UPatras S.E.G. Student Chapter Field Trip 2024
"Geo-exploration of Asia Minor: Unveiling Geological Treasures"

ACKNOWLEDGEMENTS

The participants of the UPatras S.E.G. Student Chapter Field Trip 2024 "Geo-exploration of Asia Minor: Unveiling Geological Treasures" would like to express heartfelt thanks to Dr. Mehmet Akbulut, Department of Geological Engineering, Dokuz Eylul University, for his invaluable assistance and guidance.

We would like to thank our sponsors:

We would also like to thank our collaborators:

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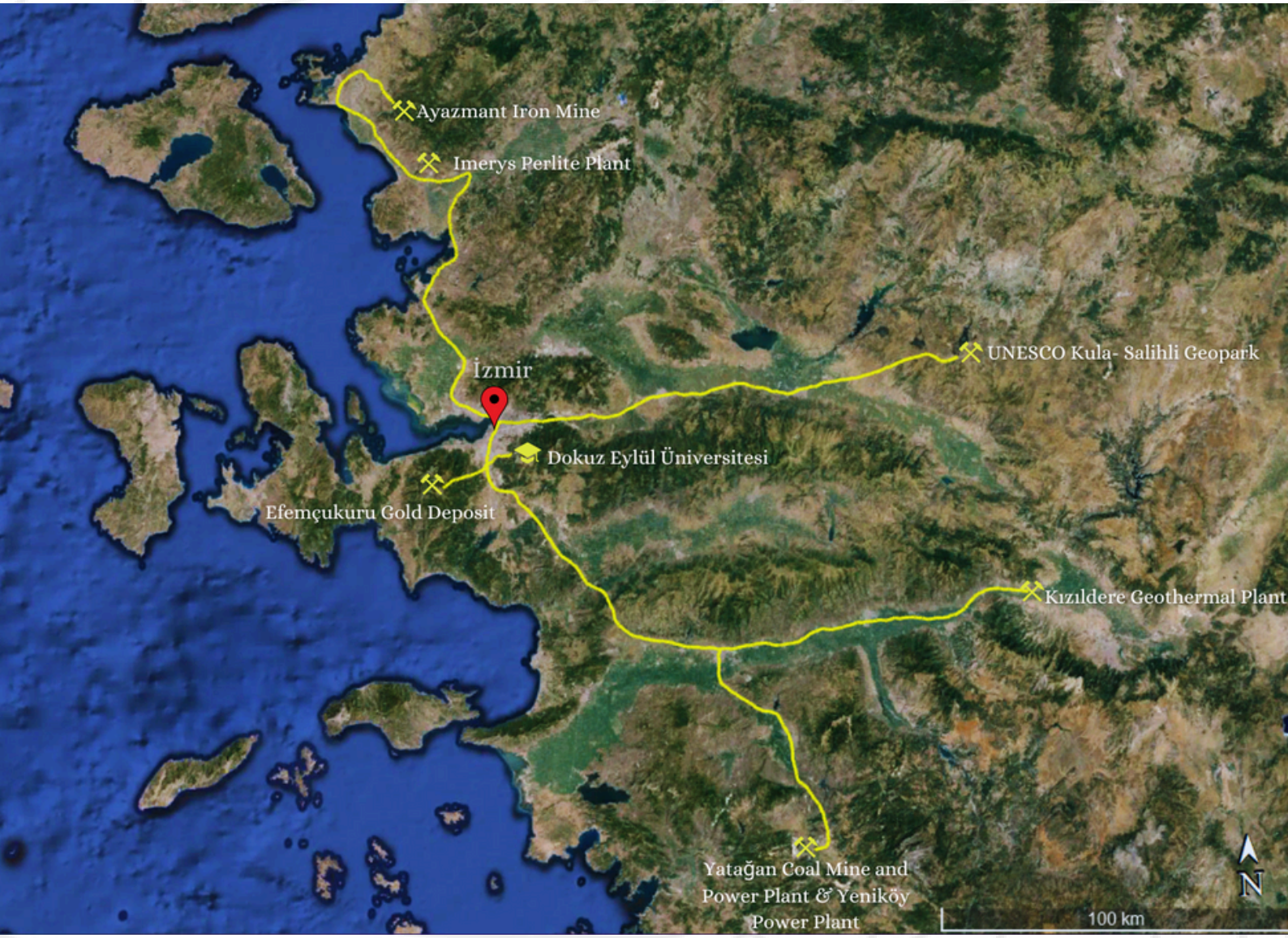


Field Trip Itinerary

- **Sunday, 23 June: Arrival at Izmir**

16:30 – Fly out from Athens
17:30 – Arrival at Izmir (Bus to Greymark Hotel)

