



Orogenic gold mineralization at the Chah Bagh deposit, Muteh gold district, Iran



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ABSTRACT

The Chah Bagh gold deposit, in the Muteh gold district, is located in the central part of the Sanandaj–Sirjan zone (SSZ), Iran. Gold mineralization at Chah Bagh is hosted by a Paleozoic sequence of rocks that is dominated by deformed schist, metarhyolite, and amphibolite that exhibits a greenschist- to lower amphibolite-facies metamorphism. Three deformation events are recognized in the Chah Bagh area, D₁, D₂, and D₃. The major NW-trending (N280–N290) dextral strike-slip shear zone in the area was formed during D₂ ductile events. Gold mineralization at Chah Bagh occurred over a prolonged deformation history, but is closely related to alteration, retrograde greenschist-facies assemblages, and ductile and brittle deformation during D₂ and D₃. The geometry of the Au-bearing quartz veins indicates that they are temporally related to the S₂ foliation and therefore to the D₂ flattening and shearing. Some veins, however, are spatially and temporally related to D₃ brittle normal faults and are brecciated and boudinaged during the associated shear movement. The presence of deformed Au-bearing quartz veins, and their concordant and discordant relation with respect to the main mylonitic foliation and the shear zone, indicates continuous mineralization during the D₂ and D₃ episodes. The Au-hosting shear zones are characterized by extensive development of heterogeneous mylonitic rocks that enhanced the permeability within the shear zones. This gave rise to further extensive dilatancy within major dilational jogs and produced a suitable structural regime for vein-hosted Au mineralization. The epigenetic Au mineralization resulted from metamorphic hydrothermal fluids circulating through major shear zones and associated structures during the late stages of orogeny. Our investigation shows that granitic intrusions have no genetic link with gold mineralization and we propose an orogenic gold model for Chah Bagh deposit, similar to Qolqoleh and Kervian in the northwestern part of the SSZ. This model is consistent with a dextral transpressional deformation kinematic model along the SSZ and, refutes the previous intrusion-related model suggested for the Muteh gold deposits. Metamorphic devolatilization and fluid flow within a ca. 30-m.y.-long period in Late Cretaceous and Early Tertiary is suggested for the genesis of the gold occurrences in both ductile and post-transpressional brittle structures.

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1. Introduction

Gold deposits formed as direct consequence of mountain-building processes in Phanerozoic terranes have a wide distribution throughout the world (Bierlein and Crowe, 2000; Bouchot and Moritz, 2000; Goldfarb et al., 2001). These so-called “orogenic” gold deposits (Groves et al., 1998, 2003; Kerrich et al., 2000) constitute an economically important class of auriferous mineralization styles

(Bierlein et al., 2004) that have recently been identified in Iran. The Sanandaj–Sirjan zone (SSZ) is the most prospective area for orogenic gold exploration in Iran and hosts several orogenic gold deposits (inset of Fig. 1) that include Kervian (Heidari, 2004; Heidari et al., 2006), Qolqoleh (Aliyari, 2006; Aliyari et al., 2007, 2009), Qabaqloujeh (Nosratpour, 2008), Muteh (Rashidnejad-Omran, 2001; Kouhestani, 2005; Kouhestani et al., 2006; Abdollahi et al., 2009) and Zartorosht (Rastgoo-Moghaddam, 2005; Rastgoo-Moghaddam et al., 2008; Rashidnejad-Omran et al., 2008; Aliyari et al., 2010).

The Muteh gold district, 270 km southwest of Tehran (inset of Fig. 1), is the most important active gold mining region in Iran.

