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"INDUSTRIAL" ROCKS AND MINERALS IN STRABO'S ANCIENT WORLD (1ST CENTURY A.D.)

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Abstract

Industrial rocks and minerals of the modern world comprise of natural products applied in e.g. energy, cement, plastics, fillers, food, computer hardware etc. Indeed, the applications of these minerals are enormous and versatile. On the other hand, industrialization had not occurred during the 1st century A.D., when Strabo, the famous geographer of the Roman era lived. Thus, the term "industrial" used in this study has a rather philological meaning and refers to the useful rocks and minerals in the ancient times. Metallic ores (copper, iron, zinc etc.), precious metals (gold, silver) and earth minerals (e.g. Kimolo's earth, Chalkidiki's earth, Sinopi's earth etc.) are not included in this study. Humans of the antiquity needed building rocks, medical and pharmaceautical minerals, fertilizers for their crops, sealing agents and millstones, just to mention a few of them. The identification and classification of these valuable "industrial" rocks and minerals, mentioned in Strabo's Geographica, is the scope of this work. The spatial distribution of these mineral resources in the ancient world of that time, is also studied. The main industrial rocks and minerals are (in descending order of the number of citations): salt, marble, asphalt, quarry rocks, sulphur, millstones, pyroclastics, clays, soda (sodium carbonate), naphtha (petroleum), asbestos and sand.
Keywords: *Strabo's Geographica, antiquity, salt, marble, asphalt.*

Περίληψη

Στην παρούσα μελέτη ερευνώνται σχολαστικά τα δεκαεπτά βιβλία των Γεωγραφικών του αρχαίου γεωγράφου Στράβωνα (1ος αι. μ.Χ.), με σκοπό να καταγραφούν τα σημαίνοντα «βιομηχανικά» ορυκτά και πετρώματα της αρχαιότητας, σύμφωνα πάντα με τον Στράβωνα. Με τον όρο «βιομηχανικά» βέβαια αναφερόμαστε στις χρήσιμες για την καθημερινή ζωή των αρχαίων ανθρώπων πρώτες ύλες, π.χ. κατασκευαστικά και διακοσμητικά πετρώματα, εδαφοβελτιωτικά, στεγανοποιητικά υλικά, μυλόπετρες κλπ. Πρέπει να τονιστεί ότι η παρούσα μελέτη δεν περιλαμβάνει τα μεταλλικά ορυκτά (σίδηρος, χαλκός, ψευδάργυρος κλπ.) και τις γαίες (Σινωπική, Κιμώλου, Χαλκιδικής κ.α.). Τα σημαντικότερα, κατά Στράβωνα, «βιομηχανικά» ορυκτά και πετρώματα είναι με φθίνουσα, όσο αφορά το πλήθος αναφορών, σειρά: αλάτι, μάρμαρο, φυσική άσφαλτος, λατομικά προϊόντα, θείο, μυλόπετρες, πυροκλαστικά, άργιλοι, σόδα (ανθρακικό νάτριο), νάφθα (πετρέλαιο), αμίαντος και άμμος. Η κατανομή αυτών των ορυκτών πρώτων υλών στον τότε γνωστό κόσμο περιλαμβάνεται επίσης στην παρούσα μελέτη.
Λέξεις Κλειδιά: *Γεωγραφικά, Στράβωνας, βιομηχανικά ορυκτά και πετρώματα, αλάτι, μάρμαρο, φυσική άσφαλτος, αρχαιότητα.*

1. Strabo's Geography and Mineral Resources

Strabo, (born c. 64 BCE, Amaseia, Pontus-died after 21 CE), is a Greek geographer and historian whose Geography is the only extant work covering the whole range of peoples and countries known to both Greeks and Romans during the reign of Augustus (Brittanica, 2015; Strabo, 1815, 1917, 1994). Geography *(Γεωγραφικά)* comprises of seventeen books, which present a descriptive history of people and places from different regions of the world known to his era. The geological information provided by Strabo is notable and has been documented by several scholars (Iordanidis, 2014).

The main mineral resources exploited in antiquity are discussed in *Geography*, implying that the exploitation of these resources had always been of paramount importance in human life. While the metallic ores were always significant (Wellmer and Becker-Platen, 2007), we emphasize in the present study in the non-metallic resources, i.e. the "industrial" rocks and minerals. The term "industrial" used in this study has a rather philological meaning and refers to the useful rocks and minerals in the ancient times. Metallic ores (copper, iron, zinc etc.), precious metals (gold, silver) and earth minerals (e.g. Kimolo's earth, Chalkidiki's earth, Sinopi's earth etc.) are not included in this study. These "industrial" rocks and minerals, which are documented in Strabo's *Geography* are recorded and classified in our study, along with their geographical distribution in the ancient world.

