

Geography, Nationalism and Mining Development in the Emergence of High Altitude Pathologies

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Despite the hostile geographic and climatic conditions, millions of people live, work and reproduce at great altitudes in the mountainous regions of the Andes, the Himalayas, the Ethiopian highlands, the Rocky Mountains and the Swiss Alps. High altitude areas, defined as over 2,500 meters above sea level, are characterized by numerous atmospheric challenges, such as low temperatures, aridity, high levels of ultraviolet radiation, and, most important, decreased partial pressure of oxygen. In the high Andes it is possible to find permanent settlements located at more than 5,000 meters above sea level, where local populations live with half the atmospheric oxygen pressure than at sea level. How have entire populations managed to adapt to high altitude environments? What are the bodily mechanisms of adaptation to hypoxia? What are the physical and mental effects of prolonged exposure to low oxygen environments? How are disease and epidemiological patterns, mortality and morbidity rates affected by hypoxia? These

are some questions medical practitioners and respiratory physiologists have been systematically trying to answer since the early twentieth century.

In my Ph.D. dissertation I explore medical efforts to understand the effects of altitude on health during the first half of the twentieth century. By doing so I intend to fill a historiographical void, since almost nothing has been written on twentieth century medical ideas on human adaptation to 'extreme' environments. This is unfortunate, because medical debates on human adaptation reflect otherwise hidden ideas about race, population anxieties, and the role of 'place' in medical practice.

I undertook research at the Rockefeller Archive Center during March 2006. The Rockefeller Foundation (RF) gave much financial and institutional support for the development of physiology in Latin America, including respiratory and high altitude physiology in Peru (Cueto, 1989). The extract that follows constitutes a section of my dissertation and is based partly upon the material I found in the Rockefeller Foundation Archives. This very well organized archive holds research reports, grant applications, financial statements, the correspondence between Peruvian scientists and RF officers, and the most complete photographic collection of high altitude laboratories and research stations placed in the high Andes, many of which were equipped by the Rockefeller Foundation.¹

¹ Most of this material is held under the heading: Rockefeller Foundation, Record Group 1.1, Series 331 (Peru). Among others I consulted correspondence with Peruvian physiologist Alberto Hurtado, located in Series 331 (Peru), Record Groups 1.1 and 1.2, Boxes 1-2, Folders 5-16 and Boxes 3-4, Folders 23-27. I also explored the correspondence of Alberto Hurtado with Rockefeller Foundation officers such as Alan Gregg (diaries located in RG 12.1) and Wade Olivier (RG 12.1). I also consulted materials related to Carlos Monge (Series 331, Record Group 1.1, Box 1, Folder 8; Box 4, Folders 28-29; Record Group 1.2, Box 2, Folder 14). Carlos Monge was the pioneer of high-altitude studies in Peru. While the focus of my research was in the Peruvian papers, I also gathered material from Wallace O. Fenn (the Archive holds materials on RF support for his work at the University of Rochester) and the files on C. A. Binger (Rockefeller University Archives, Record Group 450.1, Box 4, Folders 5-6). Binger was a member of the Rockefeller Institute of Medical Research, and as such accompanied the 1921-1922 Anglo-American Scientific Expedition to the Andes to do high-altitude research.

In this paper I discuss the emergence of the notion of 'high altitude pathology', a term that was used to group a set of diseases produced by exposure to hypoxia, such as chronic mountain sickness, high altitude pulmonary edema, high altitude cerebral edema, among others, that had the particularity that they were cured by descending to sea level. In its broader sense it also referred to the unique epidemiological patterns encountered among populations living in mountainous regions. My argument is that the 'discovery' of several high altitude diseases was the product of the combination of three factors: i) the development of the mining compounds of Cerro de Pasco in the central high Andes, which encouraged the migration of thousands of workers from moderate to extreme altitudes; ii) the establishment of modern hospitals and laboratories in these mining compounds, which offered medical investigators access to hundreds of patients and the most sophisticated technology for medical research; and iii) the emergence of an elite group of physiologists interested in doing altitude research in Peru. The role of the Rockefeller Foundation in this process can be observed at two levels: in the formation of an elite group of physiologists devoted to altitude research in Peru by means of the provision of scholarships for medical research and training in North American universities; and the funding the foundation provided for the establishment of laboratories for scientific research in the mining districts of the high Andes.

