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title: **The effects of Takht Coal Mine (Minoodasht, Iran) on the groundwater quality**

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INTRODUCTION

Coal is one of the important sources of energy and an essential material in many industries (Wolela, 2007). The total coal deposit in the world is about 1060 MT, e.g. 5 times more than petroleum deposit. Iranian coal deposit is estimated to be 11.3 MT, %1.1 of the world deposit (Worldcoal). From an environmental point of view, coal mining is one of the notable sources for groundwater pollution. Extraction tunnel effluent and drainages from the coal and tailing depots are three possible way of releasing the pollutant into the environment in the vicinity of coal mines. Since in many cases sulfate minerals accompany coal layers, tunnel effluent are usually acidic and thus, carry heavy metals (Laus et al., 2007). Pyrite, marcasite, and pyrotite are the major sulfide minerals in coal. These minerals have the highest oxidation rate and play the main role in acidic mine drainage production (Butler et al., 2000). In some cases, neutralizing agents such as lime and dolomite exist in the area which cause increase in pH and causes the production of natural alkaline mine drainage (NAMD). This augmentation in pH consequently causes the precipitation of heavy metals although this does not affect the concentration of sulfate (Butler et al., 2000; Arthur et al., 1999). It is reported that total dissolved solids (TDS) in the mine drain could be controlled by complexes of iron and aluminum oxides. Adsorption of dissolved cations and anions in mine drains onto those complexes is completely dependent to pH. Increment of pH causes elevation of cation adsorption and precipitations while it decrease the anion adsorption and increase in anion solubility (Smith, 1999). A comprehensive study of open coal mines in the USA showed that quality characteristics of surface runoff and groundwater resources in the mining area were remarkably worsened. TDS, TSS, calcium carbonate, and heavy metals showed the highest increment in downstream of the mines (Laus et al., 2007). AMD effluent from Siti coal mine in Shanxi Province, Northern China, was held responsible for considerable augmentation in trace soil elements and sulfate ion in the soil downstream of the mine (Zhao et al., 2007).

This research dealt with the effects of coal extraction from Takht Coal Mine, southeast of Minoodasht, north of Iran, on the quality of the groundwater resources in the area.

METHODS AND MATERIAL

Samples were taken from the surface and subsurface water resources, both upstream and downstream, of the mine, extraction tunnel effluent, and tailing drainage in order to measure the physicochemical characteristics of water through pH, EC, concentration of cations (calcium, magnesium, and sodium) and anions (bicarbonate, chloride, sulfate, phosphate, and nitrate).

RESULTS AND DISCUSSION

The pH was measured at 8.41 and 8.12 in tunnel extraction effluent and tailing drainage. This finding indicates the presence of natural alkalinity mine drainage (NAMD) in the area. The field investigations disclosed that the mine is located in Shemshak calcareous formation. It can be interpreted by the geochemical characteristics of the area that neutralized the primary acidic mine drainage (AMD) into NAMD. NAMD is responsible for increment in pH of groundwater from 7.23 in upstream to 7.58 in downstream. pH in upstream runoff of the mine elevated from 8.21 to 8.29 in downstream runoff and 8.31 in downstream river. Entertainment of extraction tunnel effluent and tailing drainage with high concentration of calcium, magnesium, and sodium ions (68–120, 51–35, 160–402 ppm respectively) caused elevation in the concentration of these ions in the groundwater that in downstream were 2.7, 2.8, 4 times higher than upstream (Fig. 1). Also, coal mining doubled the concentration of magnesium and sodium ions in the downstream runoff in compare with upstream(Fig. 2).

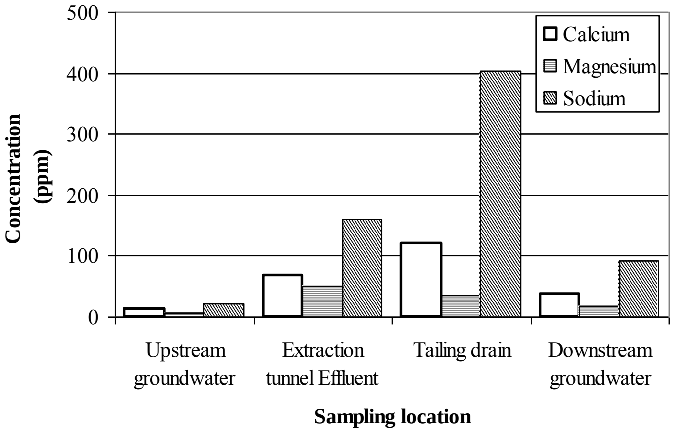

Figure 1. Cation concentrations in the groundwater, tailing drain, and tunnel effluent.