2. Principal "industrial" rocks and minerals

The scope of this work is the comprehensive study of the essential mineral resources, emphasizing in the "industrial" rocks and minerals, mentioned in Strabo's *Geography*. A plethora of minerals and rocks is recorded and all information is summarized in the Tables 1-5. The principal mineral resources documented by Strabo are, in descending order (considering the times mentioned within the text): salt, marble, asphalt, quarry rocks, sulphur, millstones, pyroclastics, clays, soda (sodium carbonate), naphtha (petroleum), asbestos and sand.

Figure 1 - The ancient Roman salt mine in Cardona, western Spain (Iberia), as it looks today.

2.1 Salt (ἅλας)

Salt is generally recognized to have been an important commodity in ancient times. It is well-known that a certain intake of salt is required for human health, and also for animal health, notwithstanding the preservation of food, its curative properties, and other applications (Wilson, 2006; Harding,

2014). It is thus obvious that salt is the mineral mostly mentioned in Geography. It has also been cited by several other ancient scholars, e.g. Herodotus (book 4, paragraph 185) refers to salt mines and salt houses in Libya (northern Africa). The exploitation regions include India, central Italy, Sicily, Caucasus, Iberia (Fig. 1), Media, Armenia, Pontus, Galatia, Ethiopia, Carmania and Syria (Table 1).

2.2 Marble (μάρμαρο) and Quarry rocks (λατομικά)

Marble and Quarry rocks are the second most significant resource according to Strabo's citations within *Geography*. Marbles were, and still are, used for building public monuments, statues, sanctuaries and other building projects. Quarry stones had also numerous applications as construction material. Marbles had a large variety in colour, quality and form and there were transported by sea with a relative ease (Wilson, 2006). All these rocks are distributed throughout the ancient world, including the places below: Tyrrhenia and Umbria (central Italy), Illyria, Attica. Thessaly, Cyclades, Arcadia, Ionia, Troad, Syria (for marbles, see Table 2) and Latium (northwestern Italy), Galatia, Laconia, Attica and Tyrrhenia (for quarry rocks, see Table 3).

Figure 2 – A natural asphalt lake in Trinidad in present times. (photo by http://www.vaasphalt.org).

2.3 Asphalt (πίσσα)

The first recorded use of asphalt (Fig. 2) as a road-building material was in Babylon. Herodotus (book 1, paragraph 179) cites the use of asphalt in the sealing of boats and the construction of bricks in Babylon. The ancient Mesopotamians used it to waterproof temple baths and water tanks. The Phoenicians caulked the seams of their merchant ships with asphalt. In the days of the Pharaohs, Egyptians used the material as mortar for rocks laid along the banks of the Nile to prevent erosion, and the infant Moses' basket was waterproofed with asphalt. The ancient Greeks were also familiar with asphalt. The word asphalt comes from the Greek "asphaltos," meaning "secure." The Romans used it to seal their baths, reservoirs and aqueducts. The geographical distribution of asphalt, based on Strabo's citations, contains regions which are known to have bitumen deposits even nowadays, i.e. Illyria, Thessaly Bactria, Iberia, northern Italy, Persia and Syria (Table 4).

2.4 Other mineral resources

The other, less cited, "industrial" rocks and minerals by Strabo are, in descending (number of citations) order: sulphur, millstones, pyroclastics, clay, soda, naphtha, asbestos and sand (Table 5).

Table 1 - Salt mines and exploitation in Strabo's Geographica (citations by Book, Chapter and Paragraph).

