Advances in Bioresearch
Adv. Biores., Vol 6 (5) September 2015: 146-155
©2015 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
ICV 7.20 [Poland]

Advances in Bioresearch

ORIGINAL ARTICLE

Mineralography and Mineral-chemistry in Mazayjan Copper Deposit (NE ofShiraz, Iran)

K. Noori Khankahdani[1]
[1]Department of Geology,Shiraz Branch, Islamic Azad University - Shiraz- Iran
E-mail: noorikamal@yahoo.com

ABSTRACT

Mazayjan copper deposit is located in the Sanandaj - Sirjan metamorphic province and almost in the center of Iran.The host rocks of copper mineralization in this area are basic schist of Surian metamorphic complex which are of Carboniferous age. Microscopic studies showed that the mineralogical composition of the host rocks consist of albite, tremolite - actinolite, calcite, biotite and quartz, hence the initial basic rocks are metamorphosed in green schistfacies. Also, based on mineralography studies, chalcopyrite, pyrite, marcasite, covellite, malachite,chrysocolla and hematite are present in the schist. Chalcopyrite, is the most important copper mineral in this area and it can be seen as a main phase and a secondary phase inclusions in other minerals. Pyrite crystals show graded bedding phenomenon that reflects the differences in the degree of over-saturation of fluids at the time of the Pyrite formation. Point analyses conducted on pyrite and chalcopyrite proved that these minerals in terms of chemical composition are uniformed and do nothave compositional zoning. This indicates that the metamorphic phases has an effect on the primary sulfide minerals.Hence, the metamorphic processes are younger than the formation phase of sulfide minerals.

EPMA method showed that examined pyrite and chalcopyrite do not include any kind of valuable elements.

***Key words**: Iran,Sanandaj-sirjan,Mazayjan copper deposit, Mineralography, EPMA*

Received 27.04.2015 Accepted 23.07.2015

How to cite this article:
K. Noori Khankahdani. Mineralography and Mineral-chemistry in Mazayjan Copper Deposit (NE ofShiraz, Iran). Adv. Biores., Vol 6 [5] September 2015:146-155. **DOI:** 10.15515 /abr.0976-4585.6.5.146155

INTRODUCTION

Mazayjan village is located at the distance of 230km north east of Shiraz and almost in the center of Iran (fig.1).Geographically, Mazayjan is situated near the confluence of the three provinces of Fars, Kerman andYazdwhich makes it accessible through these regions. Figure 1 Specifies that mazayjan area is located in Sanandaj – Sirjan metamorphic belt.

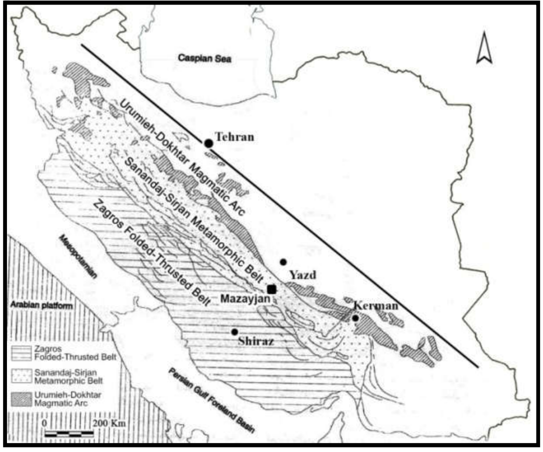


Figure 1. The situation of Mazayjan copper deposits in Sanandaj – Sirjan metamorphic belt (Base map from Ghorbani, 2007)

MATERIAL AND METHODS

After conducting field studies, the first step was the preparation of the microscopic sections. These sections have been studied by Olympus model Polarizing Microscope .Then they were separated into appropriate samples for point analysis .Point analysis tests and back scatter imagery were done by horiba instrument (XGT7200 model) in Kansaran Binalud Company. Finally, the results of microscopic and instrumental analysis studies were processed. The final result presented as follows.

RESULTS

Field Studies:

Figure 2 shows a simplified geological map of the area based on Noori and Noori et al [7,8].The oldest rock units that are exposed in the northern part of the map, have been Including Tootak metamorphic complex with devonian carboniferous age and is formed of granite gneiss, black schist, calc schist and marble.Surian metamorphic rocks with carboniferous age are located upon the Tootak complex .An important feature of the Surian complex is copper mineralization phenomenon which can be seen indifferent parts like Mazayjan (study area). Surian complex includes two main lithological units, the first unit is metapelitic rocks that currently appear in mica schist and phyllite and their source rocks has been shale. The second unit is metabolite that appears as green schist or amphibolites and infact, have been submarine basal ticvolcanic eruption that were metamorphosed with the mentioned shale. Jurassic-cretaceous lime stones out crop in the southern part of the map. These outcrops of rock units are shown infigure3.Another important point is that the metabasit unit that generally appears in green schist, within the Mazayjan region include copper mineralization index (fig.4&5) which hasbeen the subject of ongoing studies.

