Paleomagnetism of Impact Glass

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Abstract: There are claims that geochemical compositions of certain components of bulk sediment, magnetic grains, and melt glass are consistent with a cosmic impact event of transient origin (Firestone et al., 2007; Wittke et al., 2013); the controversial nature of these claims has divided the research community into several groups. Melted, glassy objects are widely accepted to have formed during impacts (Glass et al., 2004; Korchagin, 2010), but they also commonly occur throughout the geological record due to non-impact-related processes. For example, they accrete to Earth's surface as ablation products from the influx of meteorites and cosmic dust (Kukla, 1987). Also, abundant spherules and glass may be produced by continental volcanism (Smit, 1990), hydrovolcanism (Mukhopadhyay et al., 2003), metamorphism (Korchagin, 2010), wildfires (Franzen, 2006), lightning strikes (Thy et al., 1995), and coal seam fires (Thy et al., 1995). In addition, melt-glasses can be produced anthropogenically, especially by coal-fired power plants and smelters (Kapicka et al., 1999), but are typically restricted to surface deposits of industrial age (<300 years old). Although there are many ways that glasses can form other than by hyper-velocity impact, all types may exhibit a unique set of magnetic characteristics that allow differentiation from impact-related glasses. Thus, we are using magnetic petrology to differentiate YDB glasses from other types.
Magnetic characterization of the glass fragments originating from the transient events, (they include lightning, power plants, nuclear explosion, impact cratering, volcanic eruption) outlines the nature of magnetization acquired in the magnetic field present during the event and provides a test allowing more detailed characterization of such transient events. An example of radical magnetic vector change is shown in Fig.1, where magnetic grains contained within this specimen have specific coercivity distribution. Grains with a similar coercivity range recorded a specific magnetic direction, departing from grains with other ranges of coercivity values. Such behavior is consistent with airborne acquisition of geomagnetic field while individual magnetic grains with specific grain size range and corresponding blocking temperature range rotated and recorded geomagnetic field vectors during the time of flight.

Keywords: magnetic petrology, glass, impacts, airburst, paleomagnetism

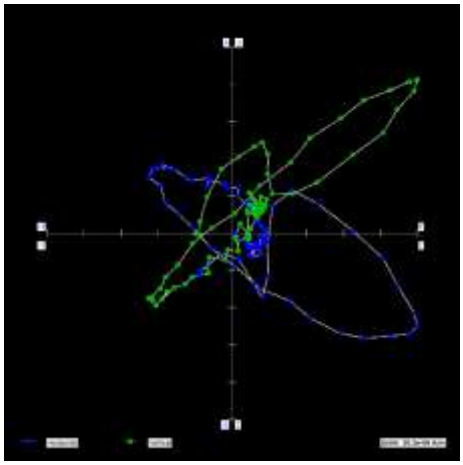

Figure 1: Demagnetization of the natural remanent magnetization recorded in the glass specimen with arbitrarily chosen XYZ coordinate system. Specimen comes from the sediment deposited during the proposed impact event at the Younger Dryas transition 12800 years ago (Wittke et al., 2013). Demagnetization was done by using alternating magnetic field in all three axes, ranging from 1 mT to 90 mT with step of 1 mT. Blue set of data is projection onto the horizontal plane. Green set of data is projection of the vector onto the vertical plane trending in Y direction..

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