The Journal of Latin American and Caribbean Anthropology

The Birth of the Mineral Species "Aguilarite" and What Came Next: A Twice-Told Tale

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Resumen

Este artículo explora la emergencia del mineral 'aguilarita' descubierta por Ponciano Aguilar en Guanajuato, México, a principios de los años 1890. Por sí misma, la aguilarita no es especialmente importante—es un mineral oscuro y opaco que no tiene un uso económico y posee un moderado interés para los coleccionistas y mineralogistas. Sin embargo, las circunstancias de su descubrimiento y designación posterior se prestan a dos modos de análisis y tipos de conocimiento: uno proviene del trabajo de Bruno Latour y otros en el campo conocido como la Teoría del Actor-Red, y el otro está influenciado por la economía política en la antropología, con particular énfasis en los estudios sobre la cadenas de mercancías. En este artículo, utilizo el nacimiento de la aguilarita para analizar algunas de las formas de cómo estos enfoques tratan la relación entre los objetos y las personas, y las consecuencias de ello. ¿Qué revelan y qué esconden estas dos formas de contar la historia de la aguilarita? ¿Cómo pueden trabajar juntas? [antropología social, México, teoría]

Abstract

This article explores the emergence of the mineral species aguilarite, discovered by Ponciano Aguilar in Guanajuato, Mexico, in the early 1890s. In itself, aguilarite is not particularly significant—it is a dark, somewhat dull mineral that has no economic use and only moderate interest for collectors or mineralogists. However, the circumstances of its discovery, naming, and subsequent life lend themselves to two modes of analysis and types of insight—one coming out of the work of Bruno Latour and others in the field, known as "Actor Network Theory" (ANT), and the other influenced by political economy in anthropology, with particular emphasis on "commodity-chain studies." This work examines aguilarite's birth to look at some of the ways these two approaches treat the relationship between things and people, and the consequences of those treatments. What do these two ways of telling aguilarite's story reveal and conceal? How might they work together? [Mexico, social anthropology, theory]

The Journal of Latin American and Caribbean Anthropology, Vol. 18, No. 3, pp. 376–394. ISSN 1935-4932, online ISSN 1935-4940.
 DOI: 10.1111/jlca.12037

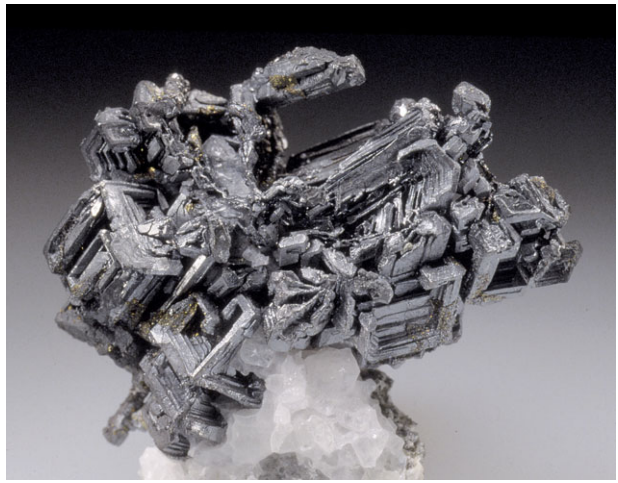

Figure 1 *Aguilarite, Ag_4SeS (photo by Wendell Wilson, reprinted by permission).*

In 1890, Ponciano Aguilar, a mining engineer, mineralogist, and mineral collector was working as the superintendent of the San Carlos silver mine in the central Mexican mining city of Guanajuato. This mine was especially rich in minerals composed of silver, in some cases with other metals, bonded to sulfur.[1] William Niven, a field collector for the Philadelphia-based mineral dealer George L. English, came to Guanajuato and met Aguilar, who provided him with a few specimens (Wilson 2006). They apparently discussed whether the specimens represented a new mineral species (i.e., one not yet formally described or named). Upon his return to the United States, Niven gave the specimens to Dr. Frederick Genth, a Philadelphia chemist. Genth in turn sent the specimens to Frank Penfield, whose analysis showed that in addition to silver and selenium, the specimens contained sulfur, distinguishing them from both acanthite (Ag_2S) and naumannite (Ag_2S e). On account of this, Genth identified it as "a new species, which has been named Aguilarite in honor of its discoverer" (Genth 1891:401).[2] Its chemical formula was identified as Ag_4SeS (see Figure 1).

On February 14, 1891, Niven wrote to Aguilar (see Figure 2), saying,

> Dear friend—I have much pleasure to inform you that the silver selenide has been analyzed by professor Genth and found to be a new mineral, which is named "aguilarite" as recommended by me. It is a most interesting species and I sincerely congratulate you. Yours very cordially, Wm. Niven. (Archivo Histórico de la Universidad de Guanajuato, Fondo Familia Ponciano Aguilar, Box 98)

We witness here the emergence of a new kind of object—one that formerly did not exist as such—the mineral aguilarite. This article explores what happened once this new mineral species came into being. In itself, aguilarite is not particularly important—it is a dark, somewhat dull mineral that has no economic use and only moderate interest for collectors or mineralogists. However, the circumstances of its discovery, naming, and subsequent life lend themselves to two modes of analysis and types of insight—one coming out of the

Figure 2 *Ponciano Aguilar in his study (Archivo Histórico de la Universidad de Guanajuato, Fondo Familia Ponciano Aguilar).*

work of Bruno Latour and others in the field known as "Actor Network Theory" (ANT) and the other influenced by the genre of political economy in anthropology, with particular emphasis on "commodity chain studies." In this article, I use aguilarite's birth to look at some of the ways these two approaches treat the relationship between things and people, and the consequences of those treatments. What do these two ways of telling aguilarite's story reveal and conceal?

