

Turkey Takes a Leading Role in Natural Stone Reserves

INTRODUCTION

Since early times, people have shown desire to use natural stone in their buildings and places of residence. The improving standards of living over time have driven people to use natural stone for its style and durability. This material gradually has become a symbol of wealth and prosperity. The contemporary admiration for natural stone at an age of machines and technology is an attribute to this fact.

As nations of the Alp-Himalayan Belt; Turkey, Portugal, Spain, Italy, Greece, Iran and Pakistan possess large calcareous stone reserves (marble, limestone, travertine and onyx). Due to its geographical position on the Alpine Belt, Turkey has many assorted types and large volumes of marble reserves. Furthermore, Turkey's developing industry and production technology has placed the country amongst the leading stone processing nations. The fact that the natural stone sector in Turkey has managed to industrialize in a relatively short period has helped the sector raise to the level of the leading sectors in terms of exports, industrialization and employment.

Turkish marble has been widely used in world famous places due to its rich color scales, different patterns and excellent texture quality. Famous places where Turkish marble is used are shown below.

a) In the church of St. Peters entrance hall, which is one of the most important churches in Vatican, marble from Afyon-İscehisar has been used in columns and coverings.

b) In the White House, the USA, Elazığ cherry has been used in the place where the press statements are made. Elazığ

Cherry marble has also been used in France Parliament Building, the US House of Representatives.

c) The Olympic Village in China is covered with Diyarbakır marbles.

d) The German and French Statehouses and the United States Congress Building. In Disneyland, the most famous amusement park in the world, 18,000 m² of Turkish marble was used.

e) In addition to these, many luxury hotels, airports, schools, hospitals, cultural and business centers preferably used Turkish marble in their floor coverings.

COMMON CHARACTERISTIC PROPERTIES OF TURKISH MARBLES

Turkey has one of the world's largest natural stone reserves, which is considered to be excellent quality and exclusive due to great variety of colors and textures patterns. Turkey is among the world's most important natural stone manufacturers with its huge reserves and well developed processing industry. The properties of Turkish marble are seen below.

- Free from any cracks or other defects
- There is a wide range of colors, which allows a wide range of choice. About 400 different color and texture qualities are available.
- Homogeneity of the resources allows the yield of big blocks.
- Uniformity and consistency in quality
- Pattern decorative arrangements of colors and crystal composition are possible
- Good technical properties result in natural resistance to air pollution, wear and dirt.

NATURAL STONE EXPORT FROM TURKEY

Natural stone exports have developed rapidly in the last ten years. Turkish stone can be found in the buildings and sidewalks of 173 different countries. Since 2000 Turkey's natural stone exports increased significantly. According to the statistics seen in Table 1 below received from the Istanbul Exporters Association, the total value of natural stone exports reached \$1.9 billion in 2012. More than one third of Turkish natural stone exports go to the China. The increase in demands in the world market and the fast pace of the export has played a very important

Countries	2009 Value (USD x million)	2010 Value (USD x million)	2011 Value (USD x million)	Change (%)
China	352.6	595.0	635.4	38.2
The USA	207.7	218.8	236.3	8.0
Iraq	33.0	71.2	81.7	14.7
Saudi Arabia	43.2	45.8	62.5	36.3
United Kingdom	51.1	47.9	45.7	-4.5
Canada	33.1	44.8	43.2	-3.5
France	26.2	32.4	42.3	30.6
India	34.7	44.2	37.5	-15.2
Israel	26.3	31.0	35.2	13.7
Arab Emirates	26.0	22.2	29.3	32.1
Russia federation	11.8	17.9	28.2	58.1
Germany	21.4	21.8	27.0	23.6
Syria	19.4	23.9	25.1	5.1
Azerbaijan	20.5	17.7	24.7	39.7
Australia	15.9	16.8	22.2	31.8
Italy	19.4	18.9	18.4	-3.0
Taiwan	13.1	12.1	17.7	46.2
Spain	18.4	17.4	16.7	-3.7
Turkmenistan	17.1	20.7	15.3	-26.2
Singapore	7.2	6.8	10.5	53.1
Other 20 countries	998.2	1,327.4	1,455.0	9.6
Total	1,232.4	1,560.2	1,663.7	6.6