No	Book	Cha	Par	Original Greek text	English Translation
1	V	2	6	καὶ τὰς ἐν Ἰνδοῖς ἅλας	the salt-rock in India
2	VI	2	9	θερμῶν γοῦν ὑδάτων ἀναβολὰς κατὰ πολλοὺς ἔχει τόπους ἡ νῆσος, ὧν τὰ μὲν Σελινούντια καὶ τὰ Ἱμεραῖα ἁλμυρά ἐστι, τὰ δὲ Αἰγεσταῖα πότιμα περὶ Ἀκράγαντα δὲ λίμναι τὴν μὲν γεῦσιν ἔχουσαι θαλάττης	the island has at many places springs of hot waters which spout up, of which those of Selinus and those of Himera are brackish, whereas those of Aegesta are potable. Near Acragas are lakes which, though they have the taste of sea-water
3	XI	5	6	**συνέρχονται δὲ τὸ πλεῖστον ἁλῶν χάριν.**	and they assemble there mostly in order to get salt
4	III	2	6	ἅλες τε ὀρυκτοὶ παρ᾽ αὐτοῖς εἰσι καὶ ποταμῶν ἁλμυρῶν ῥεύματα οὐκ ὀλίγα	and they have salt quarries in their country, and not a few streams of salt water
5	III	3	7	ἅλες πορφυροῖ, τριφθέντες δὲ λευκοί	Their rock-salt is red, but when crushed it is white.
6	XI	13	2	ἐν ᾗ ἅλες ἐπανθοῦντες πήττονται· εἰσὶ δὲ κνησμώδεις καὶ ἐπαλγεῖς·	in which salts effloresce and solidify. These salts cause itching and are painful
7	XI	14	8	Μαντιανὴ (Κυανέα μεθερμηνευθεῖσα), μεγίστη, ὥς φασι, μετὰ τὴν Μαιῶτιν, ἁλμυροῦ ὕδατος, διήκουσα μέχρι τῆς Ἀτροπατίας, ἔχουσα καὶ ἁλοπήγια· ἡ δὲ, Ἀρσηνὴ, ἣν καὶ Θωνῖτιν	the Mantianê, which being translated means "Blue"; it is the largest salt-water lake after Lake Maeotis, as they say, extending as far as Atropatia; and it also has salt-works.
8	XII	3	12	Ἐντεῦθεν δ᾽ ἐφεξῆς ἡ τοῦ Ἅλυος ἐκβολὴ ποταμοῦ· ὠνόμασται δ᾽ ἀπὸ τῶν ἁλῶν, οὓς παραῤῥεῖ·	Halys River. It was named from the "halae," past which it flows.
9	XII	3	37, 39	**ἐχούσας ὀρυκτοὺς ἅλας ἐν τῇ Ξιμηνῇ ἅλες ὀρυκτοί**	they contain rock-salt, In Ximenê there are "halae" of rock salt
10	XII	5	4	μὲν οὖν Τάττα ἁλοπήγιόν ἐστιν αὐτοφυές· οὕτω δὲ περιπήττεται ῥᾳδίως τὸ ὕδωρ παντὶ τῷ βαπτισθέντι εἰς αὐτὸ, ὥστε στεφάνους ἁλῶν ἀνέλκουσιν, ἐπειδὰν καθῶσι κύκλον σχοίνινον· τά τε	Lake Tatta is a natural salt-pan; and the water so easily congeals round everything that is immersed in it, that when people let down into it rings made of rope they draw up wreaths of salt,
11	XVII	2	2	**Ὀρυκτοὶ δὲ ἅλες**	And they have quarried salt
12	XV	1	30	**ἐν τῇ Σωπείθους χώρα ὀρυκτῶν ἁλῶν ὄρος εἶναι**	in the country of Sopeithes there is a mountain of mineral salt sufficient for the whole of India.
13	XV	2	14	**ὄρη τε εἶναι δύο, τὸ μὲν ἀρσενικοῦ, τὸ δὲ ἁλός.**	there are two mountains, one consisting of arsenic and the other of salt.
14	XVI	3	3	δαίων φυγάδων ἐκ Βαβυλῶνος, οἰκούντων τὴν ἁλμυρίδα, καὶ ἐχόντων ἁλίνας τὰς οἰκίας· ἐπεὶ δὲ λεπίδες τῶν ἁλῶν, ἀφισάμεναι κατὰ την ἐπίκαυσιν τὴν ἐκ τῶν ἡλίων, συνεχεῖς ἀπο-	the soil contains salt and the people live in houses made of salt; and since flakes of salt continually scale off, owing to the scorching heat of the rays of the sun,

Table 2 - Marble quarrying in Strabo's Geographica (citations by Book, Chapter and Paragraph).