- **Monday, 24 June: Visiting the Dokuz Eylul University**

09:00 – Departure from Greymark Hotel
09.30 – Arrival at the Department of Geological Engineering, Dokuz Eylul University
10.00 – 10.30 – Icebreaker Coffee
10.30 – 11.00 – **Lignite deposits in the post-coal era: alternative utilization**
Dr. Stavros Kalaitzidis, Department of Geology, University of Patras
11.00 – 11.30 – **Research in karst regions in Greece**
Dr. Elena Zagana, Department of Geology, University of Patras
11.30 – 12.00 – **Geology and geochronology of the basement rocks of Menderes Massif (Western Türkiye)**
Dr. O. Ersin Koralay, Department of Geological Engineering, Dokuz Eylul University
12.00 – 13.00 – Lunch break
13.00 - 13.30 – **Inquiry of peridotite massifs for carbon negative future: Evaluation of the chromium host rocks as CO_2 sequestration targets**
Dr. Mehmet Akbulut, Department of Geological Engineering, Dokuz Eylul University
13.30 - 14.00 – Coffee break
14.00 - 16.30 – **Coal Microscopy Session**
Instructors: Dr. Kimon Christanis & Dr. Stavros Kalaitzidis, Department of Geology, University of Patras
Assisting Staff: Dr. Mehmet Akbulut & Zeynep Büçkün, Department of Geological Engineering, Dokuz Eylul University
16:30 – City tour

- **Tuesday, 25 June: Visiting the Efemçukuru Gold Deposit**

08:30 – Departure from Greymark Hotel
09:30 – Arrival at Efemçukuru Gold Deposit
09:30 – 16:30 – Visiting Program
16:30 – Depart to Izmir

- **Wednesday, 26 June: Visiting the Kizildere Geothermal Power Plant**

08:30 – Departure from Greymark Hotel
10.30 – Arrival at Kizildere Geothermal Plant
10.30 – 16:30 – Visiting program
16:30 – Depart to Izmir

- **Thursday, 27 June: Visiting the Imerys Perlite Plant and the Ayazmant Iron Mine**

08:00 – Departure from Greymark Hotel
09.30 – Arrival at Imerys Perlite Plant
09.30 – 10.15 – Meeting and Safety presentation
10.15 – 10.30 – Site-specific presentation
10.30 – 11.00 – Plant Site visit
11.00 – 11.35 – Drive to Mine site
11.35 – 11.45 – Mine site – safety presentation
11.45 – 12.30 – Site visit
12.30 – 13.00 – Quick lunch break
13.30 – Depart to Ayvalik Iron Mine
14:30 – 17:00 – Site visit

- **Friday, 28 June: Visiting the Yatagan Coal Mine and Power Plant & Yeniköy Power Plant**

08:30- Departure from Greymark Hotel
10.30 – Arrival at Yatagan Coal Mine and Power Plant
10:30 – 13:30 – Yatagan Coal Mineand & Plant Site visit
13:30 – 16:30 – Yeniköy Power Plant Visit
16:30 – Depart to Izmir

- **Saturday, 29 June: Visiting the UNESCO Kula-Salihli Geopark**

08:30 – Departure from Greymark Hotel
10.30 – Arrival at Geopark
10.30 – 16:30 – Site visit
16:30 – Depart to Izmir

- **Sunday, 30 June: Return to Athens**

16:00 – Arrival at Izmir Airport
18:15 – Fly out from Izmir
19:15 – Arrival to Athens

Efemçukuru Gold Deposit

Quick Facts

- **Location:** Izmir Province, Western Türkiye
- **Mine type:** underground
- **Commodity**: Gold (Au)
- **Deposit type:** intermediate sulfidation epithermal gold
- **Total resource:** 5.580Mt*
- **Grade:** 6.69g/t Au*
- **Ownership:** Tüprag Metal Madencilik A.Ş. (Eldorado Gold), 100%

*measured and indicated, as of September 30, 2023

Geology and Mineralization

Efemçukuru is an intermediate sulfidation epithermal gold deposit hosted within Upper Cretaceous phyllite and schist at the western end of the Izmir-Ankara Suture Zone in SW Türkiye. The host rocks are locally silicified to hornfels and cut by moderately N- to NE-dipping faults that are exploited by rhyolite dykes and epithermal veins. Two major veins host mineralization, Kestanebeleni and Kokarpinar, with the former containing the bulk of the ore. Vein mineralogy is variable but primarily consists of quartz, rhodonite ($CaMn_3Mn[Si_5O_{15}]$) (commonly replaced by rhodochrosite ($MnCO_3$)), adularia ($KAlSi_3O_8$) and sulfide assemblages including pyrite (FeS_2), galena (PbS), chalcopyrite ($CuFeS_2$) and sphalerite ((Zn, Fe)S). Spectacular, high grade banded crustiform-colloform textures characterize the veins in addition to multi-stage breccias that were likely the result of shallow-level boiling. Most of the gold is very fine (2.5 to 50 microns), occurring as free grains in quartz and carbonate, and as inclusions in sulphide minerals. Lower grade mineralized stockworks occur peripheraly to the ore shoots, and are most strongly developed in hangingwall rocks.