The rise of the mining compounds of Cerro de Pasco in the high Andes

Cerro de Pasco is a mining district located in the Peruvian central Andes at 4,380 meters above sea level. Mining activity in the district of Cerro de Pasco can be traced back to pre-Columbian times. However, the rise of Cerro de Pasco as a modern industrial center began in the early twentieth century when the Cerro de Pasco Corporation, a United States based financial group, took possession of most of the lands and mines of central Peru and initiated what may be

the greatest mining project in South American history. Important investments in mining infrastructure, such as the construction of smelters and refineries, the installation of the most sophisticated machinery, and the completion of railroads that connected these mining districts with the main ports of Lima, placed Peru amongst the leading producers of copper and silver in the world. During the first decades of the twentieth century, the Pasco Corporation expanded its operations to neighboring districts and communities, attracting thousands of workers and their families to previously desolate altitudes and dramatically altering the social, economic and demographic structure of the high Andes. (Abeyta, 2005).

One of the most enduring consequences of the arrival of North American capital was the modification of the population structure of Cerro de Pasco. The labor force was initially recruited from the local population, given their mining expertise, but in order to meet the demands of the growing mining operations, the company administrators were forced to recruit workers from neighboring peasant communities, usually located at more moderate altitudes. For the company managers there was no doubt whatsoever about the need to rely upon the native Andean population, rather than importing specialized work force, given the proximity of many Indian communities to the mineral areas, the familiarity of the Andean natives with the mining processes, the need of this population to supplement their peasant activities with the cash wages that were paid in the mines, and, most important, the belief in the unique capacity of the Andean population to resist the effects of the high altitude.

To recruit workers, the company used posters that promised advanced payments, housing, electricity, and free medical attention and hospital services. In some cases, entire peasant communities were forced to migrate to the mining towns of the Pasco Corporation after the pollution produced by the mining activity destroyed their lands, pastures and livestock. Within a few years this impetus had encouraged an important population movement and the establishment

of a permanent work force in these mining districts. In addition to the social disarticulation produced by their transformation from peasants to miners and by the migration from moderate to high altitudes, Andean natives had to confront extremely hard living and working conditions. In addition to the Andean natives, the Pasco Corporation also attracted a smaller group of North American businessmen, administrators and engineers who settled with their families in Cerro de Pasco.

Although mistreatment of workers was never abandoned, the Corporation administrators realized that some concession to workers' welfare was necessary in order to secure the permanence of a stable and experienced work force, and as a response to both workers' uprisings and social campaigns on behalf of indigenous rights. In addition to moderate wage increases, the Corporation developed a welfare program that included the establishment of "a large and furnished school" for the children of the workers and the construction of recreational clubs that offered "billiards, books and refreshments" to the men. (Abeyta, 2005). It was within this context that one of the most modern hospitals in Peru, the Chulec Hospital, was established.

The Chulec Hospital: a privileged site for the observation of high altitude diseases

The Chulec Hospital was established in 1921 by the Cerro de Pasco Copper Corporation to provide medical assistance to the corporation's workers, staff members and families, a population of around 70,000. Located in the mining town of La Oroya (3,782 meters above sea level), the Chulec was the central hospital for the corporation, with two satellite hospitals in the surrounding area, the Esperanza Hospital in Cerro de Pasco and the Puquiococha Hospital in Morococha. The hospital was established with three American doctors and a staff of American and Peruvian nurses. By 1950, the number of doctors had increased to sixteen. Especially noticeable was the increase in the number of beds: from 48 in 1921 to 155 in 1958. (Ganoza,

1958). The construction and further development of the hospital partly responded to the rapid expansion of the Corporation, the need to attract a labor force from neighboring peasant communities and a way of improving the reputation of these mining districts. In addition to providing medical assistance, the Chulec Hospital also became a center of medical training, particularly for nurses and medical students from Lima interested in high altitude related disorders, and a center for the promotion of sanitary education in the central Andes, mostly in areas related to infant care, tuberculosis, and sexually transmitted diseases.

