Deep-sea Limu o Pele: The Significance of Bubble-wall Shards inHyaloclastite Deposits

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Many cases have recently been documented where limu shards occur in sheethyaloclastite deposits in the deep sea (800-3200 m below sea level (bsl)).Their model of formation accounts explicitely for mildly explosiveinteraction of seawater and lava under high confining pressure.Deep-sea sheet hyaloclastite consists mostly of sand-sized blocky andsplinter-shaped shards. They may also contain up to 25 % of mm-cm sizedthin, curved, and wrinkled plates and sheets of sideromelane. This type ofshards, termed Limu o Pele, has been observed forming subaerially inKilauea by entrapment of water in flowing lava followed by expansion ofsteam to form large bubbles that burst into thin fragments. Deep-marinelimu has been inferred, from comparative morphological studies andassessment of physical bubble-forming conditions, to form in a similar way. The increased ambient pressure and higher viscosity of water, however,reduces bubble expansion, and differing mechanisms of heat transfer andrates of magma chilling further modify limu-forming process in the deep sea.The quantitatively supported model developed is based on observed limuforming processes and criteria derived from dive samples and observationsat Seamount Six, Cocos Plate. It is inferred that water and/orwater-saturated sediment was trapped in extremely thin, fluid and rapidlyadvancing lava flows by various processes. This is supported by an absenceof limu-bearing hyaloclastite in sediment-free areas of e.g. the EastPacific Rise. Other bubble forming mechanisms, however likely, are notconfirmed by collected samples.Subaqueous limu formation appears to be restricted to basalticcompositions, as shards analyzed range from MORB to Hawaiite, and to waterdepths greater than 800 m bsl. No shards have been described from shallowsubaqueous deposits formed by highly explosive magmatic and hydrovolcanicmagma-water interactions, nor from sediment-free areas. Limu-bearinghyaloclastite is thus interpreted to represent a good paleoenvironment and-depth indicator.