

## Water Management and AMD Minimizing in Sarcheshmeh Mine, Iran

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**Abstract:** This study try to give a solution for minimizing acid mine drainage (AMD) in Sarcheshmeh mine, one of the biggest porphyry mines of the world, with considering the AMD sources and emphasis on water supply management. Shur River runoff, the Sarcheshmeh mine dewatering, springs around the mine and Khatounabad aquifer are of the Sarcheshmeh water supply sources. Contacting the Shur River runoff (at the waste dumps upstream) and the spring discharge with the mine waste dumps are the most important AMD's sources. Mixing the dewatering water and AMD lead to the dewatering pollution. Base on our results the AMD volume could be minimized by isolation the waste dumps from water. Also, the dewatering pollution could be prevented by transport it directly into plant. This study shows that the AMD generation and therefore the environmental impacts could be minimized by the mine water supply management.

**Key words:** Acid mine drainage • Sarcheshmeh copper mine • Waste dump • Pollution

### INTRODUCTION

However there are significant improvements in mining technologies, but some important environmental risks, like acid mine drainage (AMD) still remain [1]. AMD could be a major problem on mines all over the world [2] and Sarcheshmeh Copper mine, the case of this study, is no exception. Recently, for AMD remediation, many techniques have been developed.

Incorporation of alkaline products into soil via trenches or as mine overburden [3-7] or applying them into the mine discharge [8, 9], application of activated silica sol [10], using Fenton process [11] and studying roles of algae and fungi as a technology for passive remediation of AMD [12] are some of those techniques. Beside them, injection of lime-rich grout is known as a key to control AMD in underground coal mines [13-15]. McCauley [16] operated Six continuously fed anaerobic bioreactors to investigate relationships between sulfate and metal removal from AMD because of various problems in some AMD remediation techniques due to the formation of metal precipitates and the armoring of the alkaline products [3, 17, 18].

The main focus of this research is to investigate a method to mitigate acid mine drainage in Sarcheshmeh

copper mine which is situated in the Central Iranian Volcanic Belt (Figure 1). This belt with NW-SE direction extends parallel to the Zagros Mountain Range [19]. The eruption of this volcanic belt got to its highest activity in the Eocene [20] and most of the study area is covered by volcanic-alluvial parts of Eocene time [21-23]. From the middle Oligocene to Miocene, the injection of diorite to granodiorite bodies creates the porphyry copper of the zone and most of related occurrences [24].

There are 11 wells in the Sarcheshmeh mine pit for controlling groundwater level where Sarcheshmeh mine pit cross the water table. The extracted water is discharged into Shur River (totally 120 lit/sec). Sarcheshmeh mine is located on Shur river branches. Shur River starts from Sarcheshmeh mine and discharge into tailings dam decant pond. The tailings dam is located on the Shur River, 20 kilometers far from the Sarcheshmeh mine (Figure 2). There are several springs around Sarcheshmeh mine. These springs were discharged into the Shur River directly. But, the wasted of Sarcheshmeh mine close the branches of Shur River and the springs couldn't be discharged into Shur River directly (Figure 3). The spring's outflow accumulates behind the waste dumps. The dewatering wells, the spring's discharge and the Shur river runoff discharge into the Shur River.

