

The effect of glacial load on magma evolution, contamination and mixing at the Pleiades Volcanic Field, Antarctica

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In the Pleiades Volcanic Field (PVF), northern Victoria Land, Antarctica, volcanic activity has occurred from 1 Ma to recent times, with distinct eruptive episodes mostly clustering at ~900, ~630, ~340-310, and 50-25 ka. The analyzed samples record two differentiation trends: a strongly alkaline scattered trend, from tephrite to tephriphonolite with rare phonolites, and a complete mildly Na-alkaline differentiation trend from alkali basalt to trachyte, which is quite unusual for monogenetic volcanic fields.

Mafic samples exhibit multi-elemental patterns typical of OIB magmas, with low to moderately $^{87}\text{Sr}/^{86}\text{Sr}$ (0.7032-0.7037) and high $^{143}\text{Nd}/^{144}\text{Nd}$ ratios, indicating a clear within-plate affinity and a subcontinental lithospheric source. As differentiation progresses, two main trends emerge: in the strongly alkaline trend, $^{87}\text{Sr}/^{86}\text{Sr}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ ratios remain nearly constant, whereas $^{87}\text{Sr}/^{86}\text{Sr}$ increases up to 0.7052 and at the same time $^{143}\text{Nd}/^{144}\text{Nd}$ decreases to 0.51277 in the mild alkaline samples. This suggests the occurrence of two distinct evolutionary pathways: the first dominated by simple fractional crystallization with minimal crustal assimilation, and the second one – characterizing the majority of studied samples – experiencing significant crustal assimilation during fractional crystallization.

The Pleiades volcanic field comprises more than 20 scoria cones, similar to the numerous small monogenetic centers of the Northern Local Suite in northern Victoria Land. However, it is located further inland compared to most of the other volcanic complexes in NVL. The total volume of the most evolved erupted products is estimated at ~7 km³; Assimilation plus Fractional Crystallization modeling, however, indicates that volume of primitive magmas must have been more than 10 times greater and high rates of digestion of crustal material. This suggests that the exposed scoria cones may constitute the exposed part of a polygenetic volcanic system, largely buried by ice and snow.

Notably, strongly alkaline products were erupted during warmer periods and evolved through simple fractional crystallization in closed systems. In contrast, evolutionary trends associated with products erupted during colder periods exhibit significant crustal assimilation. This pattern suggests that during periods of increased ice sheet thickness, volcanic eruptions were temporarily suppressed, leading to prolonged magma residence