

Tracing volcanic activities from the geochemistry of pumices in Upper Holocene deposits of Taiwan

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As the analogue of volcanic ash in tephrochronology, pumice-bearing sandy deposits have the potential to be the archives of Holocene volcanic activity. Pumices were widely embedded in the Upper Holocene (<2000 yrs.) backshore colluvium of the Taiwan area. In this study, their bulk compositions of major and specifically trace elements are determined in order to trace their provenances, and thus to provide constraints on the violent eruptive events of intermediate-acid volcanoes around the western Pacific.

The 65 pumice pebbles studied can be reliably classified into three groups based on their internal color, namely the types of black (B), white (W) and others with gray or brown color (O). In major-element geochemistry, B-pumices can be discriminated from W-pumices by (1) their intermediate silicate contents (56.2~60.6 wt.% SiO₂; W: 65.2~75.5 wt.% or acid), (2) higher K₂O (>4.0 wt.% and alkaline; W: <2.0 wt.% and low-K to medium-K calc-alkaline), (3) higher Al₂O₃ (>16 wt.%; W: <16 wt.%), and (4) higher P₂O₅ (>0.3 wt.%; W: <0.3 wt.%). The O-pumices lie mainly between the other two types in the Harker diagrams.

For trace elements, all pumice samples have geochemical signatures of arc-related magmatism, including enrichments in large ion lithophile elements (LILE) and light rare earth elements (LREE), and depletions in Ti, Nb and Ta (TNT). Their incompatible-element distribution patterns are categorized into two types. Type I is found only in the B- and O-pumices, and the samples showing type II patterns include all W-pumices, few B- and some O-pumices studied. Type I displays higher abundances than Type II in most incompatible elements, including LILE (but not Cs), Th, U, Pb, TNT and LREE (e.g., Type I: Th_N>100; Type II: Th_N<100). At least two and six sub-types of Type I and Type II, respectively, are recognized, depending on the significant variations in the contents of incompatible elements, e.g., Ba, Th, Nb, Sr and P. These eight patterns are proposed to correspond to eight eruptive events of active volcanoes, including the 1986 eruption of the Fukutoku-Oka-no-Ba submarine volcano (Type IA) and the 1924 eruption of the Submarine Volcano NNE of Iriomotejima (Type IIA).