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GEOLOGY OF THE EYMIR IRON MINE, EDREMIT, TURKEY

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ABSTRACT

The Eymir mine near Edremit on Turkey's Aegean coast (long 27°30'E.; lat 39°36'N.) was investigated as part of the Maden Tetkik ve Arama Enstitüsü (MTA)-U. S. Geological Survey (USGS) mineral exploration and training project, for the purpose of increasing the known mineral reserves. Geologic mapping of the mine area indicates that hematite is restricted to argillized, silicified, and pyritized dacite and possibly andesite. Hematite is present as massive replacements, impregnations, disseminations, and fracture fillings. Most of the upper part of the iron deposit consists of a breccia composed mostly of silicified dacite fragments in a hematite matrix. The iron deposit was apparently formed in three steps:

1. Argillation, silicification, and pyritization of the andesitic lava and dacite units as a result of a regional intrusion.
2. Intrusion of the Dere Ören dacite stock, with associated faulting, fracturing, and breccia formation at the surface.
3. Deposition of hematite by oxidation of pyrite, and transfer of iron via fractures and faults by hydrothermal or meteoric fluids.

The Eymir iron deposit is a blanketlike deposit on the crest of the Sivritepe-Eymir ridge. It is 1300 meters long, 80 to 450 meters wide, and has an average thickness of 18.6 meters. Drill holes in the deposit show the iron content to range from 32.0 to 57.6 percent, and to average 46.5 percent. Most of the gangue is silica, and an arsenic impurity averaging 0.39 percent is present. Most of the deposit cannot be utilized as iron ore because of low iron content, high silica content, and high arsenic content.

Ore-dressing tests have shown that it is feasible to concentrate the low-grade material, producing a concentrate having increased iron content and reduced silica content. Tests have shown also that the arsenic content of the ore can be reduced substantially by sintering. Further tests and economic feasibility studies are necessary to determine whether an economic marketable iron ore can be produced.

If such studies indicate the technical and economic feasibility of utilizing all the Eymir iron deposit, detailed additional studies are recommended including:

1. A detailed drilling and sampling program to include 60 drill holes averaging 40 meters in depth and detailed sampling of mine dumps.
2. Pilot-plant testing of concentration and sintering procedures.
3. A detailed pre-investment economic feasibility study.

INTRODUCTION

Location and access

The Eymir mine is approximately 135 km north of Izmir and 22 km east of Edremit near Turkey's Aegean coast (fig. 1). Geographic coordinates of the mine are approximately 27°30'E.; lat 39°36'N. The mine lies 3 km north of the Edremit-Balikesir highway and may be reached by a 5-km access road.

Purpose and scope of investigation

The investigation was conducted to define the geological relationships of the iron deposit, explore for additional iron ore reserves, and provide experience in geological mapping methods for MTA counterparts.

The work was done as part of the MTA-USGS mineral exploration and training project under the auspices of the Agency for International Development (AID), U. S. Department of State, and was sponsored by the Government of Turkey. Geological mapping was conducted from April 12 to July 15, 1968. A preliminary report recommending drilling was submitted on July 29, 1968, followed by diamond drilling from December 1968 to February 1969.

This report is a compilation of results obtained from the above activities, as well as considerable data available from other investigations.

