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Hyperquenched Subaerial Pele´s Hair Glasses from Kilauea Volcano, Hawaii

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Pele´s hair is fibrous glassy material formed by deformation of fluidal lava in the air during fountaining. We have identified and separated three different types of glass fibres formed during an eruption on the slope of Kilauea volcano, Hawaii in August 1998. These samples were collected close to the skylight on the lava surface, where the jet stream expelled fluidal lava droplets with a high spurting velocity. The eruption velocity seems to be the most significant parameter in forming Pele´s Hair.

Glassy fibres were separated under optical microscope, dried over night at 120 ºC in the oven, and then compressed into pellets by applying pressure of 0.74 GPa in hand press. These pellets have then been analysed by differential scanning calorimetry (DSC) in order to compare cooling rates using their *Cp*-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 Pele´s Hair have been analysed in such a way. The *Cp* paths show the glassy state and peak in *Cp* associated with the glass transition. Notably, during the initial heating of all three types of fibre glass the transient *Cp* exhibits a deep trough before the glass transition peak, this trough is absent in subsequent controlled cooling-heating paths. 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, and fibre spinning techniques, which generate cooling rates up to 10^{6} K s^{-1}. The *Cp* curves for the Pele´s Hair were compared with *Cp* curves generated during DSC analysis of bubble-wall fragments (limu-o Pele, submarine explosive glassy deposits from Loihi, Hawaii) also analysed in our laboratory and with the *Cp* data of compositionally similar synthetic fibre glasses published in the literature. The observed *Cp* values of all glasses are within analytical error. The trough on the *Cp* curve created during the initial heating of the sample is deepest for the limu-o Pele, followed by fibre spinning glasses, Pele´s Hair and finally the splat-quench glasses. Calculated excess energy stored in the structure of the Pele´s Hair glasses and the fictive temperature suggest very fast cooling rates, considerably faster than those of up to 25 K min^{-1} already measured for deep-sea hyaloclastites, but slower than the cooling rate estimated for the fibre spinning glasses (i.e., 10^6 K s^{-1}). The water content of Pele´s Hair was measured by FTIR prior to DSC measurements and is below detection limits. This is contrary to the limu-o Pele glasses where water contents vary between 0.23 and 0.51wt%. Water plays an important role in the structure of the glasses and is probably the most significant parameter influencing the onset of the glass transition temperature interval. This has also been confirmed in this study where the onset in the water bearing limu-o Pele glasses is about 60K lower then those in the dry Pele´s Hair glasses.