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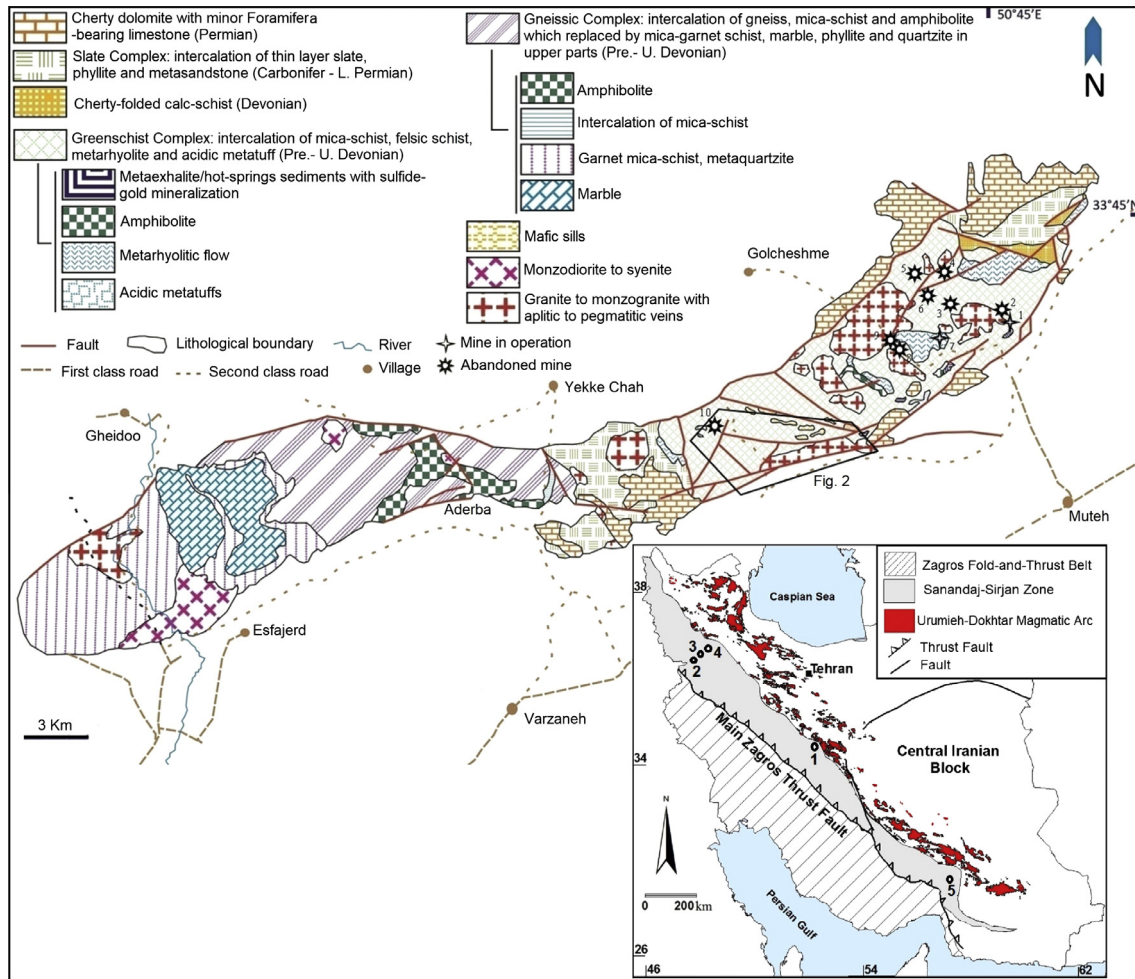


Fig. 1. Geological map of the Muteh gold district (after Rashidnejad-Omran et al., 2002), delimits the area of Fig. 2 and location of the Chah Bagh and other gold deposits in the area: (1) Chah Khatoun, (2) Darreh Ashki, (3) Cheshmeh Gowhar, (4) Sekolop, (5) Tangheh Zar, (6) Chah Allumeh, (7) Senjedeh, (8) Ghorom Ghorom, (9) Cheshmeh Dastar, (10) Chah Bagh. Inset: Zonal subdivision of the Zagros orogen (after Alavi, 1994) shows location of Muteh and other orogenic gold deposits within the SSZ: (1) Muteh, (2) Kervian, (3) Qolqoleh, (4) Qabaqloujeh, (5) Zartorosht.

Ten deposits in the area (Fig. 1), with an average grade of 4 g/t Au, were at one time stated to have a combined reserve of 1.2 tonnes Au (Farhangi, 1991), but probably contain significantly more gold if mined at large-scale in the future. The deposits are typically hosted by felsic schist, derived from pelitic and felsic tuffs, and mylonitized metarhyolite. They have broadly similar structural and metallogenic features, although there are some local differences in structural control, mineralogy, and gold distribution (Table 1). The country rocks are mainly metamorphosed to greenschist facies and are intruded by granitic bodies (Rashidnejad-Omran, 2001; Rashidnejad-Omran et al., 2002). Orebodies occur as quartz veins along brittle normal faults (Hasani and Mohajjel, 1998; Moritz and Ghazban, 1995, 1996) that suggest a temporal association of mineralization with extensional tectonism that was coeval with the granitic magmatism (Hasani and Mohajjel, 1998). Spatial association of mineralization with some of the granite plutons has been used to suggest a genetic relationship (Thiele et al., 1968; Samani, 1988); alternatively, the deposits are believed to have formed during metamorphic devolatilization reactions (Paidar-Saravi, 1989) or through mixing of meteoric and metamorphic fluids during a period of granite emplacement (Moritz and Ghazban, 1995, 1996).

The Chah Bagh gold deposit (No. 10, Fig. 1) is structurally unique among the numerous extension-related gold deposits in

the Muteh area. A ductile NW-trending dextral strike-slip shear zone is recognized as the main controlling feature of the gold ore at Chah Bagh. This study is aimed to explain the role of ductile shear zone on gold ore formation at Chah Bagh and to present a genetic model for ore genesis throughout the Muteh gold district.

2. Regional geological setting

The Muteh gold district is situated in the central part of the SSZ, Iran (inset of Fig. 1). The SSZ, 150- to 200-km-wide and 2000-km-long, was formed during Neo-Tethys subduction along the western margin of Iran (Alavi, 1994; Agard et al., 2005, 2011; Omrani et al., 2008). This zone is characterized by regionally metamorphosed and complexly deformed Paleozoic and Mesozoic rocks (Rashidnejad-Omran et al., 2002; Mohajjel et al., 2003; Sheikholeslami et al., 2003; Baharifar et al., 2004) that are intruded by abundant deformed and undeformed Late Jurassic to Eocene calc-alkaline plutons (Berberian et al., 1982; Agard et al., 2005; Ghasemi and Tlabot, 2005); widespread Mesozoic volcanic rocks are also recognized along the structure (Mohajjel et al., 2003). Berberian (1983) considered the SSZ to be the site of a Mesozoic magmatic arc and a subsequent Tertiary fore-arc. The geodynamic and metallogenic setting of this zone and relationship of its ore

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