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Literature and Contextualization of Classical Texts on Mining in Antiquity

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Abstract

This manuscript is a compilation of accounts by classical writers referring to the mining of precious minerals and stones. The timeframe is the Roman Imperial period; Herodotus (fourth century BC) is also included to emphasize the perception of the early understanding of gold and its extraction. It seems that factual knowledge and descriptions of mining were reserved for the western provinces of the Roman Empire, while those for the eastern provinces had a more mythical character. Many did not understand the origin of gold in its correct geological terms even though they seemed to comprehend that there were different types of stones and that (ground) water could pose danger. However, as time progresses the technological understanding of classical writers increases, and the descriptions become less mythical.

Keywords

Roman Gold Mining, Classical Writers, Gold, Roman, Herodotus, Agatharchidus of Cnidos, Diodorus of Siculus, Strabo, Pliny the Elder, Tacitus, Suetonius, Arrian, Photius

1. Introduction

This manuscript is a compilation of descriptions and accounts by classical writers referring to the mining of precious minerals and stones. The timeframe is the Roman Imperial period; Herodotus (fourth century BC) is also included to emphasize the perception of the early understanding of gold and its extraction. The main authors are, in chronological order, Diodorus Siculus, Strabo, Pliny the Elder, Tacitus, Suetonius, Arrian and Photius. It seems that factual knowledge and descriptions of mining were reserved for the western provinces of the Roman Empire, while those for the eastern provinces had a more mythical character. Arrian states that some writers of his time were not so particular about what they wrote on the

eastern provinces as, at that time, it was unlikely that people would travel there and witness the operations in these regions. Despite that, Diodorus Siculus and Strabo appear to have obtained a factual understanding of mining in Egypt and India. Some of the classical writers were critical of others who believed gold was organic and could be made to "grow" such as Strabo 3.2.9: in this book *Strabo warns his readers not to believe Poseidonius, who writes that gold can only be obtained from setting the forest and the soil on fire to make gold and silver "grow"* and Strabo 16.4.19-20: *The territories of the Sabaeans and Gerrhaeans were very rich in gold and silver "as their land is fertile."* (Jones, 1949: pp. 220-222 (Strabo 3.2.9); Hamilton & Falconer, 1912: pp. 43-47 and 16.4.19-20; Jones, 1954b: pp. 349-351). They did not understand the origin of gold in correct geological terms even though they seemed to comprehend that there were different types of stones and that (ground) water could pose danger to those working the veins. On only two occasions a deity is mentioned in relation to mining and/or refining gold—*Hephaestus*—though only Diodorus Siculus (5.74) refers to him by this name. *Pan* or *Min* was the Ptolemaic god taken over by Roman miners in the Eastern Desert of Egypt, as well as the protector of travelers in the desert. There were also mythical creatures assigned to mining, such as the gold-digging ants who ferociously hunted down those who tried to dig up "their gold"; and there is Jason and the Argonauts looking for the Golden Fleece.

2. Classical Writers

2.1. Herodotus (Dave, 2024)

Herodotus is a historian and geographer from the Greek city of Halicarnassus in the 5th c BC, he lived during the Persian era and became a citizen of Thurri, Italy where he was buried. Herodotus is called the Father of History based on his historical accounts known as "The Histories", an objective account of the Greco-Persian wars of the late 5th c BC recorded in 9 books. He was revered for his honesty as he stated that his information was gathered by talking to the locals. He often starts his accounts by acknowledging this. However, whilst gathering information on him another title seems to have been given to him, the "Father of lies". This title was first given to him by Plutarch from the 1st AD as the latter did not agree with some of his accounts concerning his people who, according to Herodotus, fought on the wrong side of the war. But more recent scholars have adopted this term as well as they criticized that some of his accounts are inaccurate and at times unbelievable. Herodotus was a historian and geographer who states in his accounts that he writes down what he hears, so some details or descriptions will be exaggerated by the storyteller and Herodotus was most likely not able to verify some of what he has been told. As a historian this can be considered a flaw. A 'flawed' story is the one of the giant ants protecting gold, which has been repeated many times in later works:

Name-reference: Herodotus, 3.102-05 (De Sélincourt, 1959: pp. 217-218; Rawlinson, 1996: pp. 270-271).

Location of the mine: N India, neighbourhood of Caspatyrus in the country of Pactyica

In the desert of India, Herodotus describes gold-digging ants "of great size, bigger than a fox though not as big as a dog". The ants burrow underground and throw up sand in heaps; Herodotus compares them with "modern" ants. The sand has a rich content of gold, which is what the Indians were after. But collecting the gold was not easy as it had to be done when the sun was at its highest and the ants had burrowed deep for shade and coolness. Otherwise, the ants, which are extremely fast, would chase and attack the men collecting the gold. [Further in the text Herodotus admits that he has quoted this story from a Persian man, and even Herodotus seems to have queried its authenticity]

It appears that Herodotus does not always understand the principle of prospecting for gold. Later in the article we will see that he is not the only one. In Herodotus 4.200 he describes tapping the ground with a bronze shield when prospecting for gold; a difference in tone would signal its presence he stated (De Sélincourt, 1959: pp. 308-309; Rawlinson, 1996: pp. 374-375, the location of the mine is Berca, Persia). In other sections of his books he gives a more technically accurate description of how gold occurs in the form of primary (underground mines) or secondary deposits (river sediments) when in book 5.101 he explains how the *gold dust was brought via the river Pactolus from Tmolus, which flowed through the market at Sardis and joined the Hermus before reaching the sea* (De Sélincourt, 1959: p. 352; Rawlinson, 1996: pp. 431-432). In book 6.46-47 he talks about a mine that yielded 80 talents a year, this mine is a primary deposit in *Scapte Hyde*, near Thasos (Phoenician Island) and Thasos self: "*a whole mountain, Coenyra, and a place called Aenyra were turned upside down in the search for gold*" (De Sélincourt, 1959: pp. 375-376; Rawlinson, 1996: pp. 464-465). Another brief comment that is revealing is on how people will go to war over a precious ore deposits is described in book 9.75: *Sophanes of Decelea fought the Edoni for the goldmines at Datum but died* (*he was joint commander of the Athenian army with Leagrus, son of Glaucon*) (De Sélincourt, 1959: p. 581; Rawlinson, 1996: pp. 709-710, location of the mine is Datum (465 BC)). And 7.112: *The gold and silver mines were mined partially by the Pierians and the Odomanti but mostly by the Satrae, who were said to be enslaved by Xerxes* (*for this purpose*?).