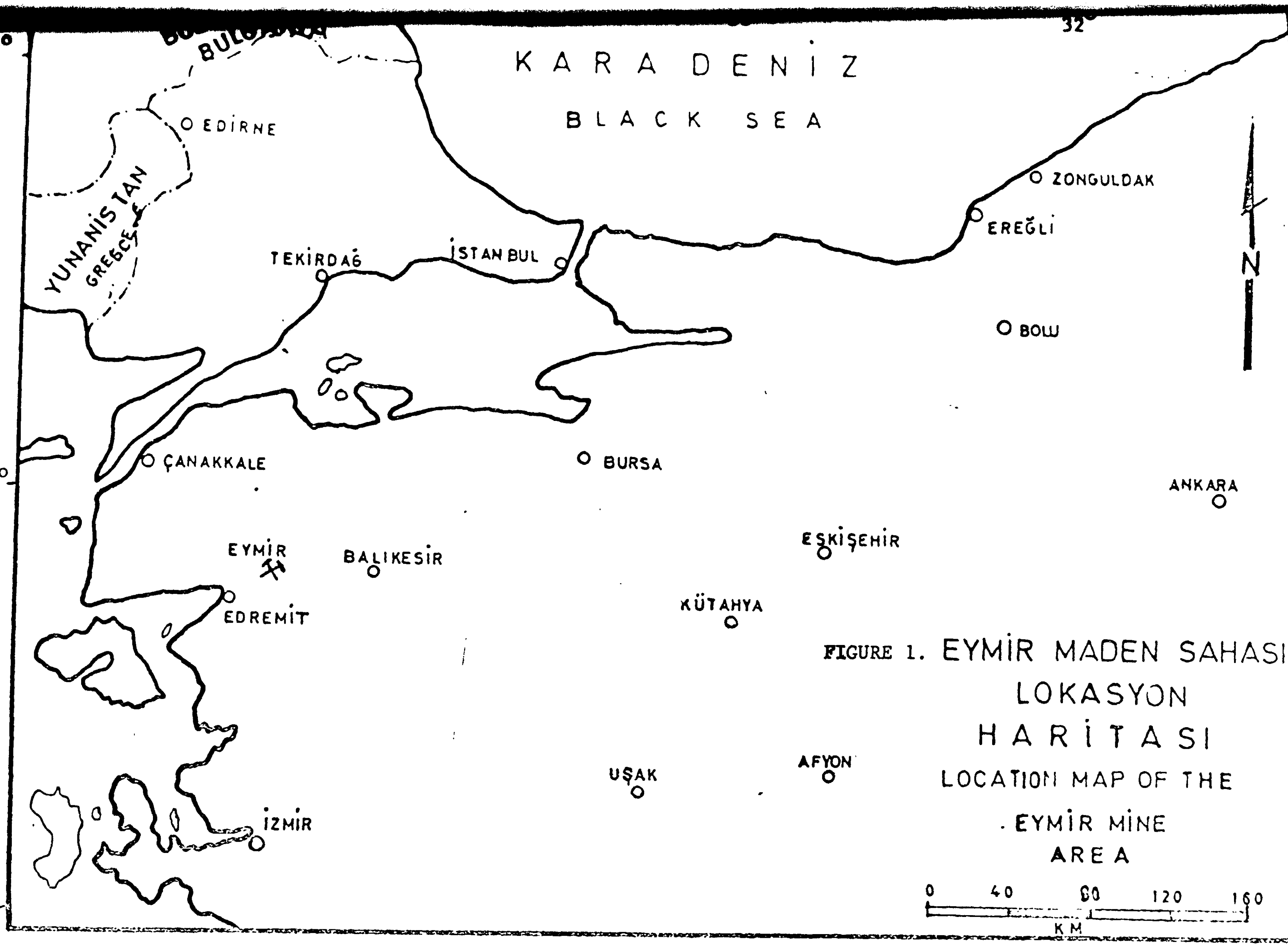

FIGURE 1. EYMİR MADEN SAHASI LOKASYON HARİTASI
LOCATION MAP OF THE EYMİR MINE AREA

Acknowledgments

We are grateful for the assistance received in the field from geologists Tannür Kayaöz and Yalçin Tuğrul, (MTA), and for assistance in rock sample identification and core logging received from Richard D. Krushensky (USGS). The Dumeks Ticaret TAO mining company facilitated field activities. The ore dressing and metallurgical tests were conducted by the MTA laboratories under the supervision of Nahid Kiragli.

PREVIOUS AND CONCURRENT WORK

Many geologists and engineers have studied the Eymir mine and adjoining areas. The principal investigators of the mine itself were S. Turkunal of MTA (Turkunal, 1957) and the Fried. Krupp Company (Krupp, 1959). Other previous investigators are listed in a report by R. D. Krushensky, Y. Akcay, and E. Karaege (Krushensky and others, in press).

While the authors were studying the mine, the surrounding area was investigated by R. D. Krushensky, E. Karaege, and H. Filibeli, as part of the same MTA-USGS mineral exploration and training project. They mapped the geology of the area to provide a geologic framework for the Eymir mine and to explore for previously unknown deposits.

PRODUCTION AND MINING

The Eymir mine has been operated by the Dumeks Ticaret TAO company from 1953 to the present. Annual production ranged from about 341,000 tons in 1956 to 92,000 tons in 1962, while the mine was exporting to European markets. Since 1962 production has ranged from 32,000 to 51,000 tons, and the ore has been sold in Turkey to the Ereğli steel plant.

The mine produces ore from two open pits: Büyük Eymir and Ana Eymir (pls. 1 and 2). Current mining activities employ about 200 men and women, and daily production is 200 tons.

Mining is carried out in the following steps:

1. Stripping of waste and low-grade material using diesel-powered loaders and dump trucks. Some of the low-grade is subsequently hand sorted, and high-grade fragments are shipped.
2. Breaking ore by drilling blastholes with air compressors and hand-held jackhammer drills, followed by blasting with dynamite.
3. Crushing oversize boulders at the face by use of sledge hammers.
4. Hand loading on trucks for shipment to Akcay. Some low-arsenic ore from the Ana Eymir pit is blended with high-grade iron ore from the Büyük Eymir pit during the loading operation.

