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学位論文題名

Distribution of Naturally Occurring Radionuclides and Rare Earth Elements in Monazite Soils of a Natural High Background Radiation Area in India

インドの高自然放射線地域におけるモナザイトに含まれる天然放射性核種と希土類元素の分布に関する研究

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The main objective of this study is to understand the distribution pattern of absorbed dose in a high background radiation area, Odisha coast, India and to explore the radiological and geochemical processes on natural radionuclides, e.g. uranium (U), thorium (Th), potassium (K) and rare earth elements (REEs) in the environment. The study area is one of the well-known placer deposits that is rich in monazite and ilmenite. It covers nine coastal villages of Chhatrapur-Gopalpur region, Odisha. There are very few investigations in this region to correlate with the source and nature of minerals causing enhanced levels of natural radiation.

A car-borne (vehicle-mounted NaI(Tl) gamma spectrometer) survey was undertaken to measure absorbed dose in study area. Measurement of activity concentration of naturally occurring radionuclides in sand and soil were carried out using a high purity germanium (HPGe) gamma spectroscopy. Radiological hazard parameters including radium equivalent (Ra_{eq}), Absorbed dose rate (D), annual effective dose equivalent (AEDE), and external and internal hazard index (H_{ex} and H_{in}) were estimated by considering activity concentration of ^{226}Ra , ^{232}Th and ^{40}K in sand and soil.

Geochemical investigation of sand and soil were carried out to understand the mineralogical composition, weathering, geochemical facies, sources of monazite and other heavy minerals of the placer deposits. The concentration of U and Th were measured using inductively coupled plasma mass spectrometer (ICP-MS) and major elements (TiO_2 , Fe_2O_3 and P_2O_5) were measured using X-ray fluorescence spectrometer (XRF). The sand and soils are undergoing moderate to intense weathering in humid and oxidized arid environment. U is highly

mobile and leaching from the samples in oxidizing environment whereas Th is highly stable and resistant in sand and soil. Therefore, Th may contribute to major radiation in the environment.

REEs in samples were measured using inductively coupled plasma mass spectrometry (ICP-MS) to understand the origin of the monazite in the beach placer deposits. The chondrite normalized REE pattern of sand and sandy soil uniformly enriched in LREE (La, Ce, Nd) with prominent negative Eu anomaly, which clearly suggest the presence of monazite and felsic origin. REE pattern of sand and soil with different rock types of Eastern Ghats Mobile Belt (EGMB) indicates that granite, charnockite and migmatites are the major contributor of monazite to the Chhatrapur - Gopalpur beach placer deposit.

The concentration of U is relatively high due to dominant source of monazites in sand and soil samples., Therefore, $^{234}\text{U}/^{238}\text{U}$ were measured using a multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) to understand the secular equilibrium of $^{234}\text{U}/^{238}\text{U}$ ratio in a natural high background area first time in Indian samples. U isotope data in sand and soil of the Chhatrapur-Gopalpur beach placer will be beneficial for environmental monitoring studies as well as to understand the uranium disequilibrium in environment and geological process in beach placer deposit.

This research study serves as radiological and geochemical aspects of a natural high background radiation area, India and it is useful primarily for environmental radioactivity monitoring and radiological risk assessment.