Table 1: Country wide distribution of the exported natural stones of Turkey

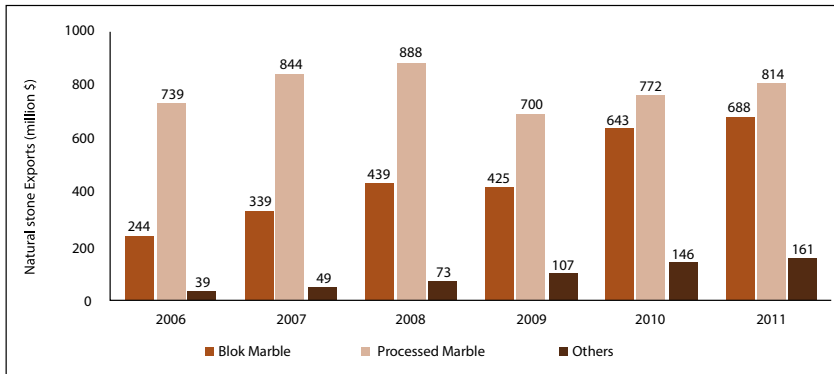


Figure 1: Export of the Turkish natural stone

role in this sense. The export and production of natural stone products have an important share in the mining sector that has improved in parallel to the investments in recent years (Figure 1).

The most value-added-product in exports is processed marble which is cut and polished marble. Processed marble ranks first with a 813 million USD export value in 2011. Block marble is in the second place with 688 million USD.

NATURAL STONE POTENTIAL OF TURKEY

In terms of natural stones and especially marble, Turkey has rich resources since it is located in the Alpine orogenic belt. Turkey has been one of the oldest marble producers in the world with its 4.000 years of production history starting from the Marmara Island. Turkey has a significant place in terms of world natural stone reserves and is increasing its share in the international markets every year with a variety of products. Turkey is producing various kinds of stones like granite, onyx, limestone, basalt, andesite, conglomerate, breccia, magmatic rocks, slate stone, diabase and travertine that are with a

special emphasis on marble. Turkey marble reserves are shown Figure 2.

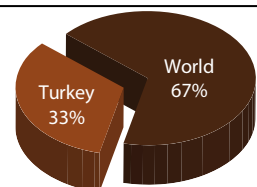


Figure 2: Natural stone reserves in Turkey

Turkey's total natural stone reserves including proven, likely and possible reserves are about 5.2 billion m³→ 13.9 billion Tonnes. According to some estimates, Turkey has 33% of the world total natural stone reserves (Table 2). In accordance with some sources, this resource is estimated to be able to meet the world's natural stone need for 80 years.

Reserves	Reserve Quantity (m ³) x 106	Reserve Quantity (Ton) x 106
Proven	589	1,590
Likely	1,545	4,171
Possible	3,027	8,172
Total Potential	5,161	13,934

Table 2: Turkey's natural stone reserves and share Turkey's natural stone reserves in the world



NATURAL STONE POTENTIAL OF REGIONS

As a result of its geological location, Turkey possesses very rich, natural stone reserves in various colors and patterns. There are approximately 3,872,000 m³ of workable natural stone, (Table 3) and 2,720,000 m³ workable limestone and 995,300 m³ workable travertine (Table 4) and 1,307 m³ onyx reserves in Turkey. ▶▶

Region	Location	Workable Reserve (x1000 m ³)
Marmara	Balıkesir	1,300,000
	Bursa	135,000
	Kırklareli	33,500
Aegean	Afyon	135,000
	Aydın	9,000
	Izmir	1,500
	Muğla	181,000
	Kütahya	200,000
Central Anatolia	Uşak	500,000
	Ankara	2,000
	Eskişehir	960,000
	Kırşehir	165,000
	Niğde	250,000
Grand Total		3,872,000

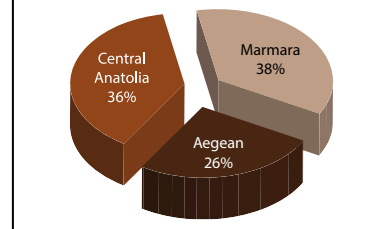


Table 3: Workable natural stone reserves in Turkey and distribution of the regions