This article is not only about ANT and commodity chains, but also about mineralogy and mineral collecting in 19th- and 20th-century Mexico and the United States. In touching on these topics, it aims to contribute to the emerging field of "postcolonial technoscience," which in the words of Warwick Anderson seeks to

> understand the ways in which technoscience is implicated in the postcolonial provincializing of 'universal' reason, the description of 'alternative modernities,' and the recognition of hybridities, borderlands and inbetween conditions. (Anderson 2002:643)

Recent work on technoscience in Latin America, for example, has focused on health (Biehl 2009; Cueto 2007), bioprospecting (Hayden 2003; Soto Laveaga 2009), human–nature interactions in the formation of a region (Raffles 2002), and space programs (Redfield 2000).

These works have opened up new questions and discussions about how science and technology, formerly claimed as universal knowledge, are particularized in colonial and postcolonial projects. For instance, Anderson's own research, on the prion disease Kuru, identified interlocking gift exchange cycles between Melanesians and Americans on the one hand and among scientists back in the United States on the other. By looking at the exchange of tissue through the lens of gift exchange, Anderson treats biomedicine as symmetrical to the

Melanesian exchanges more usually subjected to such analysis. He thereby particularizes the practices of medical research in the mid–20th-century United States (2005). Celia Lowe's study of biodiversity in Indonesia explores the ways that Indonesian scientists made "a particular way of understanding the 'human' that contributed not only to the transnational problematization of environmental risk known as biodiversity, but also to a domestic project of building the Indonesian nation-state" (Lowe 2006:14). Conservation biology in the late 20th century, like mineralogy of the 19th century, cannot be simply read as the spread of universal science from metropole to periphery.

Yet, where the Indonesian scientists studied by Lowe saw themselves in great part as provincializing "European" science, the Mexican scientists had no such aim. Taking into account the particularities of how aguilarite was discovered, and what came next, means recognizing that Aguilar and his Mexican contemporaries were committed to the idea of universal knowledge, as defined in a late 19th century Mexican–European tradition in Mexico. Aguilarite's story is thus not so much about how attention to the postcolonial context provincializes the presumed universality of technoscience, as is foregrounded in many of these studies. Rather, it shows how the particular (in the form of chunks of silver bonded to selenium and/or silver in the San Carlos mine) comes to take part in the universal (the Dana System of mineral classification and all its attendant apparatuses) at a given historical moment (late 19th-century Mexico), and how Aguilar and his colleagues used these particular bits of rock to constitute universal knowledge, not provincialize it. The particularities of aguilarite thus include its engagement with the universal.

A Twice-Told Tale

Neither ANT nor commodity chain studies within political economy can readily be characterized as "schools" or "theories."[3] They are more like clusters of works in conversation, approaches, or even "genres" that share certain premises, methodologies, and objects of interest. My aim in this article is not to decide which approach works better in this or any other case, but to examine what is revealed and concealed by the ways each might "tell the story" of aguilarite's naming and later life.

Rather like the experimental feminist ethnography *A Thrice-told Tale* (Wolf 1992), which inspired this article's subtitle, this article tells the same story twice in different genres. However, where Wolf was attempting to combine the insights of "postmodern" destabilizations of ethnographic authority (Clifford and Marcus 1986; Rabinow 1985) and feminist positionality (Mascia-Lees et al. 1989; Wolf 1992), this article attempts something a bit different. Instead, I draw on a strategy of juxtaposition suggested by Annemarie Mol's ethnography *The Body Multiple: Ontology in Medical Practice* (2002) to anchor my analysis of aguilarite's discovery.

Wolf's book is an experimental reflection on ethnographic authority situated at the boundary between feminist and postmodern anthropology. To examine the political and ethical implications of ethnography, Wolf employs a strategy of juxtaposition. She tells the same events thrice: as short story; ethnographic fieldnotes; and polished anthropological article. She does so in an attempt to steer a middle ground between, as she says, the assertion that "ethnographic research is but another form of white domination" (Wolf 1992:5) and

a traditional understanding of anthropology as objective science and ethnographic as a neutral "writing up" of the facts. Juxtaposition here emphasizes positionality, perspective, and the lack of a single objective truth.

Mol's book *The Body Multiple: Ontology in Medical Practice* (2002) does not undertake a project of revealing different perspectives, or of destabilizing representational authority. Mol states, "The move . . . is away from epistemology [which] . . . asks whether representations of reality are accurate" (Mol 2002:vii). Rather, Mol is interested in ontology—in what kind of thing (in her case, the body) is enacted through multiple practices. She does this, in part, through the juxtaposition of parallel accounts of the disease atherosclerosis. Reminiscent of Nabokov's *Pale Fire* (1962), the pages of Mol's text are divided in half: the top half concerns her fieldwork, while the bottom half enters into conversation with varied scholarly literature on, for instance, ontology and technoscience. The structure of Mol's text thus mirrors her argument, which addresses the body as an "intricately coordinated group" (Mol 2002:viii) of objects enacted in different medical practices (medical examinations, tests of different sorts, views through a microscope, e.g.).[4] This kind of juxtaposition is perhaps particularly helpful to my argument about aguilarite. Juxtaposition proves useful here, because it shows how the different genres analyzed might also be seen as technologies for knowing that, such as a microscope or a GPS device, produce knowledge in practice rather than an essential a priori knowledge.

Descriptive Mineralogy in 19th-century Mexico and the United States

The word *mineral*, imported from the Celtic, entered Latin in the 12th century, and was used to designate metallic ores in contrast to *lapis*, which referred to rocks and silicates. The first use of the word *mineralogy* came in 1690, in Robert Boyle's essay "A Previous Hydrostatical Way of Estimating Ores." However, the first forays into scientific examination of the physical, chemical, and crystallographic properties of inorganic matter came in the late 18th century, with the work of Lavoisier and his students in chemistry, and that of René Just Haüy in crystallography (Greene and Burke 1978:5; Wilson 1994). In the last two decades of the century, the study of minerals was to be found in the state-sponsored schools of mines that had been established over the previous century in Europe. These included the Mining Academy at Selmecbanya in Hungary, and the Bergakademie at Freiberg in Saxony, where Abraham Gottlob Werner served on the faculty from 1775 until 1817.

