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Chemical zonation of the rhyolitic Toya caldera magma body (Southwest Hokkaido, Japan)

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Toya caldera, southwest Hokkaido is one of the largest calderas of the late Pleistocene (0.13±0.03 Ma; [1]) in north Japan. The volume of the Toya pyroclastic deposit is estimated to be more than 150 km^3. The pyroclastic deposits are divided into several sheets of pyroclastic flow and fall, Tpfl-I (Toya pyroclastic flow I), Tpfl-II, Tpfa (Toya pyroclastic fall), Tpfl-III and Tpfl-IV in ascending order [2]. The earlier pyroclastic flow and fall deposits consist predominantly of ash associated with accretionary lapilli, suggesting they are the products of phreatomagmatic explosions. After a short hiatus, the later stage pyroclastic flow, Tpfl-IV, composed of large pumice lumps and ash, was discharged during the climax event and forms an extensive pyroclastic plateau around the Toya caldera. Highly evolved and crystalpoor rhyolitic magma, representing the upper to middle levels of the reservoir, was erupted during the first Plinian stages producing pyroclastic flow and fall deposits (Tpfl-I, -II, Tpfa, and Tpfl-III). Crystal-rich, more mafic rhyolitic magma was tapped from the lowermost parts of the reservoir during the last stage of pyroclastic flow eruption (uppermost Tpfl-IV). The most common phenocryst, plagioclase, ranges from 10-15 vol.% in pre-Tpfl-IV deposits to up to 50 vol.% in the uppermost Tpfl-IV. Glass shards are both spherical (bubble-walled) and elongate (pumiceous) in pre-Tpfl-IV but become more pumiceous in the uppermost Tpfl-IV. SiO_2 content in whole rocks ranges from 76.9 wt% in pre-Tpfl-IV deposits to 70.6 wt% in the uppermost Tpfl-IV. Al_2O_3 indicates a reverse trend from 13.0 wt% in pre-Tpfl-IVdeposits to 19.3 wt % in the uppermost Tpfl-IV. There is a steep gradient in trace element content within the Tpfl-IV deposit. The upper part of plagioclase-rich Tpfl-IV deposit is strongly enriched in Sr, Zr and depleted in Rb, Ba and Y. The chemical zonation of the Toya pyroclastic deposit is interpreted as the result of an eruption from a zoned magma body. Crystal-liquid fractionation processes may have contributed to the highly differentiated upper levels of the reservoir.

Keywords: zoned magma body1; rhyolitic magma2; Toya caldera3;

References

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