PS Source Rock Potential Evaluation of the Eagle Ford - Austin Chalk Transition in San Antonio, Texas*

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Abstract

Sea level changes, subsea volcanism, and local to global anoxic events shaped Late Cretaceous sedimentation in South Central Texas. Near the Turonian – Coniacian boundary, organic-rich calcareous mudrocks of the Eagle Ford Group transition into finely-grained facies of the Austin Chalk Group (e.g., Phelps et al., 2014). The objective of this research is to understand what depositional and diagenetic parameters favored the preservation of organic matter and could account for fluctuating kerogen types. Two outcrops in the San Antonio area are investigated to develop an integrated depositional model based on a sedimentological and geochemical approach. We aim to improve our understanding of organic matter production, preservation, and source rock potential during the late Turonian – early Coniacian.

The two studied outcrops are located on the northeast and the northwest side of the city of San Antonio. Their detailed sedimentological description suggests a deeper, more complex depositional setting to the northeast, where organic material was preferentiality preserved as suggested by dark, finely laminated mudrocks. Moreover, the occurrence of an iron-stained layer caped by levels with iron and phosphate ooids constitutes an additional difference compared to the second study location where ripples and small scale hummocky-cross stratifications highlight a higher energy depositional environment. Geochemical analyses (X-ray fluorescence spectrometry, rock-eval pyrolysis) of samples from both locales provide information on the nature of the organic matter preserved. On the north-east side of San Antonio, a deeper, suboxic depositional environment (enrichment factor in vanadium of up to 18; e.g., Tribovillard et al., 2006) favored the preservation of organic material produced by an enhanced primary productivity stimulated by an increased nutrient supply (high phosphorus content). This is not the case on the northwest side of San Antonio where wave activity might have promoted oxidation of organic material. Van Krevelen and Pseudo Van Krevelen diagrams reveal the presence of moderately mature type I to less mature type II kerogens to the northeast, and of degraded type III kerogen to the northwest, suggesting a stronger influence of neighboring landmasses and the development of small-sized intrashelf basin where marine organic matter has been preserved to the northwest and northeast parts of San Antonio, respectively.

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Research Aim

Sea level changes, subsea volcanism, and local to global anoxic events shaped Late Cretaceous sedimentation in South Central Texas (Fig. 1). Near the Turonian – Coniacian boundary (Fig. 2), organic-rich calcareous mud rocks of the Eagle Ford Group transition into finely-grained facies of the Austin Chalk Group. The objective of this research is to understand what syndepositional and post-depositional parameters favored the preservation of organic matter and could account for fluctuating kerogen types.

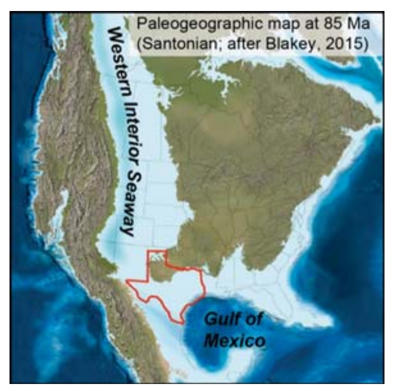

Fig. 1: Location map of Texas during the Santonian (Late Cretaceous).

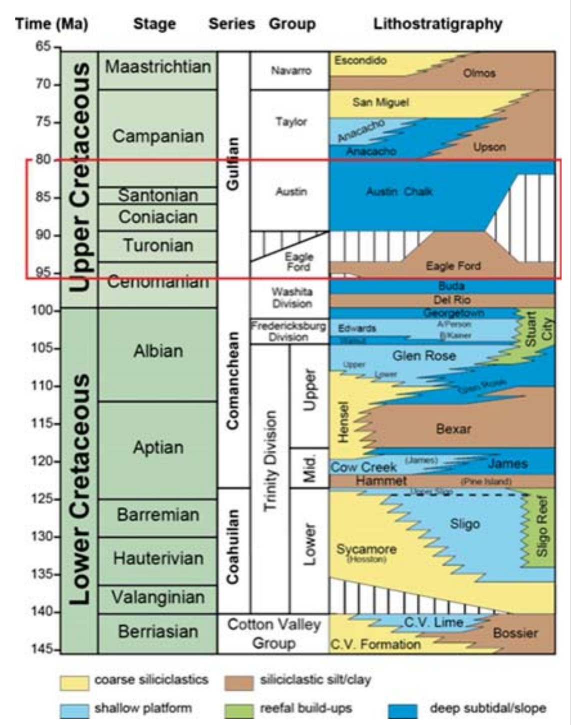

Fig. 2: Cretaceous chronostratigraphic chart of central Texas (after Phelps et al., 2014). The Eagle Ford and Austin Chalk Groups are highlighted by the red box.