In their comprehensive article on early mineralogy in the United States, John C. Greene and John G. Burke write,

> The influence of these schools [the mining schools of continental Europe] on the development of mineralogical science can scarcely be exaggerated . . . Their combined practical and theoretical curricula produced graduates who made important contributions both to mining technology and metallurgical practices and to the sciences of geology, mineralogy, and crystallography. (Greene and Burke 1978:7)

This model of a state-sponsored school of mines was continued in New Spain with the founding of the Real Seminario de Minería in Mexico City on January 1, 1792 (Uribe and Cortes Zavala 2006:493–494). The school, the first of its kind in the New World, was

founded as part of the Spanish crown's efforts to revitalize and modernize mining in its colonial possessions, especially in New Spain. The Real Seminario's first director, Fausto de Elyuhar (discoverer, along with his brother Juan José, of the element tungsten), had studied at the Mining Academy at Selmecbanya. He recognized that the mining industry suffered from a lack of knowledge of the geology and mineralogy of the region as well as a paucity of technological expertise (Uribe Salas and Cortes Zavala 2006:494). The Real Seminario, which became the Colegio de Minería upon Mexico's independence from Spain, trained generations of scientists and engineers who populated schools of mines and government agencies all over the country (Uribe Salas 2006). Accordingly, in 1795, the school inaugurated the first course in mineralogy in the Americas, to be taught by the Spaniard Andrés Manuel del Río. Del Río was a Spanish mineralogist who had trained at the Escuela de Minas in Almadén, Spain, the École Royale de Mines in Paris, and the Bergakademie in Freiberg, Saxony. One of his fellow students at Freiberg, who would later visit and collaborate with him in New Spain, was Alexander von Humboldt (Ramírez 1891; Uribe 2006:239).

The science of mineralogy and earth sciences generally developed more slowly in the new United States because of a lack of state subsidies for mining and earth science. However, in the second quarter of the 19th century, U.S. mineralogists did begin to consolidate the field of descriptive mineralogy, which was focused on the classification of minerals, their properties, and uses. Most notably, in 1837, J. D. Dana, professor of geology at Yale, published *System of Mineralogy*, which described the 352 species known at the time, borrowing from biology and botany the concept of *species* and a basic system of classification (Dana 1837; Gray 2002). It was not until the fourth edition (1854) that Dana devised the system based on the chemical composition of minerals that, with some modifications, is used today (Gray 2002). The procedures for establishing new mineral species emerged out of the Dana System and form part of what Lorraine Daston has termed the "mid–nineteenth-century movement to combat synonymy [the proliferation of names for a single species]" (2004:156); although in mineralogy the ultimate codification of mineral naming protocol did not take place till 1959, the procedures for deciding if a new mineral had been discovered remained roughly the same from the 19th century onward.

The Commission on New Minerals and New Mineral Names (CNMNMN) is the international committee authorized to confirm the discovery and baptism of new minerals. The CNMNMN defines *mineral species* in the following terms:

> A mineral substance is a naturally occurring solid that has been formed by geological processes, either on earth or in extraterrestrial bodies . . . A mineral species is a mineral substance with well-defined chemical composition and crystallographic properties, and which merits a unique name. (Nickel and Grice 1998:913)

While the CNMNMN was formed in 1959, the definition it presents here follows the standard scientific practice that prevailed in the late 19th century, when aguilarite was discovered; aguilarite, like many (but not all) minerals identified prior to 1959, was "grandfathered in" or accepted ex post facto by the Commission. This definition conforms, more or less, to the criteria followed by Genth. In order for aguilarite to "merit a unique name" then, it had to be different from others, with either a chemical composition or a crystal structure (or both) distinct from those of all other known minerals (Dunn 1977).

ANT

The approach known as ANT emerged from the work of Bruno Latour, Michel Callon, John Law, and others in the early 1980s. ANT focuses on the ways in which heterogenous and multiple actors (sometimes described as actants) come together to form associations or assemblages. Especially stable associations achieve the status of actor networks, which then motivate new actors and associations. ANT tends to proceed by example, including John Law's description of the Portuguese maritime expansion, Michel Callon's account of the failed attempt to introduce the electric vehicle, and Bruno Latour's study of the Pasteurization of France (Callon 1986b; Latour 1988; Law 1987). Each of these studies aims to tell a nonreductive story of what happens when actors of ontologically different status convene in assemblages or networks.

Most ANT-influenced analyses do not "limit in advance the shape, size, heterogeneity, and combination of associations" (Latour 2005:11) through the assumption of an a priori stable domain of society. As part of this effort, ANT adherents make a metaphysical claim of "generalized symmetry" between human and nonhuman actors (Callon 1986a; Latour 1988). In doing so, ANT accounts depart from the European philosophical tradition of seeing objects primarily as social relations in material form (Latour 1993).[5]

At stake in this project of generalized symmetry between humans and nonhumans is a disruption of the assumed separation between "nature" and "society" and the attempt to establish each as occupying a position of metaphysical priority over the other. Latour (1993) locates these premises in what he calls the "Modern Constitution," in which both "nature" and "society" are presumed to be metaphysically prior to the world as we apprehend it, and also presumed to be ontologically irreducible to each other. The solution to this "tug-of-war," Latour writes, is to acknowledge that "Nature 'out there' and Society 'up there' are no longer ontologically different. We do not make Society, more than we do Nature, and their opposition is no longer necessary" (Latour 1992:10).

The strategies of ANT are methodological as well as metaphysical, or, rather, its metaphysics entails a particular methodology. In keeping with a resolute stance against the "social" as a distinct and privileged domain of analysis, ANT scholars aim to treat human and nonhuman actors and actions as parallel, rather than privileging humans as the only relevant actors. Additionally, those using an ANT approach typically avoid reference to explanatory context, macrolevel analysis, or privileged group categories (such as gender or class, for instance) as prior tools for understanding a given assemblage of actors. Such an approach does not see the object of analysis as being to discern what a given situation is an example of—for example, neoliberalism, upward mobility, or the modern world system (Callon 1986a). In this sense, an ANT account does not seek to take networks of humans and nonhumans as examples of some prior state of affairs known as "society" or "the social," but simply to follow, resolutely, the formation of these networks.

