



Investigating the level of water pollution in areas of alteration and mineralization (Case study: Northwest of Meshginshahr)¹

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Received Date: 02 November 2024 Accepted Date: 01 February 2025

Abstract

Background and Aim :Water is one of the most important and fundamental factors for the life of living organisms, in this regard, one of the most important categories that affects it is alteration and mineralization. In this regard, the soils of the northwest of Meshginshahr, which have been exposed to mineralization and alteration processes, contain large amounts of toxic and heavy elements that affect the water quality of this region. On this basis, the aim of the present study is to study the level of contamination of water in wells, springs and rivers by heavy metals in alteration and mineralization areas in the northwest of Meshginshahr.

Methods and Material: In the present study, library and field studies have been used as needed. Based on these data, a hydrographic map of the region was prepared using topographic maps (1:250,000, 1:50,000) and aerial photographs (1:20,000). In the following work process, water sampling was carried out from 3 sources: wells, springs and rivers, and existing standards (WHO) were used for chemical analysis of these samples. In this regard, sampling was carried out from 20 points of wells, springs, waterways and the Qara Su River in altered and non-altered areas.

Results and Findings: Studies conducted based on the Piper, Wilcox, Schuler diagrams and also the Stiff diagram showed that most of the waters in the study area are undesirable, non-potable and harmful for agriculture. The Langier coefficient also indicates very high sedimentation to corrosion. Another part of the research findings was based on the geochemical behavior of the elements (iron, arsenic, copper, molybdenum, lead, antimony and zinc). Studies conducted in this regard also showed that in most cases the waters under study contain more elements than the permitted limit and the declared standard. However, regarding the lead element, all the water samples in the area have a desirable quality compared to the recommended standard for irrigation. The results obtained from the chemical analysis of the waters in the studied area show that the groundwater of the alteration areas is mainly sulfated, magnesium and calcium, and with the intensification of alteration, the amount of earth elements and strong acids also increases. Most of the waters of the mineralization and alteration areas are among the undesirable and poorly known waters and are also harmful for drinking and agriculture. The high content of sulfate ions, low pH and high corrosiveness of these types of waters are among the factors that make them undesirable. Considering the pollution that has occurred in the surface and groundwater of the area, the purification of drinking water for the residents of the area can play an effective role in reducing the transfer of toxic metals to the biological cycle.

Keywords: Water, alteration, mineralization, environment, soil, Meshginshahr

¹This article is an extracted from a Ph.D Thesis titled "Investigation of the geochemical mineralization and alteration of intrusive masses in the Meshginshahr region and their role in environmental pollution" first author, supervisors: second author, University of Tabriz, Tabriz, Iran.

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Cite this article: Alavi, S. G. and Saffari, A. (2025). Investigating the level of water pollution in areas of alteration and mineralization (Case study: Northwest of Meshginshahr). Journal of Sustainable Urban & Regional Development Studies (JSURDS), 5(4), 347-362.

Extended Abstract

Introduction:

Environmental pollution is one of the most important problems that threatens the health and food security of society. The development of industries and human activities is the main cause of these problems. Water pollution directly and indirectly affects the surrounding environment and the biodiversity of living organisms. In addition to its destructive environmental effects, this type of pollution, by penetrating the human food chain, creates numerous health and social problems and imposes significant damage to the national economy. Water pollution is one of the most important serious threats facing many countries, arising from the discharge of industrial waste into water or the use of chemical fertilizers and pesticides in agriculture. Water is a vital resource that potentially affects all aspects of daily life. Access to safe drinking water is one of the health indicators determined by the World Health Organization and is of interest to relevant authorities in various societies. Today, water quality studies have become more extensive and include issues related to surface and groundwater pollution. One of the fundamental and important challenges in environmental fields is the gradual increase or accumulation of heavy metal concentrations in high concentrations due to their lack of decomposition in the environment. Sources of pollution are basically divided into two groups: terrestrial and anthropogenic. Geogenic sources include pollution from geological formations, mineral springs, saline and brackish water sources, and anthropogenic pollution includes industrial activities, transportation, use of agricultural fertilizers, mining activities, and waste and wastewater (soil is a natural source of heavy metals and other chemical elements, and human activities also cause a multifold increase in the concentration of heavy metals in the soil and an increasing threat to health, as well as a decrease in the quality of the human environment. Heavy metal pollution is one of the most important global problems of soil pollution, which is related to human activities such as mining, metal and chemical industries, worn-out vehicles, etc. On the other hand, mineralization and the resulting alterations create important changes in the chemical composition and mineralogy of primary rocks and cause the release and concentration of some toxic and heavy metal elements in the environment. Therefore, in such areas, the spread and dispersion of toxic elements in water resources, soil, and plants and the creation of Environmental pollution is not far from the expectation. Therefore, the destruction of rocks in mineralization and alteration areas can be considered as a center for natural decentralized pollution. Since the Qaradagh-Tarom zone in the northwest of the country is considered a metallogenic zone (with extensive mineralization and alteration areas) and in some of its areas, extensive mining activities have been carried out or are being carried out, it seems necessary to investigate the possibility of contamination of such areas from an environmental point of view and the problems that arise in their water and soil resources, because heavy and toxic metals ultimately accumulate in the soil and enter the food cycle of livestock and humans through plants or water. Many mineral and geological studies have been carried out in the mining area north of Meshginshahr as part of the Qaradagh-Tarom zone, and the results obtained have confirmed the existence of copper, lead, zinc, cobalt, nickel, gold and silver mineralization. Also, based on the data obtained, the expansion and type of mineralization zones and alteration, as well as primary and secondary halos related to metallic elements, have been determined.

Methodology:

In the present study, library, office, and field studies were used. Each of them is discussed below:

Office studies: During these studies, after collecting previous information, the altered and mineralized areas were prepared using topographic maps and aerial photographs with a scale

of 1:20,000 along with geological information. In these maps, while drawing the contours of different lithologies and the mineralization and alteration phenomena resulting from them, important tectonic structures such as faults were identified. While studying the existing aerial photographs and topographic maps, a hydrographic map of the region was prepared, showing the existing rivers, waterways, springs, and water wells.

Field studies: After collecting and studying the previous information and data, and preparing basic and preliminary maps, field studies began. The different stages of field studies are examined below.

- Control and correction of maps prepared based on field visits: After collecting the available information including geological and topographic maps, reports, aerial photographs and performing office work, necessary planning was done to carry out field operations. In this stage, geological and alteration maps were prepared by surveying and investigating the surface of the region and using 1:20,000 aerial photographs and topographic maps. In this way, all geological units, including sedimentary, volcanic and plutonic units, tectonic structures, mineralization traces and the location of the samples taken, were identified on the base maps. Considering the importance of identifying the relationship between existing alterations and mineralization with water resources, an attempt was made to separate the alteration zones using the available data and with great precision. In this stage, the results of petrography, mineralogy, XRD and ICP studies conducted by the Ardabil Province Industries and Mines Organization were used.

- Preparation water sampling stage: In this stage, 20 water samples were collected from wells, springs, streams and the Ghare Su River in altered and unaltered areas on a case-by-case basis. Water samples were collected by hand and were transferred to the laboratory within 3 days of water sample collection and stored in a cool environment (about 4°C). In the sampling stage, first, sampling containers with a volume of 1.5 liters and the required number were acid-washed and the samples were collected from the center of the sampling site and from below the water surface slowly and without disturbance. The aforementioned samples were analyzed chemically (CO₃²⁻, HCO₃⁻, SO₄²⁻, K⁺, Na⁺, Mg²⁺, Ca²⁺, pH, EC, TH, TDS and Cl⁻) and geochemically for metallic elements. The ICP method was also used to determine the concentration of these elements.

