

A Review on the Evolution of the Turkey Mining Sector

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Abstract

Mining is an extremely crucial sector that provides the necessary raw materials for several industries. The mining sector plays a significant part in the development and the socio-economical growth of any country as natural resources directly contribute to its value-added and increasing its employment rate. Our country is characterized by the wealth and the diversity of its mineral reserves. Therefore, empowering the production ensures the economic and technological development of the country by creating employment opportunities and meeting the needs in raw materials of several sectors. This paper reviews the international mining market by investigating the top produced minerals and their producing countries. In addition, this review paper studies the development of the mining sector in Turkey in the last few years and its contribution to the socio-economical growth of the country.

Key words: Mining sector, Mineral export statistics, Economy

1. Introduction

Mining may well have been the second of humankind's earliest endeavors - granted that agriculture was the first. The two industries ranked together as the primary or basic industries of early civilizations were and still are the main sources of raw materials. Throughout history, mining has continued to make great contributions to the social and economical welfare of several societies which explains the identification of several cultural eras by various minerals or by their derivatives: the Stone Age (prior to 4000 B.C.E.), the Bronze Age (4000 to 5000 B.C.E.), the Iron Age (1500 B.C.E. to 1780 C.E.), the Steel Age (1780 to 1945) and the Nuclear Age (1945 to the present) [1-2]. Therefore, human culture is bound to the availability of minerals and metals, and our prehistoric ancestors depended on mining just as we do today [3].

Nowadays, several sectors (as construction, manufacturing, transport and industrial activities) totally depend on acknowledged raw materials and are easily influenced by their deficiency or any increment in their prices [4]. Beside these common resources, the last few decades have been marked by a primary attention towards relatively scarce and uncommon mineral resources as Rare earth elements (REEs) and conflict minerals (3TG). These materials play a decisive role in keeping up with the non-stop technological revolution and allow achieving the complex functions of the new technological inventions. In fact, Germanium (Ge) used in fiber optic systems, Indium employed in LCD displays, Rare earth elements (REEs) which are essential for batteries, fertilizers, medical tracers, the automobile industry, water treatment and electronics together with conflict minerals as Tin, Tantalum, Tungsten and Gold (3TG) utilized for GPS systems in vehicles, airplane instruments and medical equipments are gaining an increasing significance on a day-by-day basis [5-6-7].

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In the light of the above considerations, nowadays, modern living is highly dependent on mining activities since the socio-economical development requires massive inputs of natural resources especially energy which is regarded as the main driver of economic growth and a sector of significant contributions to the development of regional areas, the prevention of migration together with increasing the value-added and the employment rate in every country [2-8]. Furthermore, under certain circumstances, particularly in periods of war, mineral resources gain additional importance as countries struggle to ensure storing a secure and stable supply of mineral resources. For instance, the European defense industry defines 39 raw materials as ‘strategic’ and 16 as critical due to their economical value and the risks related to their supply [9]. Despite the limited number of researches investigating the oldest mines exploited by the earliest civilizations in Turkey, several studies highlighted that a few mines of copper, iron and gold dating from 7000 B.C.E. were found in the Anatolian region [10]. In fact, the complex geological and tectonic structure allowed the formation of a large number, diverse and significant reserves of mineral deposits in Turkey and enabled the country to be an important global mining force recognized as the 25th producer country in the world in 2016.

For instance, Turkey produces and trades 60 of the 90 mineral materials produced in the world (as industrial raw materials, industrial minerals, Chrome, Mercury, Boron, Salts, Wolfram and Lignite) and is marked by the absence of only 13 types of the missing 30 minerals. In terms of the world reserves, Turkey holds 2.5% of the global industrial material reserve; 40% of the mondial natural stone reserve, 20% of the bentonite reserve, 1% of the coal reserve, 0.4% of the metallic mineral reserve and 72% of the global Boron reserve [2-11-12-13].

This paper reviews the international mining market by investigating the top producer countries in the world, the most produced mineral materials and the main factors affecting the global mining evolution trends. In addition, this review paper studies the development of the mining sector in Turkey in the last few years and its contribution to the socio-economical growth of the country.