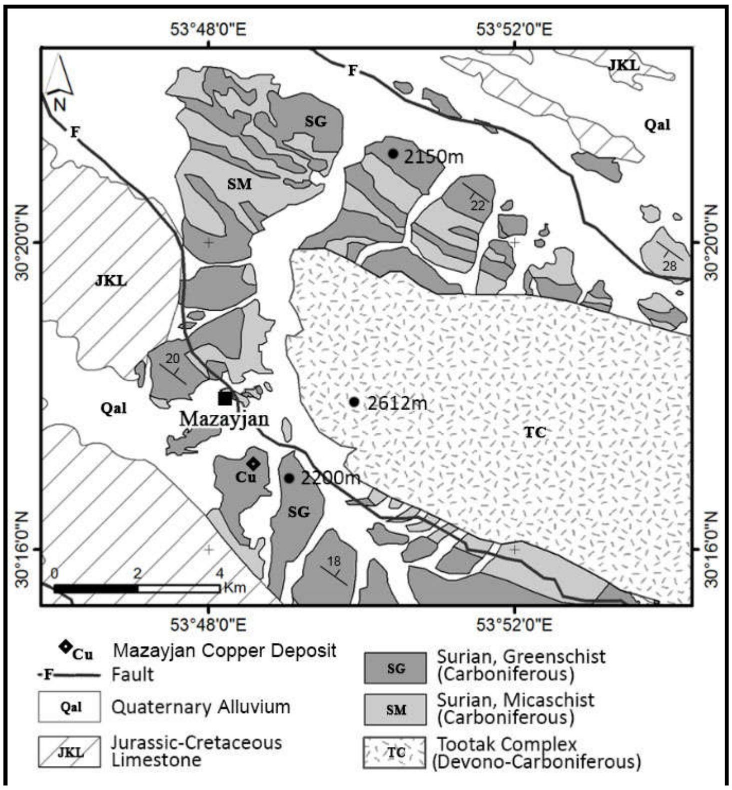


Figure 2. Simplified geological map of the Mazayjan area, based on Noori (2005 and 2009) and Noori et al (2009)

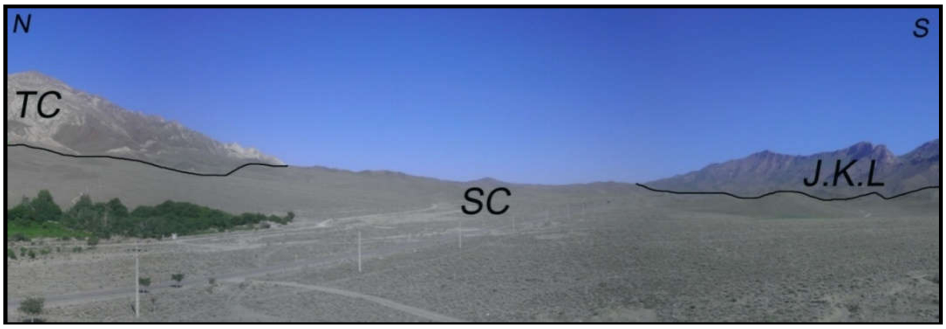


Figure 3: Outcrop of rock units (Mazayjan area), view toward the east.
JKL: Jurassic Cretaceous Limestones
SC: Suriyan Complex (greenschist & micaschist)
TC: Tootak Complex (Marble & Calcschist)

Figure 4. Close-upof basic schist of Surian complex
This green schist has been the host of copper mineralization in Mazayjan

Figure 5.Coppermineralizationin Surian basic schists
In this figure, copper mineralization is seen as the form of malachite and chrysocolla

Minerolography studies:
Metabasite of Surian complex are host rocks of copper mineralization in Mazayjan [[9. The study of thin sections in these rocks revealed the most important on-metallic minerals are albite, tremolite-actinolite, calcite, biotite and quartz (Fig.6).This mineralogy, represents the metamorphism of this region at green schist faces [7].To display the index minerals Kretz [5] is used.

Based on polished sections studies, sulfide minerals of this complex are pyrite and chalcopyrite that are accompanied with other minerals such as marcasite, covellites, malachite, chrysocolla and hematite. In the following section, a brief description of the minerals is offered.

