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THE BAUXITE DEPOSITS OF SEYDİŞEHİR REGION (MORTAŞ AND DOĞANKUZU DEPOSITS); THEIR GEOLOGICAL, MINERALOGICAL AND GEOCHEMICAL CHARACTERISTICS

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Abstract

Turkey hosts essential bauxite deposits, typically of the karstic-type. The most economically important bauxite deposits of Turkey form in the Seydişehir-Akseki region of the central Taurides Mountains. The Mortaş and Doğankuzu deposits are the most important deposits in that region. The bauxite beds contain boehmite, hematite, rutile, smectite, quartz, diaspore, calcite, pyrite, marcasite and goethite. Brown to red-colored bauxite minerals are massive, oolitic – pisolitic textured. The Seydişehir schists could be possible parent rocks of bauxites, and have unearthed acidic source (mostly granite) with hornblende and plagioclase minerals. The schists were compositionally mature with minimal alkali feldspar sediments.

The Mortaş deposit is 400 m long and up to 40 m thick; it averages 10 m thick. It has about 5 million tons of ore reserves, with ~50 percent Al_2O_3 . The Doğankuzu bauxite deposit is situated 2 km southwest of the Mortaş deposit, with 14.9 million metric tons of ore at 61 percent Al_2O_3 . The Doğankuzu ore was deposited on a fault-controlled karst surface of Cenomanian limestone succession, which was overlain by 5- to 10-cm-thick Santonian limestones. The bauxite has been mined by the Seydişehir aluminum factory, which was founded in 1973, and privatized in 2005. The plant is capable to produce 65.000 ton liquid aluminum per year, around 15% of Turkey's Aluminum demand.

Keywords: Geology, bauxite, karstic, Tauride, Seydişehir.

INTRODUCTION

The study area is located in the Tauride Belt of southern Turkey (Fig.1), at where six bauxite provinces are located. These are (1) the Milas–Yatağan (Muğla) Province, (2) the Bolkardağı (Karaman) Province, (3) the Tufanbeyli–Saimbeyli–Kadirli Province, (4) the Seydişehir–Akseki Province (5) the Payas–İslahiye Province, and (6) the Isparta–Şarkikaraağaç Province. The Seydişehir – Akseki bauxite province contains too many (>100 occurrences) Mediterranean type, paleo-karst bauxite deposits, nevertheless only a few are large enough to be of value (Fig.1, 2).

Figure 1: Bauxite deposits of Tauride belt, Turkey [1]

GEOLOGIC SETTING

In the central Taurides Mountains, there are major autochthonous and allochthonous tectonostratigraphic units. The autochthonous unit includes lower Paleozoic phyllite and graywacke known as the Seydişehir schist, which was unconformably overlaid by Triassic and Jurassic limestone and dolomitic limestone.

Figure 2: Geological map of the Seydişehir-Akseki bauxite province [2]

Cretaceous rocks are made up of limestone, dolomitic limestone, which have thickness more than 1000 m, and associated bauxites (Fig.2). Paleocene and Eocene limestone and sandstone (Fig.3) conformably rest on the Cretaceous rocks. From the north onto the autochthonous basement, all the units were obducted during the Oligocene by Hadim nappes, which consists of two tectonostratigraphic subunits: serpentized ultramafic-mafic rocks and limestone and dolostone of Permian age. Posttectonic sedimentary rocks contain alluvial fan deposits of Miocene and Pliocene ages.

Figure 3: Geological map of the Mortas and Doğankuzu bauxite district [3]

BAUXITE DEPOSITS

In the Seydisehir - Akseki area, there are economically important bauxite deposits [2,3,4], the most important of which are Mortas, and Doğankuzu deposits mined by the Seydisehir aluminum company. The deposits are of karst unconformity-type deposits placed unconformably between Cenomanian and Santonian shallow marine limestones. Bauxite minerals are brown to red, massive, oolitic – pisolitic textured. Mineralizations formed at the crest of the Taurides Mountains more than 1,500 m above sea level, and have roughly north-south trend, with thickness varying from 1 to 40 m. They are often cut by various normal faults. The Mortas deposition is one of the most important bauxite mines currently operating in Turkey. The exploration studies taken place from 1970 to 1980, show that the Mortas bauxite deposit have 10.9 million metric tons of ore, with ~50 percent Al_2O_3 (Table 1). The lensoidal deposit is 950 m in length, 350m in width and an average thickness of 40m. By 1999, six million metric tons of ore has been mined, leaving about 5 million tons of ore reserves. The Doğankuzu bauxite deposit, located 2 km southwest of the Mortas deposit, has 14.9 million metric tons of ore, with ~61 percent Al_2O_3 (Table 1). Ore was deposited on fault-controlled karst surface of Cenomanian limestone succession, and overlain by 5- to 10-cm-thick Santonian limestone [3]. The ore from both deposits is transported to the Seydisehir aluminum factory, which was established in 1973, put into operation at full capacity in 1977.

