Insights into volcanic fissure eruption dynamics based on detailed field mapping and geochemical analysis: A case study of the Mt. Eccles Volcanic Complex, south-eastern Australia

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The Mt. Eccles Volcanic Complex (MEVC; 38° 3.66'S, 141° 55.34'E) forms part of the Newer Volcanics province (NVP) of south-eastern Australia, which is the site of Australia's most recent volcanic activity. The MEVC is the only known exposed fissure vent system in Australia and represents a 'snap-shot' into the intermediate stages of shield volcano development. The MEVC has been dated as young as 7 ka, and comprises a spectacular NW-SE trending fissure vent system that is aligned with several small cinder and spatter cones to the south, forming a ~2 km long array. The strong alignment of the MEVC fissure vent and cone array suggests dykes utilized pre-existing structures during magma ascent, a hypothesis supported by co-alignment with large-scale Paleozoic basement faults in the area. Partial collapse of the vent walls reveals excellent exposure of the internal structure of the fissure, which comprises alternating horizons of lava and spatter sequences. The fissure vent is breached to the north by a substantial lava field, the longest of these lavas extends over 50 km in length reaching the current coastline to the south. These sizable flows indicate a sustained high effusive phase in the MEVC eruption that allowed the development of an extensive lava tube network, which is preserved as numerous lava caves, channels and tumuli. Quarrying of scoria cones to the south of the array has provided excellent exposure of their internal structure, down to the lava flows on which the cones were built. Stratigraphic logging of the quarry walls and detailed mapping of the quarry floor provides insights into the growth of cinder cones and the nature of the shallow feeder system. Field relations suggest the volcanism started in the north of the area and moved progressively southwards. Hawaiian fire-fountaining was a dominant eruptive style at the MEVC, with minor Strombolian and phreatomagmatic behaviour to the south. XRF analyses of stratigraphically constrained samples show the erupted products comprise hawaiite, nepheline-hawaiite, basanite and alkali-olivine basalt, with a strong Ocean Island Basalt character that is consistent with other erupted products in the NVP. The MEVC eruptive period was likely short-lived, with punctuated events lasting in total several weeks to months.