Chalcopyrite: The most important mineral containing copper in the Mazayjan is chalcopyrite that is usually about 20 to 50microns in size and has a frequency of between 5 and 10per cent. In some sections, chalcopyrite is observed as inclusion sinpyrite (figure7).

Pyrite: The most abundant sulfide mineral in Surian basic schists is pyrite which its frequency is about 5 to 20percent. Also, pyrites dimensions are about 100 to200microns and rarely appear to2mm in size. Difference of Pyrite grain size in basic schists represents the phenomenon of graded bedding (Figure8).

Marcasite: This mineral is seen in rectangular shape within the polished section and due to the impact oftectonicforces, it retains the smashing and cataclastic texture (figure 9).Frequency of marcasite has been 2-4 percent .Inclusions of chalcopyrite is another feature of this mineral.

Marcasite formation instead of pyrite in Mazayjan schists is associated with a decrease in temperature during the crystallization of iron sulfides because marcasite requires a lower crystallization temperature than pyrite [1].

Covellites: This mineral with FeS formula is a secondary mineral which is usually formed by the decomposition of chalcopyrite [1].Within the studied sections, covellite generally appear in the format of chalcopyrite such as false shape (Figure 10).Also, covellite grows within the inside spaces as a secondary mineral.Itsfrequencyis3%insomesections.

Malachite: Malachite is the most important secondary copper mineral in Mazayjan which its green color is effective for the detection field of copper contamination areas. In the thin sections, malachite filled fractures and cavities (figure 11). Sometimes, this mineral is seen along with chrysocolla and hematite.

Chrysocolla: According to the available classification, this mineral is placed in group of copperhydrous silicate that is formed by the alteration of coppersulfide minerals such as chalcopyrite (1).In examined polished section, chrysocolla shows banded colloform texture (fig.11); while that hematite such as paragenesis of chrysocolla has the appearance concentric colloform texture (fig.12).

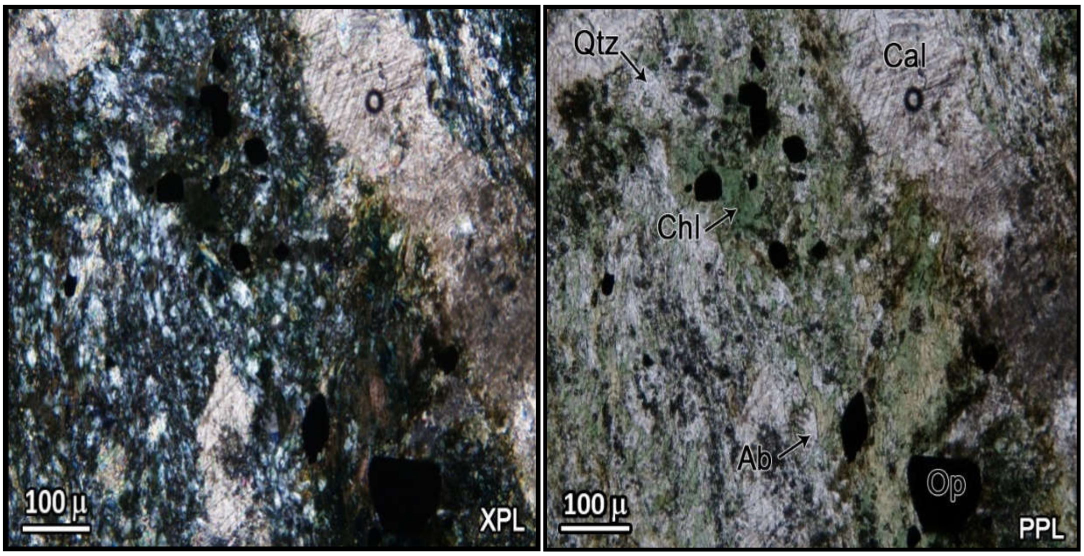


Figure6. Accompaniment of chlorite (chl),Albite(Ab),calcite(Cal) and quartz(Qtz) with opaque minerals(Op) in surian basic schist (rock name: pyrite-bearing green schist)

