Fluid Inclusion Study of Tappeh Sorkh-E-Bejegan Mine Delijan, Markazi Provience

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Abstract

Bijegan Tappeh Sorkh Barite Mine is located at 21km from northeast of Delijan and 4km from northwest of Bijegan Village in Markazi Province, and also is located on a volcanic belt of Oroumieh-Dokhtar, which is one of the most active volcanic belts. The nature of the host rock is igneous and its age related to the late Eocene and early Oligocene? Ore body is an incomplete red - colored legume lentil adjacent to Cretaceous marl, along the fault, with dimensions of 50×15×6 m and with northeastward-southwestward trend, and is located between the Eocene Volcanic and Lower Red Formation (LRF). Red color of Ore due to the existence of Iron Hydroxide resulted from high level of fugacity of the environment. Study performed on Fluid Inclusion in Tappeh Sorkh Barite Mine, knows that the temperature of ore formation is 175^{0}C and its average salinity is 19.5wt% equivalent

Keywords: *Fluid Inclusion, Tappeh Sorkh-E-Bejegan, Barite Mine*

Petrography Studies of Fluid Inclusion of Tappeh -E-Sorkh Mine

The petrography and thermobarometric studies of fluid inclusion, which are performed on the bright mineral exist in thin sections, like barite and calcite minerals, as based on division which is performed by Nush(1) in 1976, we can identify 5 types of fluids in samples including:

1. Type A: Single Phase, Liquid (Figure 1)
2. Type B: Two Phase, Liquid-Gas (Figure 2)
3. Type C: Two Phase, Gas-Liquid (Figure 3)
4. Type D: Single Phase, Gas (Figure 4)
5. Type E: Three Phases, Liquid-Gas-Solid (halite ± silvite). (Figure 5).

Fig.1. Single Phase, Liquid

Fig.2. Two Phase, Liquid-Gas

Fig.3. Two Phase,Gas- Liquid


Fig.4. Single Phase, and Gas **Fig.5.Three phases Liquid, Gas, Solid**

From the viewpoint of the origin of the studied fluids inclusion of sections, and based on division which was made by Yermakouf(1) in 1965, these fluids are divided into two primitive and secondary types.1-Primitive:These fluids are scattered in all crystals with no relation with breakage and or any kind of structure that lets these fluids to enter or exit.
2-Secondary: These fluids will produce when the primitive crystallization of the host ore is ended studied thin sections, the primitive fluids inclusion are scattered as separate large fluids, shapelessly and partly are scattered on the groundmass of case study Ores, and the number of this kind of fluid is less than number of secondary type.(Figure,6and7).


Fig. 6. Primitive fluids inclusion **Fig.7. Secondary fluids inclusion**

Secondary fluids are seen mostly as tiny and linear in minerals. (Shapes 8, 9, 10, 11). these fluids are seen as circular, elongated, rod, and partly shapeless, but scarcely these fluid are seen in a regular form. In blow pictures, different shapes of those fluids can be seen. The size of these studied fluids is in three thin sections very tiny and is between 2 to10 microns.During measurement of thermobarometry,it is tried to apply fluids containing two phase, liquid- gas.




Fig.11.Rod **Fig.10. Erratic** **Fig.8. Circular** **Fig.9.Shape Freezing**

By measuring changes of the freezing degree, we can measure the amount of salinity and density in those mentioned fluids. The first recorded temperature during formation of the first melt drop is (Te) or temperature of eutectic point. The eutectic point for system of Nacl+H20 is approximately Te<-20.8CO whereas this point in some other studied samples is less than -20.8CO, as it represents the presence of other salts besides NaCl in minerals. The gradual melting of ice continues till the last crystal of ice disappears. The final recorded temperature during melt is called as Tm, as by using this, we can find out the salinity rate of a fluid.
Studied samples, the amount of salinity Wt% NaCl and density by PVTX modeling software of Linkam Company is measured, and the information is presented as table and histogram

diagrams will be seen in section of drawing diagrams. The diagram of salinity presents more abundance in salinities of 14-16, 16-18, and 18-20, 20-22 Wt NaCl%. The average of studied salinity degree equals to 19.5 Wt NaCl%.