Region	Location	Limestone Reserve (x1000 m ³)	Region	Location	Travertine Reserve (x1000 m ³)
Marmara	Adapazarı	3,500	Marmara	Bursa	1,200
	Balıkesir	7,500			
	Bilecik	640,000			
	Bursa	240,000			
Aegean	İzmir	175,000	Aegean	Afyon	120,000
	Manisa	500		Denizli Burdur	500,000 75,000
Mediterranean	Adana	7,000	Central Anatolia	Çankırı	210,000
	Burdur	2,000		Nevşehir	100
	Hatay	60,000		Sivas	75,000
Central Anatolia	Ankara	16,000	Black Sea	Bolu-Karabük	10,000
	Eskişehir	475,000			
	Kayseri	3,000			
	Konya	70,000			
Black Sea	Bartın	1,000,000			
East Anatolia	Elazığ	20,000			
Southern East Anatolia	Diyarbakır	9,000			
Total		2,720,000	Total		995,300

Table 4: Workable limestone and travertine reserves of Turkey

Province	Reserves (million m ³)	%
Balıkesir	1.850	35.8
Denizli	652	12.6
Afyon	629	12.2
Tokat	410	7.9
Çanakkale	252	4.9
Muğla	200	3.9
İzmir	120	2.3
Other	1,054	20.4
Total	5,167	100

Table 6: Natural stone reserves of Aegean Region

NATURAL STONE POTENTIAL IN AFYON

The Afyon place is known as one of the most important natural stone production and processing centres in Turkey. Afyon-Iscehisar's natural stone originate from limestone rocks that metamorphosed under heat and pressure. The main mineral component of Afyon Iscehisar marble is calcite (more than 90%). The sizes of calcite crystals are 0.2 - 0.5 mm, and between 1,000 and 1,700 crystals per cm² area.

Afyon province has 135,000,000 m³ of workable resources and this means 3.5% of workable natural stone resources of Turkey. Most of the Afyon province natural stone and processing plants are located three areas, these areas are Iscehisar, Susuz Boğazi, and the Afyon industrial region. There are over 400 marble processing plants of different sizes operate in Afyon and these companies are processing a great variety of marbles from the Afyon quarries and also from other parts of Turkey. Many of these plants are equipped for slab production with simple machinery, like splitting machines and 1/3 of the block marble production of Turkey is made in Afyon-Iscehisar. According to an MTA report, Afyon white marble reserves are 2,500,000 m³ and Afyon Tigerskin marble reserves are 3,600,000 m³.

In Afyon-Iscehisar, over 200 marble processing plants are operating with at least one marble gang saw or one S/T (disc-cutter). The plaque marble production of Afyon-Iscehisar region consists of ►

It's known that there are over 250 kinds of stones with different colors, textures and designs in Turkey. The natural stones sector today, with its high production, export potential and domestic market consumption, makes an important contribution to the Turkish economy. There are more than 2000 quarries, small and medium sized 2,000 factories and 9,000 workshops and also 300,000 workers in the natural stone sector. 27% of the quarries are situated in the city of Balıkesir, 24% in Afyon, and 11% in Bilecik as summarized in Table 5. Around 90% of quarries are located in the west of Anatolia, mainly in the Aegean and Marmara Regions. The distributions of the companies which have got marble licenses according to the regions are shown in Figure 3. The

Provinces	Quarries (%)
Balıkesir	27.00
Afyon	23.60
Bilecik	11.14
Denizli	7.58
Bursa	6.92
Muğla	6.40
Eskişehir	4.03
Uşak	2.37
Kırklareli	1.90
Kırşehir	1.18