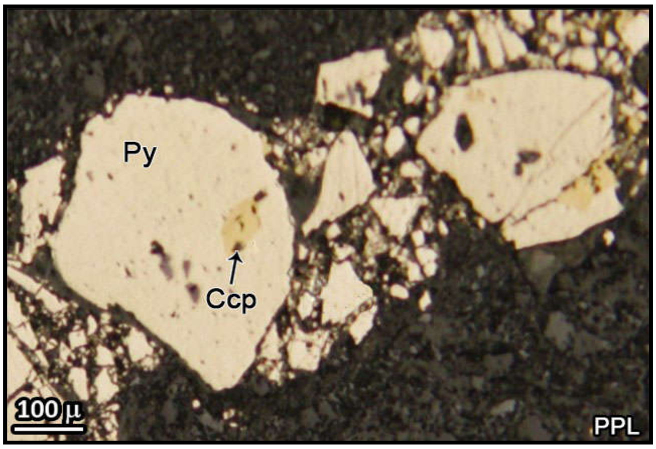


Figure 7.Brecciated pyrite in Surian basic schist (Mazayjan region), note that pyrite crystalcontains the inclusions of chalcopyrite.

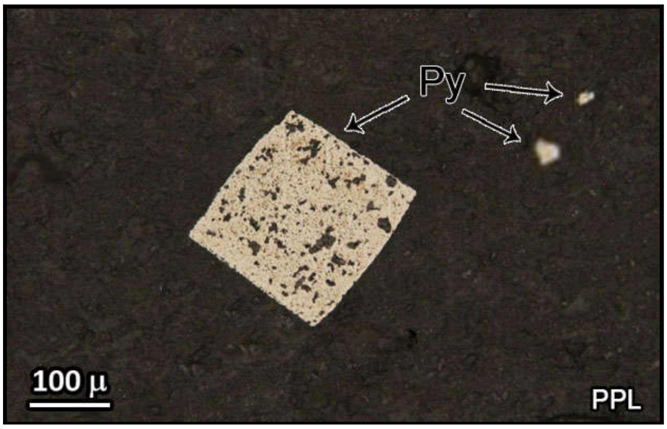


Figure8.Difference of grain size and graded bedding in pyrite

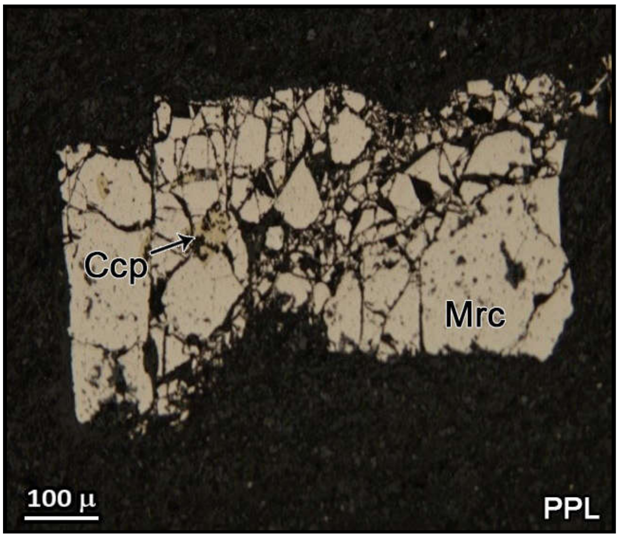


Figure 9.Marcasite (Mrc) with inclusion of calcopytite (Ccp) in Mazayjan metabasite

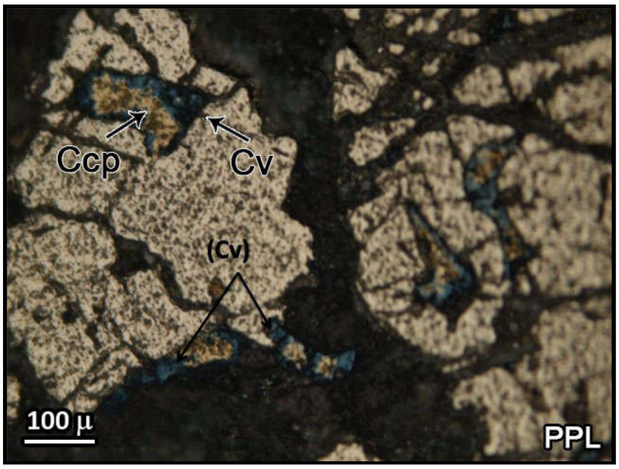


Figure 10.Calcopyrite (Ccp) is transforming into covellite (Cv) in Mazayjan greenschist