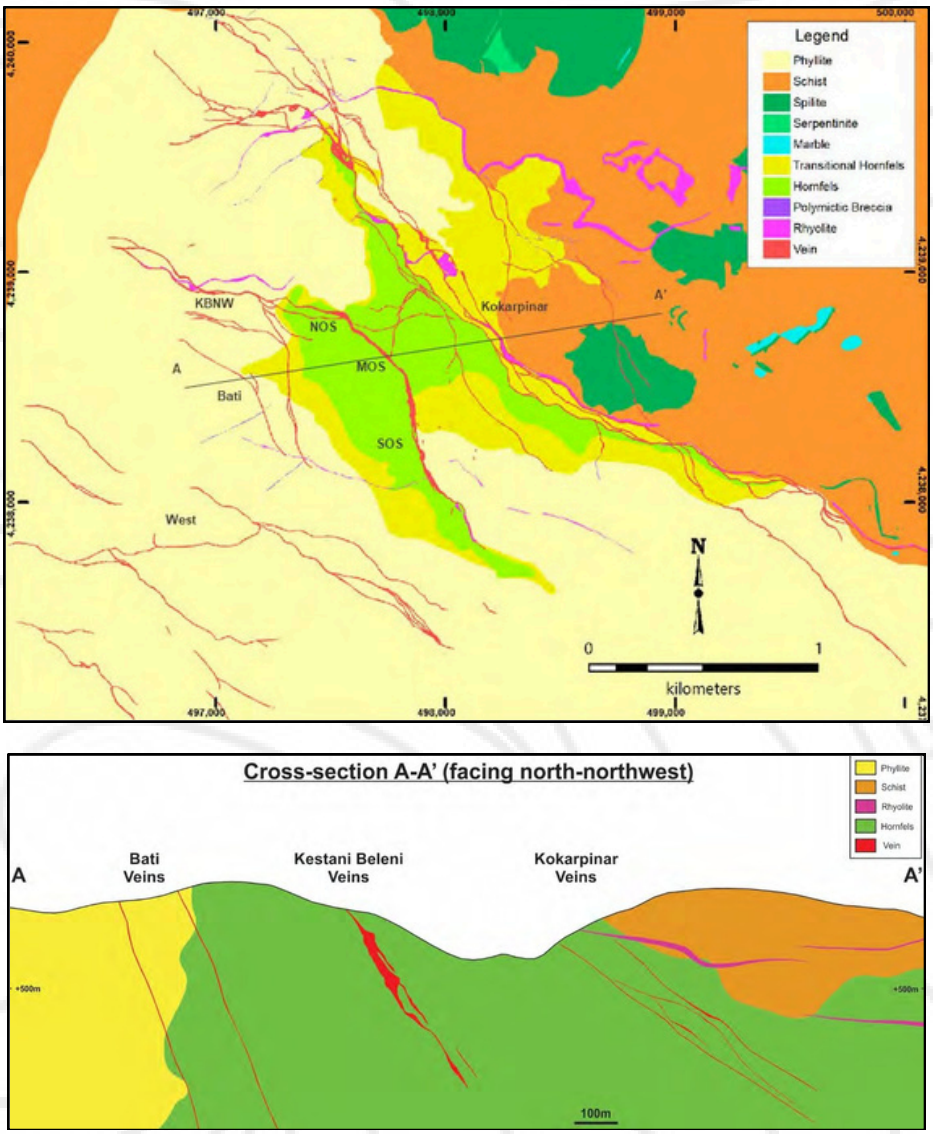
Exploration

The Efemçukuru epithermal vein deposit was identified and defined by Eldorado in the late 1990s. Current exploration is focused on adding resources to the two principal mineralized veins at the project: the Kestane Beleni Vein, which hosts the present mine reserves, and the subparallel Kokarpinar Vein, located 400m to the east.

Mineral Processing & Recovery Methods

The Efemçukuru operation is an underground mine with facilities consisting of an underground crushing plant, milling and flotation plant, filtration and paste backfill plant, water treatment plant, and ancillary buildings. The process plant produces a gold-containing bulk sulphide flotation concentrate. Major sulfide minerals comprise pyrite, sphalerite, and galena. In most cases, gold recovery is proportional to sulfur recovery and has averaged between 93 to 94% in recent years.

Run-of-mine ore is crushed underground and transferred to two ore storage bins on surface via a conveyor. The two ore storage bins allow for blending of different ore types feeding the process plant to target a desirable gold / sulfur ratio and reduce contents of penalty elements for concentrate sales.



Geological Map and cross-section A-A' of the Efemçukuru Deposit (Eldorado, 2023).

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https://www.eldoradogold.com/assets/operations-and-projects/operations/efemcukuru-turkey/default.aspx
"Technical Report, Efemçukuru Gold Mine,Türkiye" by Eldorado Gold, 2023 (report)

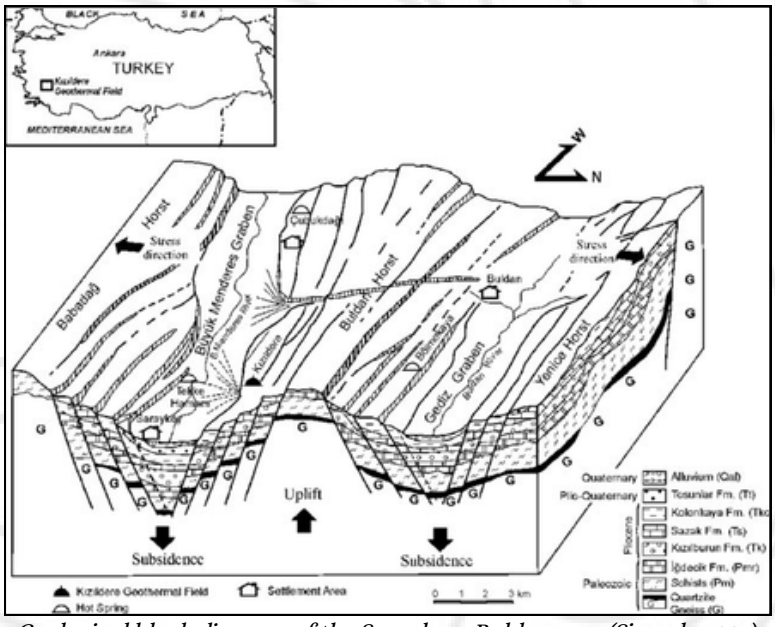
Kizildere Geothermal Power Plant

Quick Facts

- **Location:** Denizli Province, Western Anatolia, Türkiye
- **Project type:** Geothermal
- **Total Capacity (MW):** 80
- **Reservoir temperature:** 200–242°C
- **pH:** ~5.9
- **Ownership:** Zorlu Energy Inc.