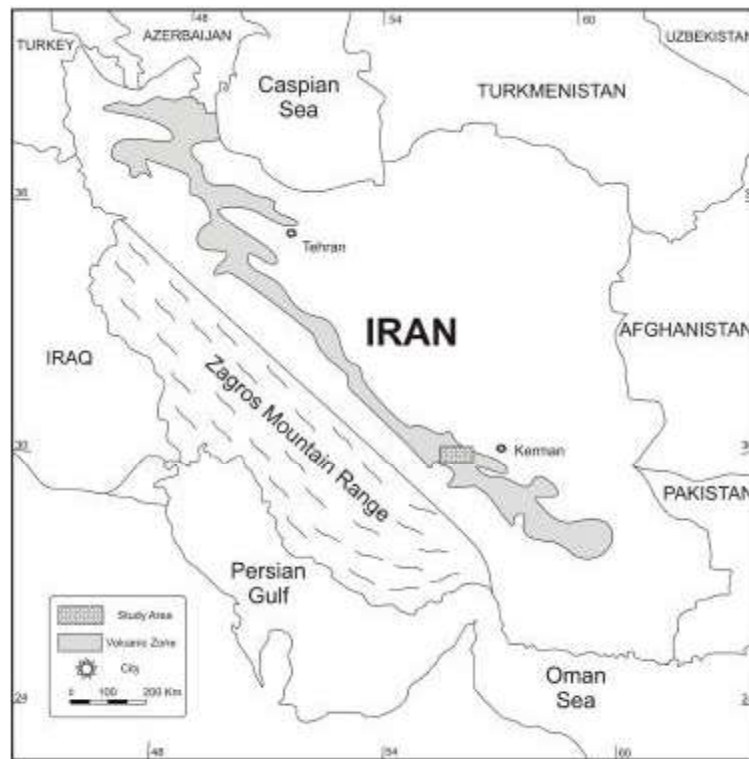


Fig. 1: Location of the study area

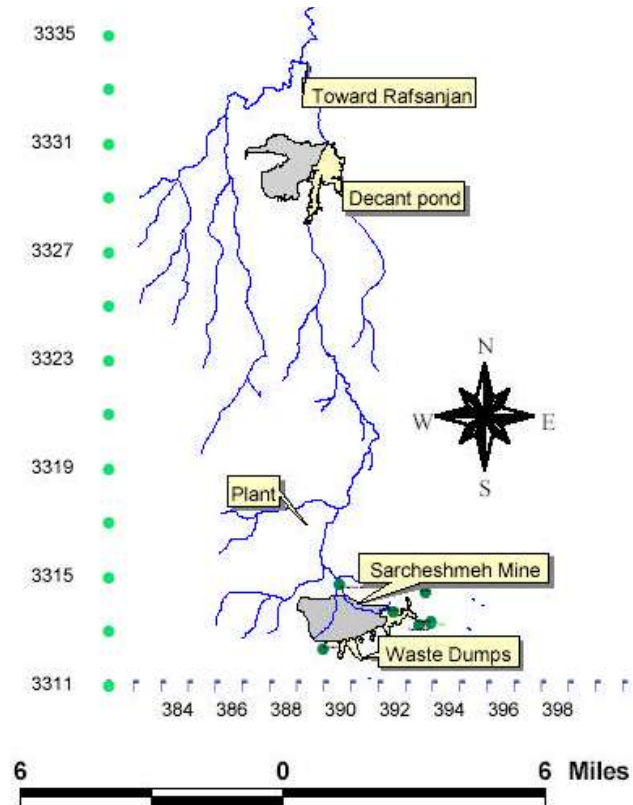


Fig. 2: Sarcheshmeh mine, Shur river and tailings dam

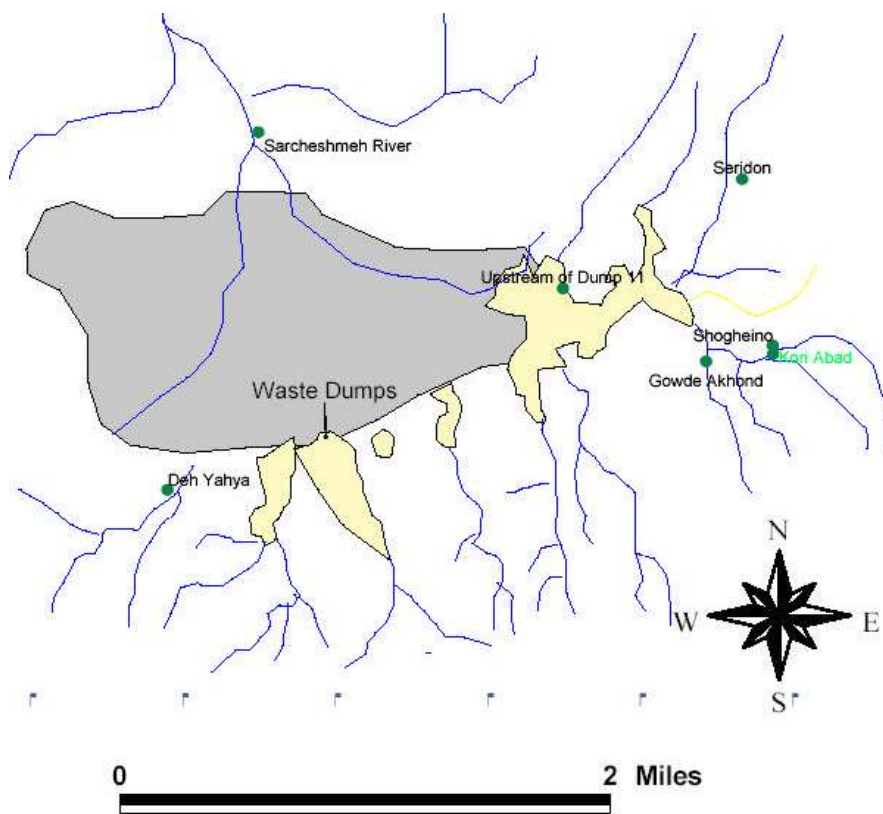


Fig. 3: Springs, Waste dumps and Shur river branches

## MATERIALS AND METHODS

This study focus on the Sarcheshmeh water sources management to preventing or minimizing AMD generation and its effects. In order to, the Sarcheshmeh mine water sources will be demonstrated.

The Shur River runoff and Khatonabad plain aquifer construct the Sarcheshmeh mine water sources. The Khatonabad plain is located in the west of Kerman (29°, 55' and 30°, 10' north latitudes and 55°, 15' and 55°, 30' east longitudes. Geological studies show the depth of the aquifer varies from about 50 meters in the southern part to 450 meters in the middle part. The aquifer is unconfined, consisting of sandstone and limestone. It provides 15-20 MCM/year fresh water.

As pervious mentioned, there are several spring around the Sarcheshmeh mine (Figure 3). These springs discharged into Shur River. Also, there are 11 wells in the Sarcheshmeh mine pit to control the groundwater level. The extracted water is discharged into Shur River (totally 120 lit/sec). The Shur River's average discharge is 150 lit/sec near the factory. The Shur River and the

spring's discharges accumulated behind the Sarcheshmeh mine wastes. This causes the AMD and pollutes the Shur River's water [2]. The Shur River discharged into the decant pond. The shur river water is mixed with tailing's decant water. It is returned into factory as return water. Also, some water (100 lit/Sec) is released toward the Rafsanjan plain to irrigate farms. Figure 4 demonstrate the Sarcheshmeh water cycle.

## RESULTS

In order to AMD management, the AMD sources must be recognized. Base on pervious researches [2], the Sarcheshmeh mine wastes are the most important AMD sources. The Shur River's and the spring's discharges accumulated behind the wastes. It causes the pyrite, water and oxygen contact. Table 1 shows the Shur River quality data and spring's and Shur river water accumulated in the upstream and the downstream of the waste dump no.11. Comparison the up and downstream dump no.11 data show that the dump no.11 increases the Shur River acidity.