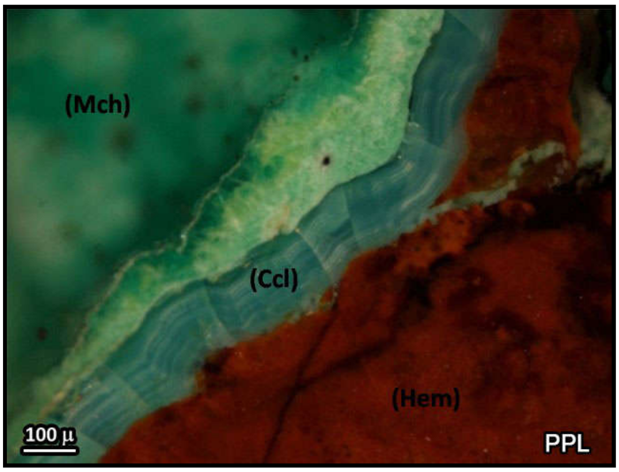


Figure 11.Paragenesis of malachite (Mch) with chrysocolla(Ccl) and hematite(Hem),note the banded colloform texture in chrysocolla

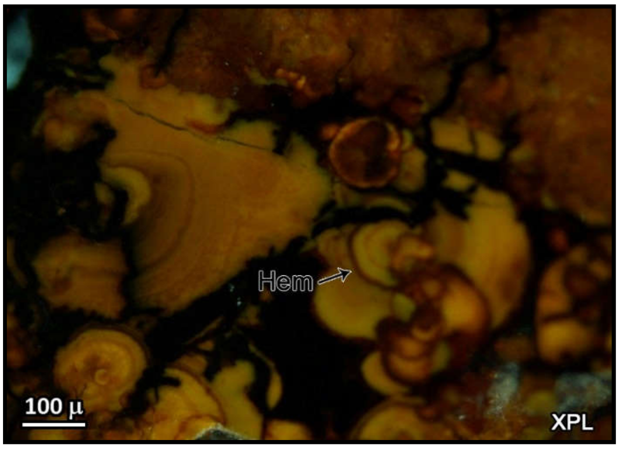


Figure 12. Concentric colloform texture in hematite (Mazayjan area)

Mineral chemistry studies:

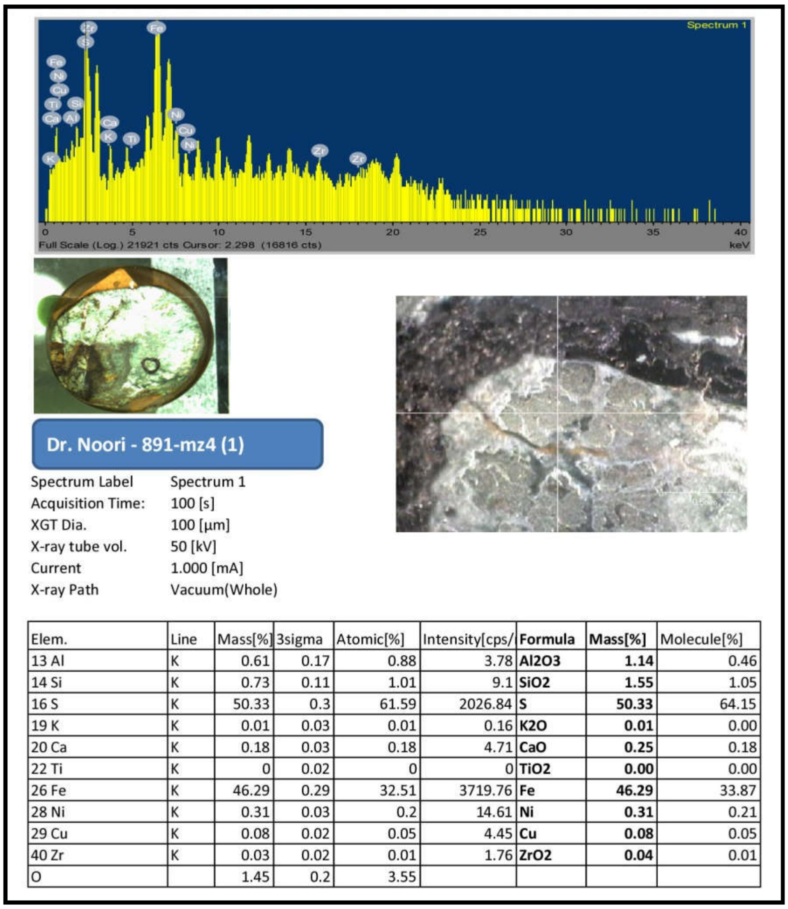
To study the chemistry of minerals, probe microanalysis method was used. This point analysis style, is a perfect analytical method to the microscopic scale which is used for inorganic solid samples [11]. These nondestructive analysis method, can identify the elements of mineral specimens with smooth surface.For this purpose, X-rays excited by an electron beam were used.