Goal

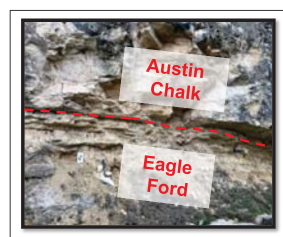

Fig. 3: Target Section, TS, outcrop, NW San Antonio

Fig. 4: Olympia Golf, OG, outcrop, NE San Antonio

Fig. 5: Location map of the studied outcrops.

Two outcrops (Figs. 3-5) were investigated to develop an integrated depositional model based on a sedimentological and geochemical approach. We aim to improve our understanding of organic matter preservation and source rock potential during the late Turonian – early Coniacian.

Methods

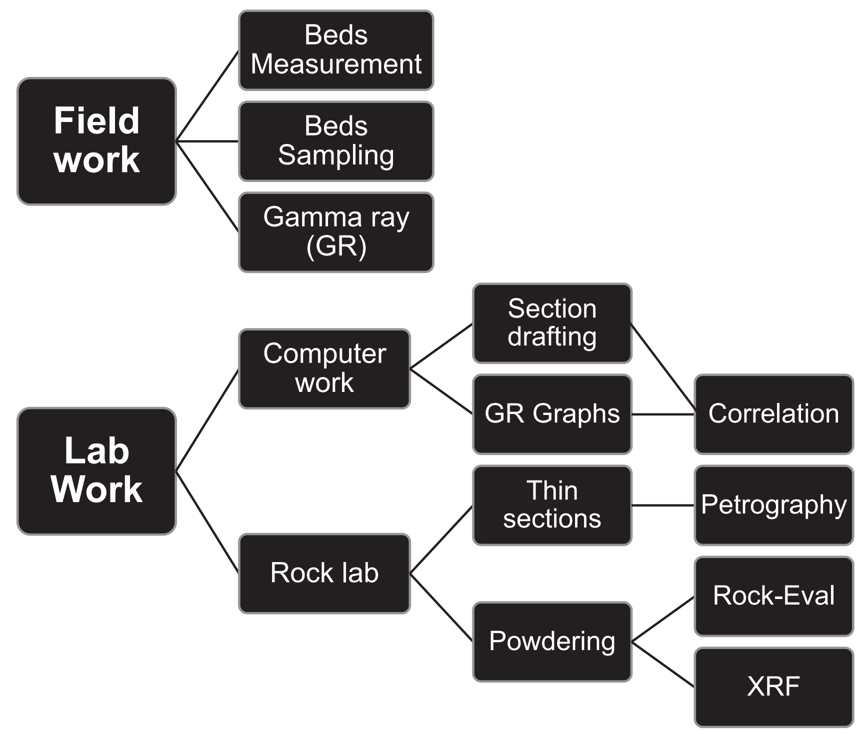

Fig. 6: Flowchart diagram of the methodology used in this study.

