

Changes in the calcocarbonic system of karst groundwaters by infiltration of leachates from a USWL (La Mina landfill, South of Spain)

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ABSTRACT: Leachates from La Mina landfill are degrading the natural quality of a karstic aquifer. The chemical composition of waters from wells, piezometers and main springs has been analyzed and hydrochemical calculations have been performed with the aid of the EQ3NR software package. Water closer to the landfill shows that reactions take place in an open system, with constant and high P_{CO_2} ($\log P_{CO_2} = -1.40$), what provokes an “extra” dissolution of carbonated minerals. The results are lower pH's and higher calcium, magnesium and bicarbonate contents, compared to unaffected groundwaters. Samples coming from piezometers located far away from the landfill show a higher pH, lower calcium, magnesium, and bicarbonate than that of the background, and present a lower P_{CO_2} than the atmosphere ($\log P_{CO_2} < -3.50$). The calcocarbonic reactions take place within a closed system and CO_2 is being consumed without further replenishment.

1 INTRODUCTION

The urban solid waste landfill of La Mina was placed in 1975 to a distance of 2 km to the North of Marbella (Málaga, South of Spain) and it is over a karstic aquifer made up of dolomitic and calcareous marbles. Because it is unlined, leachates reach the underlying aquifer (Vadillo et al. 1998, Vadillo et al. 1999a, b). Between November 1995 and March 1998 the hydrochemical composition of water samples around the landfill has been analyzed on a monthly basis using a network of wells (numbers 1, 2 and 9), springs (numbers 7, 11, 12 and 14) and piezometers (numbers 3, 4, 5, 6 and 10). In this paper all the water samples from wells and springs, and those from piezometers showing higher Cl^- concentrations have been accounted. The hydrochemical code EQ3NR (Wolery 1992) has supplied the species concentration, the partial pressure of gases, the saturation indexes of minerals and the Eh of each redox couple.

2 RESULTS AND DISCUSSION

Figure 1a shows a scatter graph of the electrical conductivity (EC) versus chloride content. Two families of waters become apparent: (1) those belonging to the background (unpolluted) aquifer (points 3, 7, 11 y 14, within the circle), with EC and chloride content always below 600 $\mu S/cm$ and 1 mmol/l, respectively and; (2) those with EC above 600 $\mu S/cm$ and with a steady increase of chloride concentration along the sampled period (Vadillo et al. 1999b).

Water samples coming from contaminated wells close to the landfill (point 2) present pHs below 7.0 (Vadillo et al. 1999b), high calcium, magnesium, and bicarbonate contents, and a constant and high P_{CO_2} (Fig. 1b). The constant P_{CO_2} value provokes an “extra” dissolution of carbonated minerals from the rock matrix, releasing HCO_3^- , Ca^{2+} and Mg^{2+} (10 mmol/l of $Ca^{2+} + Mg^{2+}$). Addi-