

*Technical Communication*

## Heavy Metals in Stream Sediments from the Coquimbo Region (Chile): Effects of Sustained Mining and Natural Processes in a Semi-arid Andean Basin

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**Abstract.** Active sediments from the Elqui River in Chile were sampled 4 times at 10 sites during 2000. Concentrations of Ag, Ba, Cd, Co, Cr, Hg, Mn, Mo, Ni, Pb, Sr, Ti, V, Al, Ca, Fe, K, Mg, Na, P, and S were normal. Zinc levels were clearly high, and those of Cu (hundred to thousands ppm) and As (tens to hundreds ppm) were highly anomalous. Dissolved Cu (0.1–12.7 ppm) and Zn (0.1–2.2 ppm) levels were also very high. The anomalies of the upper tributaries are due to the El Indio–Tambo Au–Cu–As district and large hydrothermal alteration zones at altitudes between 3500–4500 m. Lower on the river, old and active tailing waste deposits and on-going mining operations in the Talcuna Cu (Pb) district are responsible. Partially eroded tailing deposits in the alluvial plain of the Elqui River and its tributaries, and especially in the El Indio–Tambo district, after mine closure in 2000, warrant special attention.

**Key words:** Arsenic; contamination; copper; Elqui, Chile; gold-copper mining; stream sediments; watershed; zinc

### Introduction

Drainage water and sediment geochemical studies began in Chile in the 1960s (c.f. de Grys 1961, 1962) and proliferated during the following decades. Most of these studies were carried out by mining companies for exploration purposes, though some are available and can provide useful baseline information for environmental studies. In contrast, a great deal of geochemical research has been performed in Poland and published at different scales for environmental assessment and land use purposes (e.g. Lis and Pasieczna 1995, 1999a, 1999b). This communication describes the results of a joint research program in the Elqui River basin, Coquimbo, Chile, which was carried out by the University of La Serena, Chile, the Geological Institute of Poland, and the Academy of Mining and Metallurgy of Cracow (Poland). The main purpose of this research was to assess the level of heavy metal pollution in active drainage sediments of the Elqui River and its tributaries, an area that was mined for Cu, Ag, Au, and Hg during the 19<sup>th</sup> and 20<sup>th</sup> centuries. This information is relevant to the

various users of these water resources (agriculture, municipalities, etc.) and may constitute a useful baseline for future studies. The latter is important because the Puclaro irrigation dam, in the middle course of the Elqui River, with a capacity of 200 Mm<sup>3</sup>, was inaugurated in 1999, and the El Tambo (Au) and El Indio (Au–Cu–As) mines, in the NE part of the Elqui watershed, began their closure-plan activities in 1999–2000. Both actions have the potential to induce significant changes in the geochemistry of the Elqui River.

### The Elqui Watershed

The Elqui watershed encompasses an area of 9,794 km<sup>2</sup> and is located in the so-called Transversal Valleys segment (28–33° S) of the Chilean territory, which lacks the presence of a central N–S tectonic basin. The Elqui River flows westward from the Andes Mountains to the Pacific Ocean, while its main tributaries, the Claro and Turbio Rivers, channel water coming from the north, south, and east. The Chilean territory in this realm is narrow and the high peaks of the Chilean–Argentinean border, attaining over 5000 m, are only some 130 km from the coast. Consequently, the Claro and Turbio Rivers present steep longitudinal profiles and very narrow alluvial plains. In contrast, the Elqui River plain and terraces are about 3 km wide near the town of Vicuña, and 5 to 6 km wide for the last 25 km of the river course.

Precipitation (including snowfall) in the Elqui watershed is about 100 mm/year. However, in years affected by El Niño oceanic temperature disturbances, precipitation may increase by a factor of 2 or 3 (INE 1998). Precipitation is greater in the high Andes, with a mean of 180 mm over a period of 20 years, and a maximum of 740 mm in 1987, an El Niño year (H. Zavala, pers. comm.). Except for the Andean sector, where some rain may occur during summer, rain or snowfall in the Elqui basin is restricted to the April – September period (autumn–winter). During the year 2000, the main precipitation events occurred in May (6%), June (56%), July (7%) and September (30%), totaling 103 mm at the La Florida meteorological station (La Serena).