No	Book	Cha	Par	Original Greek text	English Translation
1	V	2	6	τὴν ἐν Πάρωι πέτραν τὴν μάρμαρον	the marble-rock in Paros
2	XIV	1	35	Ἔχει δ' ἡ νῆσος καὶ λατόμιον μαρμάρου λίθου.	And the island also has a marble quarry
3	IX	1	23	δαλός. Μαρμάρου δ' ἐστὶ τῆς τε Ὑμηττίας καὶ τῆς Πεντελικῆς καλλίστα μέταλλα πλησίον τῆς πόλεως· ὁ δ' Ὑμηττὸς καὶ μέλι	Near the city are most excellent quarries of marble, the Hymettian and Pentelic.
4	IX	5	16	τὰ μέταλλα τῆς ποικίλης λίθου τῆς Σκυρίας, καθάπερ τῆς Καρυστίας, καὶ τῆς Λευκολλείου, καὶ τῆς Συνναδικῆς, καὶ Ἱεραπολιτικῆς. Μονολίθους γὰρ κίονας καὶ πλάκας μεγάλας ὁρᾶν ἔστιν ἐν τῇ Ῥώμῃ τῆς ποικίλης λιθίας, ὑφ' ἧς ἡ πόλις κοσμεῖται δημοσίᾳ τε καὶ ἰδίᾳ· πεποίηκέ τε τὰ λευκόλιθα οὐ πολλοῦ ἄξια.	the quarries of the Scyrian variegated marble, which is comparable to the Carystian marble, and to the Docimaean or Synnadic and to the Hierapolitic. For at Rome are to be seen monolithic columns and great slabs of the variegated marble; and with this marble the city is being adorned both at public and at private expense; and it has caused the quarries of white marble to be of little worth.
5	V	2	5	μέταλλα δὲ λίθου λευκοῦ τε καὶ ποικίλου γλαυκίζοντος τοσαῦτά τ᾽ ἐστὶ καὶ τηλικαῦτα, μονολίθους ἐκδιδόντα πλάκας καὶ στύλους, ὥστε τὰ πλεῖστα τῶν ἐκπρεπῶν ἔργων τῶν ἐν τῇι Ῥώμηι καὶ ταῖς ἄλλαις πόλεσιν ἐντεῦθεν ἔχειν τὴν χορηγίαν·καὶ γὰρ εὐεξάγωγός ἐστιν ἡ λίθος, τῶν μετάλλων ὑπερκειμένων τῆς θαλάττης πλησίον, ἐκ δὲ τῆς θαλάττης διαδεχομένου τοῦ Τιβέριος τὴν κομιδήν·	And the quarries of marble, both white and mottled bluish-grey marble, are so numerous, and of such quality (for they yield monolithic slabs and columns), that the material for most of the superior works of art in Rome and the rest of the cities are supplied there from; and, indeed, the marble is easy to export, since the quarries lie above the sea and p351near it.
6	X	5	7	δὲ τῇ Πάρῳ ἡ Παρία λίθος λεγομένη, ἀρίστη πρὸς τὴν μαρμαρογλυφίαν.	and so is the Parian stone, as it is called, in Paros, the best for sculpture in marble.
7	XII	8	14	κιμία κώμη, καὶ τὸ λατόμιον τοῦ Συνναδικοῦ λίθου (οὕτω μὲν [γὰρ] Ῥωμαῖοι καλοῦσιν, οἱ δ' ἐπιχώριοι Δοκιμίτην, καὶ Δοκιμαῖον), κατ' ἀρχὰς μὲν μικρὰς βώλους ἐκδιδόντος τοῦ μετάλλου· διὰ δὲ τὴν νυνὶ πολυτέλειαν τῶν Ῥωμαίων κίονες ἐξαιροῦνται μονόλιθοι μεγάλοι, πλησιάζοντες τῷ ἀλαβαστρίτῃ λίθῳ κατὰ τὴν ποικιλίαν· ὥστε, καίπερ πολλῆς οὔσης τῆς ἐπὶ θάλατταν ἀγωγῆς τῶν τηλικούτων φορτίων, ὅμως καὶ κίονες καὶ πλάκες εἰς Ῥώμην κομίζονται θαυμασταὶ κατὰ τὸ μέγεθος καὶ κάλλος.	the quarry of "Synnadic" marble (so the Romans call it, though the natives call it "Docimite" or "Docimaean"). At first this quarry yielded only stones of small size, but on account of the present extravagance of the Romans great monolithic pillars are taken from it, which in their variety of colours are nearly like the alabastrite marble; so that, although the transportation of such heavy burdens to the sea is difficult, still, both pillars and slabs, remarkable for their size and beauty, are conveyed to Rome.