The selective mining over a period of many years has resulted in accumulation of a large dump of low-grade iron raw material which may constitute a future reserve.

The Mortaş mine just south of the Eymir mine (south end of pls. 1 and 2) has been operated intermittently by the Mortaş company. The mine consists of a series of small pits from which hematite boulders were removed and shipped.

GEOLOGY OF THE EYMIR MINE AREA

The oldest rock in the immediate mine area is the porphyritic andesite which is overlain by dacite. The andesitic and dacitic rock are the source materials for a later sedimentary breccia which was subsequently mineralized to form the hematitized dacite breccia. All these rocks are covered in part by recent talus, alluvium, soil, and mine dumps. The principal lithologic units are described below.

Volcanic rocks

Porphyritic andesite

Porphyritic andesite containing local andesitic tuff lenses is extensively exposed both east and west of the Eymir mine area (pls. 1 and 2). The andesite is strongly altered, hydrothermally, near the iron deposit. This altered zone was mapped separately and is described separately below.

The porphyritic andesite has abundant plagioclase phenocrysts and rare amphibole and pyroxene phenocrysts in a fine-grained groundmass. In the field, sparse quartz grains that look like phenocrysts are visible, but microscopic study of thin sections (Krushensky, oral commun., 1969) shows that the quartz is a product of secondary silicification, and is not primary quartz. Other alteration products include clay, mica, carbonate, and iron oxide minerals.

Thin-bedded andesitic tuff is exposed only locally near the creek at the eastern margin of the area mapped (pl. 2).

Altered porphyritic andesite

The altered porphyritic andesite is probably the hydrothermally altered equivalent of the porphyritic andesite and is exposed in a narrow belt adjoining the Eymir iron deposit on the east (pls. 1 and 2). The alteration differs in intensity and in type. Silicification dominates and probably followed argillation. In the strongly altered samples the original andesite matrix is largely replaced by a fine-grained quartz mosaic. Commonly, the feldspar phenocrysts are also replaced by quartz. Argillic alteration is pervasive but less dominant than silicification. Commonly the feldspar phenocrysts are altered to clay minerals, and rarely the matrix is argillized. No attempt has been made to identify the clay minerals. Locally, feldspar phenocrysts are replaced by carbonate, and amphiboles are altered to chlorite. Disseminated pyrite was seen in one pit in the altered andesite and is also present near the bottom of some drill holes (Krupp, 1959, and Krushensky, oral commun., 1969).

The hydrothermal alteration has made positive identification of the original rock impossible, particularly around the south end of the iron deposit where both silicified dacite and altered porphyritic andesite were mapped as a single lithologic unit. Also, the change from argillized to silicified rocks appears gradational.

Silicified dacite

Silicified dacite is well exposed near the north end of the mapped area (pls. 1 and 2), and outliers are exposed elsewhere. The rock commonly consists of quartz phenocrysts in a fine-grained quartz mosaic. Silicified feldspar-phenocrysts are present in places but commonly the rock shows leached rectangular vugs after feldspar phenocrysts. Subordinate clay minerals are present in the matrix, and secondary iron oxides are locally common.

One outcrop shows thin bedding, indicating that part of the silicified dacite was originally a tuff, but some lava may also have been present. Owing to the intense silicification, few original textures can be observed.

Mineralized rocks

Altered volcanic material containing iron oxides

Strongly hydrothermally altered volcanic rocks impregnated with iron oxides are exposed in the Büyük Eymir village (pl. 2). The rocks consist of sparse quartz phenocrysts in a quartz-clay-hematite-limonite matrix and may represent mineralized silicified dacite. The rock is estimated to contain less than 30 percent iron. Locally, sandy textures were seen which may possibly represent an altered coarse tuff.

Massive hematite

Massive hematite in the Eymir mine and in the drill holes (pls. 1 and 2) is probably a more highly mineralized equivalent of the iron-oxide-impregnated dacite. The massive hematite is in a series of irregular bodies bounded by steeply dipping fractures and surrounded by barren or weakly mineralized altered rocks (pl. 2). Massive hematite bodies in the Büyük Eymir pit were mapped, but the size and distribution of similar bodies indicated by drill holes could not be determined because the holes are too far apart.

Another type of massive hematite is thinly layered hematite present only along fractures; the layering is parallel to the fractures. Fossil leaves are locally visible between the hematite layers in the fractures. The fossil leaves could not be identified (J. Wolfe, U. S. Geol. Survey, written commun., 1969).

