Study of Cadmium Element Concentration in Different Horizons of Soil in Mineralization Range of Sarcheshmeh Copper Mine and its Subsequent Damages from its Propagation in Environment

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Abstract Sarcheshmeh copper Complex is accounted as one of the greatest mine-industrial centers in Iran that the amount of heavy metals similar, Cadmium in the regions around it is more than the mineral non-active regions. Based on the researches which were done on the Cadmium concentration, it was shown that the pollution of environment to the cadmium element in near regions to Industrial Cities such as Sarcheshmeh copper Town and metal melting kilns is including as a serious matter and at present, there are evidences indicate that Cadmium is including as a carcinogenic material and as a factor in creating the deformed fetus, in addition to the above mentioned issues, it has bad and harmful effects on the bird's life and aquatics. In this manner, sampling was done from the soils around Sarcheshmeh copper mine in 56 research stations around Sarcheshmeh copper complex. The obtained results show the considerable concentration of heavy metals such as Cadmium element in the soils of Sarcheshmeh copper region.

Key Words Cadmium, Sarcheshmeh copper Mine, Environment

Introduction

Water and soil resources are important components of earth's biosphere that have main role in human and animal's safety. In addition to basic role of soil in food production, it also is a section of life cycle that have important role in element's circulation. In spite of low amounts of rare elements in soil, they serve as nutrients for plants and by food chain are necessary for human and other organisms.

Excessive amounts of these elements that originated from natural or human-made factors can be led to serious ecological risks (Meryan, 2004). Geochemical cycles are concepts of relationship among different parts of surface ecosystem and elements are main components that move within these cycles among different environments (Khorasani, 2008). Heavy metals exist in earth's crust naturally and inter ecosystem by natural reactions such as volcano, natural firing, weathering, stone's erosion and deposits. There are two human polluting resources: primary resources such as applying fertilizer in soil and another is secondary resources such as pollutants that produced by activities in soils, such as factories and pollutant deposition by air (Ghazban, 2003). Transportation of heavy and toxic metals regarding all effective factors on their production is important and their existence in optimum range is necessary. Sever increase or decrease in amounts of these elements can disturb ecological balance and be dangerous for live organisms. Studying the transportation in mine and industrial places can help to ecological analyses because of human activities amount, natural processes effect and probability of these factor's effect on adjacent residential areas. The main aims of this study in Sarcheshmeh copper mine are mostly: 1- studying mine's down stream soils to measure Cadmium's concentration in different profile of soil and its harms. 2- Studying and statistical analyses of equations that might be existed among data and mine activities. In this study we try to determine Cadmium concentration and its harms in different horizons of soil in Sarcheshmeh copper mine.

Geographical position

Sarcheshmeh copper mine is located on eastern attitude of 53°, 55'; northern latitude of 29°, 58'; height of 2600 meter above sea level, in Kerman province. This mine located on 160 km western south of Kerman and 50 km western south of Rafsanjan in Bandmazar-Pariz mountains of Pariz city. The mine's asphalt roads are: Kerman-Rafsanjan-Shahrebabak and Kerman-Rafsanjan-Pariz-Sirjan (Baniasadi, 2008). Sarcheshmeh copper mine position is shown in figure 1.

In stage 1 all informations were collected, such as information of soil resources, geology, petrology, topography and climatology. Then library studies were done and research's results about soil pollution resources particularly heavy metals were collected.

At the end, final activities were done such as field operations, maps preparing, preparing comparative maps and basic information particularly

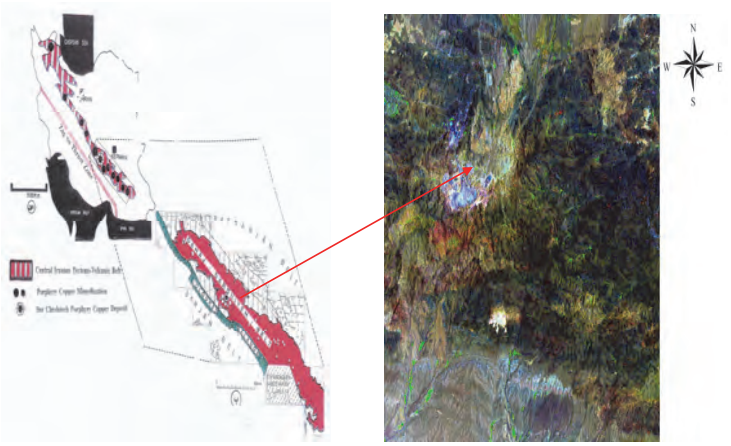

Figure 1 *Geographical situation of Porphyries Sarcheshmeh Copper Mine and ways to reach there, and the town, factory and mine location.*

about weather, geology, petrology, topography, agrology, and field utilization.