Geology

Kizildere geothermal field is in the Saraykoy–Buldan area, and is associated with the major fault along the northern boundary of the Büyük Menderes Graben. As for other fields in the graben, the basement in the Kizildere field is made up of metamorphic rocks of the Menderes Massif: augen gneisses, schists, and an alternation of quartzites, micaschists and marbles known as the Igdecik Formation. These rocks are overlain by fluvial and lacustrine Pliocene sediments, which have been divided into four lithologic units. From bottom to top these are: the Kizilburun Formation (Tk), a 200-m thick formation of alternating red and brown conglomerates, sandstones, shales and lignite layers; the Sazak Formation (Ts), comprising intercalated gray limestones, marls and siltstones, 100–250 m in thickness; the Kolonkaya Formation (Tko), made up of yellowish green marls, siltstones and sandstones, 350–500 m in thickness, and, finally, the Tosunlar Formation (Tt), composed of alternating units of poorly-consolidated conglomerates, sandstones and mudstones with fossiliferous clay units, about 500 m in thickness.



Geological block diagram of the Saraykoy–Buldan area (Şimşek, 1985)

Quaternary alluvium unconformably overlies these sedimentary units. The regional geological structure is controlled by E–W trending faults associated with the Büyük Menderes Graben, but some NW–SE trending, active faults have caused the uplift and dissection of the northern and southern flanks of the metamorphic basement.

Geothermal Field

Kizildere is Turkey's first and high-potential geothermal field explored for energy generation purposes. This field is a liquid-dominated system with a steam fraction of 10–12%. The steam field has an area of 550 m x 650 m, while the calculated reservoir area is 100 km2. The depth of the wells changes from 370 to 2261 m. The reservoir temperature is between 200 and 242°C. The estimated capacity of the field is 200 MWe. The most significant characteristic of the field is the high amount of non-condensable gases (2.5% in the reservoir, 5% by volume of steam, 10–21% by weight of steam and average 13% by weight of steam at the turbine inlet) with a CO_2 content of 96–99%, H_2S content of 100–200 ppm and NH_3 content of 72 ppm. The specific steam consumption of the plant is 10.96 kg/kWh. The first law efficiency of the plant is determined to be 11.98%.

References

Gokcen, G., Ozturk, H. K., & Hepbasli, A., 2004. Overview of Kizildere geothermal power plant in Turkey. Energy conversion and management, 45(1), 83-98.

Şimşek, Ş., 1985. Geothermal model of Denizli, Sarayköy-Buldan area. Geothermics, 14(2-3), 393-417.

Imerys Perlite Plant

Quick Facts

- **Location:** Izmir Province, Dikili, Türkiye
- **Commodity:** Perlite
- **Deposit type:** Dikili: Old rhyolite dome (12.5 Ma)
- **Ownership:** Imerys S.A.

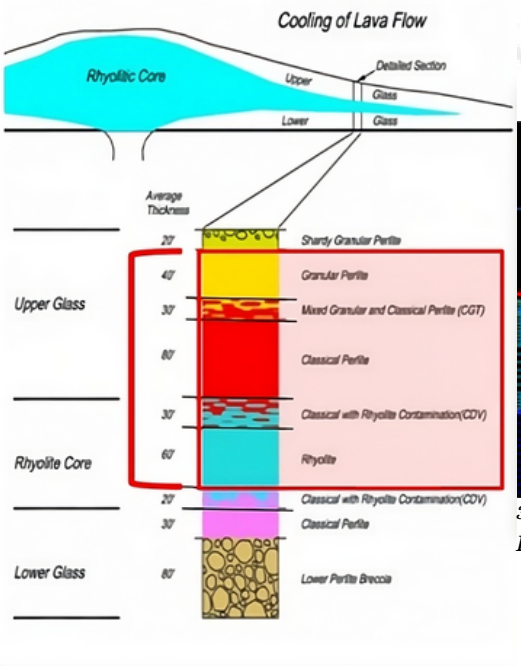
General Info

The mining areas are located 70 km northeast, and the processing plant 105 km north of the city of Izmir, close to the ports of Izmir, Aliağa and Dikili & Izmir-Çanakkale highway, providing big advantages in terms of logistics and transport.
The mining operations have started in the mid of 1980 as a series of open pits producing crude perlite for the domestic and international filter-aid market. The processing plant has established in 1987. World Minerals bought assets from Ege - Kiska.
Imerys acquired World Minerals with its assets in 2007. Since 2007 till YTD, Imerys Dikili supplies crude perlite for the internal/group plants in Europe, USA, China, Australia..etc