Results and Discussion:

Some of the metallic and even quasi-metallic and non-metallic elements present in the rocks, deposits and especially the alteration and mineralized zones of the studied area have moved and shifted during the long-term weathering period. Monovalent and divalent metallic elements are suitable for binding to the structure of clay minerals present in the soils of the area such as kaolinite, illite, jarosite and alunite as well as oxides and hydroxides of iron and manganese and possibly aluminum such as hematite and goethite. The surface adsorption of these elements depends on the element concentration, the surface coverage and the type of adsorbent in addition to pH. For example, the adsorption of transition metals such as cobalt, copper, nickel and zinc, which are strongly adsorbed by iron oxide, is pH dependent and reaches a minimum at pH <6. Therefore, the adsorption phenomenon cannot be the main factor in the stability of element adsorption. On the other hand, although copper and zinc can form strong complexes with organic matter, organic matter in the soil is not stable and is widely affected by degradation and decay processes. The above effects cause extensive mobility and movement of metal elements in different environments of the region. The excessive concentration of some toxic and pathogenic elements in the water resources of the region is the result of these processes and is worrying. Because this water in the region is not only used as drinking water for residents and livestock, but also for irrigating gardens and farmlands. Therefore, the possibility of the spread of various diseases related to contaminated water and plants in the region is not far from expectation. Unfortunately, there are no documented and accurate

statistics and information on common diseases in medical and health centers. However, according to oral statements from residents and treating doctors, the spread of skin diseases, liver diseases, and cancer is higher than in other regions.

Conclusion:

In the present study, to study the level of water pollution in wells, springs and rivers in the alteration and mineralization areas of northwest Meshginshahr, Piper classification, Wilcox diagram, Schuler diagram and Stiff diagram were first used. In this regard, the studies conducted based on Piper classification indicate that the waters of the alteration areas of the study area are magnesium and calcium sulfate. According to the Wilcox diagram, most of the waters of springs and wells in the alteration areas are in the C4S1 and C4S2 classes (very salty and harmful for agriculture). According to the Schuler diagram, most of the alteration waters are considered undesirable and unfit for drinking. The reason for this is the high sulfate ion content, sour taste and high corrosiveness of this type of water. According to the Stiff diagram, as well as Piper's classification of severe sulfate, the waters of the alteration areas are severely sulfated. In the following work, the Langelier coefficient was used. The findings of the study showed that with regard to the iron element, except for one water sample, the rest of the samples contained more iron than the permitted and standard limits and were unfit for drinking. A comparison of the values of the arsenic element in the water samples of the rivers, springs and wells of the region shows that, except for three samples, the rest of the samples have concentrations exceeding the standard limits. In such a way that the arsenic concentration in most of the samples is higher than the average. An examination of the copper element indicates that the level of contamination is not only much higher than the standard limit, but its concentration in some water samples is also several times the permitted limit. The study of molybdenum element shows that in more than 90 percent of the water samples of the studied area, the amount of molybdenum element is higher than the WHO standard. The study of lead element shows that all the water samples of the area are of desirable quality compared to the recommended standard for irrigation, but two spring water samples are not of suitable quality for livestock drinking. The next element that was studied in the present study is antimony element. The findings of the study in this regard showed that the waters of the studied area are contaminated. Since this element has low mobility and is concentrated in the soil and enters the water less. The last element that was studied was zinc element. The studies conducted in this regard showed that in three spring water samples it was 1 time the standard, in 6 samples of groundwater and 2 samples of river water it was higher than the Iranian standard, which could be related to minerals such as sphalerite. Considering that the maximum limit of this element for permanent irrigation is 2 mg/liter, we have witnessed an increase in zinc in 7 water samples. The study of the environmental characteristics of the elements under study, especially arsenic, indicates their severe toxicity. Therefore, a serious study of the methods for reducing environmental pollution in the region is extremely necessary. It is important to note that the standards used in this study and other environmental studies are conventional and do not fully express the level and severity of pollution. However, this study used standards that are most widely used in environmental studies. Considering the pollution in the surface and groundwater of the region, the treatment of drinking water for residents of the region can play an effective role in reducing the transfer of toxic metals to the biological cycle. For example, the use of activated alumina can be used as a reliable adsorbent in removing arsenic from drinking water in simple home purification systems and in the form of absorbent columns.

Declarations

- Funding:** There is no funding support for this study.
- Authors' Contributions:** All authors contributed equally to the conceptualization and writing of the article. The authors approved the manuscript's content and agreed on all aspects of the work.
- Conflict of Interest:** The authors declare no conflict of interest.
- Acknowledgments:** The authors extend their gratitude to all scientific consultants who provided invaluable insights during this research.

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