In stage 2 according to proposal design and regarding mentioned information, the uniform plan was prepared. Then soil sampling was carried in that area. In each work unit, three soil sampling stations were selected, randomly. Then soil sampling was done by Auger based on soil depth in each work unit and in each station from depth of 0—10, 10—20 and 20—40 (cm). Soil samples were sent to Soil Science laboratory of Kerman Agricultural Research Center.

In total, from each work unit 9 homogenous samples were taken. That is, 423 samples from 47 work units that were sent to the laboratory to measure PH, EC, soil tissue and Cd, Pb, Mo amount. Some work units were not available and some work units had only one or two depths of soil sampling. In third stage, analyzing the data and determining the standard error limits were done, using RCBD with split plots and Duncan's multiple range method. Three sampling depths (0—10; 10—20; 20—40 cm) in main plots and 47 sampling places in sub plots were compared. All sampling methods are done based on standard methods. Atomic absorption set were used to determine the amount of heavy metals. Excel And SPSS soft wares were used to analyze data.

Results and Discussion

Data obtained from the laboratory were analyzed by a RCBD with split plots and three replications. Three depths (0—10; 10—20; 20—40 cm)) and 47 places in sub plots were compared. The data were statistically analyzed (ANOVA) by SPSS. The mean amounts of Cadmium were compared using Duncan's method and results are shown in table 1.

Statistically analysis of Cadmium element

Table 1 shows the results of mean comparison of Cadmium element, in soil of various parts of

Table 1 *Mean comparison of Cadmium element in various parts of Sarcheshmeh watershed.*

Cadmium (ppm)	*Number*
2.3 cd	1
1.83 d…h	2
1.53 d…k	3
2.05 c…f	4
1.87 d…g	5
1.82 d…i	6
1.78 d…j	7
1.28 d…l	8
2.28 c…d	9
1.35 d…k	10
2.09 c…e	11
1.9 d…g	12
1.95 d…g	13
1.45 d…k	14
2.13 c…d	15
2. 3 c…d	16
2.27 d…l	17
1.23 d…l	18
2.05 c…f	19
2.27 c…d	20
1.92 d…g	21
2.08 c…e	22
1.92 d…g	23
2.08 c…e	24
1.88 d…g	25
1.22 d…l	26
1.38 d….k	27
0.92 e…m	28
1.33 d…k	29
1.32 d…k	30
1.49 d…k	31
0.67 h…m	32
0.87 f…m	33
0.53 k…m	34
0.79 g…m	35
0.13 l…m	36
0.39 klm	37
0.62 jklm	38
2.17 cd	39
5.85 a	40
0.04 m	41
0.91 e…m	42
0.65 h…m	43
3.1 bc	44
6.45 a	45
3.36 b	46
0.63 ijklm	**47**

Table 2 *Table of ANOVA of measured properties mean squares.*

Cadmium	Grade	Resorce
0/034 ns	2	Reapit
282/4 **	2	Depth
/015	4	Error a
1/58**	47	various parts
./114	368	Total Error
٪16		CV %

** and ns having very significant difference %1 and no significant difference, respectively

Table 3 *Mean comparison of Cadmium element in various depths (PPM).*

Depths(cm)	Cd	
	Mean	Class
0-10	2/336	A
10-20	1/395	B
20-40	1/439	B

Means with same alphabet have no significant difference %1

Sarcheshmeh watershed, by Duncan's method. The soil samples were categorized in 13 groups, considering their concentration of Cadmium element. The highest amounts were observed in places number 45 and 46. These two places in the watershed were near Sarcheshmeh mine and town. Fig 2 shows a decrease in soil Cadmium concentration as distance from mine is increased, in the studied watershed. Considering table 4, the most wind frequency was toward south and south west, being Cadmium element in smoke of copper melting process in Sarcheshmeh Copper Complex is the same as soil Cadmium (ppm) distribution map (Figure 2) in the watershed. Since the most wind frequency is toward south and south west, it seems that the root of Cadmium in soil surface is wind and the dust produced by factory.

Table 3 shows the result of mean comparison of 3 depth of soil sampling in work units, by Duncan's method. The difference in Cadmium concentration in three depths is significant and categorized in two groups of A and B. The most concentration (2.336 ppm) is measured in depth of 0—10 (cm). The least concentration was measured in depth of 10—20 and 20—40, with no significant difference.

Figure 3 shows the distribution of absorbable Cadmium amount frequency in the studied depths. The most amount of the frequency is observed in depth of 0—10 (cm) that is significantly more than the two soil depths. The reason of higher concentration of the element in upper soil layer may be natural or man-made events. The natural event may be Cadmium element transportation by water or wind. Man-made events may increase the effect of natural events and are due to any land use in the region. As mentioned already, the dominant wind direction can be the factor that increases the Cadmium concentration in soil surface. Since Cadmium in factory smoke is reported, it seems the source of contamination with Cadmium is factory smoke, therefore more attention should be paid to it.