2.2. Diodorus

Diodorus is a Greek historian born in Sicily, who lived during the reigns of Julius Caesar and Augustus and is thought to have died in the first half of the second century AD. He wrote the *Bibliotheca Historica* which consisted of 40 books but only 15 are known today. His work covers the period from the mythical age till about 60BC. Diodorus, like Herodotus, acknowledges his earlier sources and is criticized by earlier historians for being a compiler. Contrary to modern standards he is seen as a preserver of older works. The former group doubted his experience as he had no political or military experience and cast doubts over his travels abroad. However,

in modern times Diodorus of Siculus is considered a preserver of older historians whose works have not passed the test of time (Wasson, 2020, https://www.worldhistory.org/Diodorus_Siculus/ [accessed 15.08.2025]).

Even with only 15 books preserved he has left us a detailed description of an underground mine in Egypt, 3.12-14. This description was originally recorded by Agatharchides of Cnidos (2nd c BC) and the mine is thought to be Ptolemaic, but no name or location is known, only that it was located in the Eastern Desert of Egypt. The other quotes are part of larger paragraphs and paint a picture of the perceptions and attitudes towards this precious metal during his lifetime. Gold was used for adornment, religious and political reasons; and at times offered as tribute to the Romans mainly (books 2.36 India, 11.70 Greece). He talks about gold used for adornment in book 5.27 where the gold from the river sediments in Gaul were used to bracelets, necklaces of solid gold (torque), rings and corselets, used in dedications to their gods (Oldfather, 1993: pp. 167-169). Book 5.46.1-4 *describes how Panchaea was inhabited by the Cretans who were brought there by Zeus when he still lived among men. The land was rich in precious metals that were forbidden to leave the island as it was to be offered to the gods* (Oldfather, 1993: p. 227). There is not much information on deities being the protector of the gold mines, but Diodorus does mentions *Hephaestus* who is credited with the discovery of working precious metals in book 5.74; Pliny the Elder refers to him as the "god of handicraft" (Pliny *Naturalis Historia* XXXIII 4.12).

Diodorus mentions both primary (underground mines) and secondary deposits (river sediments) in various countries. Descriptions of primary deposits can be found in books 2.36 India, 3.12-14 Egypt, 3.45 Corinth, 5.36-38 and 5.46.14-4 both Iberia, 11.70 Greece where he stated that the mine brought in 1,000 talents a year and 16.3 Greece. Secondary deposits he writes about can be found in books 2.50 Arabia, 3.45 Corinth and 5.27 Gaul. Diodorus describes the use of slaves and *condenmati* in books 3.12-14 Egypt and 5.36-38 Corinth and Attica. Gold was originally used as barter for copper and iron, book 3.45 Corinth before it was mined on an industrial scale and August created his *Aerius* (Oldfather, 1953: pp. 221-225). Book 17.71 describes that the ratio of gold to silver was 12 or 15 to 1 and at the time of Persian rule in 330-291BC, gold was estimated in terms of silver (Oldfather, 1953, 1956; Oldfather, 1993; Sherman, 1952; Wellesley, 1990 and Walton, 1968).

As stated in the beginning of this paragraph non-indigenous peoples tried and were often successful in usurping local mines. Diodorus casually mentions this in books 5.36-38 Iberia: *The indigenous people working the silver mines are giving them great revenues. The mines contain gold, silver and copper, the local population dig up one quarter of all the copper and unskilled workers dig up the silver ore* (silver dust). *This also gives them great wealth. When the Romans conquered Iberia, they brought Italians with them to mine the ore and tool all the wealth. They used slaves who dug the shafts, underground galleries and tunnels* (Oldfather, 1993: pp. 195-203). *It was greed that drove them to go to great depths*, Dio-

dorus explains. Book 31.8 is dated to 167BC where he describes how *Rome behaves magnanimously towards the conquered Macedonians and Illyrians in the second century BC. Both countries were to be "set free again" providing they pay tribute to Rome* (Walton, 1968: pp. 323-333). And in 31.26 he mentions *Aemillius who is said to have brought a lot of gold as part of his tribute from Spain to Rome, and makes it clear that it was more than the army as a counterpart* (Walton, 1968: p. 377). On only one occasion (book 11.70) a reference is made to Philip of Macedon *who confiscated the mines of Mount Pangaeus* [*now Pirnari*] *on the mainland yielded both gold and silver. The seizure of these mines by Philip of Macedonia in* 35 *BC, from which he eventually derived an income of* 1000 *talents a year, laid the financial basis for the rise of Macedonia to supreme power in Greece* (Oldfather, 1956: p. 307). There is one location that boasted (book 3.46-47) never have been invaded for its gold deposits and that is the tribe which inhabited Arabia the Blessed (*Arabia Felix* in the Roman era), and is described as a land of plenty. The chief city was *Sabae* and was never invaded because of its secluded location (Oldfather, 1953: pp. 225-231). In book 3.45 he describes how the *natives of Debae* (*coast of Corinth*) *are entirely without experience in the working of gold, but they are hospitable to strangers, but not, however, to everyone... only to the Boeotians and the Peleponnesians* (Oldfather, 1953: pp. 221-225).

Diodorus also recounts the mythical story of the Golden Fleece and Jason and the Argonauts in book 4.40-54; which is also mentioned by Strabo (11.4.8 and 11.2.19). In earlier books (3.12-14 and 5.27) he gives a technical description of how the gold ore was extracted from an underground mine in Egypt and river sediments in Gaul respectively.