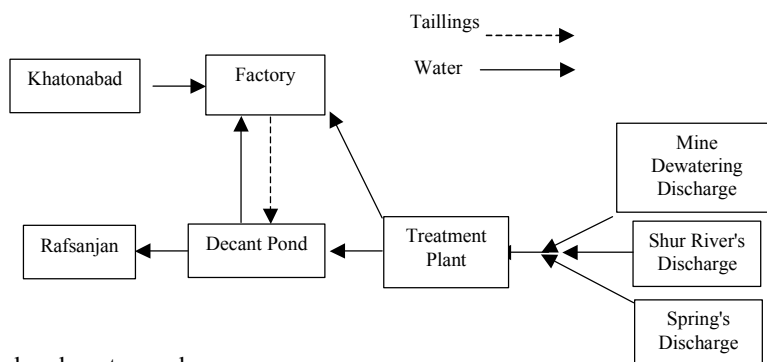


Fig. 4: Present Sarcheshmeh water cycle

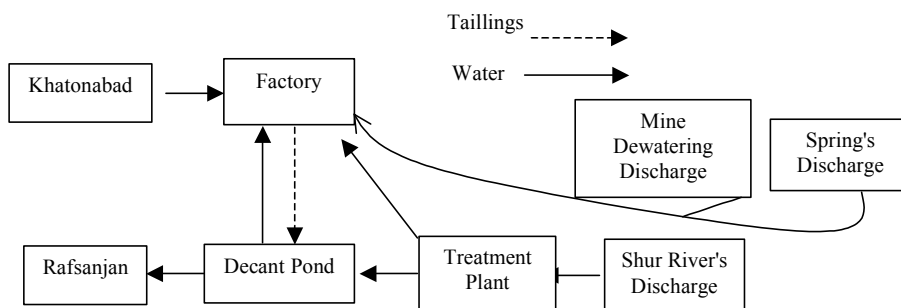


Fig. 5: Sarcheshmeh water cycle after divert Spring's and Shur river runoff

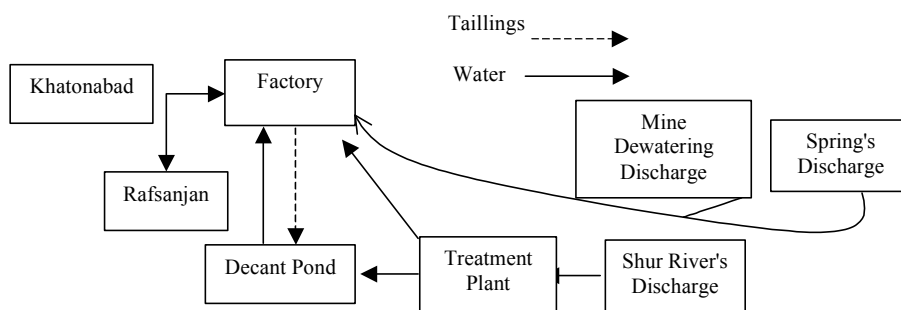


Fig. 6: Sarcheshmeh water cycle after replace the water released toward Rafsanjan with the Khatonabad water

Table 1: Shur River, Dump No.11 upstream and Downstream data (ppm)

	pH	Cu	Fe	Mn	Zn
Domp No.11 Upstream					
min	4.10	0.00	0.00	3.00	0.00
Max	6.60	150.00	2.00	124.56	32.00
Average	5.10	43.45	0.24	36.76	10.64
Domp No.11 Downstreamstream					
min	3.25	13.40	0.00	13.90	6.30
Max	4.70	192.00	1.80	98.60	38.20
Average	3.83	115.07	0.42	58.58	20.80
Shur river					
min	3.53	0.00	0.00	0.00	0.00
Max	7.55	82.20	23.00	49.69	31.48
Average	5.57	12.49	3.60	13.38	5.31

Table 2: Sarcheshmeh drainage water wells data (ppm)

	pH	Cu	Fe	Mn	Zn
Dwo1					
min	7.03	0	0	0	0
Max	7.49	0.11	1.82	0.9	1.04
Average	7.26	0.05	0.35	0.18	0.12
Dwo2					
min	5.95	0	0.83	0.8	0.12
Max	6.29	0.06	4.7	1.27	0.42
Average	6.15	0.02	2.18	0.97	0.23
Dwo3					
min	6.68	0	0.04	0.09	0.02
Max	7.28	0.75	4.47	1.17	0.35
Average	6.98	0.1	0.75	0.6	0.09

Table 2: Continued

Dwo4					
min	6.43	0	0.24	0.29	0
Max	7.04	1.01	9.4	3.87	0.53
Average	6.72	0.13	1.91	0.83	0.09
Dwo5					
min	6.28	0	0.15	1.14	0.13
Max	7.12	0.15	16	4.67	1.03
Average	6.58	0.06	5.17	2.6	0.42
Dwo6					
min	6.08	0	0	0.94	0.18
Max	7	0.25	16.68	2.65	0.8
Average	6.52	0.08	6.06	1.85	0.41
Dwo9					
min	6.06	0	0	0.8	0.06
Max	6.58	6.3	20.6	3.25	1.08
Average	6.35	0.33	5.14	1.45	0.28
Dwo11					
min	6.05	0	0	1.25	0.1
Max	6.85	7.14	14.4	5.95	1.47
Average	6.49	0.37	4.53	3.22	0.38
Dwo13					
min	6.45	0.01	0.01	0.57	0.02
Max	6.89	0.54	7	2.45	0.25
Average	6.72	0.14	1.64	1.32	0.13
Dwo13					
min	5.97	0	0	0.9	0.05
Max	6.78	6.24	36	7.6	4.55
Average	6.49	0.31	6.58	1.85	0.45

