An Archean Submarine Pyroclastic Flow Due to Submarine Dome Collapse: The Hurd Deposit, Harker Township, Ontario, Canada

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The Hurd Volcaniclastic Deposit lies within the Kinojevis Assemblage, a group of submarine volcanic rocks dominated by Mg-and Fe-rich metamorphosed pillow-basalt. The volcaniclastic deposit can be subdivided into two facies, a lower unorganized massive facies and an upper imbricated facies. The lower facies is composed of cm-to-m-scale flow-banded dacite blocks interspersed with angular to-curved-to-blocky and equant mm-to-cm-scale fragments of altered glass; it has a sharp but undulatory basal contact with underlying massive to lobate dacitic lavas. Some blocks are partly composed of in-situ breccia, and agglomerations or curvilinear arrays of spherulites. This lithofacies contains well-developed columnar joints that terminate at the sharp contact with the ~2m thick upper imbricated facies. With the exception of numerous large imbricated tabular clasts, the imbricated facies is dominated by blocky to angular mm-to-cm-scale fragments. The presence of pillows, chert, jig-saw fit breccias, and microscopic quench textures are evidence of a subaqueous environment of deposition. Similarly, the presence of columnar joints, plastically deformed clasts, quench breccias, and possible gas escape structures indicate hot emplacement, perhaps by a gas-supported pyroclastic flow. Together, the massive and imbricated facies represent one flow unit that was quickly emplaced. The lower facies was deposited by a high-density flow isolated from the aqueous environment by the development of a steam carapace, whereas the overlying facies was emplaced by a turbulent, aqueous flow. The onset of magmatic fragmentation may have been the result of sudden decompression possibly triggered by the gravitational collapse of a submarine dacite dome.

1.0 INTRODUCTION

The nature of transport within, and deposition from, subaqueous pyroclastic flows, either those of subaerial origin [*Whitham, 1989; Mandeville et al., 1996; Kokelaar and Königer, 2000*] or originating from completely submarine eruptions [*Kokelaar, 1992; Fritz & Stillman, 1996*], remains a contentious issue [*Cas and Wright, 1991*]. The continued debate stems from uncertainty related to the extrinsic conditions and mechanics of subaqueous eruptions, and is fueled by the paucity of irrefutably primary pyroclastic flow deposits emplaced in a submarine environment. Direct observations of entirely subaqueous eruptions are absent and, only recently have pyroclastic flows entering the sea have been well documented, from Soufriere Hills, Montserrat [*Young et al., 1997*], though some information is also available from historical events such as the eruption of Mt. Pelée, Martinique [*Lacroix, 1904*]. Subaerially produced pyroclastic flows that reach the coast may only have limited interaction with water. For instance, they may glide over the water surface [e.g. *Allen, 2001*], or segregate into an overriding turbulent cloud with an advancing underwater aqueous density current [*Carey & Sigurdsson, 1980; Mandeville et al., 1996*] as observed from video of pyroclastic flows flowing out of Tar River Valley in Montserrat.

Typically a submarine pyroclastic flow will transform from an initial gas-supported, high-density, dominantly laminar current to a water-supported, high-density turbulent aqueous current due to water ingestion [*Fisher, 1983; White, 2000*]. Resulting deposits tend to be better sorted due to the viscosity contrast between gas and water [e.g. *Stix, 1991*] forming stratified beds that can be doubly graded [*Fiske & Matsuda, 1964*]. Critical to the