2. The International Mining Market

As the main supplier of several industries, the mining sector is considered to be a critical basis of the global economy. The total mining production reached 116,200 million dollars in 2012 then started to slightly decrease over the following years [14]. However, even by considering this reduction, the available data still reflect the significant weight of the mining sector in the global economy. For instance, the mining industry has a positive impact on the employment rate ensuring an average of 1256 thousands employments in diverse mining sectors (coal mining; non-fuel mining; chemical and allied products; stone, clay and glass products and primary metal industries) (Table.1).

The last few decades are bringing a few changes to the sector as experts highlight the steady increase in the importance of advanced ceramic materials, plastic and polymer-based materials used for high-tech technology compared to the production of traditional metals as Steel, Copper, Lead and Tin which are experiencing a noticeable diminish throughout the years. Another critical influencing factor in the evolution of the global mining industry is the supply and demand of the market since the development of numerous countries as Brazil, China and India add up to the growth of this sector and play a significant role in the variation of the prices of these materials. Furthermore, economical crises as the one experienced by most countries in 2008 also highly affect the demand and the prices of such materials.

Table.1: Evolution of the production and employment related to the mining sector between 2012 and 2016, [14]

	2012	2013	2014	2015	2016 ^e
Mine Production (million dollars)					
Metals	34,600	31,600	30,700	24,300	23,000
Industrial minerals	41,000	43,200	50,100	49,100	51,600
Coal	40,600	36,700	34,800	28,500	23,800
Total mine production (million dollars)	116,200	111,500	115,600	111,900	98,400
Employment (thousands of production workers)					
Coal mining	74	67	63	55	46
Non-fuel mineral mining	101	100	100	100	96
Chemicals and allied products	491	490	497	510	521
Stone, clay, and glass products	273	275	282	299	302
Primary metal industries	317	306	311	310	294
Total Employment (thousands of production workers)	1,256	1,238	1,253	1,274	1,259
°Estimated. NA Not available.					
Source: U.S. Geological Survey, U.S. Department of Energy, U.S. Department of Labor.					

This evaluation of the global production of mineral materials is based on the study presented by [11] which investigated the world mining data from 1984 to 2016. The conducted investigation covered the following mineral groups:

- **Iron and ferro-Alloy metals:** represented by Iron, Chromium, Cobalt, Manganese, Molybdenum, Nickel, Niobium, Tantalum, Titanium, Tungsten and Vanadium.
- **Non-ferrous metals:** Aluminium, Antimony, Arsenic, Bauxite, Bismuth, Cadmium, Copper, Gallium, Germanium, Lead, Lithium, Mercury, Rare Earth Minerals, Rhenium, Selenium, Tellurium, Tin and Zinc.
- **Precious metals:** i.e. Gold, Platinum-Group Metals (Palladium, Platinum, Rhodium) and Silver.
- **Industrial minerals:** represented by Asbestos, Baryte, Bentonite, Boron Minerals, Diamond (Gem/Industrial), Diatomite, Feldspar, Fluorspar, Graphite, Gypsum and Anhydrite, Kaolin, Magnesite, Perlite, Phosphate, Potash, Salt, Sulfur, Talc, Vermiculite and Zircon.
- **Mineral fuels:** Steam Coal (incl. Anthracite and Sub-Bituminous Coal), Coking Coal, Lignite, Natural Gas, Crude Petroleum, Oil Sands, Oil Shales and Uranium.

The analysis of the above mentioned data related to the mining industry demonstrated the significant contribution of this sector to the global economical growth and indicated that the world mining production went from 9.7 billion metric tons in 1985 to 11.3 billion metric tons in 2000 and reached 16.9 billion metric tons in 2016 (Table 2).

