Impact of Mining on Platinum Group Elements in Stream Sediments: Example of the Hex River (Bushveld Complex, South Africa)

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Introduction: The Bushveld Complex (BC), in South Africa, is the World´s largest resource of Platinum Group Elements (PGE); almost 80% of platinum is mined in this area. Assessing Pt emission from mining activities and subsequent environmental and health impact and risk has a relevant importance [1, 2]. This work reports the concentration of PGE in sediments of the Hex River to evaluate the anthropogenic disturbance of surface PGE biogeochemical cycle.

Methods: Water and sediments were collected at four stations (A-D) along the Hex River, which flows near Rustenburg city and crosses the mining area. Major and trace elements (Mn, Fe, Ca, Al, Mg, V, Cr, Zn, Cu, As, Co, Ni, Cd and Pb) were analysed in sediments by Flame AAS and ICP-OES.
PGE concentration (Pt, Pd, Rh, Ir) in sediments were measured by ICP-MS. Prior to analysis, samples were ashed (450ºC) to remove organic matter, *aqua-reggia* digested, and passed through a cation exchange resin (50W-DOWEX-X8) to remove isobaric interferences [3].
CRM were used to check the methods: LGC-6137 (Estuarine Sediment) and PACS-2 (Marine Sediment) for trace elements; Jsd-2 (River Sediment) and BCR-723 (Road Dust) for PGE. CRM recovery was >95% for major and trace metals, close to 100% for PGE in road dust and >75% in PGE in sediments.

Results: All values obtained are in the range and consistent with other previous environmental [1, 2] and petrologycal [4] geochemistry studies (Figure 1).

Discussion: The highest PGE concentrations in the clay and mud fractions responds to the grain-size partitioning of platinum group minerals (PGM) in the BC. Also, the lack of diagenetic processes in this area impedes the growth of PGM [1, 2, 5]. Besides, mining emissions with elevated PGE concentrations are mainly in fine particles, increasing the Pt accumulation and remarks an efficient atmospheric transport [1]. Dispersion of PGE values in different sediment replicates suggests a "nugget effect".
Highest PGE concentrations were obtained for the station closet to the mining area (station B). [Pt] in B (34ppb) is similar to sediments near to PGE-rich layers (less than 1km) [2], even though the distance to the outcrop is larger. These results reinforce the idea of mining as PGE source; although other studies in mining areas show higher [Pt] in soils (60 times background levels; [1]) than this study (20-fold), which may be indicative of edaphic concentration processes.
PGM in BC appear associated with chromite [4]. Figure 1 shows a close relation between PGE and Cr in several studies.

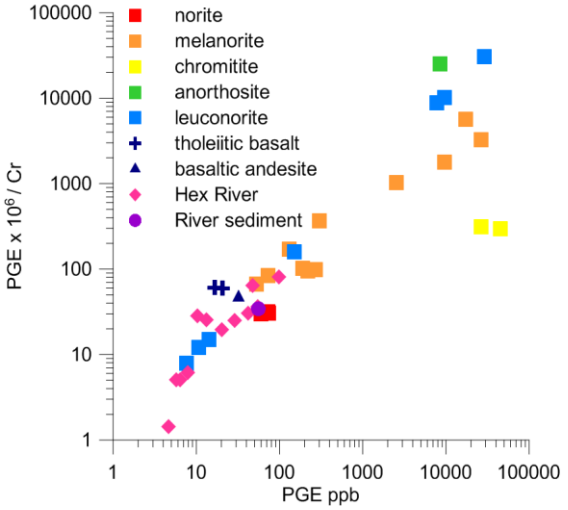

Fig. 1: PGE/Cr vs PGE ratios in Hex River (this study), river sediment [2] and Impala Mine core [4].

The pool of data shows that the BC rocks are a primary source of PGE in sediments, but atmospheric deposition of PGE-rich particles arising from the nearby mines may be playing a significant role increasing the overall concentrations in the Hex river sediments. Further studies should evaluate the impact of these elevated PGE concentrations on population (e.g. exposure from agricultural activities).

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