Syn-eruptive Submarine Pumice and Shard-rich Deposits From ~ 1 Ma Explosive Trachydacitic Eruptions: Efate Pumice Formation, Vanuatu

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The Efate Island Group is a trachydacite-dominated volcanic centre in the Vanuatu island arc, southwestern Pacific. On the main island, Efate, the oldest known unit is the Efate Pumice Formation, a succession of non-welded, trachydacitic pumice breccia and shard-rich sand and silt beds. This unit is the record of a major explosive eruption that occurred in the Vanuatu arc at about 1 Ma.

The base of the formation is not exposed, but it has a minimum thickness of about 500 m and a minimum bulk volume of approximately 85 km3. The lower part (Efate Pumice Breccias) is dominated by thick to very thick (up to 5 m) beds of massive to graded and stratified pumice breccia that are locally interbedded with shard-rich sand and silt. The dominant components are angular or ragged, glassy tube pumice clasts with subordinate perlitic obsidian and dense porphyritic lava clasts in a minor matrix of glass shards and crystals. The glassy components are uniformly trachydacitic. The majority of pumice clasts have ruptured bubble walls indicating fragmentation by "dry" explosive processes. Very few have the blocky, equant shapes and arcuate fracture surfaces typically associated with the influence of external water.

The facies characteristics of the Efate Pumice Breccias indicate below wave-base deposition principally from turbidity currents and debris flows of waterlogged pumice. These volcaniclastic currents were probably generated directly from contemporaneous explosive eruptions by the turbulent mixing of initially hot pyroclastic debris with seawater. Stratification, cross-stratification and grading developed as particle-rich currents lost capacity, allowing traction sedimentation to dominate over suspension fallout sedimentation. The generally fines-poor nature of the Efat Pumice Breccias may reflect efficient elutriation of these particles during transport.

The upper part (Rentabau Tuffs) consists of up to 70 m of well-bedded and well-sorted shard-rich sand and silt. The minimum bulk volume is ~3 km3. Beds are typically massive to locally internally stratified and cross-stratified. The clast population is generally >95 % glassy or formerly glassy shards, but fossil foraminifera are a ubiquitous and important non-volcanic component. The Rentabau Tuffs are interpreted

to represent a change in explosive activity from "dry" to hydromagmatic in response to waning discharge that allowed ingress of water (presumably seawater) to the vent(s). Deposition of the Rentabau Tuffs occurred from steady turbidity currents generated directly from explosive eruptions, by post-eruptive remobilisation of unconsolidated shard-rich ash, and by water-settling of fallout from the eruption column.

The Efat Pumice Formation was clearly deposited in a submarine environment but the vent or vents for the eruption are not preserved or not exposed and their precise location remains unknown. However, sparse palaeocurrent indicators and grain-size variations point to a source offshore to the north of Efate. The vent setting is also difficult to constrain. Although clast shapes in the Efate Pumice Breccias indicate dominantly "dry" explosive fragmentation, this does not preclude eruption from submarine vents: energetic discharge may prevent water gaining access to vents, and further, submarine eruption columns may remain protected from interaction with seawater by a steam carapace. For the Rentabau Tuffs, a submarine vent setting is consistent with the overwhelming dominance of ash and the presence of shards bounded by arcuate fracture surfaces, both of which are typical of deposits from hydromagmatic activity. In addition, no regional ash layer correlated with the Efate Pumice Formation has been recognised within the Vanuatu arc. A subaerial eruption of this style and scale would be expected to produce a widespread ash bed, implying that in this case, vents were probably submarine, although the eruption column may have breached the sea surface.