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Geochemistry of shales of the Upper Cretaceous Hayang Group, SE Korea: implications for provenance and source weathering at an active continental margin

Y. I. Lee

School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea
(lee2602@plaza.snu.ac.kr/+82-2-871-3269)

Shales of the Upper Cretaceous Hayang Group in the Yeongyang Subbasin, southeastern Korea were deposited in fluvio-lacustrine environments as the Paleo-Pacific (Izanagi) Plate obliquely subducted beneath the Asian continent. Major and trace element compositions derived from shales analyzed from the Hayang Group reveal geochemical signatures that are different from Post-Archean average Australian Shale (PAAS), but are typical of igneous rocks found in the continental-margin island arc settings. For example, most major element concentrations are depleted relative to PAAS; among them MgO and MnO depletions are most pronounced in all shales. CaO enrichment is notable in some formations due to the presence of secondary calcite as dispersed micro-calcite nodules. Sc, Y, and Th concentrations are also slightly depleted relative to PAAS while chondrite-normalized REE data for shales from the Hayang Group show moderate to large uniform LREE enrichment but variable HREE depletions. In addition, they are more fractionated than PAAS, and have significant negative Eu anomalies. Moreover, the chemical index of alteration and A-CN-K relations comply that the source area was dominated by non-steady state weathering regimes indicative of active uplift along an active continental margin. These regions were punctuated by two periods of steady-state weathering or alternatively by enhanced recycling of sediments. The latter interpretation is in accord with the timing of exposure of a cherty sequence in the source area. Mixing calculations based on REE data suggest that the average shale in the Hayang Group was derived from sources composed of Precambrian granitic gneiss, arc basaltic rocks, Triassic Yeongdeok Granite in the subbasin, and the Mino accretionary complex of SW Japan with ratios around 43.7 (31.8-73.2):26.4 (15.8-36.7) :15.4 (2.8-33.9):14.5 (0.0-33.8). However, these proportions change up sequence.