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Study on eco-geochemical environmental characteristics and heavy metal pollution assessment in high incidence area of nasopharyngeal carcinoma in Sihui, Guangdong (China)



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Nasopharyngeal Carcinoma (NPC) is one of the most common malignant tumours in China, especially in South China. The incidence and mortality in Sihui of Guangdong province are highest, but its etiology remains unknown. It has been studied by investigators from different fields. However, the potential role of environmental geochemistry in the high incidence of NPC is has not been studied. This study analysed concentrations of inorganic elements of rock, surface soil, soil profile, drinking water, and crops in both the higher incidence lower incidence areas in Sihui region. This paper also evaluates pollution and potential health risks of heavy metals in different environmental media. Through studying distribution characteristics of inorganic elements in the soil profiles and geochemistry character of inorganic elements, the study analyses the sources of inorganic elements with several methods including enrichment factor, multivariate statistics and geostatistics. This study attempts to find out the sources, the existing forms, release, migration, and transformation of elements in different environmental media. This study also analyses the geochemical characteristics of ecological environment in the high and low incidence areas, and relates the role of environmental geochemistry to the high incidence of NPC. Our main conclusions are: (1) Compared to elemental abundance of the continental crust, the contents of Cu and Se are very low in the Sihui granite in the NPC high incidence area. The Cu and Se contents of rock, soil and crops in the high incidence area are all remarkably lower than in the low incidence area ($P < 0.01$). However, the contents of radioelements U and Th in rocks have notable enrichment compared to their abundance in the continental crust, especially U in the Sihui granite of high incidence area the content is eight times higher than its content in the continental crust. The U and Th content of rock and soil in the high incidence area is remarkably higher than in the low incidence area (U: $P < 0.01$; Th: $P < 0.05$). (2) Assessment of heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, and Zn) pollution in the soils of the high and low incidence of NPC region shows that the soils are of good quality in general. However, some sampling points are worth detailed investigation. (3) The level of pollution of heavy metals in crops is middle in the mass, and the main elements exceeding food hygienic standard are Pb, Ni, Cd and As. The drinking water has the feature of high contents NO_3^- and NH_4^+ in high incidence area, and it is higher in high incidence area than in the low incidence area ($P < 0.05$). The carcinogenic risks of heavy metals caused by the edible crops and drinking water are lower and the non-carcinogenic health risks are much higher. (4) Different kinds of heavy metals show great range in availability-Cd and Mn have the maximal availability, and the availability coefficients reach to 0.54, 0.50 respectively. The order of all heavy metals availability is: $\text{Cd} > \text{Mn} > \text{Pb} > \text{Ni} > \text{Zn} > \text{Cr} > \text{Mo} > \text{Cu} > \text{Hg} > \text{As}$. (5) The levels of radioelements U, Th, trace elements Se, Cu, and N-nitroso compounds in the high incidence and low incidence areas of NPC are probably the main factors that lead to high incidence that is endemic in the Sihui region.

