

## Geochemistry and mineralogy of Kesht Mahaki volcanic Cu deposit in Safashahr, Southern Sanandaj- Sirjan

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### Abstract

Kesht Mahaki Cu deposit located at 20 Km northwest of Safashahr (Dehbid), southern Sanandaj-Sirjan zone, and hosted in the lower Cretaceous volcano-sedimentary sequences. Mineralization occurred as stratabound and lenticular shape, NW-SE trending approximately extended 34 Km as discontinuous bodies from Kesht Mahaki in NW to Simakan district in SE. The host rocks of the ore bodies are include lithic crystal tuff with dacite to rhyodacite in affinity. Ore minerals predominantly consist of chalcocite, bornite, digenite, chalcopyrite, pyrite, covellite, native copper, malachite, azurite, chrysocolla, Fe-oxide- hydroxide minerals. The textures of mineralization include vein-veinlets, open space filling, and replacement. Volcanic and volcanoclastic rocks indicate subalkaline affinity and occupy in calcalkaline area in AFM diagram. Mineralogy, alteration, textural and structural evidences and geochemical data indicate that the Kesht Mahaki Cu belong to Michigan (Volcanic Red Bed) Cu deposit type.

**Keywords:** geochemistry, volcanic Cu, stratabound, Safashahr, Sanandaj- Sirjan.

### Introduction

More than 2000 Km of the world Cu belt have passed through Iran (Ghorbani, 1386). Most of the Cu deposits of Iran located in Urumieh-Dokhtar and Alborz-Azarbayejan magmatic Assemblage complex. Kesht Mahaki Cu deposit is the first volcanic red bed type Cu deposit that reported from south Sanandaj-Sirjan zone. This deposit located at 20 Km Northwest of Safashahr district in the dehbid 1:100000 quadrangles (Shahidi et al, 1369).

This deposit located in marginal sub zone of the Sanandaj-Sirjan zone based on mohajjal et al (2003) classification. The importance of this investigation on Kesht Mahaki and a few similar occurrences in adjacent areas is examining the academic and exploration considerations. In this research the grade of Cu mineralization was approximately 1% on a basis of extensive analysis on mineralized samples in the ALS-Chemex, Vancouver, Canada. Previous study on Kesht Mahaki Cu deposit was reconnaissance study by Samani (1377) who Estimated the grade of Cu about 2% .

### Geological setting

The structure of mining district composed an anticycline with NW-SE axis. the core of this structure comprising of volcanic and pyroclastic units and limb of anticline consist of limestone Cretaceous age. The oldest lithology in the district show Jurassic age that the limestone units ( $K_1^{lm}$ ) of lower Cretaceous overlaid it by disconformity shape and with conglomerate- sandstone lithology. This limestone is overlying by Orbitolina limestone unit ( $K_1^l$ )(Fig.1). In this unit, from Northwest to Southeast of Dehbid, there are volcanic units with interlayer form and more than 2 Km in width. In mining district, this volcanic sequence laterally and vertically is transformed to the orbitolina limestone unit. The volcano-

sedimentary sequence is comprised of pyroclastics and lava. The composition of lavas varies from trachytic to trachy-andesitic and andesitic composition. The pyroclastic parts consist of crystal lithic tuff and lithic crystal tuff being host the mineralization. The orbitolina limestone is covered by plagic limestone in upper cretaceous age. Ultimately, Miocene marble is trusted on plagic limestone. The faults and fractures reveal most NW-SE trend and to a lesser amount NE-SW.

### **Stratigraphy**

The oldest rocks in the district consist of shale, sandstone and conglomerate units together with intercalations limestone in Jurassic age. The lithological contact between Jurassic and Cretaceous rock units is commonly normal, whereas in some places it is faulted. The lithostratigraphy of cretaceous rock units in Kesht Mahaki and KaleRize, HassanAbad, Khurjan and Simakan areas are as follows:

- Tuffaceous sandstone consisting of pyroclastic and detritic feldspar and quartz grains with rounded shape. Noticeably, the carbonaceous matrix is observed in some parts.
- Silty wackstone: this unit consists of detritic quartz and feldspar (with rounding in rim) and carbonaceous alchem. Fossils are also observed which was not distinguished as a result of diagenetic occurrences that effect in region but probably are forammonifera.
- Silty shale composed of detritic components of quartz and feldspar and contains many fractures filled by quartz grains. These fractures show differences in width and also moved by faulting function.
- Orbitolina limestone: this unit is distinguished by tiny to medium layering, frequency of silicic and calcitic vein and veinlet and intercalational microfold. Width of this unit increased from NW to SE that in Simakan is nearly 428 m (nejad shirazi et al., 1381).
- Crystal lithic tuff in dacitic- rhyodacitic affinity: this rock consists of porphyric lithic, varies in affinity from dacitic- rhyodacitic to trachite, and fenocrysts of K-feldspar and plagioclase in kryptocrystalline to microcrystalline and sometimes subordinated matrix from K-feldspar, quartz, esphene, chlorite, ceresite, calcite, epidote, zeosite and opaque minerals.
- Trachite to trachyandesite lava: this unit is distinguished by amygdaloidal texture that is filled by secondary minerals such as calcite, quartz and chlorite. In petrographic studies, there are a porphyritic texture consists of K-feldspar with karlesbad twining and plagioclase with recrystallized matrix of quartz, microlites of K-feldspar and secondary minerals such as esphene, chlorite, ceresite, calcite, epidote, zeosite, oxide- hydroxide- Fe and opaque minerals.
- Porphyritic andesite: This units including of fenocherists of calcitized and serisitized plagioclase in serisitized plagioclase microlites and opacitized glass Plagioclase has zoning and crushed form that has inferred from stress and later recrystallization of them.
- Plagic limestone: this unit is recognized by massive and thick-bedded form, grey color and frequently veins- veinlets of calcite.

### **Ore mineralogy**

Mineralization in Kesht Mahaki deposit and Kalerize, Hassanabad, Khurjan and Simakan occurrences occurred as stratabound form and lenses with 2 meter in width and NW-SE trend. The main host rocks are include in composition crystal lithic tuff and lithic Crystal tuff,

with dacitic- rhyodacitic affinity, are main host rocks. Mineralized zone in this district is either underlined by Trachite- trachyandesite lava, andesite, Silty shale, Siltic wackstone and orbitolina limestone or overlaid by them.

Ore mineralogy consists of chalcocite, bornite, digenite, chalcopyrite, pyrite, covelite, native copper, malachite, azurite and chrysocolla (table 1).

Mineralization textures consist of open space filling (Fig. 2a), vein- veinlet and replacement.

There are a clearly zonation among the ore minerals on a basis of mineralogy studies:

bornite and chalcopyrite → secondary bornite → chalcocite →digenite →covelite  
malachite.

This zonation indicated decrease in amount of Cu element and increase in S from centre to border and shown that there are the changes in pH, Eh and content of Cu and Fe within mineralization fluid(s) (Fig. 2b). This kind of zonation also reported from Sustut deposit in British Colombia in which observed specific zonation from native copper and chalcocite in centre and bornite and chalcopyrite in border (Kirkham, 1996).

Blades of chalcopyrite with exsolution form observed in bornite that could indicate either rapid cooling of this minerals in high temperatures (Cabral, 2007) or replacement of bornite in low temperature (Frence et al,2001).

## Geochemistry

The paragenetic assemblage of propylitic alteration are chlorite and epidote(Based on XRD analysis). Major and trace elements composition of volcanic and pyroclastic rocks indicate that the area indicate an arc environment. The REE distribution patterns of host rocks and wall rocks are same habitant (Fig. 3). Therefore, host rock and other rocks (trachite to trachyandesite lava) have a similar generation. In Harker diagram, there is an increase in amount of major oxides together with SiO<sub>2</sub> content that indicate the differentiation is the main process in the formation of rock units. These rocks show sub-alkaline to alkaline (Fig.4b) (in Winchester&Floyd, 1977, diagram) and calc- alkaline nature (Fig.4b). The plotted data revealed an island arc tectonic setting for host rock units.

## Conclusion

The ore mineralogy in Kesht Mahaki Cu deposit are composed of chalcocite, bornite, digenite, chalcopyrite, covelite, pyrite, malachite, azurite, chrysocolla, Fe oxide- hydroxide. The texture in deposit composed of vein-veinlets, open space filling, and replacement. Geochemical data indicating calcalkaline affinity for host rocks and island arc tectonic setting for deposit. Comparison between Kesht Mahaki Cu deposit and volcanic red bed Cu type (Lefbure and Church, 1996), indicate that this deposit has more similarity to volcanic red bed Cu deposits (Michigan Cu) type.