This features analysis that the studied microscopic ample in current research were investigated with point analysis method. After microscopic study and an identification of the main phases of metallic minerals (including pyrite and chalcopyrite), point study analysis was done. A recent study has pursued several major objectives. First of all, chemical and mineralogical composition of the main metallic minerals should be determined.

Secondly, an identification of the probable mineral inclusions in the main minerals and the thirdobjective, an introduction of the probable valuable elements in the main phases. Apyrite crystal (sample No. 891MZ4) was studied by probe analysis (Fig.13).As can be seen molecular percentage of the sulfur and iron is equivalent to 98.02.This number is consistent with the percentage of S and Fe in thepyrite mineral. Also, abundance of worthwhile elements such as Cu and Ni has been low.

In continuation of this phase, a chalcopyrite crystal has been analyzed (fig.14).In this sample, molecular percent of Fe, Cu and S is equal to 98.94 in which the amount of copper has been 23.72%. So,this mineral has been chalcopyrite that other constituents had been alumina and silica. No other important element is reported. To investigate the compositional zoning in the sulfide minerals, backscatter image method was used. A sample of chalcopyrite (S-16) was studied by this method (Fig. 15).

The results showed that the mineral do not have compositional zoning and has been uniformed to a high extent so that the main elements of this mineral such as Cu, Fe and S are scattered in all parts of it. Further discussion on the results of analysis of this sample showed that unfortunately, there is not notable valuable element in the studied chalcopyrite.The silicate mineral around the chalcopyrite is quartz (Fig.15).

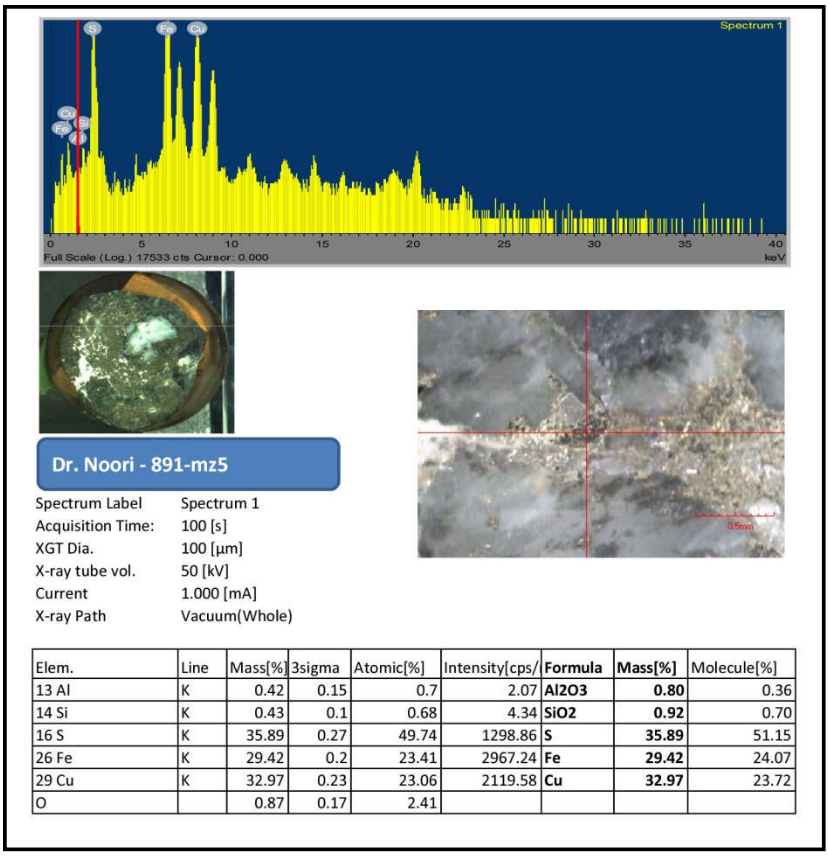


Dr. Noori - 891-mz4 (1)

Spectrum Label	Spectrum 1
Acquisition Time:	100 [s]
XGT Dia.	100 [µm]
X-ray tube vol.	50 [kV]
Current	1.000 [mA]
X-ray Path	Vacuum(Whole)

