

GROUNDWATER IN KUWAIT AND THE ENVIRONMENTAL FACTORS AFFECTING ITS QUALITY

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ABSTRACT

The present paper discusses the hydrogeological conditions and groundwater quality of the different aquifers in the main groundwater fields in Kuwait, the groundwater chemical regime and the environmental factors affecting this regime and also the genesis and formation of groundwater mineralization. Three genetic hydrogeochemical zones could be recognized in Kuwait Group and Damman Limestone aquifers. Hydrogeochemical regime of most usable groundwater proved to be steady in time except for Rawdatain area and some shallow groundwater accumulations. The main factors determining groundwater quality are the climatic conditions, leaching of water-bearing rocks, interaction of meteoric water and both recent and old marine water and cationic exchange between percolating water and aquifer rocks.

INTRODUCTION

Groundwater resources are of vital importance in an arid country like Kuwait. The most important usable groundwater resources in this country are mainly contained in the different water-bearing horizons of both Kuwait Group and Damman Limestone. These two formations constitute the upper-most part of the geological section in Kuwait. Hydrogeological and hydrogeochemical evidences indicate that both formations are hydraulically connected and, in fact, can be considered as one complex aquifer.

Al-Rawdatain and Umm Al-Aish are the main fresh groundwater fields producing from the Kuwait Group (Dibdibba Formation). On the other hand the main brackish groundwater fields producing from the Damman Limestone aquifers are distributed in the area between Al-Shagaya and Al-Sulaibya in the central regions of the country beside Magwa and Abduliya fields in the southern regions.

Periodical chemical analyses were carried out for groundwater

collected from the different above-mentioned water fields in the period from 1973 to 1977. Moreover, old chemical data and hydrogeological information were revised and used.

Hydrogeochemical zonation

Studying the results of all groundwater chemical analyses for different areas in Kuwait the following hydrogeochemical zones could be recognized on basis of application of Solin's genetic classification of groundwater (Fig. 1):

Zone of Sulphate-Sodium groundwater. It is essentially of pure meteoric origin. It covers an extensive area including nearly the whole regions of fresh and brackish groundwater fields.

Zone of Chloride-Magnesium groundwater. It contains groundwater chemical type considerably affected by traces of recent sea water. It forms an arc surrounding the above-mentioned zone from sea-side. Small isolated areas belonging to this zone could be recognized in the eastern part of Al-Shagaya - Al-Sulaibya area.

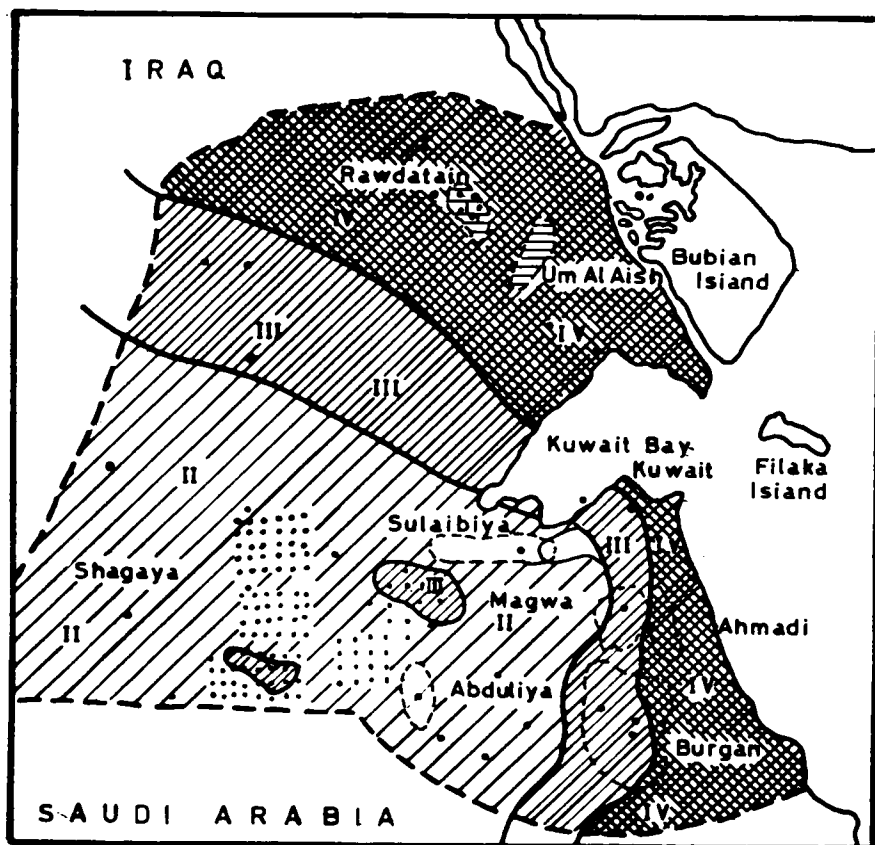
Zone of Chloride-Calcium groundwater. This zone characterizes the occurrence of old sedimentation metamorphosed sea water having salinity more than 50 000 ppm.