In an actor network genre, then, we might begin by looking at the interaction of the different elements in combination—in this case, silver, selenium, and sulfur. Implied in the brief story I told at the beginning of this article is the fact that aguilarite appears as a middle term in the "acanthite-naumannite series" (Francis et al. 1999), a spectrum from Ag_2S to Ag_2Se. The boundaries between these three different species (egacanthite, aguilarite, and naumannite) are not completely distinct; instead, there is a "compositional range" (Petruk

and Owens 1974). Thus, some specimens denoted as acanthite contain small amounts of selenium, and some specimens denoted as naumannite contain small amounts of sulfur. Within the compositional range of aguilarite, sulfur and selenium are roughly equal. While in many cases the middle term of a binary solid solution series (a series of minerals where one element completely replaces another at the two end points of the series, as with sulfur and selenium here) is not recognized as a separate mineral, the X-ray powder pattern of aguilarite reveals a sufficiently different structure to qualify it as a separate mineral species (Earley 1950:244–245). Over the course of the series, however, selenium completely replaces sulfur. So, the existence of the three species and their interaction depends on the substitutability, in chemical terms, of selenium for sulfur. This property of the series helps to bring the species into being and to make the distinction between them meaningful.

Now we can step back to look at the interaction of the different species as part of a stratified geological profile. The substitution of selenium for sulfur in the acanthite–aguilarite–naumannite series in the Guanajuato mining district can be correlated with the sequence of the district's three major geologic formations. At the lowest level, dating from the Mesozoic period, only acanthite appears; aguilarite can be found beginning in the second layer of red conglomerate, approximately 13 hundred meters thick and dating from the Eocene period (it is known as the Guanajuato formation); aguilarite continues, accompanied increasingly by naumannite, through a layer of volcanic rock laid on top of the Guanajuato formation. This paragenesis speaks to the earlier presence of sulfur (prior to 67 million years ago) and the later entrance of selenium (56 million years ago or less; Francis et al. 1999; Vassallo 1988). The geologic time frame for this part of aguilarite's story is, of course, huge, but we can infer a slowly unfolding movement from acanthite to aguilarite and then to naumannite over the course of millions of years. These conditions bring actors such as acanthite, aguilarite, and naumannite together in certain particular assemblages or networks.

For instance, the fact that aguilarite occurs in the intermediate Guanajuato formation, which is also where there is the highest concentration of silver ore, brought the rocks that came to be called aguilarite into contact with the miners who extracted them and sold them to Aguilar. A variety of technological actors, then, had to come into play, in the form of picks, hammers, and chisels and other tools for mining of the late 19th century, as well as the stagecoaches and railroad trains that brought Niven to Guanajuato and the laboratory equipment in Chicago that Penfield used to identify the mineral. Each of these actors had their own exigencies and material agencies (Pickering 1995) that went into the constitution of the actor network resulting in aguilarite's "discovery." Following John Law, we could usefully describe aguilarite as the result of "heterogeneous engineering in which systems containing both the social and the technological are constructed in a context of conflict with other actors, both natural and social"[6] (1987:231). Thus, a new kind of scientifically significant object—the mineral species aguilarite—emerged at the crux of a new set of associations. Once this happened, aguilarite became an actor in its own right, in the sense that it could now do things. What kind of things did aguilarite do? What sort of actor network was created through the process of its discovery?

First, it engaged Aguilar in new or altered relationships with scientists and collectors. For instance, a year after notifying Aguilar of the new mineral's baptism as aguilarite, Niven wrote again, on February 8, 1892, this time sending a specimen from his own explorations:

> I send you herewith a specimen of the new rose garnet which I have been working since I saw you last. I would like to hear from you. Have you found any more aguilarite? I would like a nice specimen for my private collection. I will give you more particulars of the prospects of this country when I hear from you. Yours sincerely, Guillermo Niven. Wm. Niven
>
> (Archivo Histórico de la Universidad de Guanajuato, Fondo Familia Ponciano Aguilar, Box 98)

Similarly, Pedro Monroy, one of the top mining engineers in Mexico, wrote to "congratulate on the honor of which you have been the object," and to request a sample. The fact that aguilarite now existed as a new mineral made it a desired object for collectors, particularly those who specialized in minerals from Mexico. The fact that Aguilar was not only in control of the only known source of aguilarite, but also that it had been named for him, engaged him in new transactions and communications in Mexico and abroad.

Aguilarite also enlarged the category of "Mexican minerals," thus making Mexico more significant in the field of descriptive mineralogy as a whole. To understand why this is, we need to know more about *type localities*. In mineralogy, type locality refers to where a new mineral species was first discovered. Once aguilarite was elevated to the status of mineral species, distinct from acanthite and naumannite, it also made the San Carlos mine in the La Luz mining district into the type locality for that species. As of now, there are approximately 65 type species for Mexico (for which the first or "type" specimen described came from Mexico). Collections that emphasize a particular country or area—such as Mexico—may commit their owners or curators to collecting an example of as many specimens from that country or area as possible. The most prestigious collections can go one step further and seek the *type specimens* (a particular specimen from among those used to describe the new mineral) from particular localities and areas.

As with many scientific objects, the existence of aguilarite as a new mineral species led to new scientific research. A series of studies mapping the presence of selenium at different levels of the Guanajuato mining district, as well as the identification of a number of other silver minerals with selenium content, began with the identification of aguilarite in 1891 (Earley 1950;Petruk and Owens 1974; Vassalo and Reyes-Salas 2007). An article from the journal *Canadian Mineralogist* begins

> The relationships between acanthite, aguilarite and naumannite were investigated by studying acanthite and aguilarite in an ore suite from Guanajuato, Mexico, naumannite, aguilarite, and acanthite in a sample from Silver City, Idaho, and a synthetic naumannite. (Petruk and Owens 1974:365).

The exchanges that made those Mexican and U.S. samples available for study were not especially interesting to the authors or, probably, to most of their readers. Nevertheless, they had to take place: someone had to write, call, or visit Guanajuato, and the samples had to be brought or sent back. Scientists had to talk to each other, and probably also to technicians, secretaries, shipping services, and customs officials, on both sides of the border. These interactions took place because the relationships between acanthite, aguilarite, and naumannite were seen as sufficiently interesting to merit study. If aguilarite had never been

distinguished from acanthite and naumannite, these networks of people and objects would never have been created, at least not in this particular way.

