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Magnetic properties of tephra in Lake Biwa sediments

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We conducted a series of magnetic and chemical analysis of 27 tephra to examine methodology for identification and to understand the relation between volcanism and magnetic properties. We examined volcanic ashes in a drilling core from Lake Biwa sediments: K-Ah, U-Oki, Sakate. DHg, DSs, AT, SI, DNP, DAP2, Aso-4, K-Tz, Aso-ABCD, Ata, BT29, BT34, BT37, Aso-3B, Aso-2, BT44, BT45, BT48, Ata-Th, BT59, Aso-1, Tky-Ng1, BT67, and Ss-Pk. The followings are results from magnetic measurements of bulk samples and analysis of magnetic minerals using EDS (Electron Dispersive System) electron microprobe.

(1) Titanomagnetite (x=0.1-0.6) exists in all samples and titanohematite (y=0.5-0.9) exsits in some samples. There are also hematite and maghemitized magnetite in some samples. These are not materials of tephra origin but represent contaminants from clay beds of Lake Biwa sediments.

(2) We found contrasting magnetic grain-size distribution between the tephra from Kyushu and San-in region based on King plot and Day plot. Moreover, we noted that data from Kyushu region are plotted on PSD (pseudo-single domain) field and data from San-in region are on MD (multi domain) field. Magnetic grains can reflect the distance from source to the place of deposition.

(3) We classified the tephra based on magnetic minerals species utilizing the behavior of Js-T curves (high-temperature), ZFC and FC curves (low-temperature). We finally divided the tephra into six groups: KA & AT (Kikai caldera and Aira caldera), ATA (Ata caldera), ASO (Aso caldera), DAISEN-A (Daisen volcano), DAISEN-B (Daisen volcano), and SAMBE (Sambe volcano). Thus magnetic mineralogy is useful in identifying source volcano of each tephra. We also applied this classification to so far unclassified BT samples and concluded that BT34 and BT59 were from Aso caldera and BT37, BT44, BT45, BT48, and BT67 were from Daisen volcano. Magmatic temperatures at the time of eruptions were estimated with geothermometer based on coexistence of two Fe-Ti oxide series (Ghiorso and Sack, 1991). Approximate magmatic temperatures are estimated to be 750-850 ^{o}C (Kikai caldera and Aira caldera), 800-950 ^{o}C (Ata caldera), 850-1000 ^{o}C (Shishimuta caldera), 700-950 ^{o}C (Daisen volcano), and 800 ^{o}C (Sambe volcano), respectively.

We suggest that precise tephra identification can be possible if we measure magnetic properties such as Js-T curve, ZFC and FC curve, and Curie temperature. Curie temperature higher than 580 ^{o}C can not be used for identification, because of the following two reasons: high Curie temperature can be a result from hematite and maghematized magnetite contaminated from clay beds of Lake Biwa sediments and hematite can be also formed through high-temperature oxidation during experiments.