CHROMIUM CONTAMINATION OF WATER DUE TO NI MINES, NEW-CALEDONIA

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Keywords: Ni mines, mining sediments, chromium, surface water, ophiolotic substrate

Introduction

Opencast mines in New Caledonia are characterized by ultramafic rocks with lithologies rich in nickel (Ni), and other metallic elements such as chromium (Cr). Cr occurs in chromite as its trivalent form Cr(III) but its oxidation to the hexavalent form Cr(VI) is likely under oxic conditions (Fander et al., 2009). In mining sediments the predominant mineral is goethite which is known to adsorb reversibly Cr(VI) (Deng et al., 1996). Opencast mines are then a potential source of Cr for aqueous media by Cr(VI) or Cr(III) desorption or by dissolution of Cr(III) precipitates formed at the interface. Cr is hightly toxic in its Cr(VI) form. Analyses of water show a significant increase of [Cr] for rivers downstream Ni mines. The aim of the present study is to determine if mining sediments are a significant reservoir of available Cr(VI) for surface waters since the baring of ultramafic soil by the mining activity leads the mobilization of sediments to surface waters as suspended particles (Figure 1-a) and to understand high Cr concentrations in surface waters.

Methods

Chromium content (dissolved and total concentrations) in rivers of the Koniambo massif (North of New Caledonia) was analyzed over 14 years (1995-2009). These data were provided by KNS SAS mining company (Koniambo mine) from pre-mining survey of the massif catchments. Data gathered Cr contents in rivers not affected by KNS SAS activity (before 2010) and affected by a past mining activity in a catchment of the Koniambo massif at the 19th century. Additionally, water samples were collected in 2011 downstream an old mine still in use (Est of New Caledonia - Poro mine), after various rainfall rates for dissolved Cr content analysis (Cr(III) and Cr(VI)). Batch leaching experiments have been performed on mining sediments collected in settling tanks in order to determine their anionic exchangeable Cr content.

Results

Based on the data from the pre-mining survey of the Koniambo massif, the $[Cr]_{total}$ median values for ultramafic and non-anthropic catchments range from 11 to 24 µg/L and the $[Cr]_{dissolved}$ median values range from 9.5 to 16 µg/L. Data from the catchment impacted by a past mining activity revealed much

higher medians values: $[Cr]_{total}$ median value is 660 µg/L and $[Cr]_{dissolved}$ median value is 108µg/L (Table 1).

Table 1. Median values for Cr content in Koniambo's catchments from pre-mining survey (1995-2009)

	Rivers names	$[Cr]_{total}$ in µg/L	$[Cr]_{dissolved}$ in µg/L
No mining activity before 2010	Coco	15 (n=61)	10 (n=56)
	Confiance	11 (n=21)	9.5 (n=14)
	Népia	15 (n=15)	10 (n=12)
	Pandanus	24 (n=77)	16 (n=91)
Past mining activity	Foachamboué	660 (n=39)	108 (n=36)

Moreover, water samples collected in the old mine, Poro-mine, revealed huge concentrations of total dissolved Cr up to 0.73 mg/L. Moreover, Cr(VI) content in the village waters increased with the rainfall rate till 0.34 mg/L (Figure 1-b). Batch leaching experiments of sediments collected in settling tanks in the mine revealed that Cr is released from sediments solely as Cr(VI). Desorption of chromate complexes is the main process involved in Cr release.

Figure 1: Opencast mines induce particulate matter runoff downstream (a) and dissolved Cr(VI) content increase (b)

Conclusion

Data pre-survey statistical analysis allowed defining the geochemical background of Cr content in rivers in a non-anthropic ultramafic context. We demonstrate that downstream Ni mining total and dissolved Cr increase. Laboratory leaching test demonstrate that Cr is released from mining sediments only as Cr(VI) and that desorption of chromate complexes is the main process involved in Cr remobilization in surface waters. We conclude that drainage of sediments mobilized by opencast Ni mines after rainfalls is a source of toxic Cr(VI) for surface waters.

References

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