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Investigating the late Cretaceous eastern Tethys: a multi proxy record of climatic shifts and tectonic activity (Zagros Basin, Iran)

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The mid to late Cretaceous was characterized by extreme greenhouse conditions (Hay, 2008). However, the Late Cretaceous was marked by a long-term climatic cooling, which accelerated in the Campanian (Friedrich et al., 2012; Linnert et al., 2014), ending with a generally cooler, but fluctuating temperatures in the Maastrichtian (e.g. Li and Keller, 1998).
This study seeks to explore the mechanisms that triggered Late Cretaceous climatic trends (temperature and humidity) by investigating Coniacian-Maastrichtian deposits of Gurpi Formation in Shahneshin section (Fars province, Zagros Basin). The position of this basin is particularly interesting as there are very few studies on Late Cretaceous integrated stratigraphy and paleoclimate change in the eastern Tethys. For these purposes, an integrated study of clay mineralogy, calcareous nannofossil paleoecology and isotope geochemistry (δ13C and δ18O) was carried out on the Gurpi succession.
Calcareous nannofossils have been studied on 125 smear-slides. Clay mineralogy was examined for 126 samples and bulk δ13C and δ18O were conducted on 353 samples.
Our findings reveal evidence of temperature and humidity variations, sea level change and pulses of tectonic activity. The clay mineralogy shows two significant changes in detrital inputs of chlorite, illite and kaolinite during the Santonian and the late Campanian, respectively. The Coniacian-Santonian interval was marked by a small percentage of serpentine (3-5%), possibly reflecting the erosion of mafic rocks from the oceanic crust of the basin, providing a clue for the initiation of obduction in the Zagros Basin at that time. Increased tectonic activity in the mid-Santonian also led to local sea-level fall, as supported by a significant increase in benthic foraminifers, and explaining the first pulse in detrital inputs to the basin. The Campanian to Maastrichtian change in clay mineralogy was likely controlled by climate processes, caused by hydrolysis and increased humidity during the early to middle Campanian, and more arid conditions during the late Campanian through the Maastrichtian.
The data also unveil a gradual increase in δ18O values from the Coniacian through the Maastrichtian. During the middle Campanian a major positive shift occurred in the δ18O values ($\sim$ 0.5 ‰, which is coeval with a drastic increase in Micula staurophora, that may be interpreted here as a response to cooling. The δ18O values were highest during the late Campanian and Maastrichtian. Late Campanian-Maastrichtian fluctuations in bulk δ18O also negatively correlate with changes in calcareous nannofossil species richness. In addition, two distinct episodes of increase in benthic foraminifers occur in the late Campanian, and could be correlated to the polyplocum global regression. Interestingly, this late Campanian episode of shoaling correlates with the deposition of Seymareh Member in Lurestan area. However, facies of this interval at Shahneshin point to a deeper setting than the facies of Seymareh Member. Our results suggest that the conditions where Lurestan constituted a deeper portion of Zagros Basin than Fars in the Turonian to Santonian interval (Wynd, 1965; Setudehnia, 1978; Sepehr and Cosgrove, 2004), was disrupted in the Campanian, advocating for an uplift in Lurestan and further deepening in Fars.