Table 5: Distribution of the natural stone quarries in Turkey

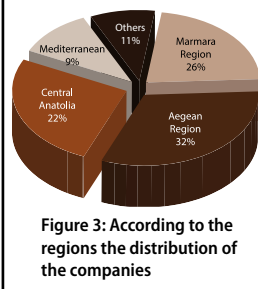


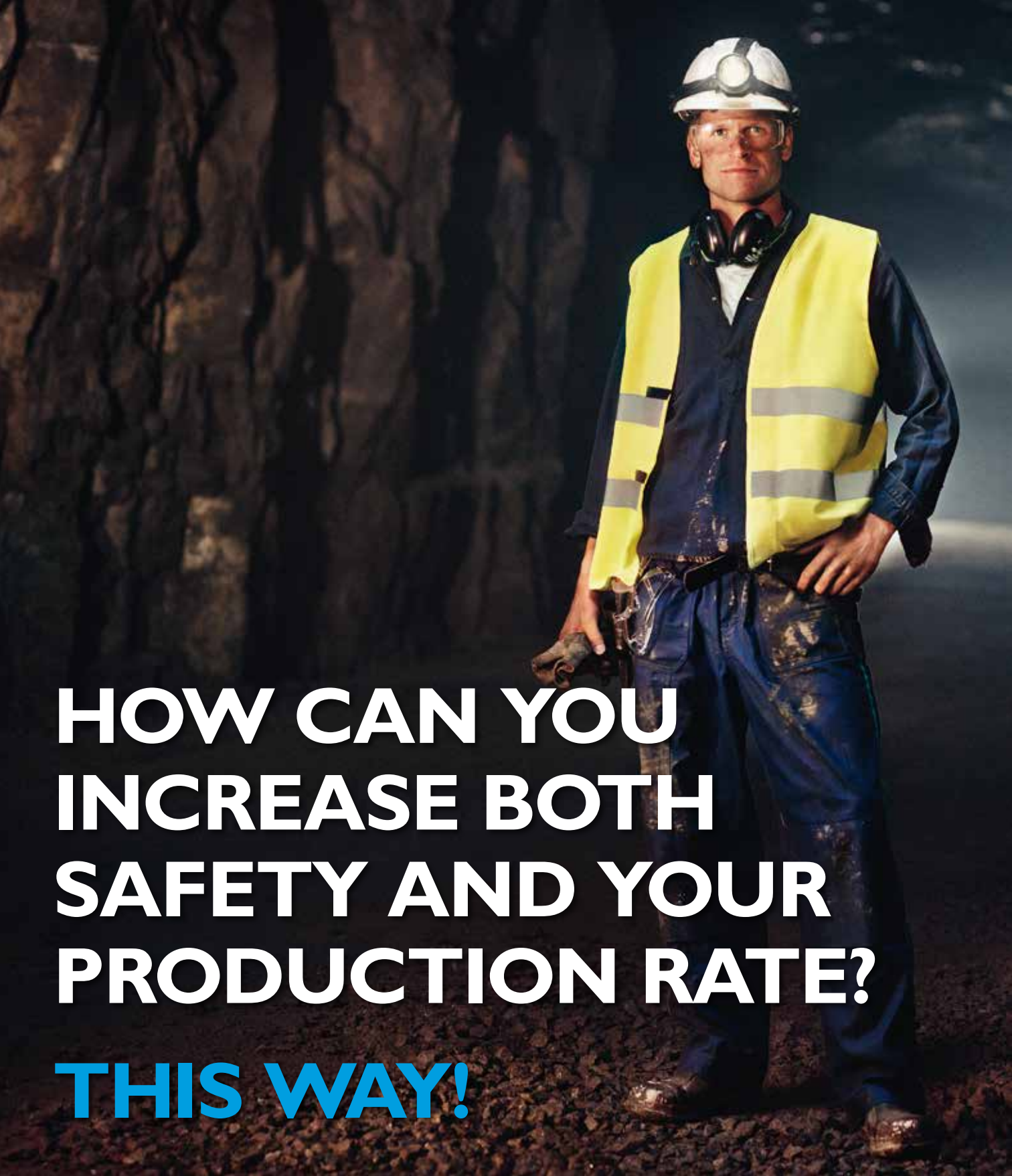
Figure 3: According to the regions the distribution of the companies

Aegean region takes the first place in the list of the marble production licenses. There are three important regions for marble resource in the Turkey, the first is south and west of the Marmara sea, the second is in the south-central Turkey and the third is in south west Turkey, especially around Yatağan in the Muğla and Aydın provinces.

NATURAL STONE POTENTIAL OF AEGEAN REGION

The Aegean Region has very rich natural stone reserves and approximately 70% of the total natural stone reserves of Turkey are in this region. Turkey's is known to have a total of 5 billion m³ natural stone reserves and approximately 3.5 billion m³ of this reserve

exists in the Aegean region. The natural stone quarries are located especially in Balıkesir, Afyon, Denizli and Muğla provinces (Table 6).



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19% of the Turkish plaque marble production. These plants employ totally 1,678 personnel and breaking down of them is 31 engineers, 33 technicians, 60 foreman and 1,552 workers. Moreover, at these quarries there exist 40 gang saw, 89 S/T disc-cutter, 47 polishing machines, and 26 tile line in the Afyon region.

