CrVI contaminated groundwater in the Mediterranean: Case study from Mersin, Turkey

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Abstract
Increasing population, industrialization, agricultural and tourism activities in Mediterranean countries do not only increase the water demand but also led to deterioration of water quality. Water quality degradation is a common problem in all circum-Mediterranean countries and there is an increasing need for the development of a common approach in tackling water resources management problems. ERANETMED CrITERIA project aims to assist the water resources management organizations with an optimization tool that includes documentation and database for decision support. Greece, Italy, Turkey, Cyprus, Jordan and Omman are the partners of the project.
The project area in Turkey covers Mersin city and its surrounding. This region is located on the Mediterranean coast and consists of two main hydrogeological parts; the Coastal Aquifer and the Hillside Aquifer. The Coastal Aquifer is represented by a deltaic environment and The Hillside Aquifer is composed mainly of sedimentary and ophiolite rocks. Within the scope of the study, surface and groundwater samples were collected from the region in May 2017 and October-November 2017 and May-June 2018. About 50 sites were sampled in each period. It is determined that none of the samples has above the 50 µg/L limit of EU drinking water standard for total Cr, but some of the samples have CrVI contents above 10 µg/L. CrVI is regarded as a potential carcinogen.
Keywords: contamination, CrVI, groundwater, Mersin

1. Introduction

Chromium is a toxic element and it can be found in different oxidation states in the environment. CrIII and CrVI are predominant oxidation states of the chromium in the environment. More stable and toxic form is CrVI, and it has higher solubility and mobility than CrIII (Silva et al, 2008). Human activities have considered the only CrVI source in groundwater, but latest research has shown that high CrVI contents can be found as a result of natural processes related to oxidation of CrIII in ultramafic rocks and particularly in serpentinites of ophiolite complexes under favorable pH and redox conditions (Dermatas et al. 2015, Oze et al, 2004, Oze et al, 2007).

The International Agency for Research on Cancer has classified CrVI compounds as carcinogenic to humans (Group 1) with respect to the cancer based on evidence from occupational studies (EFSA CONTAM Panel, 2014). Maximum limit for drinking water standard for total Cr in the EU legislation is 50 µg/L (EU, 98/83/EC). It is expected that Cr limit for drinking water will be re-evaluated in the near future because of the increased concern for CrVI toxicity. Italy has established the maximum permissible level of CrVI in drinking water as 5 µg/L.

Cr(VI) and Cr(III) can convert back and forth in water and in the human body depending on environmental conditions. EPA's regulation assumes that a measurement of total Cr is 100 percent CrVI, the more toxic form, in order to ensure that the greatest potential risk is addressed (EPA, 2019).

2. Case study from Mersin, Turkey

The study area covers the city of Mersin and its vicinity along the southern coast of Turkey. Settlement, agricultural and industrial areas are intertwined in this region.

Most of the study area is low-lying coastal plain and the hillside part of the Taurus Mountains. The stratigraphic sequence in the area ranges from Carboniferous to Quaternary. Mainly cemented Neogene formations form low-productive Hillside aquifer which also includes ophiolite rocks. Uncemented granular Quaternary units representing a deltaic environment form high-productive Coastal aquifer. The Paleozoic karst aquifer which extends beneath the Hillside Aquifer toward the Mediterranean Sea covers most of the area in the Taurus Mountains (Hatipoglu et al, 2009).

During the period of May 2017, October-November 2017 and May-June 2018, approximately 50 surface and groundwater samples were collected to represent the rainy and dry seasons. Ion Chromatography, ICP-MS and titration methods were used for major and trace elements and spectrophotometric diphenylcarbazide method was used for CrVI determination.

Major ion analyses of the groundwater samples show that the most common hydrochemical facies of the freshwater in wet and dry season samples were Ca-Mg-HCO_3 and Mg-Ca-HCO_3. Other facies in the groundwater samples include Na-Cl, Na-HCO_3, Ca-Cl, Mg-Cl, Mg-SO_4, Na-SO_4.

It is determined that none of the samples has above the 50 µg/L limit of EU drinking water standard for total Cr. In the first and third period samples representing the rainy season, the highest total chromium contents, which were measured as 27 ppb and 31 ppb, respectively, collected around the ophiolite rocks, at the higher elevations of the study area which are far from the industrial areas in the plain. In the second period which represents the dry season, the highest total Cr content was determined as 41 ppb in the Kazanli region on the coastal part, where industrial facilities are widespread.

As, Al, Fe and Pb content in some of the surface and groundwater samples were found to be above the EU limits.

Most of the samples have NO_3 contents which are close to or above the limit value of 50 mg/L EU drinking water standard for NO_3.

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