

Geology and the Aztecs: How the Ore Deposits of Mesoamerica Influenced the Socioeconomic Development of an Empire, from its Emergence to its Downfall

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Introduction

The oldest major settlement of Mesoamerica, Teotihuacan, was built mainly from pyroclasts extracted via quarry tunnels, from the basaltic flows underlying the superficial volcanic tuffs, for approximately 300 years, between 150 BC and 150 AD. These tunnels are still in existence today and were subsequently used by the inhabitants of the city for ritualistic and burial purposes (Manzanilla *et al.*, 1996). Another such example is the city of Xochicalco, where there are tunnels originally used for limestone mining. So, from an early stage, the indigenous populations of Mesoamerica build their major settlements in places where there was a relatively easy procurement of building materials, and constructed the buildings virtually on top of the quarry tunnels, which were then converted to other purposes. The Aztecs themselves claimed their descent from the Toltecs, which in turn believed themselves to be ancestors of the inhabitants of Teotihuacan (Pemberton, 2011). As far as metallurgy and use of processed metal objects is concerned, modern research maintains that metalworking was introduced gradually in Mesoamerica through maritime trade with South America, and more specifically with Ecuador between 650 and 700 AD (Hosler, 2009; and references therein). In this research we present a general description of the metallogeny of Mesoamerica, and we document how the Aztecs mined for or collected as tribute gold, silver, copper, turquoise, jadeite and obsidian, how the availability of such commodities shaped their civilisation and how in the end lead to their demise.

Metallogeny of Central America

The oldest ore deposits of the area date back to the Proterozoic (Camprubi, 2009), but here the main interest is in the metallogenic province of the Pacific margin, which is the greatest silver province of the world (Camprubi, 2009). The intense Mesozoic to Cenozoic magmatism resulted in a host of porphyry and epithermal deposits, as well as skarn deposits. Many surface manifestations of porphyry deposits were mined for Cu and Au. Examples of such deposits are San Juan Mazatlán in Oaxaca, Tiámara in Michoacán, Bacamari and La Azulita in Sinaloa, Caborca, El Promontorio, La Mariquita and El Alacrán in Sonora and many others (Camprubi, 2009; and references therein). For most of these deposits there is no evidence proving that they were the locus of Aztec mining activity but it is reasonable to assume that quarrying of some scale must have taken place in some of them, although tunnels are yet to be discovered or have since collapsed. Uncommonly, for such an extensive metallogenic province, there are very few high sulfidation epithermal deposits, while intermediate sulfidation epithermal deposits are dominant. Many such deposits are Ag/Au-rich or polymetallic, while high sulfidation deposits cluster in the NW Mexico (Camprubi, 2009).

Mining and Use of Obsidian within the Aztec Society

Perhaps the most well known rock coming to mind when seeing Aztec murals, weapons and everyday tools, is obsidian. Indeed, it can be argued that it was the most important natural resource of the Mesoamerican indigenous populations, since it was first exploited by the Olmecs (Pastrana & Domínguez, 2009). The physical properties of obsidian, namely its sharpness, durability and predictable cleavaging, made it an excellent material for a number of uses. The main sites for obsidian extraction, of the Aztec Empire, were Sierra de las Navajas, Otumba, Paredón, Tulancingo and Pico de Orizaba. The extraction of obsidian could be accomplished directly from the available outcrops, or via shallow trenches, open pits and tunnels. Obsidian was used for the creation of most implements of everyday life, be it weapons, ritual tools, everyday tools, jewels, vases and sculptures. Such was the importance of obsidian for the Aztecs that every source was assiduously exploited, while need for continuous mining and processing of obsidian lead to the gradual delineation of distinct socioeconomic strata, i.e. miners, knappers and obsidian traders.

Copper Mining and Importance for the Aztec Civilisation

Archaeological research has discovered remnants of ancient quarries in Zocotallan, Cerro del Aguilar, Tasco and in the Zapotec country (Phillips, 1925). Ayutla and Ayutlan in Jalisco and Inguaran and Bastan in Michoacán are settlements associated with copper mining and processing, while similar settlements have been found in the area of Guerrero (Hosler, 2009). However, the Aztecs did not most probably have any knowledge of bronze, as exhibited by the chemical analyses of various copper objects found in Mesoamerican archaeological sites (Phillips, 1925). While the metallurgy of the Aztecs was pretty advanced, they never progressed to the Bronze Age *sensu stricto*, as they did not intentionally use tin in conjunction with copper to produce bronze. It appears that the main focus of Aztec in particular and Mesoamerican metalworkers in general was to alloy Cu with other metals to produce religious and ornamental items which would be durable and shiny having a yellowish golden colour.

