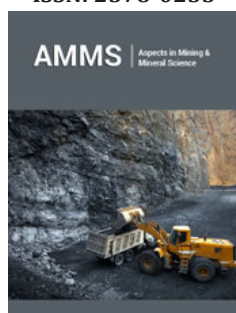


Mineralogical and Geochemical Characteristics of the Gerdeh-Bardan Titanium-Rich Bauxite Deposit, Irano-Himalayan Karst Bauxite Belt, NW Iran

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Opinion

The Irano-Himalayan karst bauxite belt in northwestern Iran hosts numerous karst bauxite deposits, including the Hossein-Abad, Ailibaltalu, Kanirash, Shahindezh, and Aghadjari deposits [1-5]. These deposits are predominantly of Permian to Triassic age. The Gerdeh-Bardan bauxite deposit is another representative karst bauxite deposit of Permian-Triassic age in northwestern Iran. This deposit is readily distinguishable from other known Permian-Triassic bauxite deposits in the region, and even worldwide, due to its high TiO_2 content (4.66-8.44wt%). The Gerdeh-Bardan bauxite deposit occurs as stratiform layers and lenses developed at the boundary between the limestones of the Rute Formation (Permian) and the dolomites of the Elika Formation (Triassic). The ores are composed mainly of diaspore, hematite, pyrophyllite, and chlorite, with minor amounts of boehmite, rutile, anatase, goethite, ilmenite, amesite, and illite. The ores are green and red in color and exhibit typical textures of authigenic bauxites [6], including pisoidic, ooidic, macropisoidic, pseudo-breccia, pseudo-porphyry, colloform, and nodular textures.

Studies have shown that in most karst bauxite deposits worldwide, there is a strong positive correlation between Al_2O_3 and TiO_2 concentrations, reflecting the similar geochemical behavior of these two elements during the bauxitization process [7,8]. However, this well-established geochemical relationship is not observed in the ores of the Gerdeh-Bardan bauxite deposit, which distinguishes it from other karst bauxite deposits globally. The decoupling of the distribution and concentration of Al_2O_3 and TiO_2 in the Gerdeh-Bardan ores indicates the influence of post-formation diagenetic and/or metasomatic processes on the deposit [9]. Deferruginization and the destruction of kaolinite are identified as two major factors controlling the development of bauxite ores. In this deposit, illite minerals, through adsorption processes, and hematite and goethite minerals, through scavenging mechanisms, have played key controlling roles in the distribution and concentration of most trace elements, especially the lanthanides [10-12].

To date, only a limited number of titanium-rich bauxite deposits have been reported worldwide. These include the Shilla-1 karst bauxite deposit in Greece [9]; the Kanigorgeh [13], Nasr-Abad [14], and Biglar [15] deposits in Iran; and the Payas deposit in Turkey [16]. Table 1 compares the titanium mineralogical characteristics and TiO_2 concentrations of these deposits with those of the Gerdeh-Bardan bauxite deposit. The TiO_2 concentration in the Gerdeh-Bardan bauxite deposit (average 6.96 wt%) is higher than that of the Shilla-1 (average 5.86

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wt%), Nasr-Abad (average 4.83 wt%), and Biglar (average 5.60 wt%) karst bauxite deposits, but lower than that of the Kanigorgeh (average 8.91 wt%) and Payas (average 9.01 wt%) deposits. In terms of titanium mineralogy, the Gerdeh-Bardan bauxite deposit, characterized by an anatase-rutile-ilmenite assemblage, differs

from all previously reported deposits. The Shilla-1, Kanigorgeh, and Payas bauxite deposits are dominated by anatase-rutile mineralogy, whereas the Nasr-Abad and Biglar deposits are characterized predominantly by rutile and anatase, respectively.

Table 1: Comparison of the Gerdeh Bardan karst bauxite deposit with other known titanium-rich karst bauxite deposits worldwide in terms of titanium mineralogy and TiO₂ concentration.

Locations of Bauxite Occurrences	TiO ₂ (wt%)	Ti-minerals	Reference
Shila 1 (Greece)	4.59-6.66 (average: 5.86)	Anatase-rutile	[9]
Kanigorgeh (Iran)	5.05-10.32 (average: 8.91)	Rutile-anatase	[13]
Payas (Turkey)	7.87-10 (average: 9.01)	Rutile-anatase	[16]
Nasr-Abad (Iran)	3.33-7.93 (average: 4.83)	Rutile	[14]
Biglar (Iran)	1.60-9.05 (average: 5.60)	Anatase	[15]
Gerdeh Bardan (Iran)	4.66-8.44 (average: 6.96)	Anatase-rutile-ilmenite	This study

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