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Constraints on the Paleoredox Conditions at Time of the Deposition of the Ab-Bagh SEDEX-Type Zn-Pb Deposit, Southeastern Part of the Malayer-Esfahan Metallogenic Belt, Iran

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The Ab-Bagh Zn-Pb deposit is located in the central part of the Sanandaj-Sirjan zone, Iran, and is hosted in the Upper Jurassic-Lower Cretaceous sedimentary sequence. This deposit contains approximately 2 Mt grading at 5.41% Zn + Pb. The mineralization occurred during the back-arc rifting of the continental margin of the Sanandaj-Sirjan zone. The Upper Jurassic-Lower Cretaceous sequence in the Ab-Bagh mining area includes alkaline feldspar-bearing volcanic units, which could have been evidence for a back-arc setting. Based on stratigraphic position, two ore horizons can be distinguished. The vent-proximal SEDEX-type ore horizon 1 is hosted by Late Jurassic-Early Cretaceous black shale and siltstone; it displays three different ore facies (stockwork, massive, and bedded ores). The carbonate replacement SEDEX-type ore horizon 2 occurs in Lower Cretaceous carbonates and exhibits two ore facies; massive ore facies is concordant with host rock layering and is underlain by a stockwork facies. The presence of synsedimentary brecciation in host rocks is considered to be favorable for SEDEX-style base metal deposition. Major metallic minerals are sphalerite, galena, and pyrite with rare chalcopyrite. Silicification and carbonatization are the main wall-rock alteration styles in both ore horizons; alteration intensity increases toward the proximal feeder zone.

Since the redox condition of the sedimentary environment has an important role in the formation of SEDEX-type deposits, we have investigated paleoanoxic or euxinic conditions of Ab-Bagh deposit by using host rock geochemistry and characteristics of pyrite framboids. While sediments can be naturally rich in vanadium, high molybdenum contents in sediment attest euxinic conditions; therefore, high V/Mo ratios in sediments suggest deposition under anoxic conditions. The high value of the V/Mo ratio obtained by ICP-MS analyses suggests that the ore-bearing sedimentary rocks of the Ab-Bagh deposit were formed under anoxic conditions. Because of the various behaviors of V, Ni, and Cr (V/Cr ratios and V/((V + Ni)) values) during redox processes in marine environments characterized by fine-grained detritic sedimentation, these elements can be used to determine redox conditions of the ore-bearing shale and siltstones of ore horizon 1. On the V/Cr vs. V/((V + Ni)) diagram, all of analyzed samples plot within the range of anoxic conditions. Pyrite framboid size may also be used to define redox conditions during deposition. A particle size of 3 to 5 μm indicates a euxinic environment, 4 to 6 μm with a few larger grains indicates anoxic conditions, 6 to 10 μm with some larger framboids and crystalline pyrite indicates lower suboxic waters, and larger grains (10–50 μm) indicate upper suboxic or oxic pore waters. Pyrite framboids at the Ab-Bagh deposit have a grain size ranging from 0.7 to 5 μm, despite some fine crystalline grains due to recrystallization. This grain size of pyrite framboids is also evidence for anoxic (to very lower suboxic) conditions. Hence, our data suggest an anoxic to locally suboxic event for the

basin at the time of formation of the Ab-Bagh deposit. It seems that this basin morphology, characterized by the absence of oxygen in the deepest part, results from extensional tectonics and development of half-graben structures during the back-arc basin formation.