Use of Ornamental Stones and Minerals

The two principal ornamental minerals of the Aztecs, which shall be examined here, were turquoise and jadeite. Turquoise $[\text{Cu}(\text{Al}, \text{Fe}^{3+})_6(\text{PO}_4)_4(\text{OH})_8 \cdot 4\text{H}_2\text{O}]$ was used in a variety of applications, from jewelry and ornaments, to

mosaics, shields and knife handles, for the upper echelons of the Aztec society. Current research (Thibodeau *et al.*, 2018) indicates that turquoise most probably was mined in SW Mesoamerica, from locations in West and Central Mexico, where copper mining has also been documented (Hosler, 2009). Since turquoise forms in the oxidation zones of copper deposits, it is reasonable to assume that in many cases turquoise and copper were extracted from the same mines. Regarding jadeite [Na(Al, Fe³⁺)Si₂O₆] was used by almost every Precolombian civilisation of Mesoamerica in some form or another. In the case of the Aztecs, jadeite had acquired a mythical status and was restricted only to upper social classes, as they valued jadeite even more than gold and silver. The sources of jadeite are believed to be the Motagua River Valley in modern-day Guatemala and the Balsas Valley in Guerrero, while possibly more sources remain to be identified (Howard, 2001).

Gold and Silver in the Aztec Society

The abundance of gold and gilded items used and possessed by the Aztecs is described by many historians and chroniclers of the 16th and 17th centuries, and is verified by archaeological discoveries. According to descriptions by Cortés and Pizarro, the gold of the Aztec Empire came from Çoçolan, Malinaltepec, Tenis, Tochtepec, Zacatula and Xaltepec. The majority of gold was extracted from placer deposits and the term «placer» itself is most probably of Spanish origin and refers to deposits of detrital and residual material, such as sand or gravel, which contain a valuable mineral as a result of weathering and preferential mechanical accumulation (Yeend & Shawe, 1989). The descriptions of the Aztecs to the Spanish, about gold procurement, present gold mining as little more than picking gold grains from the sand which they gathered from the bottom of riverbeds. The need to furnish with gold and gilded items the upper echelons of their society lead to the creation of a separate and elite class of goldsmiths. Silver is a different story altogether, as it appears to have waded its way through the Aztec society and metalworking tradition through marketing networks.

Discussion and Conclusions

In effect, the existence of many different valuable minerals and rocks, and the constant need of the upper socioeconomic classes of the Aztecs for a display of precious ornate jewels and accessories lead to the formation of different professional classes of craftsmen, who occupied a distinct spot in the social fabric of the Aztec Empire. However, gold did not have a monetary value and it is interesting to observe that entire civilisations of Mesoamerica, who had regulated their everyday life without using any metal implements, shifted their focus on associating available metals with ornamental, religious and ritualistic matters (Hosler, 2009). This is a clear formative effect of geology, as had ore deposits of particular metals not existed, a whole aspect of the Aztec civilisation – and the preceding and contemporary ones for that matter – would be significantly different if it had existed at all. Additionally, the constant demand of the Aztec society for precious stones, which could not be found in their entirety within the borders of the Aztec Empire, lead to an ever increasing need for expansion, and therefore constant warfare. However, the display of wealth, and especially of gold, or of gilded items was the catalyst of the Aztecs' downfall by Cortés and his conquistadors (Pemberton, 2011). Interestingly, the presence of gold and silver contributed in altering the perception of the Spanish about the association between land ownership and wealth. In the Old World, the ownership of arable lands meant a steady income, roughly commensurate with the productivity of said agricultural expanses. However, the conquistadors virtually destroyed local societies, and as a result local production capacity (Harrasta, 2014). So, the conquest of more land was simply the means to an end, namely in acquiring gold and silver. The influx of enormous amounts of gold to Europe in the end had negative effects for European economies, since it caused a rapid drop in the nominal value of gold, and, since currency at the time was based on a country's gold reserves, widespread inflation. Despite that, the Spanish economy was, in the short term, benefited, since it overcompensated for the partial devaluing of its gold reserves by the huge increase in the net amount of gold available (Harrasta, 2014). A more far reaching consequence of the real and imaginative wealth of Mesoamerica in particular and the New World in general, was the Treaty of Tordesillas in 1494, the race for colonisation and the eventual war between England and Spain, in 1588 (McKee, 1987).

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