Aguilarite continues to contribute to the production of new actor worlds within mineral collecting. Once the correlation between the depth of mineral deposits in the Guanajuato district and the ratio of selenium to sulfur was firmly established, new forms of knowledge production could occur. For instance, in their presentation on silver mineralogy for the Annual FM-TGMS-MSA Mineralogical Symposium, later published in the collectors' magazine *Mineralogical Record*, Francis and colleagues report on microprobe analyses of 31 specimens; they confirm,

> the Se/S ratio is indeed diagnostic for determining the proximity to the [uppermost] Tertiary volcanic unit. The only specimen of naumannite investigated was from the uppermost level of the San Carlos mine, while the large, lustrous Rayas mine acanthites (with nearly zero selenium) are from the deepest levels of that mine. (Francis et al. 1999:85)

The word "diagnostic" is critical here; the authors go on to recommend a topographic mapping of the mineralogical distribution in the district, in order to supply more accurate locality data to "the large number of specimens that have the simple, but unfortunately unspecific, label 'Guanajuato, Mexico'" (Francis et al. 1999:85). The ratio of selenium to sulfur, which came to be known through the process of naming aguilarite and then differentiating it from its neighbors, could help establish particular specimens through new actor networks composed of particular specimens, locality data, collectors, and collections, for example.

In this sense aguilarite, as an assemblage of actors that included silver, selenium, and sulfur, as well as Niven and Aguilar, exerted pressure in the formation of other assemblages such as mineral collections and Guanajuato as a mineral locality. To draw on another Latourian concept (Hayden 2003; Latour 1987), the interests of a whole slew of actors—most but not all human—became enrolled in the formation of this new actor network and helped to confer stability upon it. This process included Aguilar's interest in being recognized as a scholar of international standing, Genth's concern to publish the description of a new mineral, Niven's inclination to obtain valuable and interesting specimens, the collectors' wish to obtain aguilarite from "the source" (Aguilar), and selenium and sulfur's chemical requirement to bond to silver. The case of aguilarite shows how knowledge is produced at the point where interests converge, although, as some have noted, in an economistic idiom (Haraway 1997; Martin 1995).

By telling the story of aguilarite's emergence as a new actor, I have emphasized the multiplicity and heterogeneity of actors and the intersection of human and material agency.[7] Doing this allows me to bring out the contingent, nonteleological character of aguilarite's birth and to show how that birth in turn leads to the birth of other actors, again in a contingent and unpredictable fashion. Once aguilarite exists in the world, it creates an effect of having always existed, but this is only in retrospect. The actor network genre also helps to underscore the lack of a stable beginning or ending point; we have to begin and end the story somewhere, but only while also recognizing that there is in fact no stable point from which to view the ongoing formation and dissolution of actor networks.

Telling the story in this way also resolutely refuses to place some actors in the foreground and others in the background, as "context." It avoids the premise that some social actions (the discovery of aguilarite) can be taken as examples or effects of other social actions occurring at a broader scale (the world-system, the geopolitics of scientific knowledge). These strategies, on the other hand, are central to the genre of commodity-chain studies to which I now turn.

Commodity Chains

My second genre emerges out of the political economy school within anthropology, spearheaded by Eric Wolf and Sidney Mintz, as an anthropological engagement with power and history that had not characterized the discipline until the 1970s. Influenced by Karl Marx, Julian Steward (with whom both conducted dissertation research that was published in the book *The People of Puerto Rico*) and Immanuel Wallerstein, Mintz, and Wolf helped to bring an attention to ways farflung places were linked (and had been linked for a long time) by the movements of capital, labor, and commodities. In *Sweetness and Power*, Mintz's (1985) use of a particular object as the vehicle for and manifestation of social relations helped to form the basis for a new kind of ethnography, the ethnography of a thing.[8]

This new kind of ethnography, particularly when used by those working within a political economy tradition also drew on work in sociology on "commodity chains" seeking to trace relations of commodity exchange, value transfer, and arrangements of power along the chains of production, consumption, and distribution through which commodities pass (Gereffi and Korzeniwiecz 1997; Wallerstein 1976).

Out of these roots (though not always entirely agreeing with Wallerstein or Wolf's somewhat monolithic view of the modern world-system) came a wave of commodity studies, including William Roseberry's work on coffee (1983, 1996), Karen Tranberg Hansen's on secondhand clothing in Zambia (2002), Brenda Chalfin's on shea butter (2004), Deborah Bardnt's on tomatoes (2002), and many others.[9] Through following commodities, these studies aim to show how they are linked in a global system and how that system is constituted through power relations.

In part, they do so by counting on a particular understanding of commodities, treating them primarily as social relations in material form. This does not mean that such accounts completely ignore the materiality of objects. Marx's famous comment, "Hunger is hunger, but the hunger that is satisfied with cooked meat eaten with a fork and knife is a different kind of hunger from the one that devours raw meat with the aid of hands, nails and teeth" (1993 [1858]) refers to the specific form given to the world and to human experience by the materiality of objects.[10]

Studies within this trajectory work from the premise that the movements of capital, commodities, and labor work as capitalism's circulatory system and thus a good way to understand its workings. And since commodities can be understood as both the material form of capital and labor (as part of the dialectic relations of capital and labor), the study of commodities is even more privileged. Through this strategy, such studies construct robust accounts of power and inequality.

But while one finds in these works detailed descriptions of the sensible world, they are mostly deployed as devices for revealing social relations, especially relations of inequality. In this way, commodity studies in this political economy tradition (and I include myself in this group [Ferry 2005]) base their analysis on a strict distinction between the social and natural worlds and certainly between human and nonhuman actors. They tend to approach nonhuman objects primarily as expressions of and conduits for social action and meaning. Though often committed to the idea of reciprocal causation between the material and social world, they do not extend this idea to a principle of symmetry between humans and nonhumans of the sort described by ANT scholars.