Table 2. World mineral production 1984-2016, [11]

Mineral Groups	1984	1990	2000	2010	2016
Iron, Ferro-Alloy Metals (metr.t)	462 722 386	553 172 781	622 905 377	1 274 885 083	1 613 131 920
Non-Ferrous Metals (metr.t)	35 078 410	39 117 635	49 964 597	74 864 533	97 232 538
Precious Metals (metr.t)	14 609	17 468	21 047	26 736	30 902
Industrial Minerals (metr.t)	460 033 310	495 139 416	538 832 928	714 952 342	789 708 323
Mineral Fuels (metr.t)	8 382 447 856	9 565 645 291	10 060 884 282	13 776 169 352	14 400 451 134
TOTAL (metr.t)	9 340 296 571	10 653 092 591	11 272 608 231	15 840 898 046	16 900 454 817

China, USA, Russia, Australia, India, Saudi Arabia, Indonesia, Brazil, Canada and Iran are respectively the top 10 mineral producing countries in 2016. These countries are followed by South Africa, Kazakhstan, United Arab Emirates, Qatar, Iraq, Germany, Mexico, Norway, Kuwait and Venezuela. In this list, Turkey occupies the 25th place with a total of 104 157 930 metr.t of mining products in 2016.

3. The Mining Sector in Turkey

3.1. The Most Important Mineral Deposits of Turkey

The Alpin orogenesis played a crucial role in the formation process of the mineral deposits in Turkey [10]. As a part of the seismically active Alpine-Himalayan orogenic belt, the complex geological and tectonic context of the country stands behind the diversity and the large number of its mineral deposits represented by 3500 types of metallic and 2000 types of mineral deposits. Although, this tectonic structure encompasses multiple fault lines, which does not only results in the formation of small and distant deposits but also relatively inhibits the mineral exploration and extraction, sources estimate that 77 of globally traded mineral commodities have been identified in Turkey. In fact, Turkey is one of a few countries able to provide most of their raw materials. Furthermore, the estimations of the U.S. Geological Survey state that Turkey holds the world's largest reserves of Boron and Perlite, the world's third-largest reserves of Barite and the fourth-largest reserves of Magnesite and Feldspar [14-15].

According to the General Directorate of Mining Affairs [16], the Mineral resources in Turkey can be subdivided into 3 main categories:

- Rich mineral resources: Boron salts, Barite, Gypsum, Sepiolite, Marble, Diatomite, Perlite, Magnesite, Sodium sulphate, Zeolite, Profilitite, quartz-quartzite, Lignite, Feldspar, Salt, Olivine, Silica sand, Gold, Bentonite and Trona.
- Important mineral resources: Kaolin, Carbon dioxide, chromium, Molybdenum, Bauxite, Nepheline syenite, Mercury, Diatomite, Trass, Antimony, Thorium, alunite, Sand-Gravel, Silver and Tungsten (volfram).
- Insufficient mineral resources: Copper, Manganese, Graphite, soils (boya toprakları), Lead, Aluminum, Coal, Zircon, Zinc, Arsenic, Talc, Titan, Iron, Sulfur, Mica, Nickel, Phosphate and

Clay minerals.

The major mineral reserves of Turkey are presented in Table 3.

Table 3. The major mineral reserves of Turkey [17]

Mineral Resources	Reserves (tons)	Mineral Resources	Reserves (tons)
Marble And Building Stones	25.000.000.000	Barite	35.000.000
Lignite	14.500.000.000	Magnesite	110.000.000
Hard coal	1.100.000.000	Zinc (Zn)	5.149.600
Boron	3.066.300.000	Lead (Pb)	3.252.000
Quartz sand and Quartzite	5.000.000.000	Copper (Cu)	1.800.000
Trona	800.000.000	Celestite	300.000
Feldspar	836.000.000	Tungsten	60.000
Aluminum	240.000.000	Silver (Ag)	6.800
Chromite	300.000.000	Antimony (Sb)	125.000
Iron	85.000.000	Gold (Au)	700
Clay	575.000.000		

3.2. Evolution of The Mining Sector in Turkey Between 2012 and 2016

The evolution in the production of the industrial materials, iron and fello-alloy metals, non-ferrous metals, precious metals and mineral fuels in turkey between 2012 and 2016 is detailed below:

• Industrial minerals:

Turkey is rich in industrial minerals which is reflected in the mondial production data. In 2016, Turkey was a major producer of Boron, Perlite, feldspar, magnesite, bentonite, gypsum and anyhdrite. In the same year, Turkey earned the title of the first world producer of Boron (1 831 000 tons), Perlite (1 066 251 tons) and Feldspar (9 475 819 tons) by ensuring respectively 42.48%, 38.82% and 31.73% of the mondial production of these minerals. Within the objective of empowering its position in the global market, Turkey plans to cover 59% of the Boron market by producing 2.35 million tons of boron by the end of 2018.