Table 3: Sarcheshmeh spring's data (ppm)

	pH	Cu	Fe	Mn	Zn
Deh Yahya					
min	7.16	0.00	0.00	0.00	0.00
Max	8.40	0.02	0.40	0.10	0.27
Average	7.80	0.00	0.01	0.01	0.01
Gode Akhond					
min	7.00	0.00	0.00	0.00	0.00
Max	8.25	0.02	0.20	1.50	0.03
Average	7.72	0.00	0.01	0.04	0.00
Kori Abad					
min	7.10	0.00	0.00	0.00	0.00
Max	8.30	0.05	0.30	2.00	0.05
Average	7.69	0.00	0.01	0.05	0.00
Seridon					
min	6.80	0.00	0.00	0.00	0.00
Max	8.25	0.20	0.20	1.00	0.30
Average	7.56	0.01	0.01	0.07	0.01
Sheghino					
min	7.00	0.00	0.00	0.00	0.00
Max	8.20	0.00	0.40	2.00	0.00
Average	7.70	0.00	0.01	0.06	0.00

Table 2 shows the dewatering wells data. And Table 3 shows the spring's data. The spring's and dewatering wells discharge with Shur river runoff (mixed with the spring's discharge and accumulated behind the waste dumps) make the Shur river discharge. Table 5 shows the Shur river data. The dewatering wells pH change between 5.95 to 6.49. Also, the spring's pH change between 6.8 to 8.4. However, the Shur river pH (after mixing the Shur river runoff, dewatering wells discharge and the spring's discharge) change between 3.84 to 6.75.

## DISCUSSION

Base on data, the waste dumps are the most important causes to AMD generation. The spring's discharge and Shur River's runoff (upstream the waste dumps) provide the needed moisture to AMD generation. After that, mixing the Shur river and dewatering discharge pollutes the drainage water. Therefore, the barrier methods, isolation from water, could help the prevention and minimization AMD in the Sarcheshmeh mine area. Therefore, the waste dumps should be kept out of the spring's and runoff water. Also, the dewatering water shouldn't be mixed with the Shur river runoff. However, precipitation could provide the needed moisture to AMD generation. This confirm with Kleinmann [25].

In order to isolation the waste dumps from the spring's discharge, the spring's water and the Shur river runoff should be collected before the waste dumps. The collect water could be diverted directly into plant or mixed with return water. Figure 5 shows the Sarcheshmeh mine water system after isolation the waste dumps.

Due to the mixing of the tailing decant water with the AMD, reached the Sarcheshmeh tailings decant pond by Shur River, the AMD acidity and its metals concentration reduced [2]. However, its acidity and heavy metals could be high during heavy storms and when the tailing's decant water don't discharge into the tailing's decant pond. Therefore, the tailings decant pond water that release to irrigation purpose could be dangerous. This water could replace with the Khatonabad water. Figure 6 demonstrate the final water system.

## CONCLUSION

- The waste dumps are the most important AMD sources.
- The generated AMD pollutes the dewatering water
- Convert the dewatering and the spring's water to the plant reduce the AMD generation and eliminate the contaminated water.

- Convert the dewatering and the spring's water to the plant reduce the treatment load and treatment costs
- The Shur river flows from the Sarcheshmeh mine to the decant water pond. It may has some environmental impacts during its flow from the mine to the decant water pond. This strategy eliminates the Shur river discharge and its environmental impacts.
- Replace the released water from decant pond by the Khatounabad water prevent possibly environmental impacts.

Also, this method has some disadvantages as follow:

- This method couldn't eliminate AMD generation completely. Some AMD could be generated due to direct precipitation on the waste dumps.

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