

## Geochemistry of the Zn-Pb-Cu-(Ag)-(Au) epithermal deposits from San José (SE Spain)

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The San José Zn-Pb-Cu-(Ag-Au) vein systems, previously described as low-sulfidation [1], are located in the Cabo de Gata Volcanic Field (SE Spain). These deposits comprise mainly base metal bearing sulfide/sulfosalts quartz veins, while disseminated pyrite with small quantities of gold appear in areas of vuggy silica alteration.

Wallrock alteration includes silicification, advanced argillic, argillic and propylitic zones. Very abundant, penetrative, stockwork-like Fe-Al sulfate veins are found in the argillic and advanced argillic alteration, but ore veins do not show a clear relationship with the alteration zone. Mass balance using the isocone method reveals a gradual leaching of most of the elements (except silica) in the highly altered volcanic rocks involving a generalized loss of mass and an increase in the content of some metallic elements (Zn, Pb, Cu) in the less altered zones.

Vein sulfides show a similar or slightly heavier sulfur signature ( $\delta^{34}\text{S}$ : 6-12‰) compared to the dominant volcanic signature of the zone ( $\delta^{34}\text{S}$ : 1-7‰ [1]), suggesting a magmatic source but with possible incorporation of sea water sulfate via inorganic reduction. Such magmatic input could also be related to the gold mineralization. The barite signature ( $\delta^{34}\text{S}$ : 19-21‰) also supports sea water involvement. Pyrite in silicification shows depleted sulfur ( $\delta^{34}\text{S}$ : 2-6‰) perhaps as product of the disproportionation of magmatic  $\text{SO}_2$  which produced the acid alteration. Abundant alunite-jarosite has light sulphur ( $\delta^{34}\text{S}$ : 4-10‰), but its abundance and occurrence rule out a simple supergene origin. Meanwhile, oxygen isotopes in quartz ( $\delta^{18}\text{O}$ : 8-18‰) indicate the likely involvement of magmatic and non-magmatic fluids in ore mineralization.

The field, mineralogical and geochemical data suggest a complex mineralization history in the San José area, with evidence of both low and high sulfidation hydrothermal systems and the involvement of magmatic and seawater fluids.

[1] Arribas *et al.* (1995) *Econ. Geol.* **90**, 795-822.

## Study of sediments and polluted waste piles in Mazarrón (SE Spain)

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This work studies the pollution level of sediments and waste pile samples from the mining area of Mazarrón (SE Spain). The total concentration of trace elements was screened in the field by a portable x-Ray Fluorescence (XRF) obtaining very high values for As, Pb and Zn, with maximum concentrations higher than 100 g kg<sup>-1</sup> of Zn, 34 g kg<sup>-1</sup> of Pb and around 2000 mg kg<sup>-1</sup> of As. A toxicity bioassay with lettuce (*Lactuca sativa L*) was used to assess the level of pollution. The assay was performed with extracts obtained from a soil:water mixture (ratio 1:5), and with serial dilutions (1:1, 1:2, 1:4, 1:8, 1:16, 1:32, 1:64 and 1:128) to obtain the EC50 (Effective Concentration that reduces the response of the organism by 50% compared to the control). The water-soluble concentrations were analyzed by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). The test consisted of germinating the lettuce seeds in the different solutions obtained, for a period of 120 hours at constant temperature. The parameters evaluated were: Seed Germination (SG), Root Elongation (RE), and Root Necrosis (RN) and the results were expressed as a percentage of reduction in relation to the control (distilled water).

The results indicated that most of the samples had a high degree of toxicity, with very high RN values even at dilutions of 1:16 and 1:32. The SG and RE also indicated a strong reduction in relation to the control in most of the samples. The EC50 values indicated that in many cases the As and heavy metals concentrations in the soil solutions were highly toxic. This study therefore shows that urgent remediation measures are required to minimize the environmental risk and avoid the dispersion of the pollution to adjacent areas.