Table 1: Average of the bulk rock analyses of the bauxites (DK: Doğankuzu, MT: Mortas) and Seydişehir schists.

Number	DK[3]	MT [2]	caltepe S.sehir	southern S.sehir
	bauxite 10	bauxite 54	schist 10	schist 2
SiO ₂	5.25	7.40	65.00	70.20
Al ₂ O ₃	61.09	49.80	14.50	13.54
Fe ₂ O ₃	17.44	16.70	6.20	5.44
MgO	0.21	0.10	1.60	1.11
CaO	0.15	5.70	1.90	0.42
Na ₂ O	0.18	0.01	1.10	1.51
K ₂ O	0.23	0.30	2.60	2.29
TiO ₂	2.93	2.10	1.00	0.84
P ₂ O ₅		0.02	0.20	0.13
MnO		0.01	0.04	0.02
Cr ₂ O ₃		0.04	0.01	0.03
LOI	12.24	17.20	5.70	3.95
SUM	99.73	99.70	100.00	100.09
La		137.60	58.10	42.1
Ce		221.00	124.60	84.95
Pr		31.70	13.70	10.26
Nd		124.70	54.00	37.40
Sm		24.20	10.10	7.60
Eu		4.90	2.00	1.55
Gd		20.60	8.50	8.06
Tb		3.50	1.40	1.11
Dy		19.10	7.80	6.31
Ho		3.80	1.50	1.23
Er		11.20	4.50	3.57
Tm		1.80	0.70	0.54
Yb		12.40	4.30	3.76
Lu		1.90	0.70	0.56

The plant privatized in 2005, processes 550.000 tone / year bauxite ore; in its red mud pool, sodium aluminate (NaAlO₂) solution is obtained by precipitation of the non-soluble compounds (iron, silica etc.). Alternatively, It is capable to produce 65.000 ton liquid aluminum per year around 15% of Turkey's Aluminum demand.

MINERALOGY AND GEOCHEMISTRY

The minerals in bauxites are boehmite, hematite, rutile, smectite, quartz, calcite and tridymite. Where mineralized by sulfides, the ore also comprises pyrite, marcasite, and in places diaspore, with minor kaolinite, anatase, and in some samples goethite [2, 3].

Table-1 shows that Dogankuzu bauxites are enriched in Al₂O₃, Fe₂O₃, MgO, Na₂O and TiO₂ contents, and depleted in SiO₂, CaO and K₂O in comparing with Mortas ones. The Upper Cambrian-Lower Ordovician Seydişehir schist, made up of metamorphosed shale and greywacke, suggested to be a possible parent rock for the bauxites [2, 4]. Accordingly, REE pattern of the Mortas bauxites and Seydişehir schists, namely Caltepe and Southern Seydişehir, show consistent pattern to each other (Fig. 4). They are characterized by LREE enrichment [in

Mortas bauxites and Seydishehir schist, $(La/Sm)_N$: 3.6, 3.5, respectively] and almost flat HREE [in Mortas bauxites and Seydishehir schist, $(Eu/Yb)_N$: 1.12, 1.17, respectively]. They also show slightly concave upward REE pattern, with pronounced negative Eu (Mortas bauxites and Seydishehir schists: Eu/Eu^* : 0.70, 0.62, respectively) anomaly, indicating a source with plagioclase and hornblende. Fig. 5 also shows an unearthen acidic source for the shales. Fig. 6 confirms acidic parents, but probably mostly granite in composition, for the schists. It has been suggested that materials derived from acidic source deposited in Paleotethys Ocean as shales of the Seydishehir Formation during the Late Cambrian – Early Ordovician time [2]. In the Seydishehir schists, Index of Compositional Variability [$ICV = (Fe_2O_3^{tot} + K_2O + Na_2O + CaO + MgO + MnO + TiO_2) / Al_2O_3$] is 0.93 (average), suggesting that most shales were compositionally mature and were likely dominated by recycling. Ratios of K_2O/Al_2O_3 in the schists are less than 0.4 suggests minimal alkali feldspar in the original shale [7].

Figure 4: Chondrite normalized [5] REE pattern of the Mortas bauxite (x), and Seydishehir schists (Caltepe: $\diamond$, Southern Seydishehir: $\blacklozenge$)

Figure 5: TiO_2 % wt versus Ni ppm diagram, indicating an acidic source for the Southern Seydishehir schists [6].

Figure 6. A La–Th–Sc plot of the Seydişehir schists [7].

CONCLUSIONS

Karst unconformity-type Mortas and Dogankuzu bauxite deposits, associated with Mesozoic limestones, are the major source of Al in Turkey. Major oxides in the mineralizations are Al_2O_3 , Fe_2O_3 , SiO_2 , TiO_2 and CaO. The bauxites were suggested to have parent rock of Upper Cambrian - Lower Ordovician Seydişehir schist, which have an unearthen acidic source (mostly granite) with hornblende and plagioclase minerals.

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