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title: **Influence of runoff and ground water inflow in the stratification developed in the Concepción pit lake (Iberian Pyrite Belt, Spain)**

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INTRODUCTION

The Concepción mine, located in the northeast of Huelva province (Iberian Pyrite Belt, Spain), was exploited by underground mining and opencast since 1853. In 1874, the opencast exploitation went up to the 6th floor of the underground mine by means of five banks (Fig. 1). Water was extracted through a tunnel by gravity, which was connected with the 9th floor and had its exit close to river Odiel (Fig. 1). Ground water generated between the 9th to 12th floors was pumped toward this tunnel. The mine was abandoned in 1986. In the 1990´s, this tunnel was sealed and provoked underground mine flooding reaching the upper mining pit, which in 1993 was still not flooded. The pit was excavated in a stream bed, therefore chemistry and stratification of developed pit lake, is partially influenced by runoff contribution from a basin of 0.39 km^2, as well as inflow of water from underground mining. Nowadays, the dimensions of the pit lake are 280 × 60 m and 16 m of depth, with a volume of ~72,500 m^3. The lake level is regulated by an exit through an adit mine, which generate an acid mine drainage. Ground water chemistry can be studied through three mining shafts. The shaft-1 is inside of the pit lake, the shaft-2 in the pit slope and the shaft-3 is out of it, but both flooded too.

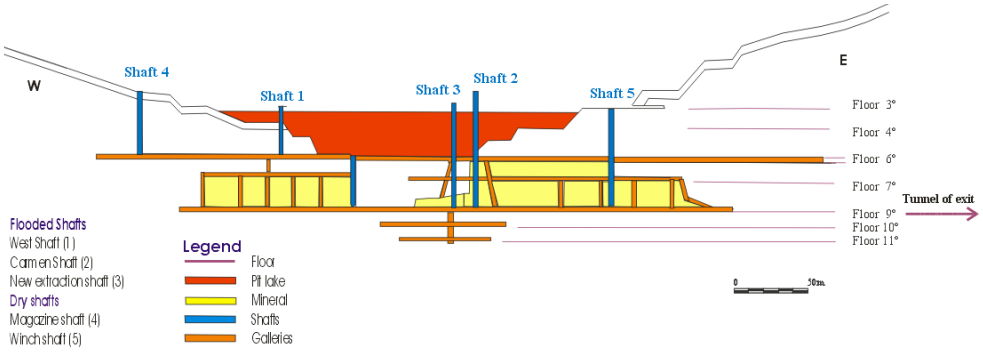

Figure 1. Sketch of underground mining and opencast in Concepción mine.

This study presents the processes that are involved in the stratification and chemistry of this pit lake, such as the inflow of metal-sulphate laden ground water from flooded shafts and galleries, the pit geometry and dilution process due to important runoff contribution.

RESULTS AND DISCUSSION

The pit lake is acidic, presenting high concentrations of sulfate and metals (Fe, Al, Zn, Mn and Cu). The vertical profiles of physico-chemical parameters and water chemistry obtained in Concepción pit lake have showed a permanent chemical stratification (Fig. 2), therefore was classified as meromictic during the hydrologic year 2008–2009, differentiating two layers with different density: 1) a thick superficial layer of ~10.5±1.5 m depth, pH 2.5–3, EC 1–2 mS/cm (oxygenated mixolimnion), this layer represents ~90% total volume of the lake, and 2) a thin bottom layer from ~10.5±1.5 m to 16 m depth (anoxic monimolimnion), which presents a chemical and thermal gradient with the depth, with pH from 2.5 to 4 and EC from 2 to 6 mS/cm. Between both layers is located a permanent chemocline.

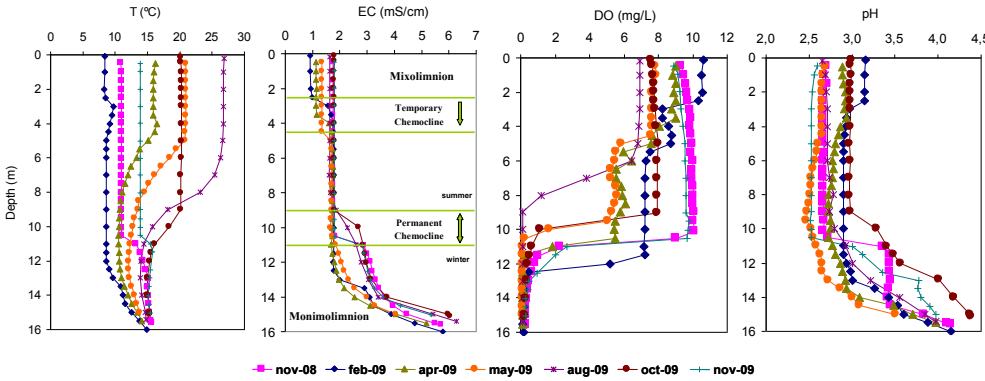

Figure 2. Depth profiles of temperature (T), electric conductivity (EC), dissolved O_2 (DO) and pH in the mining pit lake of Concepción.

In November 2008, a homogeneous mixolimnion was showed in the vertical profile (Fig. 2), but in February 2009 was recorded an upper thin layer (~3 m depth) less dense (EC <1 mS/cm), which was developed by runoff contribution during intense episodes of rain between January and February (rainfall ~220 mm), developing a temporary shallow chemocline (ectogenic meromixis). From February to May, EC and thickness was increased due to its mixing with lower layer. This shallow chemocline disappeared in August 2009, favoured in the last months by evapoconcentration. Moreover, the water lost by evaporation is partially compensated for the inflow of ground water, which induces the rise of permanent chemocline to 9 m of depth, while in winter it is situated to 12 m of depth. In this period, the level variations of lake have been lower to 1.1 m, therefore the chemocline really moves between winter and summer.

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