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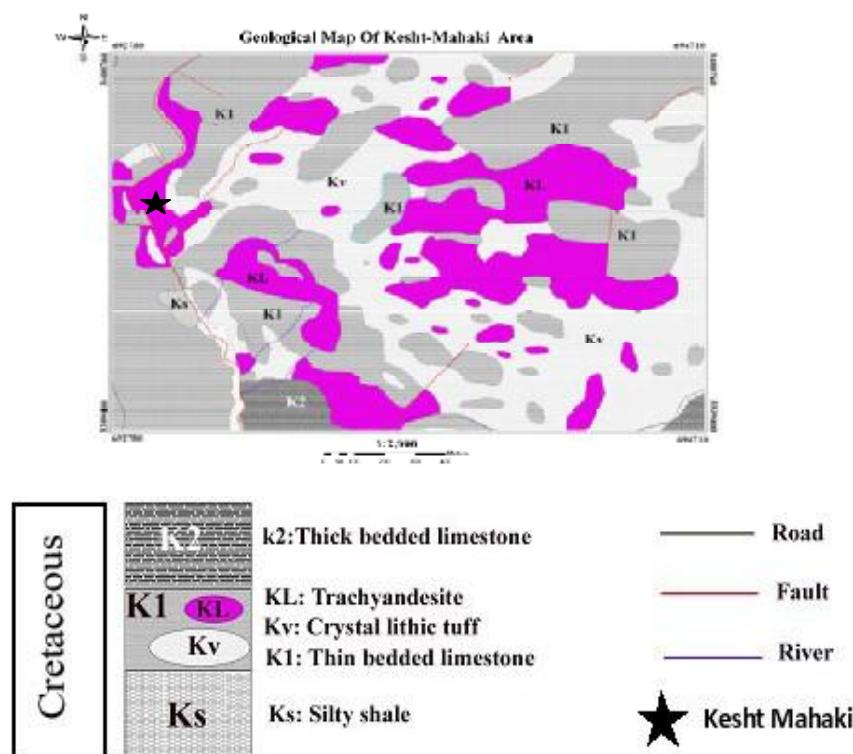
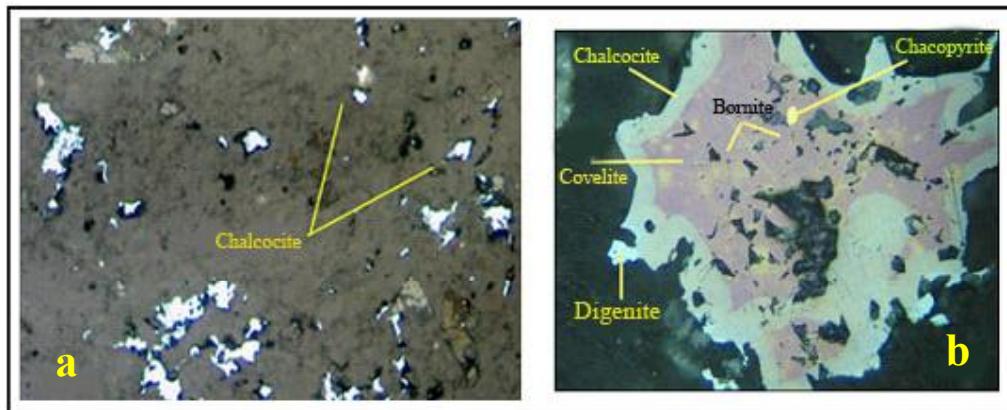


Fig. 1: 1:2000 geological map of Kesht-Mahaki area (Boveiri et al, 1388)



**Fig. 2:** a) open space filling texture (Chalcocite and other Cu minerals) in mineralized lithic crystal tuff, b) zonation in Cu sulphide minerals (20 x)

**Table 1)** stages of formation and paragenetic sequences of minerals and their texture and structure in Kesht Mahaki Cu deposit.