Hydrogeochemical regime of groundwater





For each of the main groundwater fields in Kuwait one or more representative wells were selected to study the variation in water chemical composition during a definite period of time extending for many years. In conclusion it can be stated that the groundwater of Dammam Limestone and Kuwait Group in most of the area extending between Al-Shagaya and Al-Sulaibya is characterized by steady chemical regime without appreciable change in chemical quality of groundwater by time. This may indicate that groundwater aquifers are not influenced considerably by climatic conditions or infiltration of local precipitation in this area. On the other hand, the groundwater chemical regime in different parts of Al-Rawdatain and Umm Al-Aish water fields indicate considerable increase of water salinity and chemical constituents in the period between 1962 and 1977. This is mainly due to the intensive exploitation of the shallow aquifers in these localities and the effect of the arid climatic conditions.

Genesis and formation of groundwater mineralization.

The main hydrogeochemical processes determining the groundwater quality and the main factors controlling its chemical regime could



Legend

-  Zone of SO_4 -Na water of meteoric origin (<2000 ppm)
-  Zone of SO_4 -Na water of mainly meteoric origin (2000-5000ppm)
-  Zone of Cl-Mg water of mainly marine and mixed origin (5000 - 50000 ppm)
-  Zone of Ca-Cl water of old sedimentation origin(>50000 ppm)

be summarized in the following:

Climatic conditions. Especially amount of rainfall, evaporation and evapotranspiration potential determine generally the groundwater quality and the hydrogeochemical regime of the shallow groundwater accumulations and groundwater of Al-Rawdatain and Umm Al-Aish areas

Leaching of water-bearing rocks. This effect is responsible for increase of groundwater salinity in Damman Limestone from western

localities in eastern direction . This increase in salinity is, evidently due to progressive leaching and dissolution of abundant disseminated amounts of gypsum and anhydrite in Kuwait Group, Dammam Limestone and the evaporites prevailing in the underlying Rus Formation.

Interaction between the meteoric fresh water and both recent and old sea water. The hydrogeological and hydrogeochemical conditions of the already recognized hydrogeochemical zones of groundwater indicate that these zones are originally developed due to progressive active leaching of the water-bearing rocks and replacement of the originally formed marine water by fresh meteoric water and the subsequent interaction between these two types of water.

The parts of the studied aquifers which are occupied by fresh and brackish groundwater, actually, represent the zones in which the originally deposited marine water is, almost completely replaced by meteoric groundwater of infiltration origin.

Base exchange between groundwater and water-bearing rocks. In this respect the occurrence of CaCl_2 in the highly saline groundwater and brine zone could be explained on basis of cation exchange between Na ions from the old sea water and Ca ions from the rocks. In the same time the occurrence of such salts of NaHCO_3 , Na_2SO_4 and MgCl_2 in some groundwater types may be explained by cationic exchange between Na and each of Ca and Mg ions.

Beside the above-mentioned natural factors, still there is one that certainly affects the groundwater chemical regime, especially in Rawdatain and Umm Al-Aish fields and to some extent in Al-Sulaibya field. This is the intensive pumping from these fields in a way that may disturb seriously the natural groundwater balance and result in dangerous salt water encroachment in the fresh groundwater aquifers.

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