8	XIV	2	23	κάλλιστον ἔχον· τοῦτο μὲν ὄφελός ἐστιν οὐ μικρὸν τὴν λιθίαν πρὸς τὰς οἰκοδομίας ἄφθονον καὶ ἐγγύθεν ἔχον, καὶ μάλιστα πρὸς τὰς τῶν ἱερῶν, καὶ τῶν ἄλλων δημοσίων ἔργων κατασκευάς· τοιγάρτοι στοαῖς τε καὶ ναοῖς, εἴ τις ἄλλη, κεκόσμηται παγκάλως. Θαυμάζειν δ' ἐστὶ τῶν ὑποβαλόντων οὕτως ἀλόλαιὰ Προκόννησός ἐστι καὶ ἡ νῦν Προκόννησος, πόλιν ἔχουσα, καὶ μέταλλον μέγα λευκοῦ λίθου, σφόδρα ἐπαινούμενον· τὰ γοῦν . κάλλιστα τῶν ταύτῃ πόλεων ἔργα, ἐν δὲ τοῖς, πρῶτα τὰ ἐν Κυζίκῳ, ταύτης ἐστὶ τῆς λίθου. Ἐντεῦθεν ἐστὶν Ἀριστέας, ὁ	Mylasa which has a most excellent quarry of white marble. Now this quarry is of no small advantage, since it has stone in abundance and close at hand, for building purposes and in particular for the building of temples and other public works
9	XIII	1	16		The present Proconnesus, the latter having a city and also a great quarry of white marble that is very highly commended; 589at any rate, the most beautiful works of art in the cities of that part of the world, and especially those in Cyzicus, are made of this marble.

Table 3 - Quarrying stones in Strabo's Geographica (citations by Book, Chapter and Paragraph).

No	Book	Cha	Par	Original Greek text	English Translation
1	V	3	10 11	ἐν τῆι Πραινεστίνηι ὁ δῶι κειμένη, λατόμιον ἔχουσα ὑπουργὸν τῆι Ρώμηι μάλιστα τῶν ἄλλων // πεδίον εὐκαρπότατον παρὰ τὰ μέταλλα τοῦ λίθου τοῦ Τιβουρτίνου καὶ τοῦ ἐν Γαβίοις τοῦ καὶ ἐρυθροῦ λεγομένου, ὥστε τὴν ἐκ τῶν μετάλλων ἐξαγωγὴν καὶ τὴν πορθμείαν εὐμαρῆ τελέως εἶναι, τῶν πλείστων ἔργων τῆς Ρώμης ἐντεῦθεν κατασκευαζομένων.	Gabii, situated on the Praenestine Way, with a rock-quarry that is more serviceable to Rome than any other // the quarries of the Tiburtine stone, and of the stone of Gabii, what is called "red stone"; so that the delivery from the quarries and the transportation by water are perfectly easy - most of the works of art at Rome being constructed of stone brought thence.
2	IV	1	6	ἐπὶ ἄκραν εὐμεγέθη πλησίον λατομιῶν τινων	a fair-sized promontory near some stone-quarries,
3	VIII	5	7	εἰσὶ δὲ λατομίαι λίθου πολυτελοῦς τοῦ μὲν Ταιναρίου ἐν Ταινάρωι παλαιαί, νεωστὶ δὲ καὶ ἐν τῶι Ταϋγέτωι μέταλλον ἀνέωιξάν τινες εὐμέγεθες, χορηγὸν ἔχοντες τὴν τῶν Ῥωμαίων πολυτέλειαν.	And there are quarries of very costly marble - the old quarries of Taenarian marble on Taenarum; and recently some men have opened a large quarry in Taÿgetus, being supported in their undertaking by the extravagance of the Romans.
4	IX	1	13	ἡ Ἀμφιάλη, καὶ τὸ ὑπερκείμενον λατόμιον,	Cape Amphiale and the quarry that lies above it,
5	V	2	1	τραχεῖαν γῆν ἀροῦντες καὶ σκάπτοντες, μᾶλλον δὲ λατομοῦντες	plowing and digging rough land, or rather, as Poseidonius says, quarrying stones.

Table 4 - Natural asphalt (πίσσα) in Strabo's Geographica (citations by Book, Chapter and Paragraph).

