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Short communication

## The first evidence of paleo-wildfire from the Campanian (Late Cretaceous) of North Africa

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## ABSTRACT

Although the fossil record of plant macro- and mesofossils, including fossil charcoal, is patchy geographically and temporally, such remains play an important role for the interpretation of paleo-environmental and paleoclimatic developments in the continental realm. In Egypt, previous palynological studies on the Upper Cretaceous (Campanian) deposits suggested presence of lush subtropical forests, dominated by angiosperms and pteridophytes, which developed under warm and wet climatic conditions. In the present study, the occurrence of paleo-wildfires during the Late Cretaceous (Campanian) is presented for the first time, based on samples from a surface exposure in the vicinity of the Baris Oasis, south Western Desert, Egypt. Macroscopic charcoal was collected and subsequently analyzed under a stereomicroscope and scanning electron microscope (SEM). The charred wood remains were identified as belonging to gymnosperms, which were important components of the North African paleoflora during the Cretaceous. These charcoal remains represent the first verified occurrence of paleo-wildfires in Africa during the Campanian.

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## 1. Introduction

Fossil plants are excellent proxies to reconstruct continental paleoenvironments and climates (Chaloner & Creber, 1990; Francis et al., 2008; Poole & Cantrill, 2006; Uhl, 2006). One aspect that has attracted more attention in the last decade is the occurrence of charcoal and other evidence of paleo-wildfires in pre-Quaternary deposits all over the world (cf. Scott, 2000, 2010; Scott, Bowman, Bond, Pyne, & Alexander, 2014). Since Scott (2000) published a seminal review on the “Pre-Quaternary history of fire”, our knowledge about paleo-wildfires has increased tremendously. The oldest record of charcoal comes from the Silurian (Glasspool, Edwards, & Axe, 2004) and ever since, the paleo-wildfire has occurred more or less regularly in many terrestrial ecosystems (e.g. Scott, 2010; Scott et al., 2014). However, as for many other kind of continental fossil evidence, the fossil record of paleo-wildfire (consisting mostly of charcoal, including pyrogenic inertinites, as well as pyrogenic Polyaromatic Hydrocarbons – PAHs) is patchy in

space and time (e.g. Abu Hamad, Jasper, & Uhl, 2012; Jasper et al., 2013; Scott, 2000, 2010). For certain periods and regions, many evidences exist and are well documented for paleo-wildfires, while for other periods and regions virtually very little are known (e.g. Abu Hamad et al., 2012; Jasper et al., 2013; Scott, 2010; Scott et al., 2014). In part, this is not only due to changes in fire intensity and frequency through time (e.g. Abu Hamad et al., 2012; Scott et al., 2014), but also due to various taphonomic reasons, including the lack of knowledge of many scientists for this kind of fossil evidence (Abu Hamad et al., 2012).

Periods that had enormous increases of reported evidence of wildfires during the last decade are the Permian (cf. Abu Hamad et al., 2012; Jasper et al., 2013 and citations therein) and the Cretaceous (cf. Brown, Scott, Glasspool, Margaret, & Collinson, 2012 and citations therein), two periods with supposedly high atmospheric oxygen concentrations (Scott et al., 2014). Most reports on the Permian and Cretaceous wildfires come from the Northern hemisphere (e.g. Abu Hamad et al., 2012; Brown et al., 2012; Jasper et al., 2013), but at least for the Permian the number of reports from the southern hemisphere (i.e. Gondwana) is steadily increasing (cf. Jasper et al., 2013). However, for the Cretaceous reports of charcoal and other evidence of wildfire are still scarce in Gondwana (cf.

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Brown et al., 2012 and citations therein; Manfroi, Dutra, Gnaedinger, Uhl, & Jasper, 2015; dos Santos et al., 2016).

Based on available data from the Northern hemisphere, the Cretaceous was a period of 'high-fire' period (Scott et al., 2014), but due to the scarcity of data from the Southern hemisphere it is not clear whether this holds true from a global point of view (Bond & Scott, 2010; Brown et al., 2012). Currently, it is not clear whether the differences in the numbers of published reports from the Northern and the Southern hemisphere are due to a biased fossil record, a lack of studies on Southern hemisphere fires or to real differences in the occurrence of Cretaceous fires (Bond & Scott, 2010; Brown et al., 2012).

