

The As-contaminated Elqui river basin: a long lasting perspective (1975–1995) covering the initiation and development of Au–Cu–As mining in the high Andes of northern Chile

R. Oyarzun · S. Guevara · J. Oyarzún ·
J. Lillo · H. Maturana · P. Higuera

Received: 28 October 2005 / Accepted: 22 February 2006 / Published online: 4 June 2006
© Springer Science+Business Media B.V. 2006

Abstract The Elqui watershed (northern Chile) constitutes a highly contaminated river system, with arsenic exceeding by up to three orders of magnitude the average for river waters. There are three main reasons that explain this contamination: (1) the

regional geology and hydrothermal (mineralizing) processes that developed in this realm during Miocene time; (2) the later unroofing–erosion–oxidation–leaching of As–Cu rich sulfide ores, a process that have been taking place for at least 10,000 years; and last but not least (3) mining activities at the high-altitude (>4000 m above sea level) Au–Cu–As El Indio mine, from the late 1970s onwards. The El Indio mineral deposit hosted large veins of massive sulfides, including the important presence of enargite (Cu_3AsS_4). The continuous natural erosion of these veins and their host rocks (also rich in As and Cu) during Holocene time, led to important and wide-spread metal dispersion along the river system. During the studied pre mining period (1975–1977), the high altitude river Toro waters already showed very large As concentrations ($0.36\text{--}0.52\text{ mg l}^{-1}$). The initiation of full scale mining at El Indio (1980 onwards) led to an increase of these values, reaching a concentration of 1.51 mg l^{-1} As in 1995. During the same year other rivers of the watershed reached peak As concentrations of 0.33 (Turbio) and 0.11 mg l^{-1} (Elqui). These figures largely exceed the USEPA regulations for drinking water (0.01 mg l^{-1} As), and about 10% of the total As data from the river Elqui (and 70% from the river Turbio) are above the maximum level allowed by the Chilean law for irrigation water (0.1 mg l^{-1} As).

R. Oyarzun (✉)
Departamento de Cristalografía y Mineralogía, Facultad
de Ciencias Geológicas, Universidad Complutense,
28040, Madrid, Spain
e-mail: oyarzun@geo.ucm.es

S. Guevara
ccaQualitas (Calidad, Capacitación y Asesoría S.A.),
Nicolás Tirado 386, Antofagasta, Chile

J. Oyarzún
Departamento de Minas, Facultad de Ingeniería and
CEAZA, Universidad de La Serena, Casilla 554, La
Serena, Chile

J. Lillo
Escuela Superior de Ciencias Experimentales y
Tecnología, Universidad Rey Juan Carlos, Tulipán s/n,
28933, Móstoles Madrid, Spain

H. Maturana
Departamento de Minas, Facultad de Ingeniería,
Universidad de La Serena, Casilla 554, La Serena, Chile

P. Higuera
Departamento de Ingeniería Geológica y Minera, Escuela
Universitaria Politécnica de Almadén, Universidad de
Castilla-La Mancha, Plaza M. Meca 1, 13400, Almadén,
Spain

Keywords Arsenic · Contamination · Waters ·
Mining · Elqui watershed · Chile