No	Book	Cha	Par	Original Greek text	English Translation
1	XVI	2	42 44 45	ἐξαίρεσθαι· μεσὴ δ' ἐστὶν ἀσφάλτου αὕτη· τοῦτο δὲ ἀναφυσᾶται κατὰ καιροὺς ἀτάκτους ἐκ μέσου τοῦ βάθους μετὰ πομφολύγων, ὡς ἂν ζέοντος ὕδατος· κυρτουμένη δ' ἡ ἐπιφάνεια, λόφου ἀσφαλτωδῶν τε καὶ θειωδῶν, χρῶνται δ' Αἰγύπτιοι τῇ ἀσφάλτῳ πρὸς τὰς ταριχείας τῶν νεκρῶν.	It is full of asphalt. The asphalt is blown to the surface at irregular intervals from the midst of the deep, and with it rise bubbles, // of hot waters containing asphalt and sulphur // The Aegyptians use the asphalt for embalming the bodies of the dead
2	VII	5	8	ὑπ᾽ αὐτῆι δὲ κρῆναι ῥέουσι χλιαροῦ καὶ ἀσφάλτου, καιομένης, ὡς εἰκός, τῆς βώλου τῆς ἀσφαλτίτιδος· μέταλλον δ᾽ αὐτῆς ἔστι πλησίον ἐπὶ λόφου· τὸ δὲ τμηθὲν ἐκπληροῦται πάλιν τῶι χρόνωι, τῆς ἐγχωννυμένης εἰς τὰ ὀρύγματα γῆς μεταβαλλούσης εἰς ἄσφαλτον Λέγει δ᾽ ἐκεῖνος καὶ τὴν ἀμπελῖτιν γῆν ἀσφαλτώδη τὴν ἐν Σελευκείαι τῆι Πιερίαι μεταλλευομένην ἄκος τῆς φθειριώσης ἀμπέλου τοιαύτην δ᾽ εὑρεθῆναι καὶ ἐν Ῥόδωι,	is a mine of asphalt; and the part that is trenched is filled up again in the course of time, since, as Poseidonius says, the earth that is poured into the trenches changes to asphalt. He also speaks of the asphaltic vine-earth which is mined at the Pierian Seleuceia as a cure for the infested vine earth of this sort was also discovered in Rhodes
3	VI	1	9	ὁ δρυμὸς ὁ φέρων τὴν ἀρίστην πίτταν τὴν Βρεττίαν	the forest that produces the best pitch
4	IX	5	20	Πηνειόν. Τὸ μὲν οὖν τοῦ Πηνειοῦ καθαρόν ἐστιν ὕδωρ τὸ δὲ τοῦ Τιταρησίου λιπαρὸν ἔκ τινος ὕλης, ὥσ᾽ οὐ συμμίσγεται· Ἀλλά τέ μιν καθύπερθεν ἐπιτρέχει, ἠύτ᾽ ἔλαιον.	Now the water of the Peneius is pure, but that of the Titaresius is oily, because of some substance or other, so that it does not mingle with that of the Peneius, "but runs over it on the top like oil.
5	XI	11	5	Ἀρίων ῥέοντα. Τοῦ δὲ Ὤχου ποταμοῦ πλησίον ὀρύττοντας, εὑρεῖν ἐλαίου πηγὴν λέγουσιν· εἰκὸς δὲ, ὥσπερ νιτρώδη τινὰ, καὶ στύφοντα ὑγρὰ, καὶ ἀσφαλτώδη, καὶ θειώδη διαῤῥεῖ τὴν γῆν, οὕτω καὶ λιπαρὰ εὑρίσκεσθαι· τὸ δὲ σπάνιον ποιεῖ τὴν	It is said that people digging near the Ochus River found a spring of oil. It is reasonable to suppose that, just as nitrous and astringent and bituminous and sulphurous liquids flow through the earth, so also oily liquids are found;
6	III	2	6	καὶ πίττα ἐξάγεται	and pitch are exported from there
7	V	1	12	ἔχει δὲ καὶ πιττουργεῖα θαυμαστά.	The country has wonderful pitch-works
8	XV	3	2	Μέμνονι διθυράμβῳ τῶν Δηλιακῶν. Τὸ δὲ τεῖχος ᾠκοδόμητο τῆς πόλεως, καὶ ἱερὰ, καὶ βασίλεια παραπλησίως, ὥσπερ τὰ τῶν Βαβυλωνίων ἐξ ὀπτῆς πλίνθου καὶ ἀσφάλτου, καθάπερ	The wall and the temples and the royal palace were built like those of the Babylonians, of baked brick and asphalt,

Table 5 - Other mineral resources (sulphur, millstone, pyroclastics, clays, soda (sodium carbonate), naphtha (petroleum), asbestos and sand) in Strabo's Geographica (citations by Book, Chapter and Paragraph).

