



Petrogeochemistry of listvenite association in metaophiolites of Sahlabad region, eastern Iran: Implications for possible epigenetic Cu–Au ore exploration in metaophiolites

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ABSTRACT

Petrogeochemical investigations at the Sahlabad region have revealed that epigenetic listvenite veins occur in sheared zones of metaophiolitic suites of Cretaceous age. The listvenite mineralization developed in three forms, namely (1) the silica-listvenite veins which are chiefly composed of chalcedony, opal, quartz, pyrite, chalcopryrite, serpentine and relicts of chrome spinels, magnetite and fuchsite; (2) the carbonate listvenite veins which are comprised principally of magnesite, dolomite, calcite, siderite, pyrite, chalcopryrite, serpentine and relicts of fuchsite, chrome spinels and magnetite; and (3) the silica-carbonate listvenite veins which include opal, quartz, dolomite, magnesite, pyrite, chalcopryrite, serpentine and relicts of chrome spinels and magnetite. The absence of mineralized granitoids and the frequent occurrences of clearcut non-metamorphosed veins indicate that the mineralizing fluids were rich in CO₂, H₂O, H₂S and H₄SiO₄ and possibly formed as a result of metamorphic dehydration and decarbonation reactions of the oceanic crust at the amphibolite–greenschist facies. Geochemically, the listvenites are enriched in SiO₂, MgO, CaO, CO₂, LOI, Cr, Ni, Co, Au, Cu, Ag, Hg, and Pt. Also, the veins contain high values of LOI, indicating the H₂O–CO₂-rich metamorphogenic fluids. The high Cr content and detectable values of K₂O, Al₂O₃ and Na₂O in the listvenite veins possibly indicate the presence of fuchsite and chrome spinels. The geochemical signatures attest that the hydrothermal fluids probably derived from a metamorphosed ultramafic protolith. The maximum values for gold, copper, mercury and silver in the listvenites are about 1.9 ppm, 5.4 %, 8 ppm and 6.5 ppm, respectively and provide a unique exploration guide for further gossan sampling, remote sensing mapping, isotopic and fluid inclusion studies in the Iranian metaophiolites.

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1. Introduction

In the last 150 years, various definitions and controversial genetic models have been proposed for listvenite mineralization, although unfortunately, the term is not fully defined in Glossary of Geology (Bates and Jackson, 1982; Murchison et al., 1845). The current inadequate information on geochemical data about listvenites is reflected in the lack of genetic models. The first document on listvenite mineralization long used by Soviet geologists in the Ural goldfields of Russia is reported from the type locality for listvenites in Listvenya. Most of the authors (Akbulut et al., 2006; Ash and Arksey, 1989; Auclair et al., 1993; Aydal, 1990; Boyle, 1959, 1979; Buisson and Leblanc, 1985; Çolakoğlu, 2009; Koç and Kadioğlu, 1996; Nasir et al., 2007; Plissart et al., 2009; Rose, 1837; Sazanov, 1975; Shcherban, 1967; Tsikouras et al., 2006; Uçurum, 2000; Zoheir and Lehmann, 2011) considered

the listvenites as hydrothermally or metasomatically carbonatized–silicified–pyritized–serpentinized mafic–ultramafic rocks. However, the exact nature and origin of hydrothermal fluids for listvenitization yet remain controversial and unknown. Halls and Zhao (1995), precisely defined the listvenites as “beresitic–phyllitic rocks” produced by alteration of mafic–ultramafic rocks, but did not present any geochemical data on the origin of the listvenites. Also, they did not give any supporting geochemical data, regarding the source of hydrothermal fluids, as mafic–ultramafic melts or magmas and even sedimentary rocks do not release enough hydrothermal fluids rich in potassium and silica by differentiation or remobilization to make the listvenitization possible, especially for silicified–sericitized listvenites. New nomenclature by Zharikov et al. (2006) considered “beresite” (beresitic–phyllitic rocks) as quartz–sericite–carbonate–pyrite assemblage that originated from both igneous and sedimentary protoliths, thus the term is not well-defined yet. It is widely accepted that listvenites commonly occur in shear zones developed in ophiolitic suites, in which the shear zones form the paths of hydrothermal solutions (Çolakoğlu, 2009; Uçurum, 2000; Zarrinkoub and Aftabi, 1994; Zarrinkoub et al., 2004; Zoheir and Lehmann, 2011).