Name—reference: Diodorus, 3.12-14 (Oldfather, 1953: pp. 115-123)

Location of the mine: Eastern Desert of Egypt

Paragraph 12. *At the extremity of Egypt and in the contiguous territory of both Arabia and Ethiopia, there lies a region which contains many large gold mines, where the gold is secured in great quantities with much suffering and at great expense. For the earth is naturally black and contains seams and veins of a marble that is unusually white and in brilliancy surpasses everything else which shines brightly by its nature, and here the overseers of the labour in the mines recover the gold with the aid of a multitude of workers. For the kings of Egypt gather together and condemn to the mining of the gold such as have been found guilty of some crime and captives of war. As well as those who have been accused unjustly and thrown into prison because of their anger. Not only such persons but occasionally all their relatives as well, by this means not only inflicting punishment upon those found guilty but also securing at the same time great revenues from their labours. Those who have been condemned in this way—and they are a great multitude and are all bound in chains—work at their task unceasingly both by day and night, enjoying no respite and being carefully cut off from any means of escape.* [here is a mention of forced labour working the mines, the political prisoners with their family at times and prisoners of war] *Guards of foreign sol-*

diers who speak a language different from theirs stand watch over them, so that not a man, either by conversation or by some contact of a friendly nature, is able to corrupt one of his keepers. [the only mention of guards or soldiers at an Egyptian mine and which has been copied by Diodorus and Photius] *The gold-bearing earth, which is hardest, they first burn with a hot fire. When they have crumbled it in this way they continue the working of it by hand; and the soft rock which can yield to moderate effort is crushed with a sledge by myriads of unfortunate wretches. The entire operations are in the charge of a skilled worker who distinguishes the stone and points it out to the labourers*. [the distinction between skilled and non-skilled personal is made clear here, the latter being there not by they own free will] *Those who are assigned to this unfortunate task, the physically strongest, break the quartz rock with iron hammers, applying no skill to the task, but only force, and cutting tunnels through the stone, not in a straight line but wherever the seam of gleaming rock may lead. These men, working in darkness as they do because of the bending and winding of the passages, carry lamps bound on their foreheads. As much of the time they change the position of their bodies to follow the particular character of the stone, they throw the blocks, as they cut them out, on the ground; and at this task they labour without ceasing beneath the sternness and blows of an overseer.*

Paragraph 13. *The boys there who have not yet come to maturity, entering through the tunnels into the galleries formed by the removal of the rock, laboriously gather up the rock as it is cast down piece by piece and carry it out into the open to the place outside the entrance. Then those who are above* 30 *years of age take this quarried stone from them and with iron pestles pound a specified amount of it in stone mortars, until they have worked it down to the size of a vetch. Thereupon the women and older men receive from them the rock of this size and cast it into mills of which a number stand in a row. They take their places in groups of two or three at the spoke or handle of each mill and grind it until they have worked down the amount given them to the consistency of the finest flour. And since no opportunity is afforded any of them to care for his body and they have no garment to cover their shame, no man can look upon the unfortunate wretches without feeling pity for them because of the exceeding hardship they suffer. For no leniency or respite of any kind is given to any man who is sick, or maimed, or aged, or in the case of a woman for her weakness. All without exception are compelled by blows to persevere in their labour, until through ill treatment they die in the midst of their tortures. Consequently the poor unfortunates believe, because their punishment is so excessively severe, that the future will always be more terrible than the present and therefore look forward to death as more to be desired than life*. [again reference to forced labourers doing the hard and dangerous work, as in the next section the skilled workers were doing the last dangerous work]

Paragraph 14. *In the last steps the skilled workmen receive the stone which has been ground to powder and take it off for its complete and final working; for they*

rub the marble which has been worked down upon a broad board which is slightly inclined, pouring water over it all the while; whereupon the earthy matter in it, melted away by the action of the water, runs down the inclined board, while that which contains the gold remains on the wood because of its weight. And repeating this a number of times, they first of all rub it gently with their hands, and then lightly pressing it with sponges of loose texture they remove in this way whatever is porous and earthly, until there remains only the pure gold dust. Then at last other skilled workmen take what has been recovered and put it by fixed measure and weight into earthen jars, mixing with it a lump of lead proportionate to the mass, lumps of salt and a little tin, and adding thereto barley bran; thereupon they put on it a close-fitting lid, and smearing it over carefully with mud they bake it in a kiln for five successive days and as many nights; and at the end of this period, when they have let the jars cool off, of the other matter they find no remains in the jars, but the gold they recover in pure form, there being but little waste. This working of the gold, as it is carried on at the farthermost borders of Egypt, is effected through all the extensive labours here described; for Nature herself, in my opinion, makes it clear that whereas the production of gold is laborious, the guarding of it is difficult, the zest for it very great, and that its use is half-way between pleasure and pain.

Name-reference: Diodorus, 5.27 (Oldfather, 1993: pp. 167-169)

Location of the mine: Gaul

"*Throughout Gaul... there are great quantities* [*of gold*], *which Nature provides for the inhabitants without their having to mine for it or to undergo any hardship.*" *...They washed them in the water, ground or crushed the gold-bearing lumps and smelted the remains in the furnaces. This way the local population was able to amass a great amount of gold used for ornaments* (*male and female*) *and deposits for their temple.*

2.3. Strabo (https://www.britannica.com/biography/Strabo and https://www.ocfordbibliographies.com/display/strabo Both Accessed 22.08.2025)

Strabo is a Greek geographer from the 1st c BC and his *Geographika* is the only work which has survived. 17 books cover the Greeks and Romans during the reign of August (27BC-AD14) and is a treaty of geographical science mixed with history. He describes the geography of the Iberian Peninsula to India and travelled as far as Philae on the Nile in Egypt but also relied on other sources whom he introduces at the beginning of his books. Today the names of these geographers, historians and explorers are just names as their works have not survived the passing of time. Strabo gives critical study and favours a descriptive type of geography interspersed with personal travel notes
(Lasserre, 2025 https://www.britannica.com/biography/Strabo and https://www.ocfordbibliographies.com/display/strabo, both accessed 22.08.2025).

