



## Quantifying the morphometry and drainage patterns of composite volcanoes: A comparison of the Japanese and Indonesian volcanic arcs

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The long-term (ka to ma) degradation of a volcanic edifice is controlled by both regional (e.g., climate, tectonics) and local factors (e.g., original morphology, lithology), resulting in both long-lasting weathering and river incision and short-term hazardous events, such as flank collapses and lahars. Trends among the morphometry of stratovolcanoes, their drainage network, denudation, and regional factors were recently characterised for composite volcanoes along the Indonesian arc. Denudation was shown to be negatively correlated with drainage density; the across-arc variations expose a tectonic control on the level of denudation and volcanoes' irregularity. This study applies the same method on age-constrained volcanoes in Japan to find coherent trends between arcs despite the different local and regional factors. We aim to better understand the factors that control erosion rates and patterns, and the evolutionary phases of volcano degradation.

We first compile a dataset of 35 singular, non-complex composite volcanoes with known eruption ages and spatially spread throughout the Japanese Island arc system. Using 30m TanDEM-X Digital Elevation Models, morphologies, and drainage metrics (e.g., volume, height, slopes, irregularity index, Hack's Law exponent, and drainage density) are extracted for each volcano, using the MORVOLC algorithm adapted in MATLAB as well as the newly developed DrainageVolc algorithm. Correlations between the morphometric parameters and potential controlling factors (e.g., age, climate, lithology, and tectonics) are analysed to determine quantitative relationships of edifice degradation throughout the arc. Finally, we compare relationships and correlation values of the Japanese Arc system to those from the Indonesian Arc.

The analysis shows that volcano age is positively correlated with irregularity and negatively correlated with height and volume. From the drainage parameters, we find that basins become wider and merge, resulting in lower drainage densities. The variation in erosion rates along the Japanese arc provides evidence for the degree of climatic control on the volcano degradation. The between-arc comparison shows which trends are susceptible to arc-scale variations and highlights

consistent trends that have the potential to be extrapolated to other volcanic arcs and be used as a relative age determination tool for composite volcanoes.