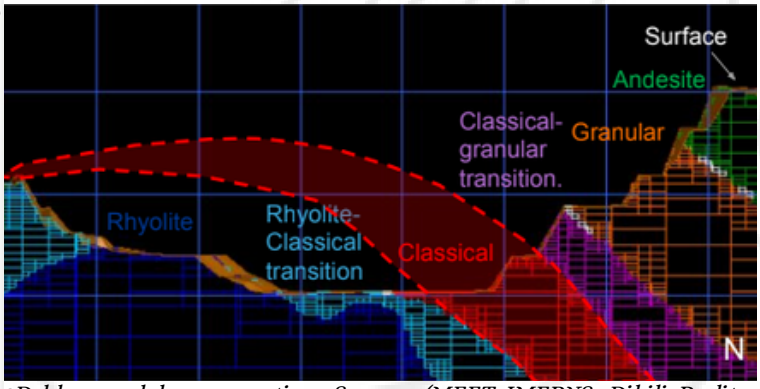
Geology and Mineralization

Perlite deposits are formed near active volcanoes and plate tectonics boundaries. Perlite rocks are acidic, hydrated, glass-rich volcanic rocks, light grey, greenish, or blackish in color, with the same chemical composition as rhyolite (>72% SiO_2). They have a lustrous appearance with onion-skin-like cracks formed by perlitization. This weathering process involves the secondary hydration of obsidian, where near-surface water (rain or groundwater) gradually diffuses into the glass over geological time.
The operations are conducted in three main mines the Sulubahçe, the Örlemişa, and GCU – Park zone The Dikili deposit is an old rhyolite dome. Only one type of perlite lithology is present: flow lava material from the upper and lower vitreous zones. In the Sulubhace mine, only the upper vitreous zone of perlite is currently being extracted.

Perlite formation (MEET IMERYS _Dikili Perlite, Presentation of Harbolite Aegean, www.imerys.com)



Stratigraphic sequence of a Rhyolitic Core (MEET IMERYS_Dikili Perlite, Presentation of Harbolite Aegean, www.imerys.com)



3D bloc model cross-section, Surpac, (MEET IMERYS_Dikili Perlite, Presentation of Harbolite Aegean, www.imerys.com)

References

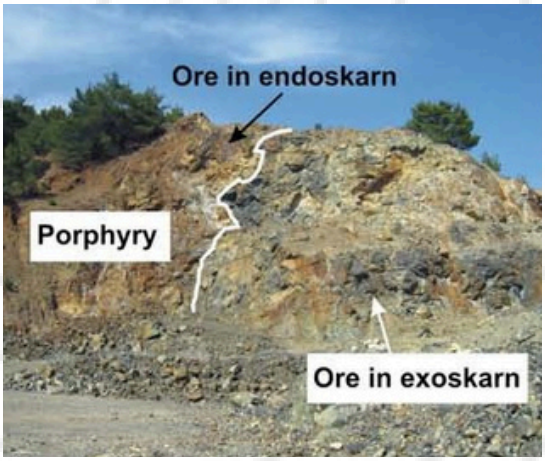
MEET IMERYS_Dikili Perlite, Presentation of Harbolite Aegean, www.imerys.com
Imerys Group Presentation, www.imerys.com

Ayazmant Iron Mine

Quick Facts

- **Location:** Balıkesir Province, Ayvalık, Türkiye
- **Mine type:** open pit
- **Commodity:** Fe, Cu
- **Deposit type:** Fe–Cu skarn deposit
- **Total resource:** 5,750,000 t*
- **Grade:** 46% Fe and 0.6% Cu*
- **Ownership:** Bilfer Mining Inc.

*the Mineral Research and Exploration Institute of Turkey (MTA) estimated the total reserve in 1984



