

A combined terrestrial and marine geochemical mapping in Central Japan

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Spatial distribution patterns of elemental concentrations on land, geochemical maps, are effective for environmental assessment. The Geological Survey of Japan, AIST conducted a nationwide geochemical mapping program at 1:2,000,000 scale using fine stream sediments for this purpose (Imai et al., 2004). Because Japan is surrounded by a vast expanse of sea, examination of geochemical baseline in coastal-open sea is also essential for environmental assessment. Consequently, we have undertaken a new geochemical mapping project in the coastal seas. Approximately 4000 coastal sea sediments were corrected and analyzed for 51 elements including heavy metals (e.g. Cu, Zn, Cd, Hg, and Pb). In this study, the regional geochemical maps in coastal seas (Ise-Tokai region) along with the existing maps in land (Kinki-Tokai region) were used to define the natural geochemical background variation, mass transport, and contamination processes.

Spatial distribution patterns of elemental concentrations in stream sediments are determined mainly by surface geology. Elevated elemental concentrations of alkali elements, Be, Ga, Y, Cs, Ba, lanthanides, Tl, Th and U are consistent with outcrop areas of granite, felsic volcanic rocks, and accretionary complexes. High concentrations of MgO, Al₂O₃, P₂O₅, CaO, 3d transition metals, Zn and Sr are present in sediments supplied from mafic volcanic rocks, high pressure metamorphic rocks, and mafic-ultramafic rocks in accretionary complexes. Correspondence of elemental abundances in stream sediments to surface geology is revealed by statistical tests (analysis of variance (ANOVA) and multiple comparison tests). Significant enrichment of Cu, Zn, Cd, Sn, Sb, Hg and Pb observed in urban areas are supported by multiple comparison procedure. We inferred that these sediment samples had been contaminated.

The elemental concentrations of marine sediments are determined primarily by grain size. Most elemental concentrations increase with decreasing grain size and eventually become constant. The mean chemical compositions of coastal sea sediments are similar to those of stream sediments in adjacent terrestrial areas. This observation supports the fact that coastal sea sediments have certainly originated from terrestrial materials. However, the spatial distributions of elemental concentrations are not always continuous between the land and coastal seas. A detailed examination of spatial distribution patterns of K (K₂O) and Cr concentrations suggests that terrestrial materials supplied through rivers are deposited near the shore initially (~20 km), and then gravity-driven processes shift the sediments deeper into the basin. Contamination with heavy metals such as Zn, Cd, and Pb was observed in coastal bays surrounded by urban and industrial areas, from which the stream sediments are extremely abundant in those elements. It is noteworthy that the areas with the highest concentration of these elements usually occur not near the shore (not near the contamination source) but at the center of the bay. Unexpected low concentrations of heavy metals near shore may either be due to a decreased anthropogenic load in the most recent sediments or to dilution by unpolluted flood sediments.

References

Imai, N. et al. (2004) Geochemical map of Japan. GSJ, AIST.