In addition, in 2016 Turkey was the second world producer of Magnesite after China by producing 3 258 445 tons i.e. 12.53 % of the mondial production. Furthermore, Turkey was the third world producer of Bentonite (1 744 912 tons) which represented 10.87 % of the mondial production. The statistics also highlighted that producing 10 124 221 tons of gypsum and anhydrite (5.8 % of the mondial production) granted Turkey the 5th place in the production of these minerals after respectively, China, USA, Iran and Thailand. Turkey was also the 7th world producer of Baryte (3.52 % of the mondial production) and 8th world producer of Diatomite and kaolin which represented respectively 3.18% and 3.29% of the mondial production.

In 2016, Turkey was also ranked 9th in the production of talk (2.71%), 12th in the production of salt (1.93%), 11th in the production of vermiculite (0.24%), 15th in the production of Fluorspar (0.17%), 19th in the production of zirconium (0.04%), 21st in the production of phosphate (0.28%) and finally 41st in the production of sulfure (0.11%). However, no production of graphite was reported neither in 2015 nor in 2016.

- **Iron and fello- alloy metals:**

Among the iron and fello - alloy metals, chromium was the most produced metal by Turkey in 2016. Aside from the iron ore, in 2016, Turkey was ranked the 4th producer country of chromium covering 8.17% of the global production. Additionally, Turkey was ranked 18th producer country of Iron (0.28%), 20th in the production of manganese (0.11%), 22nd producer country of nickel (0.48%) and 20th in the production of Titanium (0.07%). However, despite the importance of iron ore to the steel industry its production did not considerably vary due to the limited reserves.

- **Non-ferrous Metals:**

In the light of the available data, the share covered by Turkey in the mondial production of non-ferrous metals varies between 0.09% and 1.61%. For instance, in 2016, Turkey was the 8th producer country of Antimony (1.25% of the mondial production), 11th producer country of Lead (1.37%), 12th producer country of Zinc (1.61%), 16th in the production of Bauxite (0.35%), 21st in the production of Copper (0.49%) and 36th producer country of Aluminium (0.09%).

- **Precious Metals**

In 2016, Turkey occupied the 17th and 25th place in the production of respectively Silver and Gold. The country covered 0.64% of the total produced Silver in the world and 0.75% of the total amount of the produced Gold.

- **Mineral Fuels**

In 2016, Except for lignite the output of mineral fuels was modest. Turkey was ranked mondialely 6th in the production of Lignite (7.05% of the total mondiale production) as it represents the biggest national energy resource of the country. However, Turkey was ranked 20th in the production of coking coal, 27th in the production of steam coal (0.03%), 51th in the production of petroleum (0.06%) and 70th in the production of natural gas (0.01%).

In the light of the above-mentioned statistics, Turkey remains highly dependent on imported hard coal, oil and gas as more than half of the energy requirement is supplied by imports. In fact, on average, the energy demand of Turkey is mounting by 8% annually which is one of the highest rates in the world. However, the country is working on empowering its domestic energy sources (renewable energy, nuclear energy, and coal) to cover the increasingly higher demand for energy needed for the socio-economical development of the country [18-19].

3.3. Contribution of The Mining Sector to The Economical Development of Turkey

The diversity, quantity and quality of the reserves together with its significant capacity of production made Turkey one the important global mining forces in the world. In addition, the developed infrastructure and the geographical advantages which contribute to the efficiency of the transportation and shipping of the produced materials rank Turkey as the 25th mining force in the world.

Experts predict that the mining sector in Turkey will continue to grow in the next few years and emphasize that the interest of foreign investors in favor of the metal industries will assist in the development of the sector in the future. Furthermore, the beneficial regulations and procedures established by the government as the studied prices, the no tax policy on the exported minerals and

imported processing equipments with the promotion of mining activities will be of great benefit to the economical growth of the country.