Diodorus and Strabo were not that far apart historically, but the content in relation to mining is vastly more extensive with Strabo. Where Diodorus is more of

a traveler, a historian, a narrator; Strabo had a more technical background and thus expertise, which shows in his descriptions as we will discuss here (Hamilton & Falconer, 1912; Jones, 1949, 1950, 1954a, 1954b). Similar as with Diodorus Strabo makes comments about primary and secondary deposits in an area from the Iberian Peninsula and Gaul to India. Sometimes it is just a short sentence about a mine or gold dust and nuggets collected in or nearby rivers. And at other times he gives a bit more on the techniques used to extract the gold ore. Pliny the Elder will be the classical writer who will go fully descriptive of the process of mining gold. Primary deposits, or mines in Iberian can be found in books 3.2.8, 3.2.10, 3.4.2., 11.14.8; for Egypt in books 17.1.45 (but this is more on emeralds) and 17.2.2-3. Singular descriptions in books 4.6.7 Alps, Italy, 4.6.12 *Noric Taurisci*, 4.2.1. Aquitania, 5.4.9. *Pithecussae*, Italy, 7 (34) *Helveti*, Germany. And information on the gold dust and nuggets from rivers can be found in books 3.2.8. Italy, 3.3.4. river Tagus, Italy, 11.2.19 Caucassus, 13.1.23/13.4.5/14.5 river *Tmolis*, 15.1.57 India and 16.4.18 *Debae*, Arabia. In Strabo's time it appeared that primary deposits or underground mines were more talked about than panning rivers for gold nuggets. A suggestion might be because mines leave a permanent impression on the landscape and are quite localized as when panning rivers often lead to an outcropping ore and potentially a mine.

Mining for gold ore is a four staged process: prospecting, exploration, development and exploitation (Tratsaert, 2020). Strabo refers to all four stages in his works, marking him out as technically more experienced than Diodorus. Prospection: in book 4.6.12 *he quotes Polybius again, this time when he describes the gold mines of Aquilea and those in the countries of the Noric Taurisci, which were so rich* "*that if one scraped away the surface soil for a depth of only two feet, one found forthwith dug gold, and that the diggings were never deeper than* 15 *feet.*" *He goes on to say that only part of the gold was pure, in the sizes of a bean or lupin, when an eighth has been boiled away, and that although the rest needed more smelting, the smelting was very profitable* (Jones, 1949: pp. 310-311; Hamilton & Falconer, 1912: pp. 291-295). When he talks about India in book 15.1.30 he mentions a specialist, "*Gorgus* of Eretria the mining expert (*metalleutes*)", who accompanied Alexander the Great to India (Jones, 1954b: p. 53. Diodorus (3.12-14)). Exploration: book 4.6.7: *The country of the Salassi has gold mines also, which in former times, when the Salassi were powerful, they kept possession of, just as they were also masters of the passes* [the country of the Salassi lies in a glen surrounded by mountains]. *The Durias River was of the greatest aid to them in their mining—I mean, in washing the gold; and therefore, in making the water branch off to numerous places, they used to empty the common bed completely* (Jones, 1949: pp. 304-305; Hamilton & Falconer, 1912: pp. 277-281). Development: on how the ore was retrieved from the veins we will refer to Pliny the Elder (*Nat. Hist.* 33.21) further below. Once the gold was retrieved it had to be crushed and then melted to separate the impurities from the gold, as explained by Agatharchides (copied by Diodorus 3.12-14) and Pliny *Nat. Hist.* 33.21. In book 4.6.12: *He goes*

on to say that only part of the gold was pure, in the sizes of a bean or lupin, when an eighth has been boiled away, and that although the rest needed more smelting, the smelting was very profitable (Jones, 1949: pp. 310-311; Hamilton & Falconer, 1912: pp. 291-295). The crushing was done by the miners by means of querns or grinding stones, once it was fine enough it was washed to separate the dust from the gold particles. Strabo refers to this in books 3.2.10 New Carthage, where he states that it is the same process for silver and gold mines (Jones, 1949: p. 222; Hamilton & Falconer, 1912: p. 47), 5.1.8 Italy, boundary of *Aquilea* and *Heneti*, 4.6.7 Alps, Italy *Salassi* and 11.2.19: *The Soanes tribe worked on the alluvial gold that was* "*carried down by the mountain torrents* [*and*] *was obtained by perforated troughs and fleecy skins*", *which, according to Strabo, is the origin of the Golden Fleece* (Jones, 1949: p. 243). Strabo also talks about secondary gold deposits, where gold nuggets are found in riverbeds at the foot of an outcropping ore. Eventually when the riverbed has been exhausted the miner will continue upstream to find the source, i.e. the outcropping vein. Some say this might prelude underground mining, but on occasion evidence has been found that both mining practices have been found contemporary. The nuggets collected from the rivers are done by panning and are pure, therefore it does not need to be crushed and washed as in primary deposits. Book 3.2.8 Iberia: *Gold was dug from primary deposits* "*dug from the mines*", *and alluvial* "*likewise collected*". *He continues to describe that* (1) *gold derived from panning the rivers was washed in artificially constructed areas next to the same river.* "*The mines in the Cemmenus Mountains* [*mod. Cevennes*] *and on the side of the Pyrenees are superior but most people prefer those on this side* [*Iberian side*]. *Nuggets were found to be weighing* 1/2 *pound* [*palae*] *and needed little refining. Splitting open stones produced little lumps*" (Jones, 1949: pp. 39-43, 219-220; Hamilton & Falconer, 1912: pp. 39-43). And book 16.4.18: *Strabo describes the country of the Debae, where the river carried gold dust but the local population were farmers and nomads who lacked the expertise to process alluvial gold. The neighbours, who appeared to be more civilised, lived in a temperate climate with enough rain to use water as a means to extract the gold* (i.e. *they had the knowledge to process the mineral*). *The gold found in the river sediment came in the shape of nuggets that did not require purification. The smallest had the size of a fruit stone, the medium nuggets were about the size of a meddler and the largest that of a walnut* (Jones, 1954b: pp. 345-349).