Elem.	Line	Mass[%]	3sigma	Atomic[%]	Intensity[cps/	**Formula**	**Mass[%]**	Molecule[%]
13 Al	K	0.61	0.17	0.88	3.78	**Al2O3**	**1.14**	0.46
14 Si	K	0.73	0.11	1.01	9.1	**SiO2**	**1.55**	1.05
16 S	K	50.33	0.3	61.59	2026.84	**S**	**50.33**	64.15
19 K	K	0.01	0.03	0.01	0.16	**K2O**	**0.01**	0.00
20 Ca	K	0.18	0.03	0.18	4.71	**CaO**	**0.25**	0.18
22 Ti	K	0	0.02	0	0	**TiO2**	**0.00**	0.00
26 Fe	K	46.29	0.29	32.51	3719.76	**Fe**	**46.29**	33.87
28 Ni	K	0.31	0.03	0.2	14.61	**Ni**	**0.31**	0.21
29 Cu	K	0.08	0.02	0.05	4.45	**Cu**	**0.08**	0.05
40 Zr	K	0.03	0.02	0.01	1.76	**ZrO2**	**0.04**	0.01
O		1.45	0.2	3.55				

Figure13.The results of point analysis in pyrite crystal (sample No.891-MZ4)

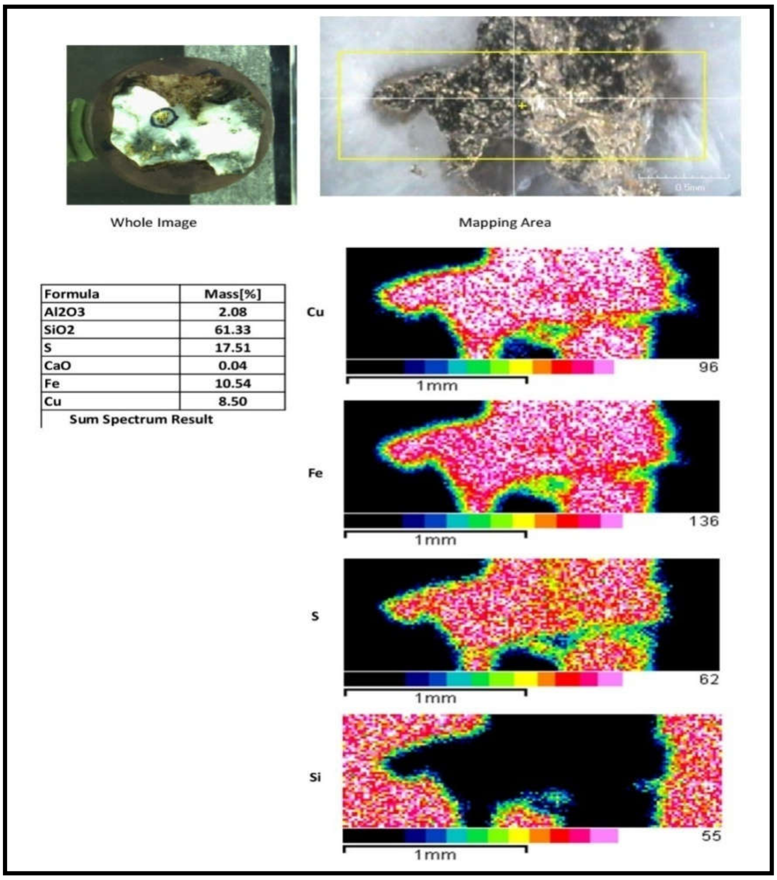


Dr. Noori - 891-mz5

Spectrum Label	Spectrum 1
Acquisition Time:	100 [s]
XGT Dia.	100 [µm]
X-ray tube vol.	50 [kV]
Current	1.000 [mA]
X-ray Path	Vacuum(Whole)

Elem.	Line	Mass[%]	3sigma	Atomic[%]	Intensity[cps/	**Formula**	**Mass[%]**	Molecule[%]
13 Al	K	0.42	0.15	0.7	2.07	**Al2O3**	**0.80**	0.36
14 Si	K	0.43	0.1	0.68	4.34	**SiO2**	**0.92**	0.70
16 S	K	35.89	0.27	49.74	1298.86	**S**	**35.89**	51.15
26 Fe	K	29.42	0.2	23.41	2967.24	**Fe**	**29.42**	24.07
29 Cu	K	32.97	0.23	23.06	2119.58	**Cu**	**32.97**	23.72
O		0.87	0.17	2.41				

Figure 14. Point analysis in chalcopyrite (891-MZ5), Mazayjan area



Formula	**Mass[%]**
Al2O3	**2.08**
SiO2	**61.33**
S	**17.51**
CaO	**0.04**
Fe	**10.54**
Cu	**8.50**

Sum Spectrum Result

Figure 15.Backscatter image of chalcopyrite(S16)

Note:This sulfide mineral have not compositional zoning and Cu, Fe and S is scattered in all levels of minerals. Note2: The containing mineral is quartz.

