Water quality mapping and assessment, and weathering processes of selected aflaj in Oman

Habes Ahmad Ghrefat · Ahmad Jamarh · Ahmed Al-Futaisi · Badr Al-Abri

Received: 8 June 2010 / Accepted: 14 December 2010 / Published online: 6 January 2011
© Springer Science+Business Media B.V. 2011

Abstract There are more than 4,000 falaj (singular of a peculiar dug channel) distributed in different regions in Oman. The chemical characteristics of the water in 42 falaj were studied to evaluate the major ion chemistry; geochemical processes controlling water composition; and suitability of water for drinking, domestic, and irrigation uses. GIS-based maps indicate that the spatial distribution of chemical properties and concentrations vary within the same region and the different regions as well. The molar ratios of \((\text{Ca} + \text{Mg})/\text{Total cations}\), \((\text{Na} + \text{K})/\text{Total cations}\), \((\text{Ca} + \text{Mg})/(\text{Na} + \text{K})\), \((\text{Ca} + \text{Mg})/(\text{HCO}_3 + \text{SO}_4)\), and \(\text{Na}/\text{Cl}\) reveal that the water chemistry of the majority of aflaj are dominated by carbonate weathering and evaporite dissolution, with minor contribution of silicate weathering. The concentrations of most of the elements were less than the permissible limits of Omani standards and WHO guidelines for drinking water and domestic use and do not generally pose any health and environmental problems. Some aflaj in ASH Sharqiyah and Muscat regions can be used for irrigation with slight to severe restriction because of the high levels of electrical conductivity, total dissolved solids, chloride, and sodium absorption ratio.

Keywords Aflaj · Geochemical mapping · Weathering · Water quality · Oman

Introduction

Oman is situated in the southeastern part of Arabian Peninsula and is bounded by the United Arab Emirates, Saudi Arabia, Republic of Yemen, Gulf of Oman, and Arabian Sea (Fig. 1). Oman has an arid climate, with an average rainfall of less than 200 mm/year (Al-Gafria et al. 2003). Groundwater is the main water source representing 92% of the total renewable water resources. Agriculture is the major consumer of waters accounting for 87% of renewable water resources. A falaj (singular of aflaj) is a channel dug into the earth or running along the earth surface that is used to collect groundwater, natural spring water,
or surface water. There are 4,112 falaj in Oman of which 3,017 are live falaj, producing about $680 \times 10^6$ m$^3$/year and $410 \times 10^6$ m$^3$/year is used (Al-Hatmi and Al-Amri 2000). The total area cultivated by the live aflaj was estimated to be 26,484 ha. The water from aflaj has provided the people of Oman with domestic and agricultural water for more than 1,500–2,000 years (Sutton 1984; Abdel-Rahman and Omezzine 1996; Al-Marshudi 2001).

There are three types of aflaj in Oman (Fig. 2), characterized by the Ghaily falaj, Daudi falaj, and Ainy falaj (Al-Rawas et al. 2000; Al-Marshudi 2001; Al-Gafria et al. 2003). Ghaily falaj, which represents 46% of the total number of aflaj in Oman, is dug close to the ground surface and is normally open channel. Water in the Ghaily falaj comes from an ephemeral wadi (valley) channel which accumulates water directly after a rainfall or through groundwater seepage from the rainfall. The Ghaily falaj is around 4 m deep and 2 km long and is not used for domestic purposes, because it is normally open and may be unsuitable for drinking purposes. The Daudi falaj consists of a long underground tunnel tens of kilometers long at depths reaching tens of meters at the source of water (the mother well). This falaj constitutes about 21% of the total number of aflaj, and is the main and permanent source of water in many regions of Oman. The Ainy falaj is fed directly from groundwater springs and represents about 33% of the total aflaj. The length of this falaj extends from 100 to 200 m. Water in the aflaj is subject to contamination as the water flows at or close to the ground surface. Moreover, aflaj also have many aeration and maintenance openings (vertical shafts), which may facilitate the entry of contaminants.

Major ions and trace elements in the water of different types of aflaj in different regions of Oman have not been previously evaluated or investigated, to the best knowledge of the authors.