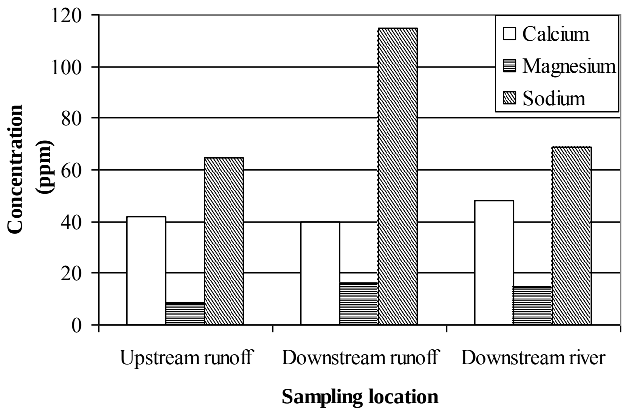

Figure 2. Cation concentrations in surface water.

The total concentration of anions was 2.15 meq/L in upstream groundwater which reached to 7.2 meq/L in downstream groundwater. This remarkable change in groundwater quality was due to the entering anions into the groundwater from tunnel extraction effluent and tailing drainage which contain sulfate (292.8–936 ppm), bicarbonate (378.2–305 ppm) and nitrate (114.1–868 ppm), (Fig. 3).

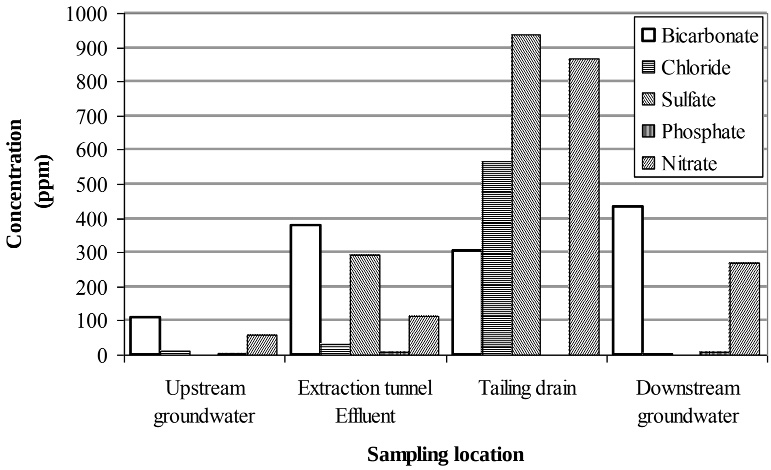

Figure 3. Anion concentrations in the groundwater, tailing drain, and tunnel effluent.

Mining also is responsible for increasing the concentration of bicarbonate and sulfate ions in downstream runoff. The total anion concentration increased from 5.35 meq/L in upstream runoff to 8.17 meq/L in downstream runoff and to 6.5 meq/L in the downstream river (Fig.4).

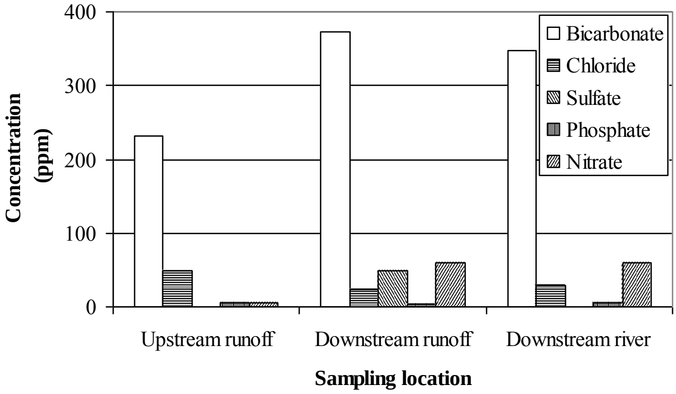

Figure 4. Anion concentrations in surface water.

CONCLUSION

It can be concluded that in the case of release of the NAMD with a pH of 8.41 into the environment, the augmentation in the concentration of calcium, sodium, magnesium, sulfate and bicarbonate are the major effects due to coal mining on the groundwater and surface water quality. Due to alkaline condition of the water resources in the region, it is predicted that the mining activities can increase the concentration of those heavy metals that have high solubility in basic solutions which opens the door for the further investigations.

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