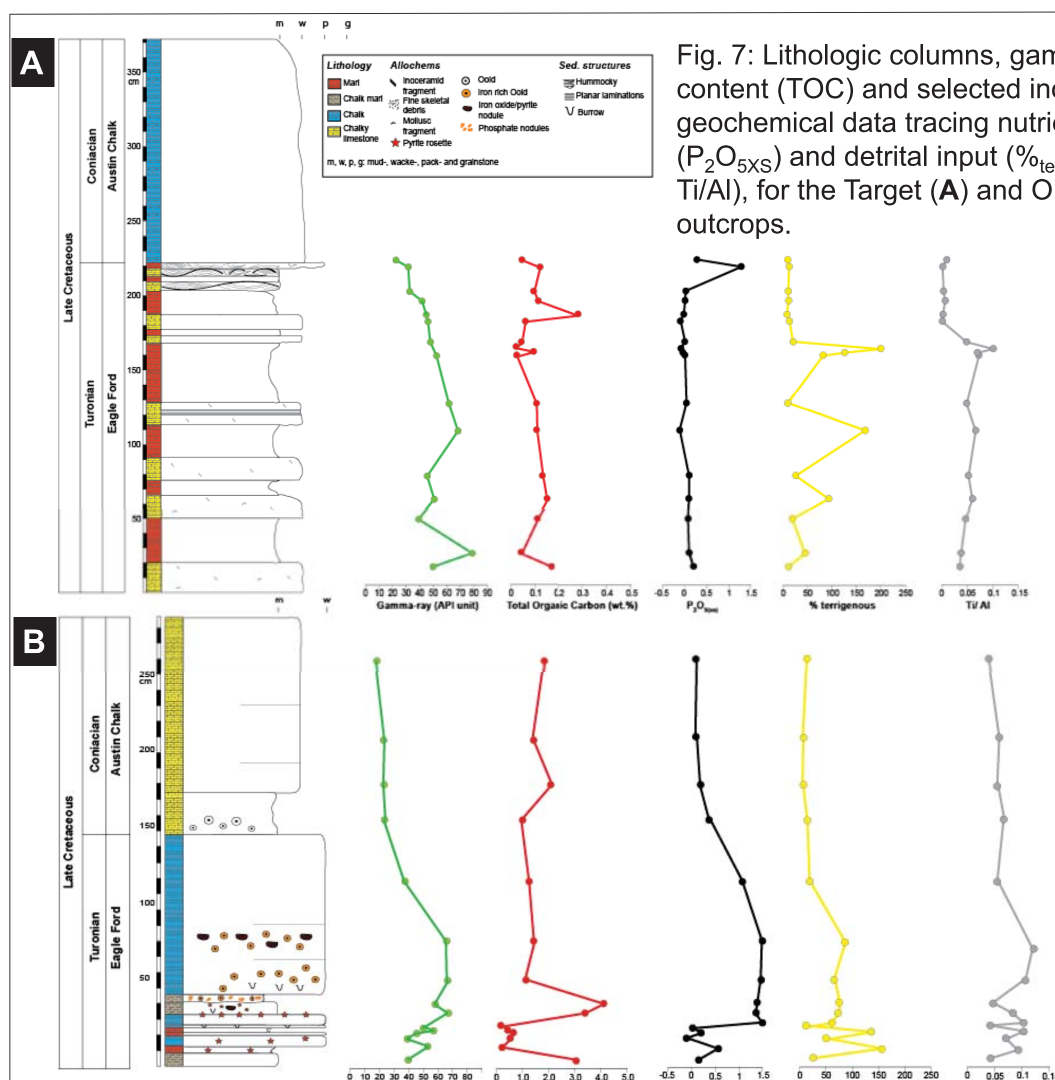

Fig. 7: Lithologic columns, gamma-ray, organic content (TOC) and selected inorganic geochemical data tracing nutrient input (P_2O_{5XS}) and detrital input ($\%_{terrigenous}$ and Ti/Al), for the Target (**A**) and Olympia Golf (**B**) outcrops.