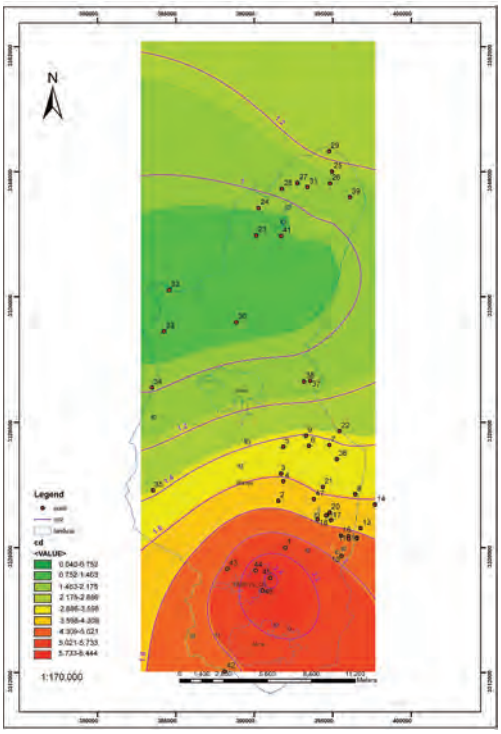

Figure 2 *Cadmium element (ppm) distribution map in soil of Sarcheshmeh watershed.*

Conclusion and Suggestion

Study the trend of changes in heavy metals in soil of Sarchesmeh copper mine led to these results in this research:

Table 4 *Frequency of percentage of wind direction in Sarcheshmeh region.*

NE	E	SE	S	Sw	W	Nw	N	Direction
6/4	1/6	1/6	27/8	16/8	4/6	4/5	9/8	%

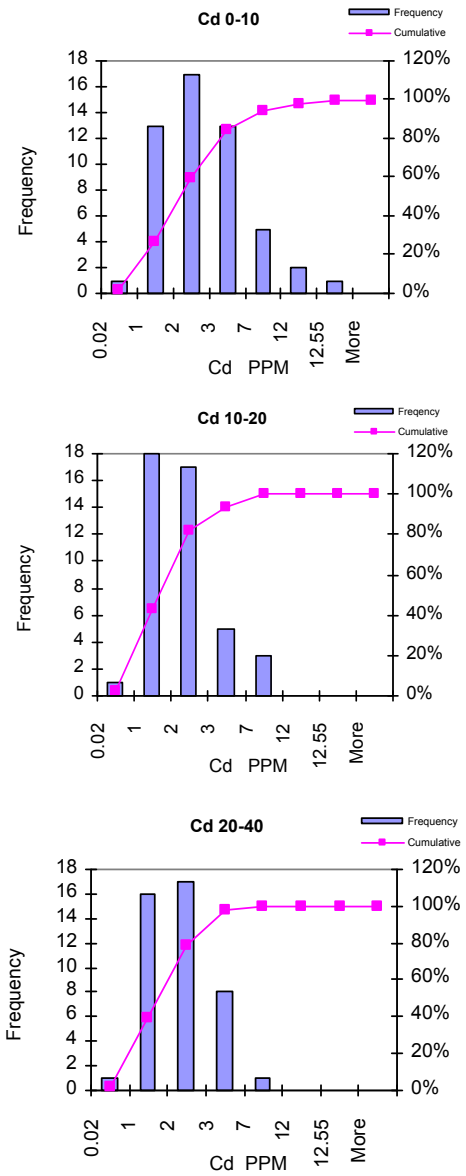

Figure 3 distribution of absorbable Cadmium amount frequency in the studied depths.

1 In ecological researches of heavy metals, the first step is selecting correct place for sampling. Then, correct sampling upon standard methods, sample preparing method and correct measuring the elements considering the ecological sensitivity of toxic elements can help analysis of results.

2 According to the results of analyzing the soil around the mine, we can conclude that the concentration of Cadmium in town and mine of Sarcheshmeh is relatively high.

3 According to table of heavy metal (Cadmium) mean comparison in various soil depth, amount of the elements in upper soil layer are higher than deeper layers.

4 Map of heavy metals distribution in soil environment indicates on man role in increase of the most elements and shows a pattern of increase in accordance with dominant wind direction. Highest concentration of heavy metals was measured near the mine and factory.

According to the above mentioned results, these suggestions are made to decrease the ecological effects of toxic elements, in Sarcheshmeh watershed and mine:

- decreasing pH in soil near the factory can be an alarm for controlling the sources of contaminations, specially the smoke of melting process,
- study the possibility the soil environment around the factory, considering that contamination is limited to the soil surface,
- to determine the trend of changes in soil heavy metals in soil of Sarcheshmeh copper mine, maps of changes in heave metal distribution should be prepared every other several years.

Acknowledgments

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