Heating

With the help of microthermometry method, we can determine the minimum temperature of minerals' formation. As the fluid is heated, all phases including solid, liquid, and gas become homogenize.This temperature are called as *Th* of a homogenization temperature. Among those studied samples, the temperature of monotonous of the fluids is involved in two phases with changing the gas to the liquid. The histogram diagram shows the homogenization of the group temperatures like 100-140, 140-180, 180-220, 220-260 and the most abundance of homogenization related to the temperature range is between 140 and 180. The average of this homogenization is about 175 degree. This amount of degree in fluids with different origin (primitive or secondary) is different., on the whole, the average temperature of ore formation is 175 degree and the average salinity of the studied case is 19.5 %Wt NaCl.

Diagrams related to the results of the fluids inclusion

Table1, table2, table3 show the total measured specifications of samples of bf-1, bf-2, and bf-3. Diagrams1-12 show the histogram of salinity abundance, the histogram of homogenization temperature degree and diffusion of salinity and temperature of homogenization in total samples (bf-1., bf-2, bf-3 and average of three samples).

Table1: The total measured specifications of sample bf-1.

sample bf-1								
No	**Type**	**F/V**	**Size(µm)**	**Components**	**Th°c**	**Tm°c**	**Salinity eq.wt.% NaCl**	**Density**
1	P	30/70	9*3	V+L	172	-16.2	19.5852	1.0438
2	P	20/80	7*3	V+L	165	-17.4	20.5043	1.0572
3	S	30/70	8*4	V+L	194	-19.2	21.8035	1.0422
4	S	15/85	7*3	V+L	120	-10.4	14.3644	1.0459
5	S	10/90	8*3	V+L	135	-13.2	17.0666	1.0548
6	P	20/80	6*2	V+L	143	-12.8	16.7036	1.0459
7	P	40/60	10*6	V+L+S	255	-17.5	20.5789	0.9726
8	P	20/80	6*3	V+L	183	-16.5	19.8192	1.0359
9	S	40/60	7*4	V+L	195	-15.8	19.2684	1.0205
10	S	10/90	7*2	V+L	117	-11.2	15.1767	1.0543
11	P	20/80	6*3	V+L	148	-15.6	19.108	1.0603
12	P	30/70	9*5	V+L	189	-16.5	19.8192	1.0305
13	P	30/70	7*3	V+L	174	-17.2	20.3542	1.0482
14	P	25/75	8*4	V+L	192	-19.2	21.8035	1.0441
15	P	15/85	6*3	V+L	178	-17.4	20.5043	1.0459

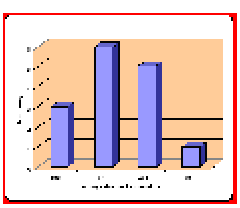


Diagram 2: Histogram of homogenization temperature degree of sample bf-1.

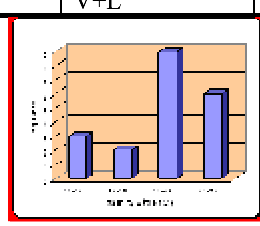


Diagram 1: Histogram of salinity of sample bf-1

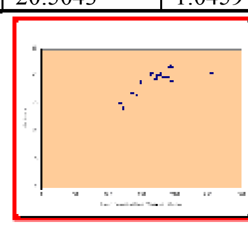


Diagram 3: Histogram of salinity and temperature of homogenization of sample bf-1

Table 2: The total measured specifications of sample bf-2.

bf-2 sample								
No	**Type**	**F/V**	**Size(µm)**	**Components**	**Th°c**	**Tm°c**	**Salinity eq.wt.% NaCl**	**Density**
1	P	40/60	7*2	V+L	215	-9.5	13.4077	O.9534
2	P	30/70	10*3	V+L	208	-8.4	12.1713	0.9508
3	S	20/80	5*3	V+L	150	-12	15.9556	1.0341
4	S	25/75	6*3	V+L	144	-15	18.6183	1.0597
5	p	30/70	9*4	V+L	170	-13	16.886	1.0241
6	S	20/80	7*3	V+L	165	-15	18.6183	1.04221
7	P	40/60	8*3	V+L	178	-17	20.2029	1.0435
8	P	30/70	7*4	V+L	188	-16.2	19.5852	1.0295
9	P	20/80	6*3	V+L	168	-13	16.886	1.0258
10	P	30/70	9*7	V+L	195	-17.3	20.4294	1.03
11	P	10/90	8*3	V+L	187	-15	18.6183	1.0225
12	S	20/80	7*2	V+L	158	-16.5	19.8192	1.0576

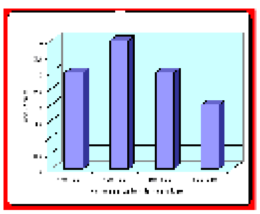


Diagram 5: Histogram of the homogenization degree of sample bf-2.

