Origin of a voluminous iron-enriched high-K rhyolite magma erupted in the North Japan Alps at 1.75 Ma: Evidence for upper crustal melting

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The 1.75 Ma Chayano–Ebisutoge Pyroclastic Deposits (PD) is a large (300 km$^3$ volume) eruptive unit consisting of ignimbrite, coignimbrite ash fall and pumice fall located in the central portion of the North Japanese Alps. The Chayano–Ebisutoge PD covered all central Japan, including the Osaka, Kyoto, Nagoya, Tokyo, and Niigata areas, distributed over a radius of >300 km. The tephra was erupted after a dacitic ignimbrite Nyukawa Pyroclastic Flow Deposit (PFD) at 1.76 Ma, and is regarded as the effusive phase of the Takidani Granodiorite, which is now exposed at the surface due to extremely rapid uplift in the area. The Chayano–Ebisutoge rhyolitic tephras have high K2O characteristics, and feature iron enrichment relative to magnesium, combined with low oxygen fugacity. The major element composition of the Chayano–Ebisutoge PD is similar to silicate melts produced experimentally from pelitic gneiss and granites at upper crustal pressures, suggesting a crustal melt origin. Neodymium and Sr isotopic compositions of the Chayano–Ebisutoge PD match those of the basement granitoids and gneiss. Assimilation-fractional crystallization of contemporaneous Ueno Basalts magma in the same area cannot account for the compositions of the Chayano–Ebisutoge PD. However, mixing between Chayano–Ebisutoge rhyolite magma and evolved Ueno basalt can generate the dacitic magma responsible for the Nyukawa Pyroclastic PFD and the Takidani Granodiorite, judging from major, trace, and isotope compositions. All the geochemical evidence above strongly supports a crustal melt origin for the Chayano–Ebisutoge PD. Accumulation of a voluminous basalt magma caused extensive melting of the crust, thus producing the huge volume of the Chayano–Ebisutoge PD.


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