foreign investors and kept the miners at a distance. This ambivalence towards the mining sector divides the city and the region, one of the largest in Bolivia and still one of the richest in terms of mineral resources. Without government protection, cooperatives are very vulnerable to expropriation.<sup>2</sup> With the recent political upheavals in Bolivia, the trend is unlikely to be reversed. But Potosí is being reborn once again, and the city known for its strong protests is not likely to remain silent. However, the metropolis is aware of its weaknesses and is desperately trying to increase tourism and diversify its economy. The upcoming exploitation of one of the largest lithium deposits in the nearby Salar of Uyuni will be a great source of opportunities that Potosi will have to seize.

But the question of heritage remains a concern: how come that such an impressive and persistent infrastructure as the Ribera de los Ingenios, an engineering marvel, goes unnoticed? And we can speak from experience: during our stay in Potosi in September, and despite our desire to discover the city in depth, we did not see or hear the slightest mention of the Ingenios. The tours offered to tourists are concentrated in the Casa de la Moneda, the churches of the colonial center, or the famous mines of the man-eating



mountain still in activity. Once again it's all about Cerro Rico, which is the pride of the Bolivians to the point that they put it in the center of their flag. It is however true that the Ribera condenses most of the contradictions of the city: great or destructive territorial machine? Uneducated Indians surviving in the ruins left behind by the colonial empire or expert and innovative entrepreneurs? Do the ruins of the Ingenios really belong to them or are they only the trace of a violent and painful past that would be better forgotten? While the majority of the young brains are leaving the city, those who do come mostly consider Potosi as a camp, a temporary place to live. The idea of a common identity is thus very weakened.

It is certain that such a heritage, combined with the water crisis that Potosi is going through, has great potential. The process of urban growth generates the need to organize spaces and the distribution of services in better conditions and the relocation of polluting sources.<sup>3</sup>

Awareness of the heritage must come from the Bolivians and not from Spain, which seeks above all to exhibit its glorious past to the detriment of indigenous cultures. One thing is certain, the „silver city that changed the world“ is facing a major challenge today and its ability to respond to it will determine, in a future that we believe to be close, its final collapse or its emancipation from the resources of the Red Mountain.

