Geophysical Research Abstracts, Vol. 9, 10975, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10975

Impact fingerprints of the 4 kyr BP dust event based on archaeological, soil, lake and marine archives

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Originally identified in buried soils of Northern Syria on the basis of distinctive facies anomalies produced by windstorms of unprecedented high energy, the 4 kyr BP (4.2 ka BP cal. BP) dust event is often commonly presented as the greatest historically recorded drought of the Holocene. The related dust spikes traced in the Gulf of Oman, in the Andes glaciers and in the Kilimanjaro ice sheet are currently interpreted as a $\sim$300 years persisting aridity with drastic effects on civilizations across the Middle-East and Asia. Systematic investigations on soils, archaeological sediments, lacustrine and marine records across the Northern and Southern hemispheres have leaded us to propose the alternative explanation of an impact-event. The results obtained are here summarized in order to further explain how impact-linked processes have resulted into a unique dust event that shows confusing resemblance to a climate-triggered drought.

The comparison of marine and continental archives using a standard analytical procedure has allowed recognizing similar micro-debris that form the 4 kyr BP dust assemblage. They consist of four distinctive species of exotic components: the Carbonaceous Components (CC), Metal Components (MC), Rock/sediment Components (RC) and Vesicular Glassy Component (VGC). In spite of the geologically disparate settings

they display a similar morphology not biased by weathering and diagenesis, forming a continuum from millimetre-sized grains down to micron-sized particles, with occasional fist-sized blocks. Heterogeneity of the dust fall at local scales is reflected by the variable amount of the different species and of the dust-layer thickness. Petrographic, geochemical and mineralogical analyses have allowed identifying at least six distinctive precursors of terrestrial origin: (i) volcano-clastic mudstone, (ii) marine clay, (iii) marine calcareous mud, (iv) basalts and basaltic breccia, (v) polymetallic marine nodules, (vi) granite-gneiss and schists clasts. Flow-textured glass, silt-sized baddeleyite clusters, diaplectic quartz, incorporation of nano-sized diamonds within the minerals and geochemical anomalies in the VGC provide irrefutable fingerprints for impact-linked transformations of the precursor materials. The later are recognised to all derive from the Kerguelen plateau in the Austral ocean on the basis of their petrography and occurrence of an Antarctic faunal assemblage in the marine components. This identification is supported by the considerable thickness (up to 7 m) of the impact-ejecta accumulation in deep-sea cores of the Kerguelen plateau. The 4 kyr BP is thus concluded to reflect the dispersal of an impact oceanic ejecta with its distinctive spatial pattern: thick ejecta accumulation throughout the proximal dispersal area; erratic dispersion at longer distance. Melting, heating, and violent airborne deflation recorded in the soil surface bearing the primary dust fall provide strong evidence for the inter-hemispheric dispersal of the impact-ejecta debris while still hot and viscous.

These results consolidate the originality of the 4 kyr BP dust event, reflected by its instantaneous initiation, its widespread occurrence and complex structure at regional scales in terms of intensity and duration. The vertical dispersion of the impact debris due to settling conditions at great water depth and subsequent reworking by bottom currents gives the erroneous impression in deep-sea cores of a long-lasting event, although the exact fall of the impact-debris flow was most likely not exceeding a few days. In addition, the high resolution records in terrestrial settings has allowed to identify fall of the impact fine aerosols loaded in the upper atmosphere, and later washed by rains in the following months.