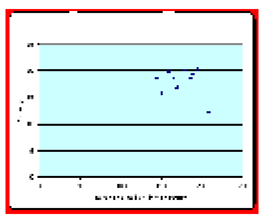


Diagram 6: Histogram salinity and homogenization temperatures of sample bf-2.

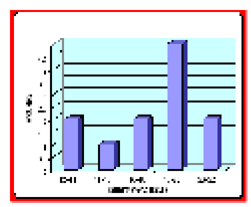


Diagram.4: Histogram of Salinityabundance of sample bf-2.

Table 3: The total measured specifications of sample bf-3.

sample-bf-3								
No	**Type**	**F/V**	**Size(µm)**	**Components**	**Th°c**	**Tm°c**	**Salinity eq.wt.% NaCl**	**Density**
1	P	30/70	7*4	V+L	170	-16	19.4275	1.0442
2	P	20/80	5*3	V+L	165	-15	18.6183	1.0421
3	P	50/50	9*6	V+L	201	-20	22.3534	1.0404
4	P	40/60	8.5*5	V+L	192	-18	20.9475	1.037
5	S	10/90	5*2	V+L	153	-19	21.6636	1.0766
6	S	20/80	6*3	V+L	155	-17	20.2029	1.0632
7	P	30/70	7*5	V+L	197	-19	21.6636	1.0383
8	P	40/60	10*6	V+L+S	261	-21	23.0189	0.9879
9	P	30/70	7*5	V+L	195	-18	20.9475	1.0342
10	S	20/80	6*4	V+L	144	-19	21.6636	1.0839
11	P	30/70	8*4	V+L	186	-16	19.4275	1.03
12	P	20/80	6*5	V+L	197	-13	16.886	0.9993
13	S	10/90	5*2	V+L	148	-12	15.9556	1.0357
14	S	30/70	7*4	V+L	157	-15	18.6183	1.0489
15	P	20/80	5*2	V+L	170	-18	20.9475	1.0565

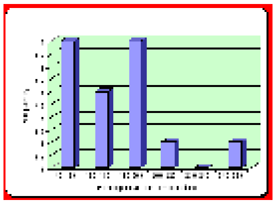


Diagram 8: Histogram of the homogenization degree of sample bf-3. the homogenization

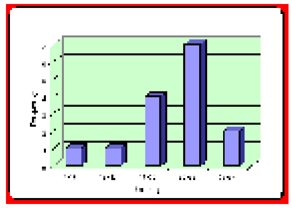


Diagram 7:Histogram of salinity abundance of sample bf-3.

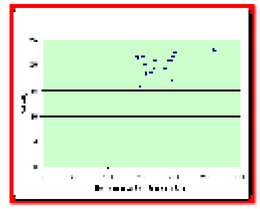


Diagram 9: Histogram of salinity abundance and of sample bf-3.

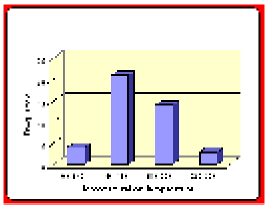


Diagram11: all sample In Histogram of homogenization

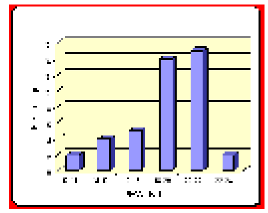


Diagram10: Histogram of the salinity abundance

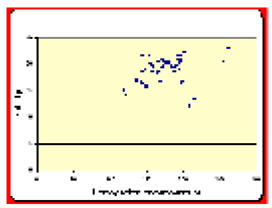


Diagram 12: The diffusion of salinity and temperature of homogenization in all studied samples (average of three samples).