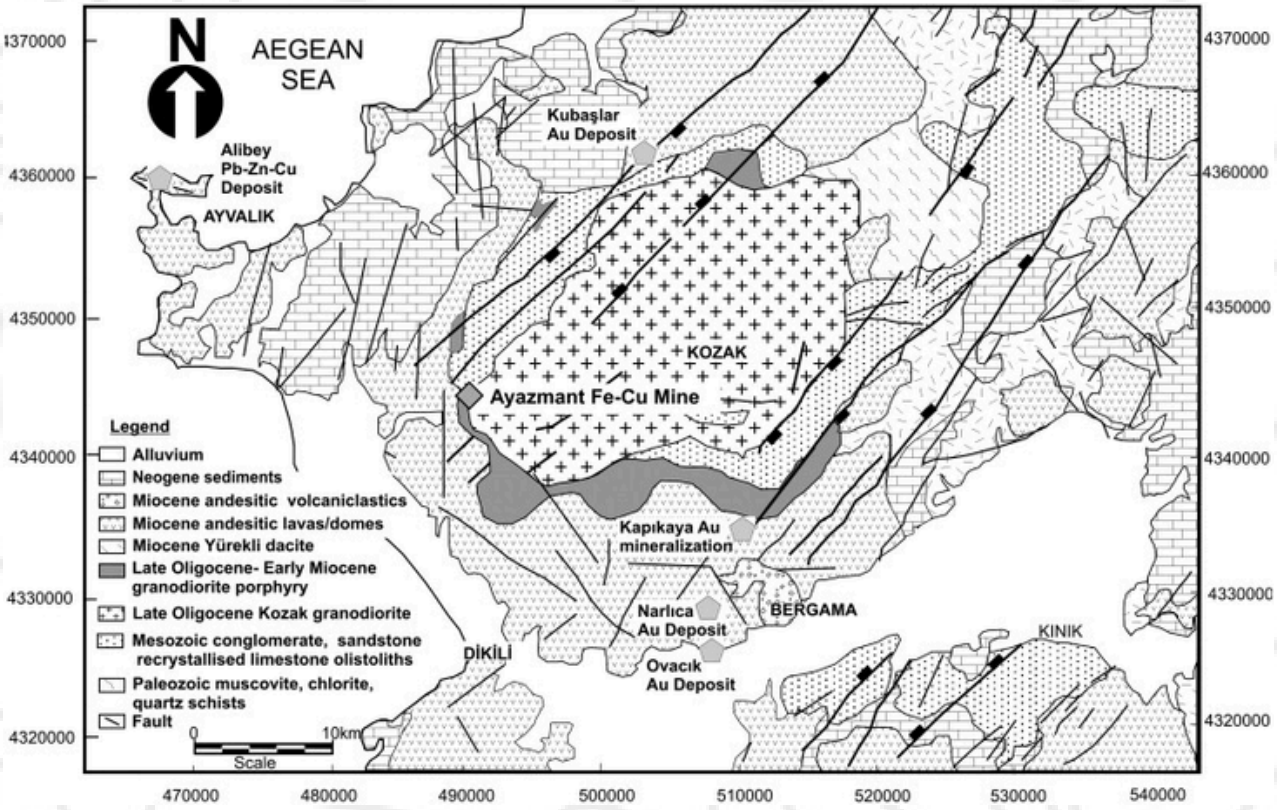
General Info

The Ayazmant Fe–Cu deposit is located approximately 20 km SE of Ayvalık, or 140 km N of Izmir, in the Aegean Region of Turkey. The Ayazmant mine exploits the largest Fe–Cu skarn deposit in the region and is apparently unique in the Aegean back-arc basins in that it differs significantly from other iron skarns in terms of mineralogy and geochemistry. The Ayazmant Fe–Cu skarn is associated with a magmatic–hydrothermal system formed in a high-level porphyry environment.

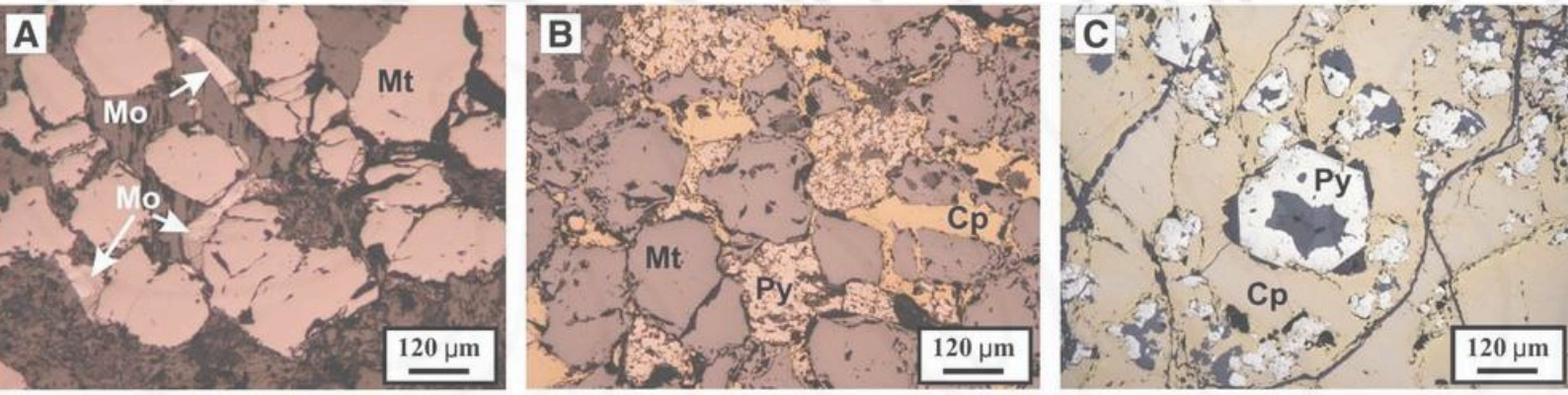
Geology

Southern zone and the northern zone. There is a large variation between these two zones in terms of skarn thickness and geometry due to the properties of the protolith and the volumes of intrusive rock units. Within the northern zone, skarns mainly occur in limestones, whereas the host rocks for skarns are meta-sedimentary rocks in the southern zone. The most important characteristic of the southern ore zone is the formation of both well-developed endo- and exoskarn. Here, post-skarn sulfide-dominated ore is represented by chalcopyrite-dominated Cu mineralization within the andradite-rich garnet zone. In the northern ore zone, sulfide is negligible and goethite-rich supergene alteration is well developed. The thickness of the ore exposed varies from 1 to 5 m at the surface in the northern ore zone. In the southern ore zone, the orebodies have a down-dip extension up to 100 m from surface.