A central figure in the history of this hospital was Chief Surgeon Harold Crane. A graduate from the University of Michigan, Crane arrived to Peru in 1920, hired by the Cerro de Pasco Corporation. Although he found Cerro de Pasco to be an extremely violent city, with high levels of alcoholism and prostitution, he remained as Chief Surgeon of the corporation for thirty years until his retirement in 1950. During this time he constantly pushed for the modernization of the hospital and became an internationally recognized expert in mountain sickness. He also became a close friend and regular correspondent of Carlos Monge and other leading American and European altitude physiologists, who visited and took advantage of the facilities at the hospital. Crane himself made important observations in the field.

This was the case with high altitude pulmonary edema (HAPE). Crane gave a very early description of this new form of mountain sickness, later recognized as a distinct disease. In 1927 he wrote an article in which he referred to some patients who combined some of the common symptoms of mountain sickness with cough, sputum containing blood and congestion in the lungs. He also observed how quickly patients recovered upon descending to sea level. (Crane, 1927). Ten years later the Peruvian physiologist Alberto Hurtado (1901-1983) described this new malady in a book entitled *Physiological and Pathological Aspects of Life at High Altitudes* (1937). "There is undoubtedly a type of mountain sickness which is quite rare and infrequent and

is characterized by the presence of intense congestion and edema of the lung.” (Hurtado, 1937; West, 1989). Hurtado presented the case of a 58-year-old man "of indigenous race" who developed high altitude pulmonary edema after returning to the highlands from a three day stay in Lima. Hurtado described the case as follows: “When he reached the altitude of Casapalca (13,600 feet) he felt a strong discomfort principally on coughing, and noted that his sputum contained a large amount of black blood. Soon there were added to his symptoms headache, intense dyspnea and some mental dis-coordination. [A chest radiograph taken the day after] showed evidence of reduced transparency of the lungs.” (Hurtado, 1937; West, 1989).

In the following years several other cases of high altitude pulmonary edema were reported in the Chulec Hospital. As historian John West has noted, in 1954 Leoncio Lizarraga, a native from the high Andes and medical resident in Chulec, wrote the first dissertation devoted to high altitude pulmonary edema, entitled *Mountain Sickness: Acute Pulmonary Edema* (West, 1989). In this study Lizarraga stated that pulmonary edema of high altitude may occur either in acclimatized dwellers returning to a high altitude after a stay at sea level or in lowland individuals during their first ascent. It was portrayed as a serious condition that could lead to death. The symptoms were relieved by oxygen administration or by descending to sea level. To Lizarraga, a unique expertise was required in order to properly practice medicine in high altitude regions, given the distinctiveness of the medical problems confronted in this environment. Hence, medical practices, therapeutics and surgical procedures had to be adjusted to the conditions imposed by hypoxia. Most important, physicians had to be able to identify promptly the symptoms of the most recurrent high altitude diseases, and be able to distinguish them from common respiratory and circulatory problems, since patients with chronic mountain sickness or high altitude pulmonary edema were exposed to permanent disability or death if they did not descend to sea level in time. "Climatic aggression of altitude has created a human race that offers

biologic characteristics different from those of the man of sea level,” Lizarraga wrote. “High altitudes confront us with new and ignored clinical pictures.” (Lizarraga, 1954).

It was also in the mining compounds of Cerro de Pasco during the 1950s that important epidemiological findings on the extent of chronic mountain sickness were produced by Carlos Monge’s son, Carlos Monge Casinelli, who had trained in John Hopkins University. The common view at that time was that chronic mountain sickness only affected a few individuals who had lost their acclimatization to high altitudes. However, Monge Casinelli’s studies demonstrated that chronic mountain sickness affected around 15% of the population of Cerro de Pasco. He also found that “most of the population” was suffering from at least some of the symptoms associated with chronic mountain sickness and that this disease became more common as the elevation increased. In 1966 Monge Cassinelli argued that “chronic mountain sickness may not be an isolated clinical picture but rather one affecting a considerable portion of the high altitude population.” Furthermore, Monge Cassinelli argued that chronic mountain sickness was a natural concomitant of permanent stays at high altitudes and increasing age. He also noted an extensive number of native adults with clubbed or drumstick fingers and cyanosis. Clubbed fingers, which demonstrated that the oxygen supply was failing at some point, represented not an exemption of some individuals but a constitutional characteristic of the adult population of Cerro de Pasco. (Monge Casinelli, 1966).