Type	Book	Cha	Par	Original Greek text	English Translation
SULPHUR	XVI	2	44	ἀσφαλτωδῶν τε καὶ θειωδῶν,	of hot waters containing asphalt and sulphur,
SULPHUR	XI	11	5	ὑγρὰ, καὶ ἀσφαλτώδη, καὶ θειώδη	and bituminous and sulphurous liquids flow
SULPHUR	V	4	6	τὸ χωρίον ἐκεῖ μέχρι Βαιῶν καὶ τῆς Κυμαίας θείου πλῆρές ἐστι // τὸ δὲ πεδίον θείου πλῆρές ἐστι συρτοῦ.	Baiae and Cumae, has a foul smell, because it is full of sulphur // and the plain is full of drifted sulphur.
SULPHUR	XIV	2	7	θείῳ καταῤῥαίνοντας	who pour the water of the Styx mixed with sulphur
MILLSTONE	VI	2	11	γενέσθαι τοῖς μυλίταις λίθοις	became as hard as mill-stone
MILLSTONE	V	5	16	Νίσυρος καὶ ὑψηλὴ, καὶ πετρώδης, τοῦ μυλίου λίθου· τοῖς γοῦν ἀσυγείτοσιν ἐκεῖθέν ἐστιν ἡ τῶν μύλων εὐπορία. Ἔχει δὲ καὶ πό–	Nisyros: is round and high and rocky, the rock being that of which millstones are made; at any rate, the neighbouring peoples well supplied with millstones from there.
MILLSTONE	XIV	1	33	μύλων ἔχουσα λατόμιον.	Melaena, as it is called, which has a millstone quarry //
PYROCLASTIC	V	4	8	ἐκ δὲ τῆς ὄψεως τεφρώδης, καὶ κοιλάδας φαίνει σηραγγώδεις πετρῶν αἰθαλωδῶν κατὰ τὴν χρόαν, ὡς ἂν ἐκβεβρωμένων ὑπὸ πυρός, ὡς τεκμαίροιτ´ ἄν τις τὸ χωρίον τοῦτο καίεσθαι πρότερον καὶ ἔχειν κρατῆρας πυρός, σβεσθῆναι δ´ ἐπιλιπούσης τῆς ὕλης. // τὸ κατατεφρωθὲν μέρος ἐκ τῆς σποδοῦ τῆς ἀνενεχθείσης ὑπὸ τοῦ Αἰτναίου πυρὸς εὐάμπελον τὴν γῆν ἐποίησεν. ἔχει μὲν γὰρ τὸ λιπαῖνον καὶ τὴν ἐκπυρουμένην βῶλον καὶ τὴν ἐκφέρουσαν τοὺς καρπούς	and looks ash-coloured, and it shows pore-like cavities in masses of rock that are soot-coloured on the surface, these masses of rock looking as though they had been eaten out by fire; and hence one might infer that in earlier times this district was on fire and had craters of fire, and then, because the fuel gave out, was quenched. // which had been covered with ash-dust from the hot ashes carried up into the air by the fire of Aetna made the land suited to the vine; for it contains the substance that fattens both the soil which is burnt out and that p455which produces the fruits;
PYROCLASTIC	VI	2	3	ἡ μὲν οὖν σποδὸς λυπήσασα πρὸς καιρὸν εὐεργετεῖ τὴν χώραν χρόνοις ὕστερον·εὐάμπελον γὰρ παρέχεται καὶ χρηστόκαρπον, τῆς ἄλλης οὐχ ὁμοίως οὔσης εὐοίνου·	the Catanaeans are covered with ash-dust to a great depth. Now although the ash is an affliction at the time, it benefits the country in later times, for it renders it fertile and suited to the vine,