According to IMIB, the most exported mining resources by Turkey are Marble, natural stones, Boron concentrates and products, Chromium, Na-feldspar, Magnesite, Copper, Zinc, Gypsum, Barite and Pumice. In fact, today the natural stones sector (Marble, Limestone, Onyx, Conglomerate, Breccia, Granite, Syenite, Diabase, Diorite, Antigorite, etc.) has become a leading sector in terms of mining exports. Between 2003 and 2016, exports of natural stones rose by 333% from 1,5 megaton to 6,5 megaton [13]. However, the country remains import dependant for other minerals in order to cover the deficit or the need for materials of a specific quality. The most imported resources are: hard coal, Iron, Marble and natural stones, Phosphate, Copper, Magnesite, Ka-feldspar, Chromium, Sulfur, Silica sand and Graphite.

Table 4 displays the significant revenues of the mining sector to the economy of Turkey between 2013 and 2017 (Table 4).

Table 4. Mineral export statistics The changes of Mining exportation from 2013 to 2017, [20]

Year	Natural Stone (USD)	Mining, natural stones not included (USD)	Total (USD)
2013	2 225 035 604	2 818 873 264	5 043 908 868
2014	2 128 729 767	2 518 282 641	4 647 012 409
2015	1 907 225 156	1 993 512 793	3 900 737 949
2016	1 805 899 382	1 980 867 353	3 786 766 734
2017	2 048 092 464	2 640 147 864	4 688 240 328

The distribution values of exports by mineral groups are also displayed in Fig. 1. On the basis of an analysis of these values, in 2017, the total exports of industrial raw materials represented 925,633,217 \$ which is 14.56% higher when compared to the previous year, natural stones export in 2017 was 2,059,301,144 \$. Furthermore, the total exports of metallic ore increased by 51.13 %.

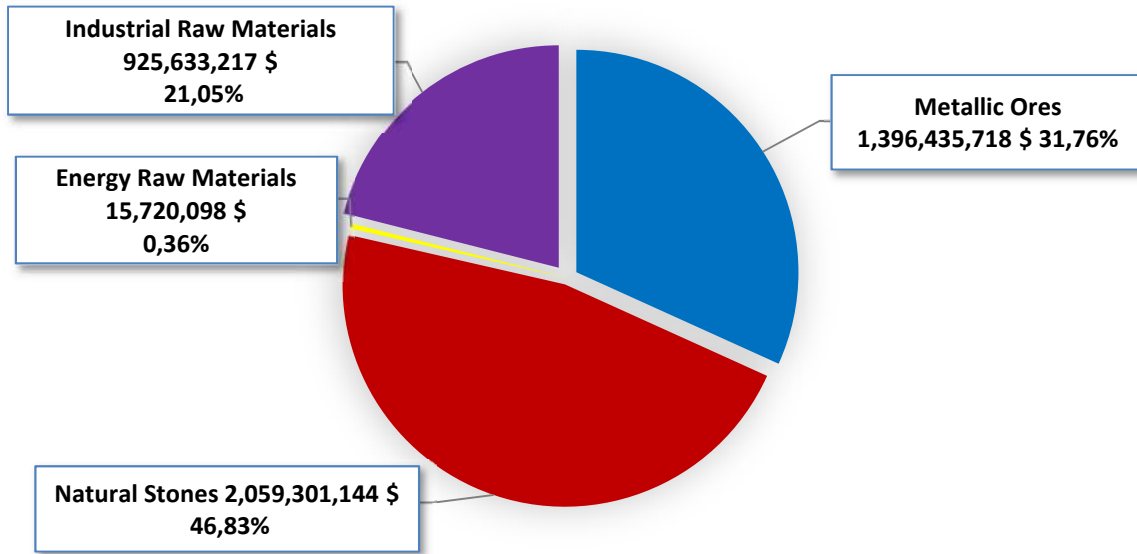


Fig. 1. Distribution of The Export Value in Turkey by Mineral Group (%), [21]

Based on their export value (\$), the top 10 exported mining products are represented in Fig. 2 The largest share within these top ten products is covered by natural building stones.

