**Supplementary Data S1**

## Grain-size analysis

High-resolution particle-size analysis of the samples was achieved using a “FRITISH ANALYSETTE MicroTech Plus” laser granulometer with a measurement range of 0.01–2000 µm. The pre-treatment of the sample with acid (HCl) and H2O2 was not performed because neither carbonate nor organic matter existed (% CaCO3 does not exceed 5%).

Statistical parameters of mean, standard deviation, skewness and mode were calculated using the graphic expressions of Folk and Ward (1957) once the percentiles given by the laser granulometer were converted to.

## Partitioning of grain-size components

Grain-size components of individual polymodal distributions of the core sediments of Sebkha Mhabeul were partitioned using the lognormal distribution function method described by Qin et al. (2005). The lognormal distribution function formula is expressed as follows:

(1)

where *n* is the number of modes, *x* = ln (*d*), *d* is the grain size in µm, *ci* is the percentage of the *i*th mode, *ci* ≥ 0, and the sum of *nci* equals 100%. σi is the standard deviation of the *i*th mode. *ai* is the mean value of the *i*th grain-size logarithmic mode in µm, i.e., *ai* = ln (*di*), and *ai*> 0.

## Magnetic susceptibility

For mineral magnetic analysis, all samples were subjected to the same preparation and analysis procedure, in which ~10 cm3 of each bulk sample was dried and then grinded, packed into 10 cm3 cylindrical Perspex pots and immobilized in the Bartington MS2B instrument to be analyzed in the laboratory of Sedimentary Dynamics and Environment, National Engineering School of Sfax in Tunisia.

Magnetic measurements are the powerful means of identifying changes in the properties and then in the sources and fluxes of mineral sediments. Commonly, ferromagnetic minerals such as magnetite have high and positive MS values, whereas paramagnetic minerals such as clays have weak and positive MS values. Diamagnetic minerals such as calcium carbonate and quartz have very weak and negative MS values.

Quantitative magnetic susceptibility (MS) measurements have become widely used in the reconstruction of flood history during the Holocene (Wolfe et al., 2005; Ghilardi et al., 2008).

## Scanning electron microscopic observations of quartz grains

Quartz grains from nine samples at different depths in the core were handpicked under the stereo zoom microscope. Samples were selected depending on the maximum SM values and high sand modes. Sand grains were washed in cold 10% HCl to clean them from carbonate-clayey and ferruginous contamination, then water distilled and finally dried. Scanning electron microscopy imaging was conducted using a JEOL-JSM-5400 LV apparatus at the «Entreprise Tunisienne d’Activité Pétrolière». The quartz grains chosen for examination had a diameter between 50 and 315 µm. The surface feature recognition and interpretation were performed in accordance with the concepts of Krinsley and Doornkamp (1973), Le Ribault (1977), Mahaney (2002), Kenig (2006) and Vos et al. (2014).

## Chemical analysis

Sodium (Na), potassium (K) and calcium (Ca) concentrations were determined using a ʺSherwoodʺ Flame Photometer 410. Samples were subjected to some pre-treatments such as air-drying at 50°C, homogenization and grinding in an agate mortar mill. Otherwise, an amount of 0.1g of sediment was put in 30 ml of distilled water, kept in a flask and mixed to dissolve the minerals. After the solid debris through filtration, an extract should be used to determine Na, K and Ca concentrations in the solution using calibration charts.

## Greyscale analysis

The relative reflectance (grey scale) and laminae thickness from the Mh1 sediment core was analyzed with digital imaging “Scion Image software”. The greyscale diagram displays a two-dimensional graph that represents pixel intensities along a line within the sediment image. The increasing relative lightness is associated with increased salt precipitation and higher content of clastic inorganic material in relationship to the cyanobacterial layer (a few fossil-degraded, microbial mat intercalated laminae within siliciclastic sediments, and they are few µm thick) which reveals dark-coloured levels.

## Chronology

Several previous works carried out withing the frame of ZARDEG project (Schulz et al, 2002, Abichou, 2002; Pomel et al., 2004) studied the sedimentary filling, the functioning and the chronology of the Sebkha Mhabeul. These works achieved by Abichou (2002) and Schulz et al. (2002), have all shown radiocarbon dating failed since there was no sufficient organic material and the AMS dating was impeded by the gypsum content. These authors established chronology from the identification of volcanic ash-falls detected in the first meter of the sedimentary sequence from the Sebkha. Therefore, tephrochronology is the age model used for dating sediment material in the Sebkha Mhabeul. Thus, several levels of tephras was identified in sedimentary laminae of the Sebkha Mhabeul, some minerals were identified on thin sections (micromorphology) others under a fiber optic microscope (Abichou, 2002). According to Abichou (2002), eight tephra layers were detected in thin sections from the sediment core collected in the central part of Sebkha Mhabeul (away from Mh1 about ~500 m), just five of them were identified (Tab. A).

Table A: Depth of tephra layers, mineralogy, source and eruptive age (Abichou, 2002)

|  |  |  |  |
| --- | --- | --- | --- |
| **Depth (cm)** | **Mineralogy** | **Source volcano** | **Eruptive age** |
| 2 | Olivine-diopside | Stromboli | AD 1930 |
| 9 | Augite-diopside | Vesuvius | AD 1631 |
| 26 | Titano-magnetite | Vulcano (Forghia Vecchia) | AD 1206? |
| 39 | hornblend | ? | ? |
| 47 | hornblend | ? | ? |
| 54 | Kaersutite | Lipari (Monte Pilato and Rocco Rosa) | 1220±100 yr BP |
| 58 | hornblend | ? | ? |
| 73 | Augite-diopside and aegyrine augite | Vesuvius | AD 97 |

All workers who studied the Sebkha Mhabeul (e.g. Essefi et al., 2014), for documenting climatic fluctuations during the last two millennia, their records was mostly based on the chronology proposed for the first time by Abichou (2002).

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