NATURAL STONE POTENTIAL IN DENİZLİ

Denizli province is located in western of the Turkey. Denizli is the second province in line after Balıkesir in terms of the total visible marble reserves of Turkey, but it is third after Balıkesir and Afyon in total marble reserves of Turkey. The region of the Denizli has the richest and excellent travertine reserves. These travertines are known in the world as Denizli travertine. There exist 52 travertine quarries and 90 factories which are located about 10 - 20 km away from the Denizli. Travertines are main export products for Denizli. Produced travertine has been used for cladding of side-wall and other internal and external usage in modern building, structures, water pools, other accessories for modern civil constructions. Both their colors and physical properties vary from location to location in the study area. The Denizli has widespread travertine reserves one of the famous one is Pamukkale-Karahayit and the second is Ballık area travertines since Late Quaternary. The total area occupied by modern and old travertines is more than 100 km² and its thickness can reach up to 60 m.

Turkey has a big share of the travertine production in the world. The United States comes first among exporting countries. Turkey provides about 50% of travertine consumption of the United States. The richest travertine reserves of Turkey in Karacasu, Kocabaş and Sarayköy within the borders of Denizli province. There are a large number of quarries which had been operated in the antique ages around Pamukkale, Yeniceköy and Kocabaş (Table 7). The large travertine quarries of Denizli are Hayrettin Noce, Bianco Rosaa and in Kaklık place which are Kömürcüoğlu's quarry and Alimoğlu's quarry.

Region	Type	Reserves x1000m ³
Tavas - Vakıfköy - Çamova Tepe	Marble	72,000
Kocabaş Village	Travertine	25,000
Kocabaş - Etence Tepe	Travertine	7,500
Kocatepe - Acadere - Zeytinlieğrek	Travertine	10,000

Table 7: Marble quarries and reserves in Denizli

NATURAL STONE POTENTIAL IN BALIKESİR

Balıkesir province is located in western of the Turkey. Balıkesir is the first province in terms of the total visible natural stone reserves of Turkey. There are large number of quarries and plants which are operated by some companies in Balıkesir. Marble quarries and reserves in Balıkesir (Table 8).

Region	Product name	Reserves x1000m ³
Marmara Island	Marmara White	1,200,000
Çayüstü Village	Kumru Tuyu	40,000
Manyas-Koçoğlu Village	Manyas White	40,000
Ayvalık-Bağyüzü Village	Ayvalık Granite	300
Bigadiç-Çayüstü Village	Onyx Marble	7

Table 8: Marble quarries and reserves in Balıkesir

NATURAL STONE POTENTIAL IN UŞAK

Uşak province is located in western of the Turkey. The potential of the marble beds in Uşak are Karahallı Country-Duraklı Village and Hacı Hüseyin Village. Uşak province's workable reserves are 500,000 m³. The best natural stone products of the Uşak province are Uşak Yellow, Uşak White and Uşak Green. These natural stone areas are shown in Table 9.

Region	Product name	Geological Reserves m ³
Karahallı, Duraklı village	Uşak Green Marble	600,000
Hacı Hüseyin Village	Yellow Marble	600,000
Hacı Hüseyin Village	Uşak White Marble	400,000
Akhisar - Efkafteke Village	Aegean Brown Marble	25,000

Table 9: Marble quarries and reserves in Uşak

NATURAL STONE POTENTIAL IN EASTERN BLACK SEA REGION

The Eastern Black Sea region has rich potential in terms of a variety of mines, mainly metallic mines. The region has approximately 435 million Tonnes natural stone reserves. The most of these reserves is particularly granite and the approximate value of this marble reserve is 90 billion USD. Giresun, Ordu, Rize and Trabzon take the first places as in the number of the marble quarries and the marble production. Giresun is first with 116 million m³ probable reserve and following Ordu, Rize and Trabzon province (Table 10).