	Mineralization		Post-mineralization	
	Dogenesis		Tectonic Processes (uplift)	Supergene
Chalcocite				
Bornite				
Digenite				
Chalcopyrite				
Covellite				
Pyrite				
Native copper				
Malachite				
Azurite				
Chrysocolla				
Hematite				
Oxidite				
Texture	Open space filling			
	Vein - veinlet			
	Replacement			

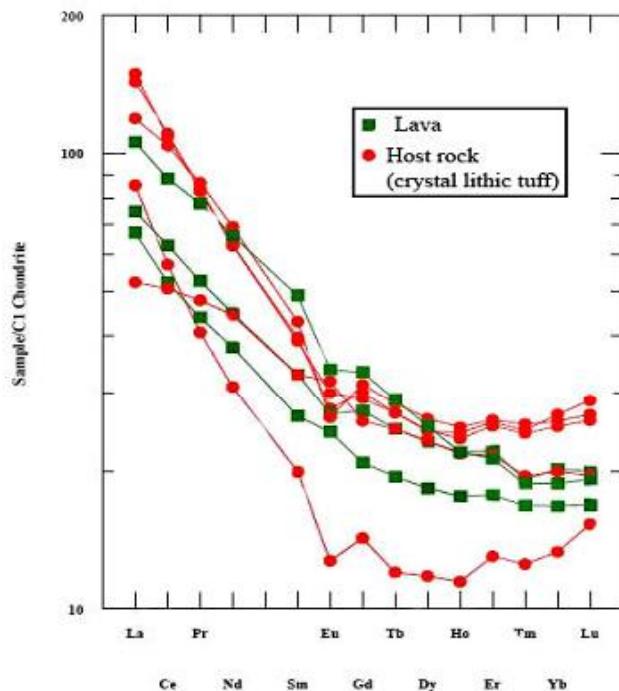


Fig. 3: REE diagram of host rock and lava in Kesht Mahaki Cu deposit

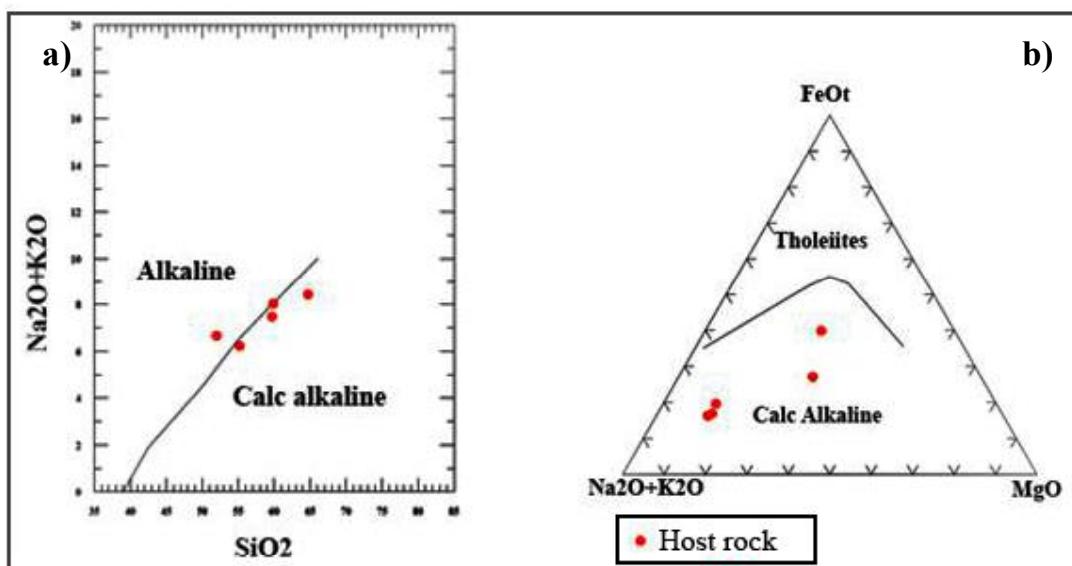


Fig. 4: a)  $\text{SiO}_2$  in contrary of alkaline (Irvin and Baragar, 1971) for detection of alkaline and sub-alkaline nature of rocks. B) AFM diagram (Irvin and Baragar, 1971) for detection of calc alkaline and tholeiites nature of rocks.