Strabo also refers to the increasing interest of the Romans in countries where there is gold in abundance and thus "interfered" with the mining of it, books 3.2.8. Iberia and 15.1.57 Indians had to pay taxes to the Romans (Jones, 1949: pp. 39-43, 219-220; Hamilton & Falconer, 1912: pp. 39-43; Jones, 1954b: p. 97). Strabo claims that some locals do not understand the value of gold and therefore never mined it and on other occasions he refers to well-established mines taken over by the Romans. It becomes clear that by the time of Strabo the gold mines were state controlled—book 3.2.10, Iberia *Silver was no longer the property of the state at the time of Strabo and was mostly in private hands. The gold mines, however,* "*nearly*

all belong to the state" (Jones, 1949: p. 222; Hamilton & Falconer, 1912: p. 47). He also warns how a monopoly can lead to a price drop (he quotes Polybius for this quote)—4.6.12, *and that two months after the Italiotes joined them in working the mine, the price of gold suddenly became a third less throughout the whole of Italy, but when the Taurisci learned this they cast out their fellow-workers and carried on a monopoly. Now, however, all the gold mines are under the control of the Romans* (Jones, 1949: pp. 310-311; Hamilton & Falconer, 1912: pp. 291-295). But he says that the cooperation with the Romans did not always go smooth and that some locals were very cunning: 4.6.7. Alps, Italy: "*The country of the Salassi has gold mines also, which in former times, when the Salassi were powerful, they kept possession of, just as they were also masters of the passes* [*the country of the Salassi lies in a glen surrounded by mountains*]. *The Durias River was of the greatest aid to them in their mining—I mean, in washing the gold; and therefore, in making the water branch off to numerous places, they used to empty the common bed completely. But although this was helpful to the Salassi in their hunt for gold, it distressed the people who farmed the plains below them, because their country was deprived of irrigation; for, since its bed was on favourable ground higher up, the river could give the country water. And for these reasons both tribes* [*those in the plains and those in the mountain ranges*] *were continually at war with each other. But after the Romans got control, the Salassi were thrown out of their gold works and country; however, since they still held possession of the mountain, they sold water to the publicans who had contracted to work the gold mines, but on account of the greediness of the publicans the Salassi were always in disagreement with them too. And in this way it resulted that those Romans who from time to time wished to lead the armies and were sent to the regions in question were well provided with pretexts for war.*" (*They were in the end overthrown by Augustus.*) (Jones, 1949: pp. 304-305; Hamilton & Falconer, 1912: pp. 277-281).

In the following books Strabo talks about indigenous people who do not know the value of gold or how to mine it: 15.1.30, *Indians were inexperienced* (*compared to the Romans*) *in mining and smelting and were unaware of the value of their resources. The Indians appeared to be* "*handling the gold-mining industry in a simple manner.*" (Jones, 1954b: p. 53); 16.4.18: the nomads from Arabia that Straits *of the Arabian Gulf had access to nuggets* (*secondary deposits*) *but lacked the expertise to process this. However, they knew the value and traded this with their neighbours for brass and silver* (Jones, 1954b: pp. 345-349). He also warns against mythical and inaccurate descriptions relating to gold mining procedures, book 3.2.9: *Strabo warns his readers not to believe Poseidonius, who writes that gold can only be obtained from setting the forest and the soil on fire to make gold and silver* "*grow*". *The fires melted the earth, which in turn* "*throw the metals up to the surface. These rich subterraneous regions should be regarded as the realms of Plutus.*" *Strabo is not flattering Poseidonius when he writes:* "*The flourished style, in which he speaks on this subject, that you would fancy is turgid language, has been dug from a mine itself*" (Jones, 1949: pp. 220-222; Hamilton & Falconer,

1912: pp. 43-47). But he speaks of people in India, the *Musicanus*, who could reach over 130 years, but were not interested in gold and silver mining, book 15.1.34 (Jones, 1954b: 61). Like Diodorus (4.40-54) Strabo relates the story of Jason and Argonauts (11.4.8.) (Jones, 1944: pp. 231-291) and like Herodotus (3.102-05) he talks about gold digging ants (15.1.37, 44, 69, 16.4.15): *ants that mine gold*, "*imaginary creatures, sometimes called* '*antlion*', *with the foreparts of a lion and the hind parts of an ant... smaller than a dog, larger than a fox.*" *In* 15.1.44 *he quotes Nearchus on the description of their skin*: "*Their skin is like that of leopards.*" *His quote from Megastenes is about how they lured the ants away with pieces of meat from wild beasts so the ants would not pursue the thieves and kill them* (*for taking the gold*). *He places the ants* (*and mines*) *in the Mountains of India on a plateau, approximately* 3,000 *stadia in circumference. These ants dug holes during the winter. The soil appears to have been auriferous and soft, and their holes looked like mole heaps. The gold dust was fairly pure and needed little smelting. But states Megasthenes, the* "*human thieves are unaware and sell the gold dust unwrought to the traders.*" *In book* 15.1.69, *Strabo states that the* "*ants that dig gold have wings*", *and in book* 16.4.15 *that* "*the ants are called lions and have their genitalia reversed; they are gold in colour though not as hairy as those in Arabia*" (Jones, 1954b: pp. 65, 75-77, 121, 335).

Only casual remarks are made on the purpose of the mined gold for religious purpose in book 4.1.13 where he describes the god fearing people of the *Tectosages* tribe threw their silver and gold in sacred lakes, which then the Romans dug up and sold to the public treasury (Jones, 1949: pp. 203-209). And Meroans who decorated their temple with a golden shrine (Jones, 1954b: pp. 143-147). Or it was used for personal adornments, 16.4.19-20: *The territories of the Sabaeans and Gerrhaeans were very rich in gold and silver* "*as their land is fertile.*" *The gold was used to make objects, such as couches, tripods, bowls and houses* (*the ceilings were variegated with ivory and silver and set with precious stones*) (Jones, 1954b: pp. 143-147).

2.4. Pliny the Elder (https://www.britannica.com/biography/ Accessed 29.08.2025)

Pliny the Elder was born in 23BC and passed away when Vesuvius erupted on 24 Aug 79AD. He did not have much following in the centuries following his death, but his technical description of mining for precious metal is detailed. Although disputed by some he gives a general idea on the procedures of prospecting, excavating and refining the mined gold. He began his career as a cavalry commander in Germany, then studied law in Rome, and eventually becoming a procurator in Spain where he must have gained his experience in mining. There have been second works attributed to him, but his *Naturalis Historica* is the only that has survived. This work consists of 37 books, of which books 33 and 34 are of interest for this article.

