DATA REPOSITORY ITEM 1 - PYROCLASTIC TERMINOLOGY

The volcaniclastic terminology used in this paper largely follows that of Fisher and Schmincke (1984) and Heiken and Wohletz (1985). A deposit made of >75% pyroclasts with pyroclasts <2 mm in size is referred to as ash (or tuff, if consolidated); if the pyroclasts are 2-64 mm, they are referred to as lapilli (lapillistone); and if the pyroclasts are >64 mm, they are referred to as blocks (breccia). Mixtures are referred to as lapilli tuff or tuff breccia.

The term "pyroclastic flow" refers to a highly-concentrated pyroclastic density current composed entirely of freshly-erupted pyroclastic debris (e.g. glass shards, crystals, pumice and rock fragments); *sensu strictu* the fluid phase is hot gases, but since the temperature of emplacement can rarely be determined in ancient settings, we use the term *sensu lato*, i.e., regardless of emplacement temperature. Pyroclastic flow deposits are predominantly massive (i.e. nonstratified) and poorly sorted (Freundt et al., 2000). Evidence for hot emplacement may include welding (at very high temperatures ~500° C), carbonized wood fragments, occurrence of columnar jointing (not discernable in drill core), or occurrence of perliticly fractured clasts suggesting quenching of glass *in situ*. Welding must be documented as sintering of shards recognizable in thin section by petrographic or scanning electron microscopes, and must not be confused with pumice flattening, which can occur diagenetically (Kokelaar and Busby, 1992).

Subaqueous pyroclastic flow deposits are the subaqueous equivalent of subaerial pyroclastic flow deposits (Fiske, 1963; Fiske and Matsuda, 1964; Gibson et al., 2000).
Several workers have proposed that the term "subaqueous pyroclastic flow" be applied only to hot, gas-supported density currents (Cas and Wright 1987, 1991; Stix, 1991; McPhie et al., 1993); subaqueous water-supported pyroclastic flows were termed "volcaniclastic mass flows". This distinction cannot be applied to most ancient pyroclastic flow deposits, where one can rarely prove whether the flow was above or below 100°C at deposition (Busby-Spera, 1986; Gibson et al, 2000). Furthermore, this nomenclature does not attempt to separate eruptive-fed density currents from those stemming from much later resedimentation (Kano, 1996). I agree with Gibson et al. (2000) that the nomenclature of Cas and Wright (1991) masks the origin of subaqueous pyroclastic flows as the direct product of an eruption. Most volcanic eruptions on Earth take place under water, and it is important to name their products accordingly where they are recognized. A deposit that is predominantly massive (i.e. lacking traction structures), nongraded, nonsorted, thick, and composed entirely of fresh pyroclastic debris is highly likely to be the direct result of an eruption (i.e it is a primary deposit), whether or not one can determine temperature of emplacement. A more complete discussion of terminology will be warranted only when the nature of submarine pyroclastic volcanology is better understood (Fiske et al., 1998). Meanwhile, a clear statement of usage of terms is all that is needed.

Pyroclastic flows may be classified according to the degree of vesiculation shown by essential fragments (Wright et al., 1981; Heiken and Wohletz, 1985). The term "ignimbrite" is used for pumiceous, ash-rich pyroclastic flow deposits, which may or may not be welded; some other workers use the term "ash-flow tuff" for these instead (Freundt et al., 2000). In this paper, we use the term "ignimbrite" for the deposits of pumiceous
pyroclastic flows. Ignimbrites result from explosive eruptions and are commonly fed by collapse of Plinian eruption columns. Block-and-ash flow deposits, in contrast, are composed of nonvesicular to poorly vesicular juvenile lithic to glassy fragments in an ash matrix. They commonly result from gravitational or explosive collapse of silicic lava domes (Fisher and Heiken, 1982; Fink and Anderson, 2000). Less commonly, block-and-ash flows form by collapse of Vulcanian eruption columns of intermediate composition (Freundt et al., 2000).

The components (i.e. glass shards, crystals, etc) of dominantly massive pyroclastic flow deposits may also be present in more stratified or cross-stratified, better sorted deposits that may show grading or partial Bouma sequences. These are referred to here as tuff turbidites, and were probably transported by high density or low density turbidity currents with interstitial water. Finally, subaqueous fallout tuffs are accumulations of pyroclastic material that settled through water; sorting and stratification are greatly accentuated by this settling process (Fisher, 1964).

Autoclastic fragments are defined as those resulting from "mechanical friction or gaseous explosion during movement of lava, or gravity crumbling of spines and domes" (p. 89, Fisher and Semincke, 1984). Autobreccias are coarse, dominantly "stony" (nonglassy) aggregates with minimal fine-grained debris, and they may form substantial proportions of lavas (Macdonald, 1972).

Rittman (1962) introduced the term "hyaloclastite" for rocks composed of glass produced by nonexplosive spalling and granulation of pillow rinds, but the term has since been expanded to include all vitroclastic (i.e. glassy) tephra produced by the interaction of water and hot magma or lava (Fisher and Schmincke, 1984). Thus, hydroclastic
processes have been defined as those causing breakup of magma by interaction with external water, including explosive comminution and nonexplosive granulation. Other workers, in contrast, restrict the term "hyaloclastite" to non-explosive or midly explosive granulation of volcanic glass due to quenching (thermal shock) on contact with water (Heiken and Wohletz, 1985; Yamagishi, 1987). These and other workers distinguish hyalotuffs from hyaloclastites on the basis of greater inferred explosivity (Honnorez and Kirst, 1975).

REFERENCES