Moreover, as we can see in the brief history I have just sketched, political economy starts with certain organizing concepts as follows: the world-system, capitalism, colonialism. Commodity studies within this tradition treat their objects of study as examples of or manifestations of these "social" (including political and economic) systems. They are thus prime candidates for the critiques leveled by ANT scholars against social scientists who assume a stable domain of the social to which objects must refer, and who conceptualize the world in terms of "macro" structures and systems which can be studied through the "micro." As we will see, I hope, in the following account, these premises have a considerable effect on how aguilarite's story gets told, and what, in turn, that story can be made to tell.

A commodity chain account might begin by looking at the context within which aguilarite was first identified. The discovery took place at a moment when U.S. mining companies were just beginning to move aggressively into Mexico. When the United States won the Mexican–American War in 1848, Mexico lost 1.36 million square kilometers, 55 percent of its territory, to the United States, including rich copper and silver lands in Arizona and New Mexico. The acquisition also opened a new possibility of a southern route for the U.S. transcontinental railroad. Over the next few decades, the first transcontinental railroad was built (1869), the United States Geological Survey was founded (1879), the silver (1870s) and copper (1880s) bonanzas of the southwest took place. All of these contributed to massive investment in the earth sciences and the exploration of the mineral resources of the continent.

By the 1890s, the United States began moving south to take over Mexican mines. At the time of aguilarite's discovery, the San Carlos mine was under Mexican ownership, but within eight years, it and nearly all other mines in Guanajuato would be operated by U.S. companies (Meyer Cosio 1999). The expanding railroad system put into place during the period of Porfirio Díaz' presidency facilitated the movement of mining wealth from south to north. U.S. interest in Mexican minerals, both for private and university collections and for scientific research, was also expanding rapidly at this time, and U.S. museums and universities were consolidating power and influence as centers of knowledge production and stewardship.

Aguilarite was discovered and named in the early 1890s, a period characterized by the rapidly expanding movements of U.S. corporate interests, scientists, and collectors into the mining localities of Northern and Central Mexico. At the same time, though the Colegio de Minería had lost much of its resources and prestige in the middle of the century, it had left its mark on scientists and engineers in Mexico City and mining/university centers, such as Guanajuato. Ponciano Aguilar was a child of this tradition.

The son of a tailor, Aguilar was born in 1853 in the city of Guanajuato. He studied Mining Engineering at the Colegio del Estado de Guanajuato. He graduated in 1876 and went to work for the Negociación Minera la Luz y Anexas. During this first job, he began to collect mineral specimens. In 1879, he married Micaela Zavaleta Pérez-Gálvez, a member of a wealthy and prestigious mining family (Jáuregui 2002:9–15). His marriage brought him into the center of Guanajuato aristocracy, and his local, Catholic education made him an ideal candidate for teaching positions at the Colegio and contracts in mining and public works.[11]

In addition to his expertise in mining, Aguilar was a civil engineer who worked on dams, tunnels, railways, and tramways in the city and all over the state of Guanajuato. He also worked periodically as a mining engineer for different companies in Guanajuato, usually as superintendent of mines. In this capacity he was able to collect mineral specimens and to compose an impressive collection, primarily from Guanajuato. Developing, cataloguing, and otherwise maintaining this collection became one of the central aspects of Aguilar's scientific work.

Aguilar's intellectual formation at the Guanajuato School of Mines—a legacy of the Colegio de Minería influence on Mexican science—helped to shape his commitment to the increase of universal knowledge and his embeddedness within national and international scientific circles. Though he never lived outside Guanajuato state, he corresponded with scientists and collectors in other parts of Mexico, the United States, and Europe. His files are full of correspondence with mineralogists and scientific societies, and mineralogical articles and citations in Spanish, English, and French, as well as items such as "Conklin's Vest Pocket Argument Settler" (1896). As a member of Guanajuato's elite, his tastes were also international. The dinner held in his honor on the 50th anniversary of his graduation was printed entirely in French and included such items as dindoneaux truffées (turkey stuffed with truffles; a dish that one would be hard pressed to find in Guanajuato today).

Aguilar participated in diverse transnational scientific networks over the course of his professional life. He received visitors from France, Italy, and the United States, with particular interests in mining, civil engineering, and mineralogy. He was a member of the Rotary Club, the National Geographic Society, La Société Academique de Histoire Internationelle, and the American Association for the Advancement of Science, among other organizations. In 1906, he helped to plan and host a field trip to the mines of Guanajuato for visiting geologists as part of the Congrés Geologique International. In 1912, he attended the first of a series of scientific congresses sponsored by the Sociedad Científica Antonio Alzate. In 1919, he presented his ongoing work on identification of minerals by means of the electric arc (then called "voltaic" arc). In addition to improving his collection, much of his working life was devoted to developing this process and using it to identify specimens in his collection. He considered himself to be a contributor to universal scientific knowledge.

Aguilar often entertained visiting dignitaries, scientists, and travelers when they passed through the city, and he did the same for William Niven. Niven was a Scottish immigrant to the United States, a self-taught mineralogist, and collector of archaeological artifacts. His class position and educational level was far lower than Aguilar's, but the history of the mineral's naming tended to downplay Aguilar's role in favor of Niven's. In this process, the prestige of scientific discovery, like other forms of value, moved from Mexico to the United

States. The muting of Aguilar's role as knowledge producer exemplified the intensifying quasi-colonial relations between the United States and Mexico in the late 19th century.

> Mineral nomenclature follows certain conventions; the Procedures of the Commission on New Minerals and Mineral Names states,
>
> A mineral is commonly named for the geographical locality of its occurrence, for the discoverer of the mineral (although not if he or she is the author), for a person prominent in the field of mineralogy, or for a particular property of the mineral. (Nickel and Grice 1998:11; my emphasis)

Most Mexican minerals (and indeed, most minerals first identified from localities in the Global South) are named either for locations or for European or North American scientists. Thus, the fact that aguilarite bears the name of a Mexican scientist, Ponciano Aguilar, is quite unusual, and was favorably remarked upon by his contemporaries in Guanajuato.[12] So for instance, naumannite was named for C. F. Naumann, a German mineralogist and crystallographer (1797–1873; http://webmineral.com/data/Naumannite.shtml.) (It is worth noting that while Aguilar's contribution to the discovery of aguilarite was recognized, the contributions of the miners involved in extractions of the specimens never were. The agreement between United States and Mexican elites at this moment most definitely did not extend to other socioeconomic classes.)