Unlike the previous writers such as Diodorus and Strabo he is very technical

but there are not so many quotes referring to mining, gold and its applications. He describes a lot of regions and tribes who have or had gold mines. He talks about the mines in Spain (3.3 and 4.20), he discusses the once famous mines of the Caucassus (6.12), India the Dardae (6.22); India in general (6.23, 24 and 26); Persian Gulf the Arabian side (6.32), the Eastern Desert of Egypt (6.34 and 6.35), Lusitania *Gallaeca* (34.47) and *Lampsacus* (34.74) (Rackham, 1937, 1968, 2003; Eichholz, 1971). The description that is a starting point can be found in book 33.21, indicating that he clearly understood the process of mining and its impact on the immediate environment (Rackham, 1968: pp. 51-61): *People seeking gold begin by getting up* segellum—*that is*, *the name for earth that indicates the presence of gold*. *This is a pocket of sand*, *which is washed*, *and from the sediment left behind an estimate of the veins is made*. *Sometimes by a rare piece of luck a pocket is found immediately*, *on the surface of the earth*, *as occurred recently in Dalmatia when Nero was emperor*, *one yielding* 50 *pounds in weight of gold a day* (*AD* 54-68). *Gold found in this way in the surface crust is called* talutium *if there is also auriferous earth underneath*. *The otherwise dry*, *barren mountains of the Spanish provinces which produce nothing else are forced into fertility by the community*. A second method involved "sinking shafts" in auriferous primary deposits "in the fallen debris of mountains". *Gold dug up from shafts is called* channelled *or* trenched gold; *it is found sticking to the grit of marble*, *not in the way in which it gleams in the lapis lazuli of the East and the stone of Thebes and in other precious stones*, *but sparkling in the folds of marble*. *These channels of veins wander to and fro along the sides of shafts*, *which give the gold its name*; *and the earth is held by wooden props*. *The substance dug out is crushed*, *washed*, *fired and ground to a soft powder*. *The powder from the mortar is called the* scudes *and the silver that comes out from the furnace the* sweat; *the dirt thrown out of the smelting furnace as in the case of every metal is called* scoria, *slag*. *In the case of gold the scoria is pounded and fired a second time*; *the crucibles for this are made of tasconium*, *which is white earth resembling clay*. *No other earth can stand the blast of air*, *fire*, *or the intensively hot material* [that held the metal]. The third method describes the sub-surface galleries, the primary deposits, with tunnels running over long distances under the mountains and mined by the light of oil lamps. Pliny remarks in a footnote that the length of time spent in a mine was determined by the ration of a lamp oil. *The third method will have outdone the achievements of the Giants*. *The name for this class of mines is* arrugiae; *cracks give way suddenly and crush the men who have been at work*, *so that it actually seems less venturesome to try to get pearls and purple fishes out of the depth of the sea—so much more dangerous have we made the earth*! *Consequently arches have been left at frequent intervals to support the weight of the mountain above*. *In both kinds of mining*, *masses of flint are encountered*, *which are burst asunder by means of fire and vinegar*, *though more often*, *as this method makes the tunnels suffocating through heat and smoke*, *they are broken to pieces with crushing machines carrying* 150 *lbs of iron*, *and the men carry the stuff on their shoulders*, *working night and day*, *each*

man passing them on to the next man in the dark, while only those at the end of the line see daylight. If the bed of flint seems too long, the miner follows along it and goes around it. And yet flint is considered comparatively easy work, as there is a kind of earth consisting of a sort of potter's clay mixed with gravel, called gangadia, *which it is almost impossible to overcome. They attack it with iron wedges and the hammer machines mentioned above; and it is thought to be the hardest thing that exists, except greed for gold, which is the most stubborn of all things. When the work is completely finished, beginning with the last, they cut through, at the tops, the supports of the arched roofs. A crack gives warning of a crash, and the only person who notices it is the sentinel on a pinnacle of the mountain. He, by shout and gesture, gives the order for the workmen to be called out, and himself at the same moment fled down from his pinnacle. The fractured mountain falls asunder in a wide gap, with a crash which it is impossible for human imagination to conceive, and likewise with an incredibly violent blast of air. The miners gaze as conquerors upon the collapse of Nature. And nevertheless, even now, there is no gold so far, nor did they know for certain there was any when they began digging; the mere hope of obtaining the coveted material was sufficient inducement for encountering such great dangers and expense. Another equally laborious task involving even greater expense is the incidental operation of previously bringing streams along mountain heights, frequently over a distance of* 100 *miles for the purpose of washing away debris of the collapse* [see above, the collapse of an exhausted mine]; *the channels made for this purpose are called* corrugi, *a term derived, I believe, from* conrivatio, *a uniting of streams of water. This also involves a thousand tasks; the dip of the fall must be steep, to cause a rush rather than a flow of water, and consequently it is brought from very high altitudes. Gorges and crevasses are bridged by aquaducts carried on masonry; at other places impassable rocks are hewn away and compelled to provide a position for hollowed troughs of timber. The workman hewing the rocks are suspended with ropes, so that spectators viewing the operations from a distance seem to see not so much a swarm of strange animals as a flight of birds. In the majority of cases they hang suspended in this way while taking the levels and marking out the lines for the route, and rivers are led by man's agency to run where there is no place for a man to plant his footsteps. It spoils the operation of washing if the current of the stream carries mud along with it; an earthy sediment of this kind if called* urium. *Consequently, they guide the flow over flint stones and pebbles, and avoid urium. At the head of the waterfall, on the brow of the mountains, reservoirs are excavated measuring* 200 *ft each way and* 10 *ft deep. In these there are left five sluices with apertures measuring about a yard each way, in order that when the reservoir is full the stopping barriers may be struck away and the torrent may burst out with such velocity as sweeping forward the broken rock. This is yet another task to perform on level ground. Trenches are excavated for the water to flow through—the Greek name for them means* leads; *and these, which descend by steps, are floored with* gorse—*his is plant resembles rosemary, which is rough and holds*

back the gold—and the channels are carried on arches over steep pitches. Thus the earth carried along in the stream slides down into the sea, and owing to these causes the land of Spain encroaches a long way into the sea. The material drowned out at such enormous labour in the former kind of mining so as not to fill up the shafts, is in this latter process washed out. The gold obtained by means of an arrugia *does not have to be melted, but is pure gold straight away. In this process nuggets are found, and also in the shafts, weighing more than* 10 *pounds. They are called* palagae, *or else* palcurnae, *and the gold in very small grains*, baluce. *The gorse is dried and burned and its ash is washed on a bed of grassy turf so that the gold is deposited on it. According to some accounts, Asturia and Callaecia and Lusitania produced in this way* 20,000 *lbs in weight of gold a year, Asturia supplying the largest amount. Nor has there been in any other part of the world such a continuous production of gold for so many centuries. We have stated that by an old prohibiting decree of the senate, Italy is protected from exploitation; otherwise no country would have been more productive in metals, as well as in crops. There is extant a ruling of the censors relating to the gold mines of Victumulae in the territory of the Vercellae, which prohibited the farmers in receipt of public revenue from having more than* 5000 *men engaged in the work.*