Monge Cassinelli attributed the extent of chronic mountain sickness to the effects of rapid industrialization, urbanization and migration from moderate to high altitudes, encouraged by the development of the mining industry. According to Monge Casinelli these movements had multiplied the extent of altitude-related disorders. This process of ‘re-population of the Andes’ was accompanied as well by several modifications in the habits of the native population that negatively influenced altitude adaptation, such as increased smoking rates, impoverished living

conditions, sedentary habits, and modifications in the traditional diets, among others (Monge Casinelli, 1966). Monge Casinelli, however, never went so far as to consider chronic mountain sickness or high altitude pulmonary edema as industrial diseases or diseases of urbanization. These ailments were "climatic diseases" aggravated by the exposure to new living and working conditions.

In certain instances the notion that altitude impinged upon particular health conditions also informed sanitary legislation, as was the case with silicosis. Today, silicosis, a type of pneumoconiosis, is a well-known occupational disease, characterized as a chronic respiratory disorder caused by inhalation of dust containing free silica. It is an incurable and irreversible lung disease that progresses even when exposure stops. While practicing in the mines of the Cerro de Pasco Corporation between 1928 and 1931, physiologist Alberto Hurtado noticed that silicosis developed in a much shorter time than at sea level and claimed that clinicians and health authorities had to take into account the special conditions imposed by altitude (Guerra García 2000). In a letter he sent in 1936 to Harold Crane, Hurtado wrote: "To establish the diagnosis of pneumoconiosis in suspected cases requires a thorough study from the clinical, radiological and laboratory points of view. The fact that these cases occur at high altitude demands an entirely new work." Altitude not only accelerated the process of pneumoconiosis but also impinged unique particularities in the development of the disease.²

Hurtado's work in Pasco was interrupted in 1931 when he received a grant from the Rockefeller Foundation to perform postdoctoral studies in the University of Rochester in respiratory physiology. When he returned to Lima three years later, he was granted the newly created chair of physiopathology at San Marcos University and appointed director of sections 3 and 4 of the most important health centre in Lima, the Arzobispo Loayza Hospital. At the same

² Letter from Alberto Hurtado to Harold Crane, La Oroya, April 1, 1936. RF, RG 1.1, Series 331, Box 1, Folder 5.

time he continued working as a consultant for the Cerro de Pasco Corporation in cases of pneumoconiosis (Cueto, 1989). Hurtado took advantage of the research facilities provided by the Loayza Hospital in Lima and the Chulec Hospital in La Oroya, and was able to observe patients from Lima and the high Andes and thus compare disease evolution when occurring at sea level or at high altitudes.

In 1936, in a letter to Alan Gregg, an RF official, Hurtado reported that: “the Cerro de Pasco Copper Corporation has installed an excellent laboratory for the study of industrial diseases, particularly pneumoconiosis, and the physiological and pathological aspects of life at high altitudes. The laboratory contains all the necessary material to make hematological, circulatory and respiratory studies, as well as other investigations that are fundamental from the point of view of altitude. As you know this company has thousands of men working at high altitudes and the conditions for work are splendid.”³

It is interesting to notice the constant support the Cerro de Pasco Copper Corporation gave to medical research. According to Marcos Cueto, this support responded to the conviction the Pasco Corporation officials had that mining companies would also benefit from this research. (Cueto, 1989). This was also a way of improving the corporation’s public image in a social and political context increasingly adverse to the presence of American-owned companies in Latin America. The influence of the Rockefeller Foundation was also instrumental in this process. In a series of letters written in the 1930s physiologist Alberto Hurtado acknowledges the positive influence the RF had in convincing the managers of the Cerro de Pasco Corporation of the need to support medical and scientific high altitude research.⁴

³ Alberto Hurtado to Alan Gregg. Oroya, March 8, 1936. RF, RG 1.1, Series 331, Box 1, Folder 5. "Health and Sickness at High-Altitudes", RF, RG 1.1, Series 331, Box 1, Folder 8.

⁴ Alberto Hurtado to Alan Gregg. Oroya, March 8, 1936. RF, RG 1.1, Series 331, Box 1, Folder 5. Hurtado to Ross, May 2, 1949. RF, RG 1.1, Series 331, Box 1, Folder 5.

