

Article

Genesis and Evolution of the Yolindi Cu-Fe Skarn Deposit in the Biga Peninsula (NW Turkey): Insights from Genetic Relationships with Calc-Alkaline Magmatic Activity

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Abstract: The current work investigates the impact of magmatic fluids and metasomatic processes on the Yolindi Cu-Fe skarn deposit in the Biga Peninsula, Turkey. It traces the stages of skarn evolution, from prograde to retrograde alterations, and investigates findings within a broader geological, mineralogical, and geochemical framework. Additionally, it assesses the evolutionary history of the Yolindi deposit in relation to calc-alkaline magmatic activity in an island-arc environment and compares its mineral compositions and genesis with other global and regional Cu-Fe skarn deposits. The Yolindi Cu-Fe skarn deposit in the Biga Peninsula was formed by the intrusion of Şaroluk quartz monzonite pluton into Upper Paleozoic Torasan Formation rocks such as phyllite, schists, hornfels, marble, and serpentinites. During skarnification, reactions between the magmatic fluids from the Şaroluk quartz monzonite pluton and the Torasan Formation produced skarn minerals associated with metals such as Fe and Cu. Initially, these reactions formed prograde skarn minerals such as augite-rich pyroxenes and andradite garnets with magnetite and pyrite. As the system cooled, these initial minerals underwent retrograde alteration, leading to the formation of minerals such as epidote, actinolite, and chlorite, as well as other copper and iron minerals including chalcopyrite, bornite, secondary magnetite, and specular hematite. Therefore, four main stages influenced the formation of the Yolindi Cu-Fe deposit: metamorphic bimetasomatic, prograde metasomatic, and retrograde metasomatic stages. Later, oxidation and weathering resulted in supergene minerals such as cerussite, malachite, and goethite, which serve as examples of the post-metamorphic stage. The mineralogical shifts, such as the andradite–grossular transition, reflect changing hydrothermal fluid compositions and characteristics due to the addition of meteoric fluids. Importantly, the formation of magnetite after garnet and clinopyroxene during the retrograde stage is evidenced by magnetite crystals within garnet. The mineral associations of the Yolindi Cu-Fe skarn deposit align with the global skarn deposits and specific Turkish skarns (e.g., Ayazmant Fe-Cu and Evciler Cu-Au skarn deposits). The Yolindi Cu-Fe skarn deposit, in association with ore-bearing solutions having magmatic origins, developed in an island-arc setting.

Keywords: EPMA data; geochemistry; mass balance calculation; Yolindi Cu-Fe skarn deposit; Şaroluk pluton; Biga Peninsula; NW Turkey



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1. Introduction

As a result of changes in fluid composition, pressure, and temperature, a skarn system frequently displays zonal alterations [1]. These zonal patterns may run concentrically (outward from the igneous intrusion) or perpendicular to the intrusion/carbonate-rich rock and limestone contact [1]. Mineral assemblages are a common way to express these zones. Based on their proximity to the caused intrusion, Ray and Webster [2] and Meinert [3]