2.5. Other Quotations

The below handful of quotes refer to another aspect of the gold mines. The author does not state that the contents of these quotes are factual and took place as said; she is merely repeating what was believed at time and found worth mentioning their works. As mentioned above Agatharchidus describes "condemnati" or "political prisoners" in his works which have been repeated by Diodorus 3.12-14 (above) and Photius (below). Strabo also refers to people being banished to the mines under the reign of Alexander the Great in book 11.14.8. In book 31.08 Diodorus speaks of Romans oppressing locals and how they confiscated a mine in Cappadocia. These are only a few examples, but it highlights that mines and most likely also quarries were used to hold unwanted groups of people and that not all working there were free contractors.

Tacitus Tiberius (Grant, 1989: pp. 7-10)

Publius (or Gaius) Cornelius Tacitus, born around AD56 or 57 to a family from the south of France or north of Italy (Cisalpine Gaul), may have survived the days of Trajan (AD98-117) and part of the reign of Hadrian (AD117-137). A member of the provincial upper class, he was a famous orator and senator and a friend and teacher of Pliny the Younger, and held the highest metropolitan position, governorship of the province of Anatolia (Asia). His works *The Annals of Imperial Rome* consisted of 10 books covering the period AD14 to the reign of Nero, and were his last and greatest work, which, together with *The Histories*, (AD14-96) were his only historical books.

He writes how Tiberius went to lengths to confiscate a profitable Spanish gold mine that was privately owned: *The gold and copper mines owned by Sextus Mar-*

ius were confiscated by Tiberius on the grounds of an allegation of incest with his daughter. Although the state confiscated the mine, *Tiberius considered it as his property* (Grant, 1989: p. 209; Roux Le, 1989: p. 176). This is believed to have happened in Iberia in the first century BC.

Suetonius Gaius (Galigula) (Graves, 1989: pp. 7-11)

Gaius Suetonius Tranquillus, born around AD75, came from Hippa Regius (now Algeria). He practiced law and served in Bithynia Pontus (north Asia Minor) on the staff of Pliny the Younger in c. AD110-12. Suetonius was a Roman knight (*eques*) and held a succession of posts at the imperial court under Trajan (AD98-117) and Hadrian (AD117-38). He was also a biographer and his book *The Lives of the Caesars* covers the lives of 12 Caesars from Julius (49-44BC) to Domitian (AD96) and is 97% complete.

He refers to the use of political prisoners in the mines as an alternative to putting them in chain gangs of feed them to the wild beasts in the arena in book 27: *Emperor Galigula was so cruel that he would* "*brand many men of decent families and send them down the mines*, *or put them on the roads or throw them to the wild beasts*" (Graves, 1989: p. 167). These types of comments and descriptions are the only sources of proof that not all miners (*fossor*) worked in the mines on a voluntary basis and has been discussed by modern scholars such as Orejas & Sánchez-Palencia (2002). *In situ* proof of their presence is often hard to find as their accommodation would have been hastily constructed, if they were given any at all. If they were housed elsewhere, it would still be impossible to see the difference between the accommodation used by forced and free labour, as when the mine was abandoned the inhabitants took everything perishable with them and poorly built remains would have been destroyed.

Paulus Sententiae (Corcoran, 2013: p. 6152)

The *Sententiae* (Sentences or Opinions) of Paulus are a pseudonymous Late Antique legal compilation. They do not survive in their original form but were reconstructed from their reuse in other works. The *Sententiae* are an edited miscellany of Paulus' material probably put together in North Africa ca AD300; they are compiled in five books. Most deal with private law.

His quote shows a distinction between the social classes; banishment to the mines was considered too harsh for the upper class, book 5.23.14: "*Those who give a drink to induce an abortion or sexual passion*, *even though they do not do so to deceive*, *nevertheless*, *because it is an act of bad example*, *people of the lower ranks are banished to a mine*, *those of the higher social ranks to an island after being deprived of part of their property. But if*, *as a consequence*, *a woman or a man should die*, *such persons are punished with the supreme penalty*" (Shrek, 2001: p. 206, on Cornelian Law).

Arrian (De Sélincourt, 1971: pp. 13-17)

Arrian Flavius Arrianus Xenophon was probably born a few years before AD90 in Nicomedia, a province of Bithynia, into a Greek family, though, like his father, he was a Roman citizen by birth, having likely received citizenship from Vespasian

(AD69-79). He was the pupil of the philosopher Epictetus and had a career in the imperial services, holding the position of chief magistrate in Rome and Athens, and governor of one of the provinces on the Roman frontier. Later he became an Athenian citizen and died at some point in AD173-180. He is also known as the author of the *Campaigns of Alexander* (the Great), as well as of numerous books on history and philosophy, and of biographies.

He repeats the gold-digging ant story with a bit more skeptically in book 5.4*:* "*Odd things have been invented for diversion rather than as serious history, in the belief that none of the absurd stories they tell about India are likely to be brought to the test of truth.*" *He further writes that Alexander and his men have debunked these stories and that India, in fact, has no gold*, "*except in a few cases where they themselves were guilty of invention*" (De Sélincourt, 1971: p. 260. Herodotus (3.102-05), Pliny (*Naturalis Historia* XXXIII.21) and Strabo (15.1.37/44/69 and 16.5.15) all described the gold-digging ants with varying degrees of belief).

Photius (Burnstein, 1989: pp. 21-22)

Photius was a ninth-century Byzantine patriarch and classical scholar whose publication *Bibliotheca*, Codex 250, contains sections of Agatharchidus' *On the Erythraean Sea* copied almost verbatim. His version is known as the best copy of Agatharchidus' work on gold mining in the Eastern Desert of Egypt as he could still read much of it in its original form. The *Bibliotheca* is a compilation of 279 reviews of books from various authors, dated between the fifth and ninth centuries AD, though many of the books he refers to no longer exist.