We herein address these issues by presenting the first detailed analysis of macroscopic charcoal as a direct evidence of paleo-wildfires from North Africa (i.e. Egypt), which also represents the first record of macroscopic charcoal from the Campanian period for all of Africa.

## 2. Material and methods

### 2.1. Locality and source data

The charcoal remains described here were collected from shale surface exposure in the Baris area, south Western Desert, Egypt

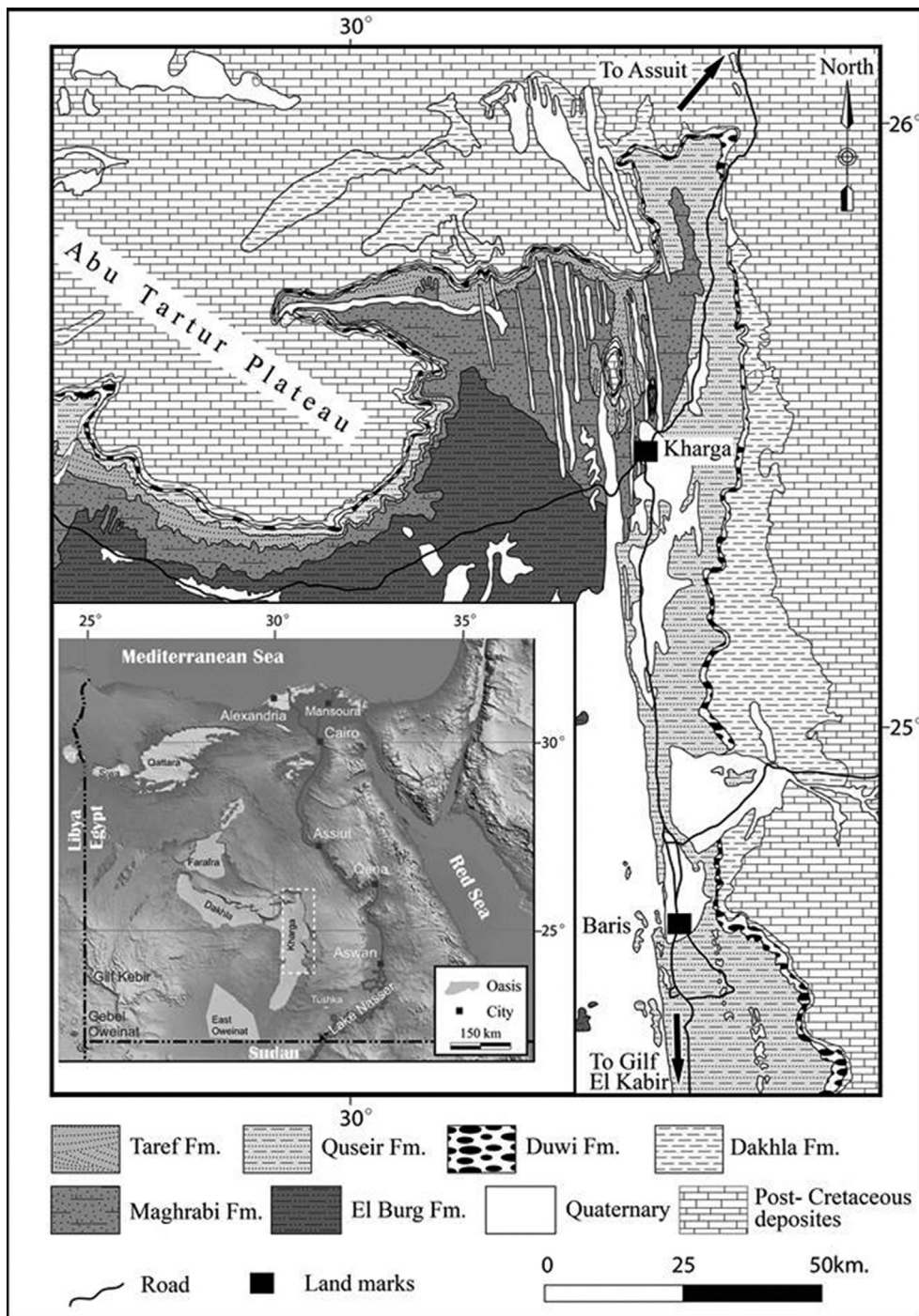


Fig. 1. Map showing the geographic location of the studied area, south Western Desert, Egypt. Charcoal found in the direct vicinity of Baris.

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