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Hyperquenched explosive submarine basaltic glass on Loihi Seamount, Hawaii

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Explosive submarine basaltic eruptions, occurring at water depths of several kilometres, result in the formation of layered volcaniclastic deposits. We have identified and separated three different types of glass fragments from these deposits; bubble-wall fragments (limu-o Pele), Pele's hair and dense angular fragments. These have then been analysed by differential scanning calorimetry (DSC) in order to compare cooling rates using their c_p-temperature paths. After initial heating at 10 K.min^{-1}, the samples were cooled and heated at matched rates of 25, 20, 15 and 10 K.min^{-1}. This is the first time pristine glassy limu-o Pele have been analysed in such a way. The c_p paths show the glassy state and peak in c_p associated with the glass transition. Notably, during the initial heating of all three types of glass the transient c_p exhibits a deep trough before the glass transition peak, this trough is absent in subsequent controlled cooling/heating paths. The trough is deepest for the limu-o Pele and Pele's hair glass. For the raw samples, the deviation from the glassy state begins at 465 K, whereas in the c_p paths for matching cooling and heating rates deviation from the glassy state doesn't occur until much higher temperatures (approximately 830 K, depending on cooling/heating rates). Such a trough is indicative of extremely rapid cooling rates. It has also been observed in DSC experiments on Si-poor glasses created synthetically using the splat-quench [1], and fibre spinning techniques [2], which generate cooling rates up to 10^6 K.s^{-1}. The troughs we have observed for these submarine explosive glassy deposits start at lower temperatures and are deeper than those for the synthetic glasses, possibly implying even faster cooling rates. Such extreme cooling rates for glass generated at pressure are considerably faster than those of up to 1500 K.s^{-1} already measured for deep-sea hyaloclastites [3]. The deepest troughs, exhibited by the

limu-o Pele and Pele's hair, suggest that these varieties have the most extreme cooling rate yet measured for natural volcanic glass.

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[2] Y. Yue et al., (2004), J. Chem. Phys., 120, 8053-8059.

[3] M. Wilding et al., (2000), Bull. Vol., 61, 527-536.