Hematitized dacite breccia

Most of the areas of mineralized rocks on the surface (pls. 1 and 2), and the mine dumps, consist of hematitized dacite breccia. The breccia is composed of common silicified dacite fragments and sparse soft argillized andesite fragments in a hematite matrix (fig. 2). The silicified dacite fragments are angular and commonly 0.5 to 5 cm in diameter, and rarely as much as 20 cm. The silicified dacite fragments appear to be identical in composition to the nearby silcified dacite outcrops. The altered andesite fragments are rounded and composed mostly of clay minerals. They appear to be the same as the altered porphyritic andesite outcrops east of the mineralized area. The matrix of the breccia is dense massive hematite.

The breccia is probably a sedimentary breccia that formed under conditions of limited movement, as indicated by the preservation of argillized andesite fragments and by the angular shape of the silicified fragments. It may be a talus deposit in which the matrix has been replaced by hematite.

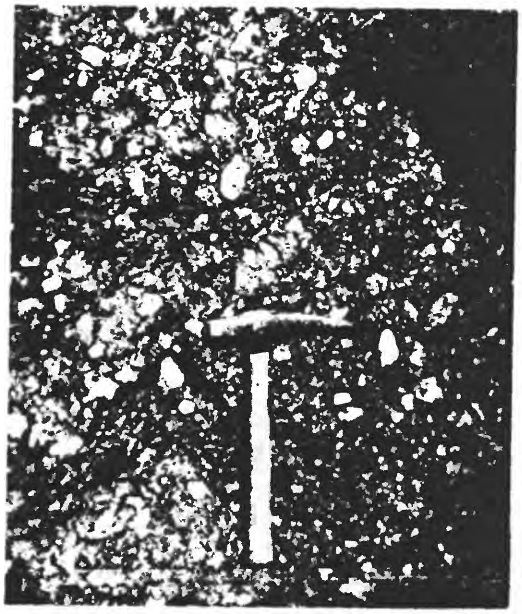

Figure 2. Hematite-quartz dacite breccia showing rock fragments in hematite matrix.

Structure

The porphyritic andesite underlying the Eymir mine area has an apparent synclinal shape. West of the mine the beds strike north-northeast and dip southeast. East of the mine the beds have a similar strike but dip northwesterly (pls. 1 and 2).

The dacite and dacite tuff are nearly horizontal, as indicated by bedding in outcrops north of the mine (pls. 1 and 2) and in the core of drill hole 1-69. Consequently, the dacite apparently overlies the porphyritic andesite unconformably.

The main period of structural deformation that formed most of the structures now visible at the Eymir mine accompanied the intrusion of the Dere Ören stock and preceded the introduction of iron oxides. The most prominent structural feature, here named the Büyük Eymir fault, forms the northern boundary of the Büyük Eymir mine (pls. 1 and 2). The fault strikes about N.65° and has a nearly vertical dip. Movement along the fault was both vertical and horizontal right lateral. The extent of the movement has not been determined. We believe that the movement was hinge-like, with greater vertical displacement toward the west than toward the east. This would have produced a post-fault topographic high just west of the Eymir village. Erosion of this topographic high could then have resulted in the presently observed hematitized dacite breccia, which dips from about 10° to 30°SE.

In the Büyük Eymir mine, open tension fractures 5-50 cm are common; they strike in two directions: N. 50°-70° W., and N. 20°-40° E. (pl. 2). All these fractures are steeply dipping. The open space at lower elevations is filled with thin banded hematite and at higher elevations by recent soil and gravel, indicating very recent filling. The fractures commonly form boundaries of the high-grade iron ore and probably were channels for mineralizing solutions.

Both the major fault and the two directions of tension fractures were probably formed at the same time as a result of compressive stress.

Geologic history

The sequence of geologic events leading to the formation of the Eymir iron deposit is believed to be as follows:

1. Deposition of andesite lava and the overlying dacite.
2. Widespread argillation and near-surface silification with concurrent pyritization of both the andesite and dacite.
3. Faulting and fracturing accompanying the intrusion of the Dere Ören stock. Simultaneous local erosion, and formation of the hematitized dacite breccia.
4. Oxidation of the pyrite in the andesite and dacite and transport of the iron by fluids in part derived from the Dere Ören stock; and ultimate deposition of hematite in a near-surface environment produced in step 3 above. The solutions may have had a hydrothermal origin or may have been heated recirculating meteoric waters, or both.

During the precipitation of iron oxides in open near-surface fractures, leaves from plants growing on the surface probably fell into the open fractures and were fossilized. The fossil leaves are only in layered hematite within the fractures. The iron deposit is not a bog iron deposit, as indicated by some writers (Ryan, 1953) on the basis of the presence of fossil leaves.

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