He repeats the citation from Agatharchidus' account of the Eastern Desert of Egypt, which has also been copied by Strabo (16.4.5-20, but Strabo had actually copied the information from *Artemidorus* of *Ephesus*), Diodorus (3.12-14) and Photius (59-66). Burnstein states that although Photius is the least well-known writer he gives the most accurate copy of Agatharchidus' work. Diodorus' copies are often more prosaic than factual. Strabo's version does not mention gold mines; he only refers briefly to the topaz mines and appeared to be more interested in the various population groups living in and close to the desert (Strabo, 16.4.5-20) (Meyer et al., 2003: pp. 37-44; Burnstein, 1989: pp. 57-68).

3. Conclusion

This article is a compilation of what was written about mining and gold during the Roman era as that was the focus of the author's project. These quotes were collected as part of a comparison exercise with what is known from modern day archaeology. It is common practice to see what the contemporarily knowledge was prior to study more technologically accurate and visible evidence. An excellent example of a similar comparison is J. Ball (1872-1941), who combined his professional knowledge of the district with a personal interest in archaeology and whose publication, *Egypt and the Classical Geographers*, has acted as a source of information and understanding about the classical (land) measuring system and is a publication still high on the consultation list for those planning surveys in this

desert (Ball, 1942). He stated that the Romans had the names right but there were some inconsistencies with distances and locations. Care must be taken with classical references to mining gold and should only be used as anecdotal. It does offer an explanation on how mining and gold were perceived over time. The writings of Agatharchidus of Cnidos about an underground gold mine in the Eastern Desert of Egypt have been lost apart from a description saved first by Diodorus of Siculus and later by Photius, in the first century BC and ninth century AD respectively. This is the only detailed description of a mine in Egypt. Diodorus wrote many books on his travels, in which he describes gold mines and trade in this precious mineral in Arabia (Arabia Felix), the Gulf of Corinth, Gaul, Iberia and Greece. Strabo was more focused on the western region, writing a history of mining in Iberia. He is also a valuable source on the struggle of the local population against the Romans, who invaded, usurped and affected the gold industry and trade, such as the Taurisci and the Salassi in the Italian Alps. Like many classical writers, Strabo also wrote about India, Arabia, the Red Sea coast of Egypt and Ethiopia. Pliny the Elder was working as a procurator in the Iberian Peninsula when he wrote a detailed essay explaining the technology of gold mining in the province. Even though he wrote about India, the Persian Gulf, Nubia and the Eastern Desert (Egypt), Pliny was skeptical about fictional stories from this part of the world.

From literary sources and later archaeological findings it seems that (Iberian) gold only became known to the classical world after the Roman conquest. However, it seems unlikely that the indigenous people were unaware of the presence of this precious mineral in their region, though they may not have realized its economic value or mined it on a scale comparable to that of the Romans. The casualness in which the writers speak about gold and its applications is confirmation that this precious metal has been valued for a longer time than when the romans came onto the playing field. The extraction and trade in gold just became industrialized in the Roman era. As communication improved and the administration was run in a more professional manner, mining settlements became known to the classical world and classical documentation on Roman mines increased as more was written down by travellers/scholars who visited them. This resulted in increased interest and understanding of the industry in the classical world and a gradual loss of gold's mythical character. Classical literary sources on Roman mining are mostly accurate for mines in the western provinces but become more mythical for the east, such as when talking about gold-digging ants in India (Herodotus 3.102-05). We know that classical writers such as Pliny the Elder, Strabo and Diodorus had visited the mines they wrote about and that their technical descriptions are trustworthy, but their theories on the origin of the gold lack any reality.

For the Western Roman Empire, the author visited Dolaucothi, S Wales UK and Las Médulas, NW Spain (For Dolaucothi see Burnham and Burnham who excavated there in the early 2000s) (Burnham & Burnham, 2004). For Las Medulas see Orejas et al. who excavated there with a large team in the 1990s (Orejas &

Sánchez-Palencia, 2002). Dolaucothi was a primary mine, where the miners dug out the gold ore through tunnels and sub-surface galleries. Pliny describes this method in NH 33.21 and Strabo in Geography 3.2.8. (Burnham and Burnham, Orejas) Las Médulas was a secondary mine where the gold was found in the pre-historic river sediment. Pliny in NH 33.21 discusses how water was used to break down this softer dirty and the dangerous work of digging to prepare for the method he names *ruinea montium* (Forbes, 1966: p. 112). Strabo in Geography 11.2.19 also describes the use of water to expose the gold in softer soils.

For the Eastern Roman Empire, the author visited Wadi Bakariya, Wadi Dagh-bag and Sokari in the Eastern desert of Egypt (Tratsaert, 2004, 2005, 2012). All three are primary mines, however only in Sokari they dug subsurface galleries. The mines in the other two were on outcropping veins that never really dived deep underground. The description provided by Agatharchidus fits the mine at Sokari; Strabo in Geography 3.2.8 can also be used as a description of these mines.

One large aspect of classical Roman era that is absent from the quotes in this article is the army. The author found only one mention of "foreign soldiers" by Agatharchidus that has been repeated by at least two later authors (Diodorus and Photius). Our understanding of their involvement comes from other sources such as the inscribed tablets found at western Roman imperial mining settlements such as Metallum Vipascense (modern Aljustrel, Portugal) that describe the organization this settlement. These date to the reign of Hadrian (AD117-38) and describe this site as a professional operation with both state and private entrepreneurs (Hirt, 2010: pp. 48-49, 226; Rickard, 1932: p. 437). For the eastern desert of Egypt it is known that soldiers were based at the imperial quarries (Mons Claudianus and Porphyry) where ostraca were found mentioning their presence (Jackson, 2002: p. 48). And from modern researches in this desert by Cuvingy and Sidebotham (Cuvigny, 1998, 2005; Sidebotham et al., 2008). The former studied a group of road stations and the latter surveyed the area and has been excavating Berenike and surroundings. Therefore, the author feels only a brief mention of military input at the gold mines in entire Roman Empire can be given as this is beyond the scope of this article.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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