In the northern ore zone, open pits are mainly oriented in a NE–SW direction. The southern zone is comprised of two main pits, 'Main' and 'Kıral' where magnetite is essentially being mined. Copper will be produced as a byproduct of magnetite from these two pits after production starts in 2011. In both pits, exoskarns predominantly occur within hornfelsed equivalents of the Kınık Formation. The northern skarn zone hosts several individual, small, NE–SW-trending bodies over an area of 500 m N–S by 300 m E–W. These skarn bodies were mined in limestone lenses of the Çamoba Formation, where goethite and hematite accompany magnetite in the absence of copper.



Regional geologic map of the Bergama–Dikili area (Altunkaynak and Yılmaz, 1998; Yılmaz, 2002).



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Yatagan Coal Mine & Power Plant

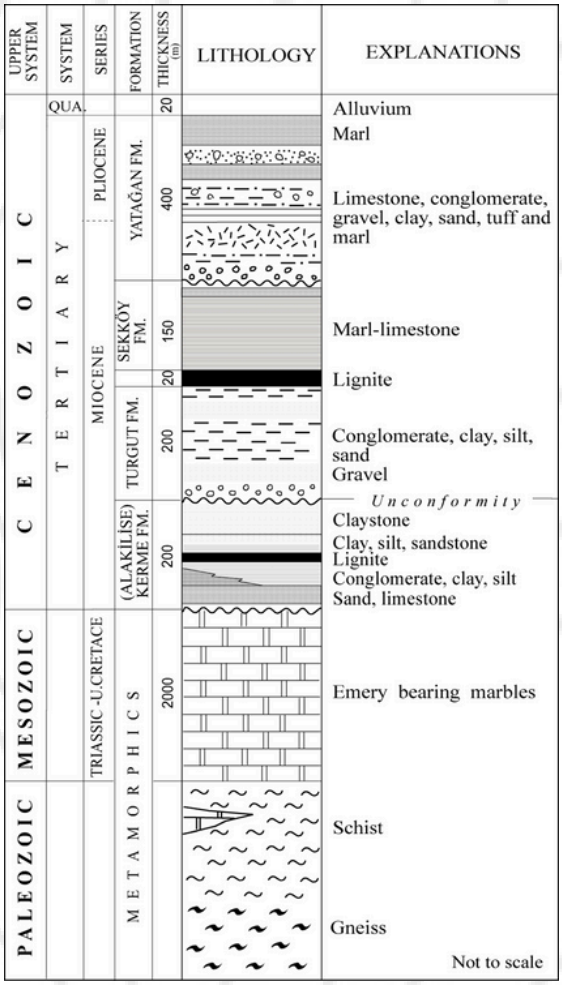
Quick Facts

- **Location:** Şahinler, Yatagan, Mugla province, Türkiye
- **Mine type:** open pit
- **Commodity:** lignite
- **Production:** 3.78 billion kWh total annual productions (power station), 5.2 MTPA (coal mine)
- **Ownership:** Yatagan Termik Enerji (power station), Üretim A.Ş., Aydem Yenilenebilir Enerji (coal mine)

Geology

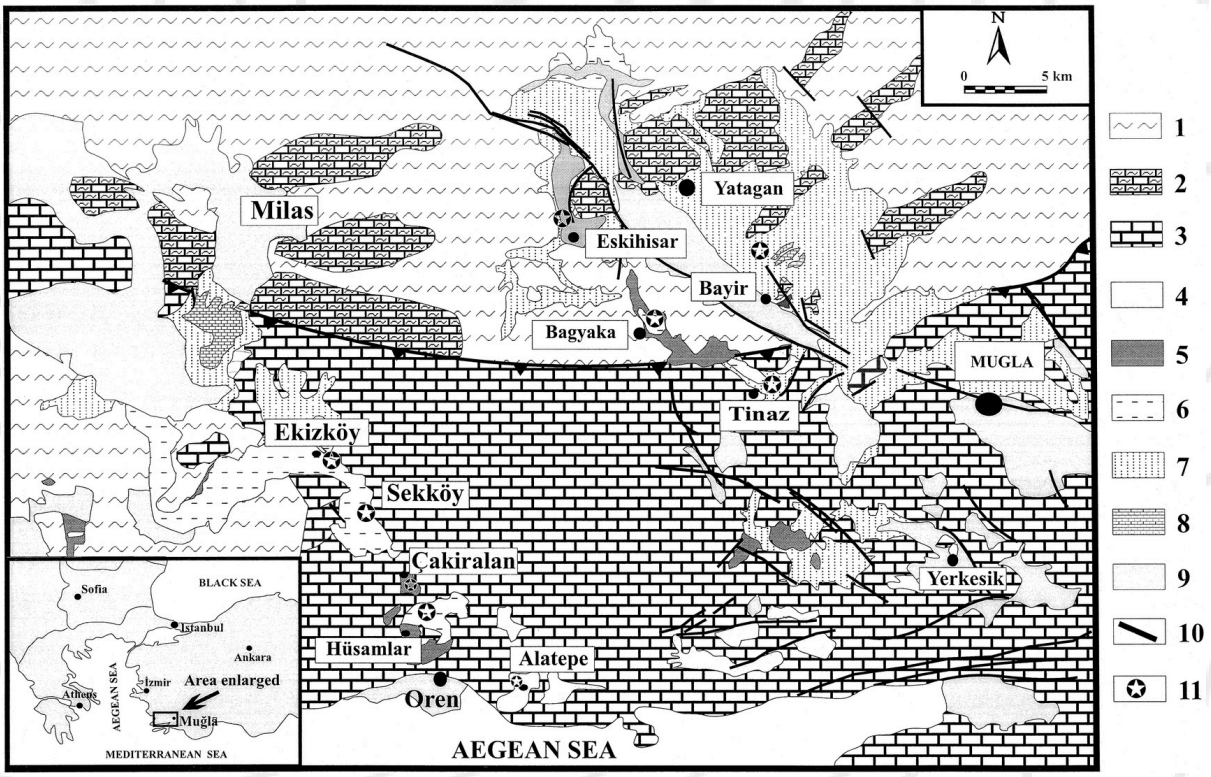
Yatagan Basin is located at the west part of Aegean Region, in the borders of Mugla City. The basin is aligned in a northwest- southeast direction. Yatagan is located at 30 km northwest of Mugla City.