CLAYS	IX	5	19	Ὀλοοσσὼν δὲ, λευκὴ προσαγορευθεῖσα ἀπὸ τοῦ λευκάργιλος εἶναι	Oloosson, called "white" from the fact that its soil is a white clay
CLAYS	XIII	1	67	πλήθους ἐπιπολάζειν ἐν τοῖς ὕδασι, καθάπερ καὶ ἐν τῇ Τυρρηνίᾳ γῆ τις [τοῦτο] πέπονθε· κουφοτέρα γὰρ ἡ γῆ τοῦ ἐπίσου ὄγκου ὕδατός ἐστιν, ὥς' ἐποχεῖσθαι. Ἐν Ἰβηρίᾳ δέ φησιν ἰδεῖν Ποσειδώνιος ἔκ τινος γῆς ἀργιλώδους, ᾗ τὰ ἀργυρώματα ἐκμάττεται, πλίνθους πηγνυμένας καὶ ἐπιπλεούσας. Μετὰ δὲ τὴν Πιτάνην ὁ	a certain earth in Tyrrhenia, for the earth is lighter than an equal bulk of water // in Iberia he saw bricks moulded from a clay-like earth, with which silver is cleaned, and that they floated on water.
SODA	XVII	1	23	Ὑπὲρ δὲ Μωμέμφεώς εἰσι δύο νιτρίαι, πλεῖστον νίτρον ἔχουσαι, καὶ νομὸς νιτριώτης. Τιμᾶται δ' ἐνταῦθα ὁ Σάραπις, καὶ	Above Momemphis are two nitre-beds, which contain very large quantities of nitre
SODA	XI	14	8	ἔστι δὲ νιτρῖτις,	It contains soda
NAPHTHA	XVI	1	4	Ἀρταχήνη λέγεται. Πορὶ Ἄρβηλα δέ ἐστι καὶ Δημητριὰς πόλις, ἥ τε τοῦ Νάφθα πηγὴ, καὶ τὰ πυρὰ, καὶ τὸ τῆς Ἀναίας ἱερὸν	and then one comes to the fountain of naphtha
NAPHTHA	XVI	1	15	ὅτι ἡ μὲν ὑγρὰ, ἣν καλοῦσι νάφθαν, γίγνεται ἐν τῇ Σουσίδι	the liquid kind, which is called naphtha, is found in Susis,
ASBESTOS	X	1	6	τὰς Ἀραχνίδας. Ἐν δὲ τῇ Καρύστῳ καὶ ἡ λίθος φύεται ἡ ξαινομένη καὶ ὑφαινομένη, ὥστε τὰ ὕφη χειρόμακτρα γίνεσθαι, ῥυπωθέντα δ' εἰς φλόγα βάλλεσθαι καὶ ἀποκαθαίρεσθαι τὸν πῖνον τῇ πλύσει παραπλησίως· ὠκίσθαι δὲ τὰ χωρία ταῦτά	In Carystus is produced also the stone which is combed and woven, so that the woven material is made into towels, and, when these are soiled, they are thrown into fire and cleansed, just as linens are cleansed by washing.
SAND	XVI	2	25	Μεταξὺ δὲ τῆς Ἄκης καὶ Τύρου θινώδης αἰγιαλός ἐστιν, ὁ φέρων τὴν ὑαλῖτιν ἄμμον· ἐνταῦθα μὲν οὖν φασὶ μὴ χεῖσθαι· κομισθεῖσαν δὲ εἰς Σιδόνα τὴν χωνείαν δέχεσθαι· τινὲς δὲ καὶ τοῖς Σιδονίοις εἶναι *τὴν* ὑαλῖτιν ψάμμον ἐπιτηδείαν εἰς χύσιν· οἱ δὲ πᾶσαν πανταχοῦ χεῖσθαι φασίν. Ἤκουσα δ' ἐν τῇ Ἀλεξανδρείᾳ παρὰ τῶν ὑαλουργῶν, εἶναί τινα καὶ κατ' Αἴγυπτον ὑαλῖτιν γῆν, ἧς χωρὶς οὐχ οἷόν τε τὰς πολυχρόους καὶ πολυτελεῖς κατασκευὰς ἀποτελεσθῆναι· καθάπερ καὶ ἄλλοις ἄλλων	Between Acê and Tyre is a sandy beach, which produces the sand used in making glass. Now the sand, it is said, is not fused here, but is carried to Sidon and there melted and cast. Some say that the Sidonians, among others, have the glass-sand that is adapted to fusing,

Sulphur (*θείο*) was used in antiquity for many purposes: as disinfectant due to its pungent fumes, for religious purification, for medical uses, as a poultice, in wool preparation etc. (Wilson, 2006). It is mentioned by Strabo at least four times and refers to the following places: Dinecum, Bactria and Caria.

Millstones (*μυλόπετρες*) were rather important for ancient people, since they used them for grinding wheat and other cereals, but also for pigments, pharmaceuticals and earth minerals. Sicily, Cyclades and Ionia are the areas mentioned by Strabo for the production of millstones and are mostly related to volcanic rocks, such as trachyte.

Other useful rocks with a volcanic origin are the pyroclastics (*σποδός*), which produce fertile soils. Such rocks are found, according to Strabo, in Pinecum and Campania (southern Italy) and Sicily.

Clay (*άργιλος*) deposits with a utilization other than pottery (e.g. cleaning the silver) were also cited, occurring in Thessaly and Achaeium (Asia Minor).

Soda (*νίτρο*) was used in antiquity as fertilizer or for various medical purposes and Strabo refers to soda dominance in Bactria and Egypt.

Naphtha (*νάφθα*, *πετρέλαιο*) indeed had not the significance it has nowadays, being the major energy source in the planet. Nevertheless, it had some medical uses and thus, it is cited, occurring in the Middle East areas.

Asbestos (*αμίαντος*) was used for making fireproof cloth and an important asbestos quarry was situated in the Euboea's serpentine deposit.

Sand (*άμμος*) is the last mineral resource cited by Strabo, having a utilization in the production of glass in Syria.

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