Conclusion

The study on the salinity of fluid inclusions of the primitive in minerals which are forming the type kuroko(3,6) deposit, shows that the salinity of the fluids equals to the see water or mostly is doubled and this problem shows that these fluids originate from sea water and the most amount of NaCl is related to magma solution, specially, in alteration zones of lead, molybdenum, tin deposits that are created directly with the influence of magma solutions. This rate is about 20% and minimum concentration of NaCl is related to the thermal deposit as are created within low temperature (epithermal storage) and underground waters are playing the most important role for their formation. So, having high concentration of NaCl during the studies of the fluids inclusion can be a confirmation of the magma origin of the deposits.The study on salinity of inclusions of primitive fluids in ores forming the Bijegan Tappeh Sorkh Barite Mine shows that salinity of these fluids is more than salinity of sea water, consequently its concentration is more too (salinity rate of the sea water is 35gr/liter or 35%, but the amount of salinity rate of Bijegan Tappeh Sorkh Barite Mine is 19.5%). This high salinity can probably be known as a result of interference of the magma waters in ore. (Origin of these waters can be seen through performance of isotopic (5) studies). The salinity rate of the deposit of massive sulfide is between 2 and 10, but the salinity of Bijegan Tappeh Sorkh Barite Mine is 19.5 %, and the salinity of the magma waters is between 5 to 15 weight percentages. Basically, after this, the subject of magma water which is mixed with sea water is shown, so, perhaps when we have higher salinity compare with ores of massive sulfide, we can have the interference of the magma waters to forming this deposit, but about the deposit of massive sulfide, the salinity of fluids is the same or two times of the sea water, as this point itself shows the origination of these fluids from seawater. Shape 12 shows the limit of temperature, and combination of magma solutions for ores of poor firry lead, massive sulfide, sedimentary lead, tin and epithermal (1) (large 1990)- as in this picture, considering temperature and degree of the salinity can be seen for Bijegan Tappeh Sorkh Barite Mine .

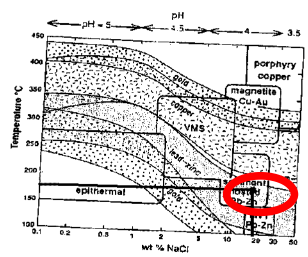


Fig. 12. limit of temperature, and combination of magma solutions for ores of poor firry lead, massive sulfide sedimentary lead, tin and epithermal (1) (large 1990) Tappeh Sorkh mine is identified with black points.

With the help of shape 13, we can obtain the depth of the boiling in hydrostatic conditions for Bijegan Tappeh Sorkh Barite Mine (having temperature and salinity in hand) as the achieved number shows the approximate depth of 100m.

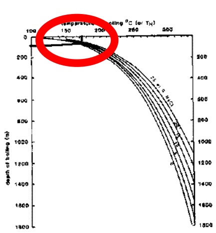
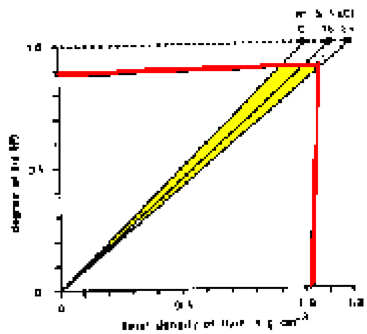


Fig. 13. Curve of boiling for solutions contain NaCl, TH and depth of the boiling in hydrostatic conditions (extracted from Hass, 1974) (1)

Diagram 14 is a curve of boiling for solutions contain NaCl, TH and depth of the boiling in hydrostatic conditions (extracted from HASS, 1974) (1) the average of the density of samples is between 1.03 to 1.04, as with the help of shape 14 we can achieve the relation among the degree of filling and the concentration of NaCl, as, the achieved number is the degree of filling about 0.89.Shape 15 shows the Amount of filling degree in fluids inclusion of liquid and gas (Sheppered and et all, 1985).



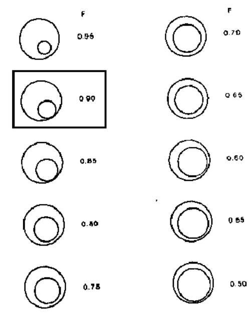


Fig. 14. Relation between degrees of filling and concentrationof NaCl in conditions of 15 and 25 % (Sheppard and et all, 1985).

Fig. 15 Amount of filling degree in fluids of Liquid and gas (Sheppered and et all, 1985).

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