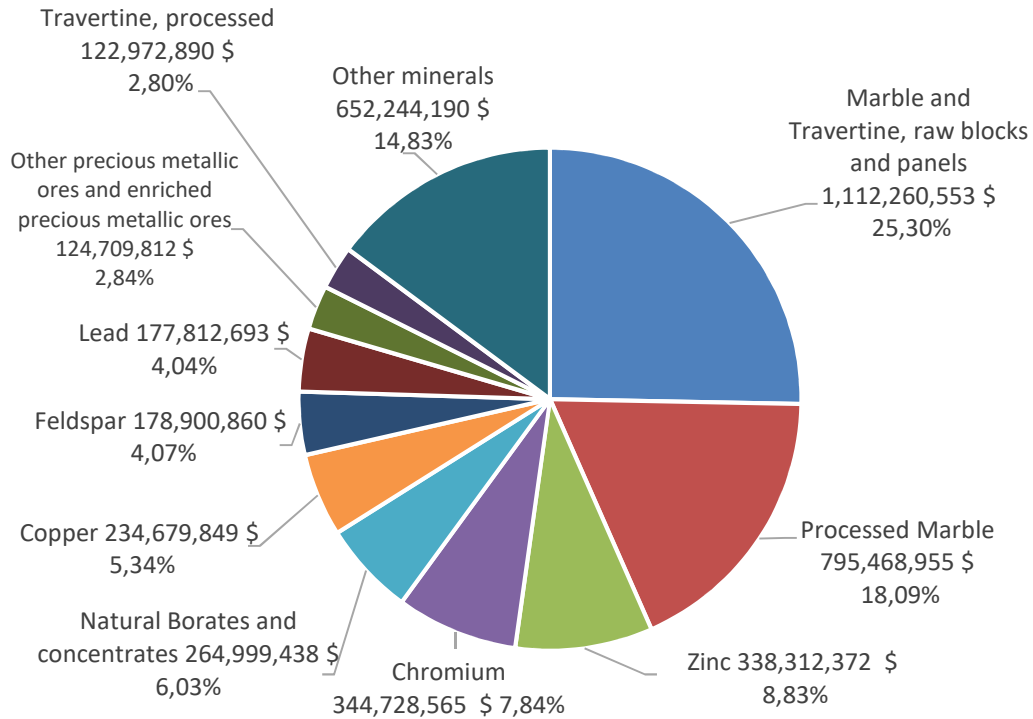


Fig. 2. Top ten products exported mining products in Turkey, [21]

The share of the mining products export value in the total export value of Turkey between 2013 and 2017 is displayed in Table 5. According to this Table, the share of mineral export value in the total export value accounted for 3% in 2017.

Table 5. Share of mine exports in total export values, [22]

	2013	2014	2015	2016	2017
Total Export Value (x 1.000 \$)	151.707.002	157.622.057	143.729.741	142.138.850	156.782.257
Mineral Export Value (x 1.000 \$)	5.042.322	4.646.945	3.906.820	3.786.686	4.688.011
Share of mineral export value in the total export value (%)	3,3	2,9	2,7	2,7	3,0

The exports value of the mining sector, which accounted for 4.68 billion USD out of a total export value of 156.7 billion USD in 2017 thus covering 3% of our country's total exports, realized an increase by 23.8 % when compared to the previous year.

4. CONCLUSION

In order to provide the necessary mineral resources for the scientific and technological development of the country, the mining sector in Turkey is rapidly expanding. In fact, this sector plays a crucial role in the social and economical growth of the country, as it ensured about 3% of the total exports value of the country in 2017. In fact, ranked 25th on the list of the global mineral resources producing countries in 2016, today, Turkey is one of the important mining forces worldwide. Several factors contributed to this achievement as the diversity and the wealth of the resources, the developed infrastructure, the disponibility of working force, the measures adopted by the government to support and empower the sector which attracted foreign investors and the geographical position of the country which played a crucial role in the transportation and shipping of the produced materials.

Aside from its significant share in the economy of the country, the mining sector constantly ensures the development of rural and regional areas near quarries, mines and processing facilities, significant employment opportunities and the prevention of internal migration.

Experts predict that the mining sector will continue to grow in the next few years as its share in the economical and social development of the country will continue to increase. However, several studies highlight that reaching these goals requires a deeper understanding of the full mining potential of the country by conducting more intensive exploration studies on the existant and potential mineral resources to determine with precision the available reserves and their geochemical particularities. In addition, reducing the country's dependency on energy imports is extremely crucial to ensure the growth of the mining sector in Turkey.

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