Province	Probable reserves (x103 m ³)
Giresun	115,965
Ordu	64,025
Rize	32,100
Trabzon	14,760
Bayburt	9,840
Gümüşhane	9,300
Total	245,990

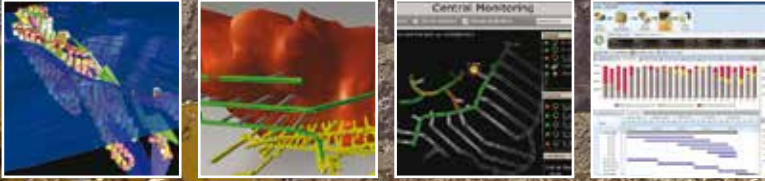
Table 10: Probable Reserves in Eastern Black Sea

NATURAL STONE POTENTIAL IN THE SOUTH EAST

NATURAL STONE POTENTIAL IN DIYARBAKIR

Diyarbakır province is located in the south east of the Turkey. Natural stone of the Diyarbakır layers, which originate from limestone, are geologically indicated by different colors, particle sizes and mineral compositions. Diyarbakır limestone is becoming increasingly popular for both interior and exterior building applications in the local area in south east Turkey, being easy to cut and shape and suitable for many purpose. Besides limestone formation, Diyarbakır - Karacadağ has 10,000 m² basalt areas. In Diyarbakır, the major source rocks are Hazro, Hani, Çermik and Çüngüs tows. In Diyarbakır, there are over 20 marble quarries. These quarries produced 82,390 m³ block marble and 36% (30,390 m³) of their production is exported. ▶▶

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NATURAL STONE VARIETIES IN TURKEY

Turkey, due to its location in the Alpine-Himalayan orogenic belt, has numerous natural stone deposits. Turkish natural stone industry has proved its consistency and continuity in the commercial arena by supplying more than 250 kinds of stones with different colors and patterns. Approximately one hundred of these natural stone are well known in the international market and are regularly demanded. The best marble reserves are located in Afyon, Eskişehir, Elazığ, Balıkesir, Denizli, Muğla and Çanakkale. The best known varieties of Turkish marble are shown in Figure 4.

I) Elazığ Cherry: Elazığ cherry is made of serpentinized and carbonated ultrabasic rocks. It is found as tectonic breccia and located around Elazığ - Güleman / Altınoluk village. Red green pebbles are attached with the same colored cement. Recommended usage of area can be used in interior exterior plating, wall cladding and decoration.

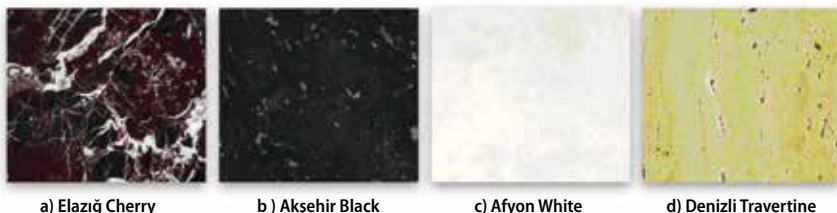


Figure 4: Elazığ cherry, Akşehir black, Afyon white and Denizli travertine

II) Akşehir Black Marble: This marble is showing cataclastic texture in general and has white calcite veins and brown stylolites. Calcite crystals of sizes between 0.9-1.9mm and also found as bands. It can be used in interior exterior cladding and decorative arrangements. It is suitable to make block and plate and can be easily cut and polished. It is located around Konya - Akşehir in Turkey.

III) Afyon White: This marble is a classical metamorphic and consists of calcite crystals texture and also contains occasional yellow veins. Its suitability for making blocks, plates, cutting sides and corners,

polishing and the shaping and the cutting rate are all excellent. There isn't any risk of rusting. It can be utilized in interior, exterior plating, statues, decorations and monuments. Block dimensions vary between 50 x 1.20 x 0.80 m and 3.0 x 2.0 x 1.2 m. There are quarries which can provide larger blocks if desired.

IV) Denizli travertine may be white, light yellow and dark yellow colored. It is usually found over clayey, sandy and alluviums. Denizli Travertine consists of 30 - 100 micron grain sizes and micritic calcite grains of 1 - 4 microns. It has a porous texture. The Denizli travertine can be used in interior and exterior cladding, floor covering and decoration. The travertine is suitable to be processed in blocks and plates and offers good shapeability. The marble is normally polishable. There is no rusting risk. Block dimensions vary between 1.50 x 1.50 x 0.80 m and 2.40 x 2.40 x 2.00 m. Larger blocks can be obtained from the portions where the fissure intervals are very wide. ●

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