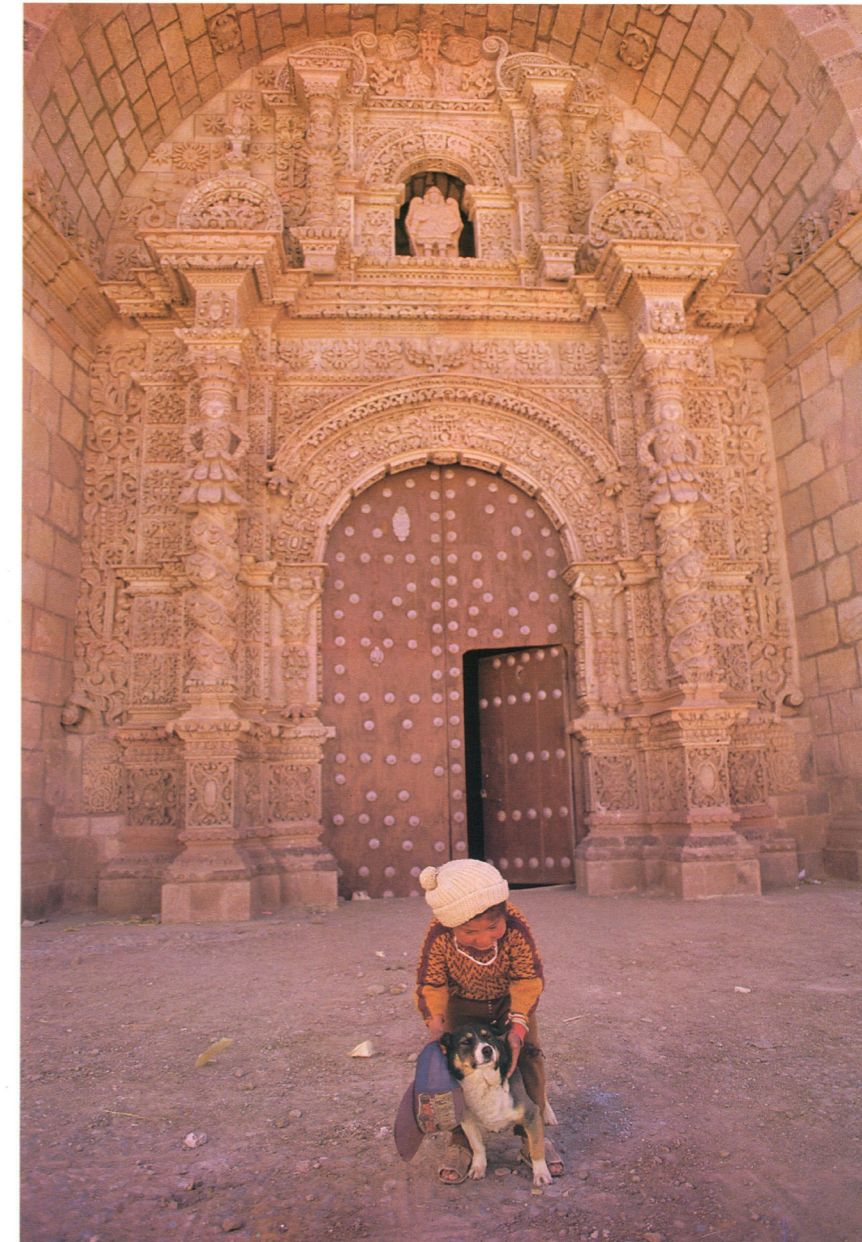


Fig.1 - Child playing in front of San Lorenzo Chuch, 1990

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## LIST OF ILLUSTRATIONS

### ILLUSTRATIONS

#### Part 1: A story of social and territorial domination

**Fig.1** Drawing by the author, based on a reference from the Mint archives, Potosí, Bolivia

**Fig.2** Worldclim.org

**Fig.3** Openstreetmap

**Fig.4** Worldclim.org

**Fig.4b** Worldclim.org

**Fig.5** Openstreetmap and [www.ethnologue.com](http://www.ethnologue.com)

**Fig.6** Castillo, José E. 2005. Qhapac Ñan Bolivia – Candidatura de Nominación. La Paz on the basis of Openstreetmap

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**Fig.8** Ibid.

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**Fig.13** Ibid.

**Fig.14** Dym, Offen, 2011

**Fig.15** Deler, Jean-Paul.2008. "La Ciudad colonial andina en los ojos de Guaman Poma de Ayala", Procesos., 7

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**Fig.18** Ibid.

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**Fig.1** : Gudynas, Eduardo. 2012. „Der neue progressive Extraktivismus in Südamerika.“ In Der Neue Extraktivismus –Eine Debatte über die Grenzen des Rohstoffmodells in Lateinamerika, edited by FDCL e.V. und Rosa-Luxemburg-Stiftung, 46-65. Berlin: FDCL-Verlag. [https://www.rosalux.de/fileadmin/rls\\_uploads/pdfs/Ausland/Lateinamerika/Der\\_Neue\\_Extraktivismus\\_web.pdf#page=46](https://www.rosalux.de/fileadmin/rls_uploads/pdfs/Ausland/Lateinamerika/Der_Neue_Extraktivismus_web.pdf#page=46).  
**Fig.2** Fundación Milenio.2015.“Potosí:cuasi monoproducer minero.”Informe Nacional de Coyuntura, Noviembre, 2016.  
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## Epilogue

**Fig.1** Gluckmann, Daniel. “Potosí”

## MAPS

Google Earth, OpenStreetMap, *Plan de Desarrollo Municipal de Potosí*, IGM Bolivia, *Plan de Rehabilitación de las Áreas Históricas de Potosí*

