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Depositional processes of the basaltic Elie Ness diatreme, East Fife, Scotland

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The East Fife coast of Scotland exposes multiple ($\sim$100) volcanic vents or diatremes of late Carboniferous to early Permian age. Here, we present preliminary results of detailed geological mapping of the Elie Ness (EN) diatreme. The key objective was to map the volcanic structure and lithofacies of the vent-fill, and to determine the eruption styles and key emplacement processes that occur more generally in basaltic maar-diatreme systems. Within the EN diatreme, seven lithofacies and three lithofacies associations (LFA 1-3) were recognised. Preliminary results demonstrate that the diatreme had a protracted history of eruption and infill. The massive lapilli tuffs of LFA 1 are texturally and compositionally homogeneous with occasional degassing structures, making them similar to typical massive volcaniclastic deposits infilling kimberlite pipes. The formation of such deposits are attributed to gas-fluidisation processes operating within the vent. The occurrence within LFA 1 of abundant volcaniclastic autoliths and megablocks together with steeply inclined lenticular breccia and tuff packages, makes the deposits similar to marginal lithofacies of the Jwaneng Centre kimberlite pipe, Botswana. All these features can be explained by subsidence of volcaniclastic strata from the surrounding tephra ring during emplacement. The steep internal contacts between the lithofacies of LFA 1 can be explained by variations in gas flux as the main eruptive phase waned. Pyroclastic base surge deposits of LFA 2 form a series of continuous sheets across the EN diatreme, and are therefore likely to have originated from a neighbouring pipe. The most probable source of the LFA 2 pyroclastic surges is a small vent to the NE of Elie Ness, where similar diffuse stratified lithofacies are observed. Minor steeply-inclined breccias and tuffs of LFA 3 cross-cut bedded tuffs of LFA 2, and are therefore likely to represent late-stage dykes and conduits. A significant observation is that the diatreme cross-cuts an anticlinal fold to the NE, and that the vent-fill is folded with a similar NE-SW fold axis orientation. This suggests that the Elie Ness diatreme was probably emplaced during the Variscan deformation, analogous with the Black Ball Head diatreme, SW Ireland. The Elie Ness diatreme offers new insights into the volcanism of low viscosity, alkali-rich silica under-saturated magmas, and provides empirical constraints on the architecture and internal workings of other types of volcanic conduit and maar-crater systems. The processes elucidated for alkali basaltic tuff diatremes are general and can also be applied to other deep volcanic conduits.