DISCUSSION AND CONCLUSION

The most important points of this study can be summarized as follows:

Basic schists have been hostrocks of copper mineralized in the Mazayjan area. Accompany of basic schist with metapelitic rocks can remind the massive sulphide origin (Besshi type) for this ore-deposit which was introduced by other researchers [2]. Further studies are necessary to identify the origin.

The Study of grains size in pyrite crystal showed that this mineral has been graded bedding. This phenomenon can be reflected by rhythmic changes in the degree of supersaturation due to intermittent discharge of hydrothermal solution on the seafloor that in other points such as Motoyasu mine was studied [13]. Some secondary minerals such as chrysocolla and hematite in microscopic polished section show colloform texture. It is generally thought that the colloform textures caused by rapid precipitation from the supersaturated solution are probably due to the mixing of hydrothermal solution and ambient cold seawater.

Also, based on previous studies [4, 12] colloform textures were found in ores of the metamorphic grades lower than the green schist facies, so the presence of this texture in Mazayjan metabasit rocks are not unusual. The studies of point analysis showed that pyrite and chalcopyrite are without compositional zoning however, because of the changes in physical and chemical conditions of environs, these sulfide minerals are generally with compositional zoning.

Uniform chemical composition of these minerals and the absence of compositional zoning structure is associated with metamorphic recrystallization because it has already been established that metamorphic processes can uniform the chemical composition of minerals [6]. This confirms that metamorphic processes do not play a role in copper mineralization in Mazayjan. Hence, metamorphic processes are younger than the mineralization processes.

ACKNOWLEDGEMENTS

This article is a part of the results of a research project with the title "mineralogical and geochemical studies of copper mineralization in the Surian metamorphic complex (Bavanat, Fars)" that is planned and accomplished in the research assistant domain in Islamic Azad University-Shiraz Branch. The author gratefully admires the useful help of Mosayyeb Sabzehei, Mehrdad Karimi and Ehsan Zarei is for their cooperation.

REFERENCES

1. Deer, W. A., Howie, R. A. and Zussman, J., "An Introduction to the Rock Forming Minerals", Longman (1991) 528.
2. Edward, R. &Atkinson, K (1986)"Ore Deposit Geology", Chapman&Hall,London, 466 PP
3. Ghorbani, M. (2007) "Economic geology of natural and mineral resources of Iran", Pars (ArianZamin geology research) 492 P.
4. Kase, K. (1988)"Tin, arsenic, zinc and silver vein mineralization in the Besshi mine, Central Shikoku, Japan". Mining Geology, 38, 407-418.
5. Kretz, R. (1983) Symbols of rock-forming minerals. American Mineralogist, 68, 277–279.
6. Mizuta, T. (1988) "Compositional homogenization of sphalerite in hydrothermal ore deposits of Japan by post-depositional diffusion processes with particular reference to metamorphosed Besshi-type deposits", Mining Geology, 38,263-278
7. NooriKhankahdani, K. (2005) "Investigation of genetic and structural relationship between Bon-do-no gneiss with Tootak metamorphic complex",Petrology PhD thesis, Islamic Azad University, Science and Research Branch of Tehran.
8. NooriKhankahdani, K. (2009)"Application of satellite data in separation of rock units of Totak and Suriyan metamorphic complexes", Report of research project,Islamic Azad University, Shiraz Branch.
9. NooriKhankahdani,K. , Karimi,M. ,(2013) "Mineralogical and geochemical studies of copper mineralization in the Surian metamorphic complex (Bavanat, Fars) ", Islamic Azad University-Shiraz Branch, research assistant domain
10. NooriKhankahdani, K., Zarei, E., Karimi, M. and Mousavi, A.(2009) "Application of Principal component analysis method(PCA) in ASTER data for the separation of Surian metamorphic complex rocks units, Bavanat, Fars", The first national conference of modern result of geosciences, Islamic Azad University of Behbahan.
11. Skoog,D.A. ,West,D.M.,F.Holler,H. and Crouch, R.(2014), "Fundamentals of Analytical Chemistry",ninth Edition,Mary Finch,P.1090
12. Watanabe, M., Hoshino, K., Osaki, T., Yukawa, M., Sugiyama, M., Nishido, H. and Kagami, H. (1993) " Mineralogy and geochemistry of Besshi-type deposits and related green rocks in the Sanbagawa belt, Japan: Implications for their metallogenic evolution", Resource Geology Special Issue, 17, 213-228.

13. Yui,S.(1983) " Texture of some Japanese Besshi-type ores and their implications for kuroko deposits",Econ. Geol. Mon., 5. 231-240.