The Mesozoic schists and marbles constitute the basement rocks of the area. Neogene sedimentary deposits, comprising the Miocene sequence comprises three formations, namely those of Turgut, Sekköy and Yatagan Formations, are in turn unconformably overlain by Quaternary sediments. From bottom to top, Turgut Fm includes conglomerate, sandstone, mudstone, limestone, coal, mudstone deposited under alluvial fan, fluvial and lacustrine conditions, whereas Sekköy Fm comprises coal, silty claystone, mudstone, marlstone and limestone deposited under telmatic/lacustrine conditions. These formations are conformably overlain by the Yatagan Fm, which hosts conglomerate, sandstone,limestone-marlstone-mudstone deposited under alluvial fan and lacustrine conditions.



Stratigraphic sequence of Yatagan sub-basin (Gursoy et al., 1993; Bulut et al., 2001).

Various lithological units, ranging from Mesozoic to Quaternary age, crop out in the catchment area. These are overlain unconformably by conglomerate, sandstone, claystone, tuff and marlstone of Miocene age. A large part of the Yatagan plain is made of alluvium, which is the principal aquifer in the catchment area, and consists of loose, interlayered clay, silt, sand, and gravel.



Location of the Miocene Mugla basin in Southwestern Anatolia, Turkey. 1-schist and gneiss, 2 -marble, 3 -Lycian nappes, 4 -Alatepe formation, 5-.Turgut formation, 6 -Sekkoy formation, 7 -Yatagan formation, 8 -Milet formation, 9 -Quaternary deposits, 10 -fault (Querol et al., 1999)

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Yeniköy Power Station

Quick Facts

- **Location:** Mugla province, Milas, Türkiye
- **Project type:** Thermal Power Plant
- **Commodity:** lignite
- **Production:** 2,73 MWh annually
- **Total resource:** 3.5 Mt lignite annually
- **Ownership:** IC İÇTAŞ Energy (50%)–LİMAK Energy (50%)

General Info

Yeniköy Thermal Power Plant was commissioned and put into operation in 1986, in the Milas district of Mugla province, in order to generate electricity using domestic lignite coal. Yeniköy-Kemerköy Electricity Production and Trade Inc. (YK Enerji) was taken over by Limak-IC İçtaş equal partnership on 23.12.2014.

Yeniköy Thermal Power Plant consists of 2 units, each with a capacity of 210 MW and the power plant has a total power of 420 MW. Unit 1 was put into operation in 1986 and Unit 2 was put into operation in 1987; both are currently producing. The total power generation of the power plant is 2,73 MWh annually. Net annual production values based on sales in 2023 was 2,6 TWh.

Each unit includes 1 steam turbine, 1 steam turbine generator, 1 boiler, 1 condenser, 1 cooling system with cooling tower and 1 flue gas purification system.

Coal is supplied to Yeniköy Thermal Power Plant from Sekköy, İkizköy, Akbelen and Karacahisar Mines. Approximately 3.5 Mt of coal are burned annually.

Reference

https://www.ykenerji.com.tr/yenikoy-termik-santrali

UNESCO Kula-Salihli Geopark

Quick Facts

- **Location:** Kula-Salihli district, Manisa Province , Türkiye
- **UNESCO Geopark**
- **Recognition:** September 2013
- **Main geological structures:** Cones and craters, Lava caves and lava tubes, Basalt columns, Hoodoos

General Info

Kula-Salihli Geopark, also known as Kula Volcanic Geopark and Kula Geopark (Turkish: Kula Volkanik Jeoparkı or Kula Jeoparkı) is a geopark and a protected area of geological heritage, located in Kula and Salihli districts of Manisa Province, western Turkey. It was recognized by UNESCO as a UNESCO Global Geopark in 2013, and is the country's only geopark. The Kula–Salihli UNESCO Geopark, is a tectonically and volcanically active region in which the most recent eruptions of basaltic lava, associated with scoria cone formation, were during the latest Pleistocene and the Holocene. Much older volcanism within the same volcanic province is also in evidence, with some of the older lavas capping mesa-style uplands, such that they have preserved underlying poorly consolidated sediments that would otherwise have been eroded. The purpose of our visit is to learn about UNESCO's geological heritage and about the general geology of the area and to get in touch with geotouristic activities.

Reference

https://kulasalihligeopark.com/en/

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
1964
UNIVERSITY OF PATRAS

SOCIETY OF ECONOMIC GEOLOGISTS
FOUNDED 1920

ΕΛΚΕ
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ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ

P&C DEVELOPMENT

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LITHOS
GEOLOGICAL SERVICES

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