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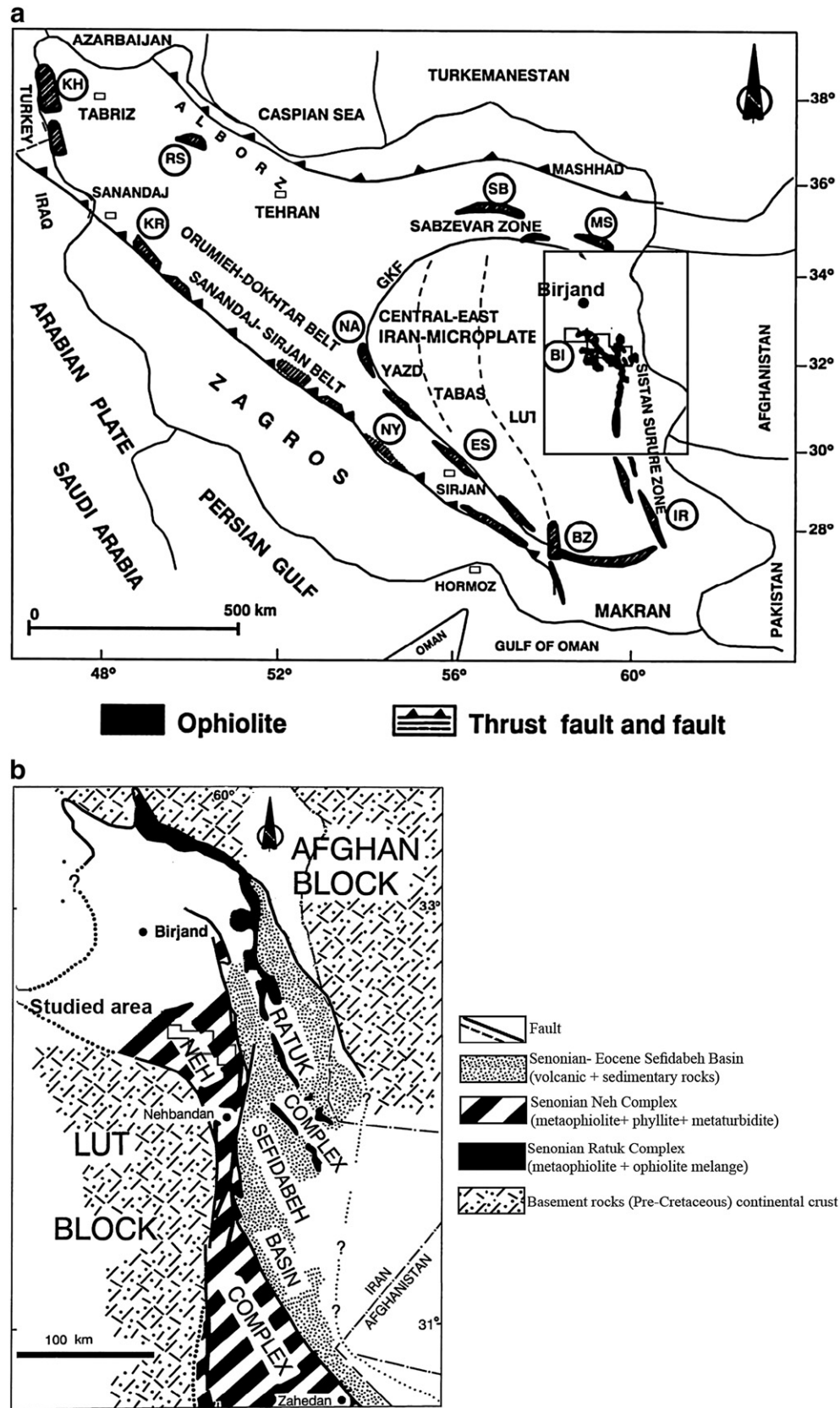


Fig. 1. (a) Geotectonic map of Iran, showing major structural zones and ophiolites (modified after Aghanabati, 1986; Alavi, 1994; Babazadeh, 2007; Stocklin, 1975; Zarrinkoub and Aftabi, 1994). KH: Khoy, KR: Kermanshah, RS: Rashat, NY: Neyriz, NA: Nain, ES: Esphandagh, BZ: Band-e-ziart, BI: Birjand, IR: Iranshahr, SB: Sabzevar, MS: Mashhad, GKF: Great Kavir Fault. (b) A simplified geotectonic map of Sistan suture zone (modified after Tirrul et al., 1983).

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