In his travels through the mining districts of the high Andes as medical consultant for the Pasco Corporation, Hurtado became aware of the extent of silicosis. He also recognized the rapidity with which silicosis developed in combination with altitude exposure. Hurtado became acquainted with statistics from South Africa and Canada that showed that the disease developed after about fifteen or twenty years of exposure to the particles of silica dust. He stated that this statistic did not apply in the mines of the high Andes, since altitude created a "special effect" (Hurtado, 1944). In Peru most mines were located thousands of meters above sea level and any physical activity required increased pulmonary ventilation; thus, in any given space of time, a greater amount of dust particles penetrated the lungs of a high altitude mine worker, compared to a miner at sea level in identical conditions. In addition, Hurtado found that the anatomy of high altitude residents, particularly their peculiar respiratory system, also influenced the rapid development of the disease. Silicosis also favored the appearance of tuberculosis and most important, impaired the possibilities of high altitude adaptation, since the lesions produced in different respiratory organs were irreversible. Silicosis was a disease known to cause respiratory insufficiency at sea level, thus its effects at high altitudes were notably more serious.⁵

In 1939 Alberto Hurtado was named General Health Director of the Ministry of Health, almost a vice-minister. A year later he visited the mining camps of Cerro de Pasco to investigate health conditions in the mines and wrote a report based on the mining company's medical records. Hurtado's 1940 report had two important consequences. Mining companies were forced

⁵ To Hurtado the study of pneumoconiosis at high altitude also had a scientific value for the better understanding of human physiology. In 1942 he wrote: "Industrial problems at high-altitudes may also be exploited from the physiological point of view. For instance, a lead anemia and silicosis can have peculiar aspects due to the fact that their altering corresponding alterations are coexistent with a certain degree of anorexia and their study adds to the understanding of the effects of oxygen deficiency upon the organism." Letter from Alberto Hurtado to Dr. H.M. Miller, Assistant Director, the Natural Sciences, Rockefeller Foundation. January 27, 1942. RF, RG 1.1, Series 331, Box 1, Folder 6. "A Physiological Study in the Peruvian Andes", RF, RG 1.1, Series 331, Box 2, Folder 14.

to perform periodic medical tests in order to detect the presence of pneumoconiosis and, if the case demanded it, to grant compensation to the worker. Mining constituted one of the main economic sectors of the country, and to public health officers pneumoconiosis was as much a hazard for the miner's health as a menace for the economic development of the country. Hurtado also persuaded the government to create a Department of Industrial Hygiene within the Ministry of Health in order to address occupational health problems in the high Andes.⁶

In this study I have highlighted the relation between the rise of the mining districts of the high Andes in the first half of the twentieth century and the emergence of high altitude related disorders. This relation was produced at two levels. The expansion of the mining compounds of the central high Andes encouraged important migratory movements from moderate to extreme altitudes and the assimilation of entire peasant communities as the work force in the mines. In addition to their transformation from peasants to miners, Andean workers had to confront extremely poor living and working conditions, inadequate water supply, high levels of atmospheric pollution, and rapid changes in their traditional lifestyles and diet, with significant consequences for their health. At the same time, the establishment of modern hospitals in these mining districts provided medical researchers with hundreds of patients, laboratories and the most sophisticated medical technology in an otherwise very inhospitable setting for medical research. Most important, it was within this context that previously unknown high altitude diseases such as chronic mountains sickness and high altitude pulmonary edema became visible.

⁶ Hurtado did fear that his work in the Ministry of Health had damaged his relationship with the Pasco Corporation. In 1949 he wrote: "The economic situation of the University is almost disastrous and my efforts to get a fair and decent pay in Pan American Grace Airways have not been successful. After a very thorough consideration I am thinking in the possibility of doing some work for them. You know of my long controversy with the Cerro de Pasco Copper Corporation in regards to the medical care of their workmen. For this reason I did not talk personally to Mr. Russell [Director of the Corporation]. I am writing to you, knowing your close friendship with Mr. Russell. Will you be willing to make a preliminary inquiry with him? I am 47 years old, healthy and quite adapted to high altitudes". Hurtado to Ross, May 2, 1949. RF, RG 1.1, Series 331, Box 1, Folder 6.

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