Fragments within fragments: are composite bombs hints of weakness or sustained violence?

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Bombs and lapilli containing or consisting of smaller fragments are composite clasts, and are produced in many mafic eruptions. They have been attributed to accretion of highly fluid pyroclasts in gas suspensions of either conduits or plumes, to hot-state vent/conduit recycling of pyroclasts, and depositional amalgamation. It is important to distinguish composite clasts formed within sustained eruption columns from the others because the hazard and depositional footprint of the former is much larger. Bombs in some inferred gas-rich systems are argued to grow by particle collisions under thermal conditions that allow surface-tension reshaping, requiring assembly of bombs while immersed in a gas jet. The jet is also considered to elutriate, rather than accrete, fine ash. Suspension of a 20 cm bomb in gas-rich particle-poor conduit flow or in gas-thrust regions of plumes requires sustained velocities associated with "violent Strombolian" eruptions that blanket many tens of square kilometres with decimetres-thick deposits. Basaltic to nephelenitic bombs formed by discrete explosions in conduits characteristicstically contain wallrock fragments. The explosions fragment fluid magma and wallrock but are ineffective in clearing the material from the conduit or vent. This general mechanism requires discrete explosions, and implies limited particle dispersal. Composite fragments from maar-diatreme environments of nephelenitic to basaltic tholeiitic compositions are typically country-rock rich and display a variety of textures, surface features, and styles of assembly. Bombs at Rotomahana incorporated many fragments that show minimal thermal alteration and must have been assembled and cooled over short timescales. Associated with fragmentation zones in Hopi Buttes maar-diatremes, are composite bombs and a variety of clastogenic lithic-rich coherent rocks, whereas in the Karoo province such composite clasts accompany lithic-rich lava flows. Composite fragments in the Antaractic Ferrar province are present in pyroclastic flow deposits of substantial extent, but also with locally dispersed layers; plume-fed fall deposits are not significant. The most consistent feature of reported composite clasts is their occurrence in mafic-intermediate to ultramafic cones or maar/diatremes, and not associated with dispersed fall deposits. The range of magma types and volcanic environments with composite bombs argues against an origin dependent on unusually fluid magmas or extreme eruption conditions. Weak dispersal of fragments formed in discrete explosions allows fallback and amalgamation or re-incorporation into magma of first-generation fragments, re-ejected by subsequent explosions as lapilli or bombs. Where fragmentation also produces wallrock fragments, these are incorporated into the composite fragments.