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Simultaneous determinations of 58 elements in volcanic glass shards using the femtosecond laser ablation ICP-MS

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Volcanic glass shards in the Quaternary widespread tephras have been chemically classified and identified on the basis of the contents of the major components (e.g. Al_2O_3, CaO, and MgO) determined using the electron beam microanalysis techniques. The abundances of the trace elements have been also measured using various analytical techniques including INAA, ICP-AES, and laser ablation ICP-mass spectrometry (LA-ICP-MS) techniques. However, the measurements of the trace elements have been generally restricted to the rare earth elements and some elements such as strontium, thorium and uranium. In this study, we carried out the quantitative analyses of the total of 58 elements from lithium to uranium simultaneously using the femtosecond LA-ICP-MS technique. Four volcanic glass samples on the International focus group on Tephrochronology And Volcanism (INTAV) sample mount described by Kuehn et al. (2011) were analyzed for comparison between the analytical values of the major components using the LA-ICP-MS technique and those obtained by the electron beam microanalysis techniques. The analytical values of the major oxide components of the INTAV volcanic glass samples deviate less than 10% from the preferred values shown in Kuehn et al. (2011). The analytical results suggests that the LA-ICP-MS technique can be reasonably available for quantitative analyses of the major elements in volcanic glass shards in addition to the trace elements, as an alternative of electron beam microanalysis techniques. We analyzed 22 tephra samples from Japan and surrounding region (e.g. Aira Tn tehphra and Aso-4 tephra) and 4 tuff samples of North America (e.g. Lava Creek Tuff and Bishop Tuff), and confirmed that the volcanic glass shards can be clearly distinguished from each other by the patterns of the wide-ranged element abundances. The abundances and the patterns of the wide-ranged elements of the volcanic glass shards are definitely helpful to more precise identification and correlation of tephra samples.

Keywords: volcanic glass, tephra, LA-ICP-MS, element abundance, element pattern, femtosecond laser