Fluidal-clast Breccia Generated by Submarine Fire Fountaining: a Cambro-Ordovician example, Queensland, Australia

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A distinctive monomictic breccia composed of fluidal and blocky, basaltic andesite clasts occurs in the Trooper Creek Formation, a Cambro-Ordovician submarine volcanic succession in northern Queensland, Australia. The fluidal-clast breccia is associated with coherent basaltic andesite and coarse and fine breccia facies of the same composition. These three facies occur together in mappable unit that is several hundred metres thick and extends for about 4.5 km along strike. This unit is overlain by turbidites and hemipelagic mudstones that contain trilobites and other marine fossils, and underlain by very thick, graded beds of felsic volcaniclastic breccia and sandstone. The depositional setting of the fluidal-clast breccia and associated facies is inferred to have been submarine, below wave base and probably relatively deep.

The fluidal-clast breccia facies is more than 250 m thick and internally massive, varying only in the ratio of fluidal clasts to blocky clasts. Fluidal clasts range in size from 2 cm to 170 cm, and have moderately to highly vesicular cores and thick (up to 1 cm), non-vesicular, formerly glassy rims. The fluidal clasts strongly resemble subaerial volcanic bombs and are interpreted to be the products of submarine fire fountaining of relatively low-viscosity lava. Blocky clasts are highly vesicular to non-vesicular, less than 2 cm across, angular, dominantly equant or splintery in shape, and identical in composition to the fluidal clasts. The blocky clasts were mainly derived from disintegration of the fluidal clasts by means of quench fragmentation.

Coherent basaltic andesite is intercalated with the fluidal-clast breccia and includes co-genetic pillow lavas, as well as dikes and irregular intrusions. The coarse and fine breccia facies is closely associated with the fluidal-clast breccia facies. It occurs in intervals at least 100 m thick and is very thickly bedded, monomictic (basaltic andesite), poorly sorted and clast supported. This facies is interpreted to have been generated by periodic gravitational collapse of unstable accumulations of the fluidal-clast breccia facies. We interpret the association of fluidal-clast breccia, coherent facies and coarse and fine breccia to be the product of basaltic andesite fire fountains operating more or less simultaneously at one or more submarine vents. The sections dominated by thick fluidal-clast breccia and coherent facies are probably the most proximal whereas sections dominated by the coarse and fine breccia

facies accumulated farther from the vent(s).

Subaqueous fire-fountain breccias are distinguished from subaerial fire-fountain breccias by thick glassy margins on fluidal clasts, the lack of welding and agglutination, and the distinctive association of highly vesicular, fluidal clasts with non-vesicular, angular, blocky clasts. Recognition of submarine fire-fountain breccias in volcanic successions constrains the eruption style, proximity (tens of metres) to source and environment of deposition. Their significance as indicators of water depth is uncertain as the depth limits for fire fountains are not well understood.