Contemporary accounts of aguilarite's discovery gave credit to Aguilar. Genth's original description states that the mineral has been dubbed "aguilarite, in honor of its discoverer." The scientific journal *Nature* reported in 1891 that "a new and very beautiful mineral is described by Mr. F. A. Genth in the May number of the American Journal of Science. It was discovered by Sr. Aguilar of the San Carlos mine of Guanajuato, Mexico and has been named after him, aguilarite." (*Nature*, May 28, 1891:89). However, more recent accounts of aguilarite's discovery note that the mineral was named for Aguilar as superintendent of the San Carlos, but rarely mention that he was a mineral collector and scientist in his own right. The intellectual role he played in the mineral's discovery has been mostly ignored. This fact has not gone unnoticed; one Mexican mineralogist remarked to me that recent accounts ignore Aguilar's scientific research and his active role in collecting the samples of what turned out to be aguilarite and sending them to the United States for analysis. The website webmineral.com, which provided the information on naumannite I mentioned above, has this to say about the origin of the name aguilarite: "Named for Ponciano Aguilar (1853–1935), superintendent of the San Carlos mine, Guanajuato, where the mineral was found" http://webmineral.com/data/Aguilarite.shtml. Likewise, a recent article on William Niven remarks that Niven recommended the name aguilarite "in honor of . . . Aguilar, who had been so courteous to him during his visit." (Wilson 2006:304).

The U.S. people in this study have tended to be seen as the intellectual protagonists in the production of value, while the Mexicans tend to be seen as passive recipients or conduits. This was less the case in the early years of the two republics, when Mexican mineralogy was far more vital than U.S. mineralogy, with more institutional support and intellectual activity (Greene and Burke 1974). But as the United States moved into mining and established its own schools of mines, collections, etc.—and as its efforts to control

Mexican territory and extract Mexican resources grew—the balance of power shifted in favor of this view of U.S. scientists as the brains and Mexican miners, engineers, and dealers as mere conduits for the production of scientific value with minerals. From this vantage point, aguilarite and the process of its discovery and naming appears as a material expression of and conduit for unequal political and economic relations between the two nations. These unequal relations, moreover, affected the kind of science that Mexicans were seen to produce. From being a nexus for the production of universal scientific knowledge, Mexico became a place that was only recognized for producing particular bits of knowledge about Mexico. The lives of Aguilar and aguilarite attest to that shift.

Admittedly, this has been a commodity chain account in a loose sense, since aguilarite does not always circulate as a commodity. However, I have included it within that tradition by analogy, for two reasons. First, I have focused on its production as a new mineral species through the work of Aguilar, Niven, Genth, and others (including the miners who took out the specimens, of whom, predictably, no record remains), its distribution in mineralogical journals and correspondence between collectors and scientists; and its consumption by collectors and researchers. In tracing these paths, furthermore, I have emphasized the ways that relations between these places and people are stitched together through their actions with respect to the mineral species as a form of knowledge and the particular specimens of aguilarite in circulation.

Second, as with commodity chain accounts, I have used the production and circulation of aguilarite to show certain "macro" relations of power between the United States and Mexico, both in the areas of mining and science. In my account, the increasing presence of U.S. mining companies and the expansion of the United States as the site of universal scientific knowledge worked as both backdrop and explanation for the gradual shift from Aguilar to Niven as intellectual authors of aguilarite. In a world-system genre, one can see this shift as another example of value extraction (in this case the value of scientific protagonism) from Mexico to the United States.

This approach, critics might say, sets up a foregone conclusion, where the story of the discovery and naming can only be seen as meaningful in terms of the supposedly prior social relations it makes manifest. It can then obscure the continual emergence of social relations, by making them seem as primarily producing effects rather than as effects themselves. As Gayatri Spivak (1985) has noted, this sets up global political economy within a "continuist narrative" that tends to the foregone conclusion. In contrast to this, an advantage of the ANT approach is its emphasis on the unpredictable and contingent—its antiteleology.

Also, where ANT avoids reference to context as explanation of a given "case," the commodity chain genre just as resolutely espouses that premise, taking the objects in the story as manifestations of social relations in congealed form. Much of the previous discussion would also provide excellent material for the mapping of networks in an ANT sense. What differs between a political economy/commodity chain account and an ANT account is not the type of information included, necessarily, but that political economy accounts place some information as "background" or "context," while ANT accounts seek to trace networks produced. A political economy account makes certain decisions concerning "figure" (the phenomenon being studied) and "ground" (the context of that phenomenon) that ANT seeks to avoid.

This strategy, of course, leads to the "foregone conclusion" effect mentioned above, but might also have some advantages, especially in making particular instances available for comparison. Political economy's commitments to investigating the translocal connections of capitalism or colonialism open the possibility for showing parallel processes in different places, articulating different phases of a commodity's movements across the world, and opening conversations between scholars (and others, like activists) each of whom focus on the particularities of one instances. One can see, then, what might be similar (or different) between televisions, sugar, and shea butter by working with a common (and therefore conceptually prior) framework. For those committed to anthropology as a project that "reveals the particular as a manifestation of the universal" (Miller 2010:9) some kind of framing "social" concept seems necessary, at least at some moments. Something like "neoliberalism" "gender" or "the gift" must do the work of "the universal," however provisionally or partially.

Finally, the two approaches entail different assumptions about materiality and different ways of treating it. Though a full discussion of materiality in political economy and ANT (referred to by some as "material semiotics") lies beyond the scope of this essay, these differences in how materiality is viewed clearly underwrite the ways aguilarite's story can be told. The differences correspond to the strategies delineated by Law in a discussion of "The Social Construction of Technology" (SCOT) and ANT and related endeavors (2009). Law points out that SCOT takes only material things as shaped through practice, holding human agency, natural environments, and social contexts as relatively stable, while material semiotics calls all of these into question, seeing them all as the relational effect of practices. The same argument can be effectively made for political economy and ANT.

Conclusion: Mexican Universalism

These descriptions of aguilarite's discovery and what came next capture a moment in the making of mineral science in late 19th-century Mexico and the United States. They show how aguilarite was made through transactions, especially exchanges of scientific descriptions, letters, specimens, and tests of various kinds. By combining these two accounts, we can see both the ongoing exchanges that create mineralogical objects and knowledges as a universal project, and the emergence of an unequal relationship in which the recognition of scientific authorship moves from south to north, as an example of the increasing economic and political power of the United States over Mexico.

I wish to conclude with some discussion of what the juxtaposition of these accounts could show us about the nature of "universal knowledge" as a project of 19th-century elite Mexicans like Aguilar. Each account contributes different things to the story that I tell here of Mexican universalist science. John Law, in his discussion of materiality in Science and Technology Studies introduced above, notes that if we assume (along with ANT) that

> realities only exist in the practices that materialise them . . . .[it] leads to a[n] . . . important consequence. If the realities materialised by science are practice-dependent, then it also follows that they cannot be universal. This means that science and its realities govern, but only in very specific practices and locations. (2009:6)

This insight shifts our understanding of "universal science," with potentially profound results. Rather than think of universality in terms of the metropolitan assumptions that undergird it (and then "provincializing" those assumptions), the angle taken by Law proposes that all universals are particular, because they are all done through practices. Aguilar's aims to contribute to universal science are no more or less provincial or located than any other. In this way, the ANT approach, which sees the discovery of aguilarite in terms of the formation of networks, helps us map the making of universal science in 1880s Guanajuato.

This does not mean, of course, that the commodity chain telling of aguilarite's birth has nothing to offer us. The phenomena that emerged in that account, such as the naming conventions for mineralogy, the U.S. capitalization of Mexican mines, the greater resources for U.S. scientists, and the greater likelihood of U.S. scientists being recognized as intellectual authors, can be usefully seen as actors in the networks of people and things realized as aguilarite. These phenomena also provide an explanatory concept for the processes of which aguilarite's origin is an example.

Notes

[1]Thus, acanthite, one of the more common silver minerals found in Guanajuato is silver sulfide, pyrargyrite is silver antimony sulfide and proustite is silver arsenic sulfide. Aguilar discovered a few specimens that appeared to be naumannite (silver selenide).

[2]The type specimen for aguilarite was purchased by the Field Museum from Ward's Natural Science Establishment in 1893, after the close of the Chicago Columbian exhibition. Many thanks to James Holstein, Collections Manager of Meteoritics and Mineralogy of the Field Museum, for his help tracking down the type specimen.

[3]Indeed several of ANT's central figure have pointed out that "theory" is a misleading term (Latour 2005; Law 2007).

[4]Adriana Petryna has made the same point for deterministic and stochastic modes of knowing and telling about the harm caused by exposure to radiation from the Chernobyl accident (2002). There are not one, but two radiation sicknesses associated with different techniques and entailing different responses.

[5]We can see this tradition both in Marxian political economy (in which commodities are understood as congealed social labor) and Maussian exchange theory (in which the gift compels its return due to the spirit of the giver that adheres to it).

[6]We might add that these interactions occur in situations of cooperation as well as conflict.

[7]Although the symmetry between human and nonhuman actors forms a necessary premise of an ANT account, this does not necessarily mean that humans and nonhumans are seen as exactly the same. Andrew Pickering, in a discussion of objects and agency explicitly influenced by and in dialogue with ANT, writes:

> As agents, we humans seem to be importantly different from nonhuman agents such as the weather, television sets or particle accelerators . . . . Semiotically, these things can be made equivalent; in practice they are not. But, still, I believe that the actor-network is onto something in its extended symmetry, actually two things. One is that there exist important parallels between human and material agency . . . the other is that a constitutive intertwining exists between human and material agency. [Pickering 1995:15]

Though ANT is not a coherent theory and not all scholars who engage with it would necessarily agree with Pickering's argument, the distinction between human and material agency and specification of the terms according to which they might be looked at together, helps to explain how an ANT account might best proceed. More broadly, anthropologists and others have been exploring ways to include humans and nonhumans in symmetrical ways in their analyses. Timothy Mitchell's account of the Aswan dam (2002) that includes the mosquito as a protagonist, and Marisol de la

Cadena's discussion of the possibility of politics that included nonhuman "earth-beings" such as mountains (2010) stand as two excellent examples of the genre.

[8]Other important influences on this trend included an influential essay on "The Cultural Biography of Things" (Kopytoff 1986) and Daniel Miller's work on consumption and material culture (1995, 1997, among others).

[9]Another method for analyzing the movement of objects, related but not precisely the same, might be called the "social life of things" approach and is best exemplified by the essays in the book of the same name, edited by Arjun Appadurai (1986) as well as works by Fred Myers (2002) and many others. These studies also see the movement of objects as a lens onto social relations, and often proceed along similar methodological lines as the political economy studies of commodities. They can be distinguished from them by an emphasis on the movements of objects in and out of the commodity phases, and a relatively greater emphasis on consumption. They trace their origins more to the work of Simmel and Mauss than to that of Marx.

[10]Peter Stallybrass's essay "Marx's Coat" addresses the issue of materiality and value in Marx's work and life (1998).

[11]Aguilar became a prominent member of the political and social elite of Guanajuato. He was a member of the social club Casino de Guanajuato, president of the group Pro-Guanajuato (the first organization in the city dedicated to urban preservation), and vice president in 1923 of the Concurso Fraterno de los Hijos del Colegio del Estado. His position in the city was sufficiently notable that in 1914 he was jailed by the revolutionary government of the city along with seven other prominent figures. He remained in jail for 97 days (Jáuregui 2002:47–49).

[12]Only four minerals of the 65 (as of 2002) whose type locality is within Mexico are named after scientists of Mexican nationality: aguilarite; ordoñezite; Mendozavilite; schmitterite (Gait 1999). In addition, a recently described mineral, miguelromeroite, is named for the famous Mexican collector, Miguel Romero (Thomas P. Moore, personal communication).

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