Results

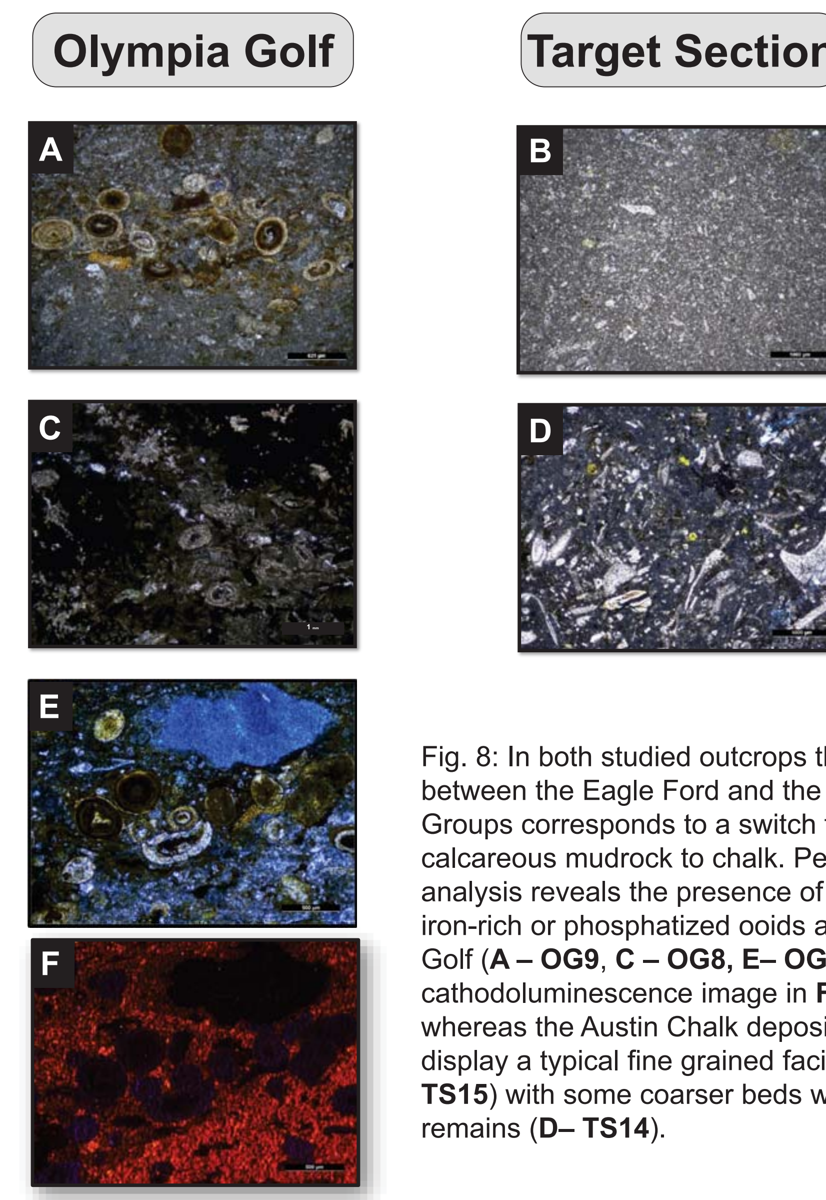

Fig. 8: In both studied outcrops the transition between the Eagle Ford and the Austin Chalk Groups corresponds to a switch from calcareous mudrock to chalk. Petrographic analysis reveals the presence of reworked, iron-rich or phosphatized ooids at Olympia Golf (**A – OG9**, **C – OG8, E– OG9B** and cathodoluminescence image in **F – OG9**), whereas the Austin Chalk deposits at Target display a typical fine grained facies (**B – TS15**) with some coarser beds with crinoid remains (**D– TS14**).

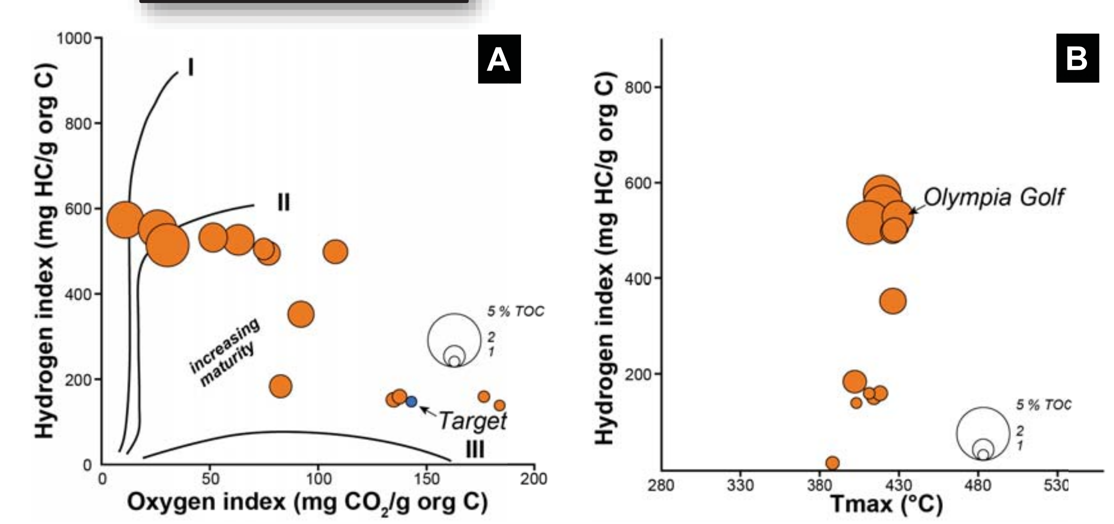

Fig.9: The Van Krevelen (**A**: Hydrogen index vs. Oxygen index) and pseudo-van Krevelen (**B**: Hydrogen index vs. Tmax) diagrams indicate that samples from Olympia Golf mostly correspond to a mature, type I/II (marine) organic matter, whereas the organic matter at the Target outcrop is probably altered.

Reflection

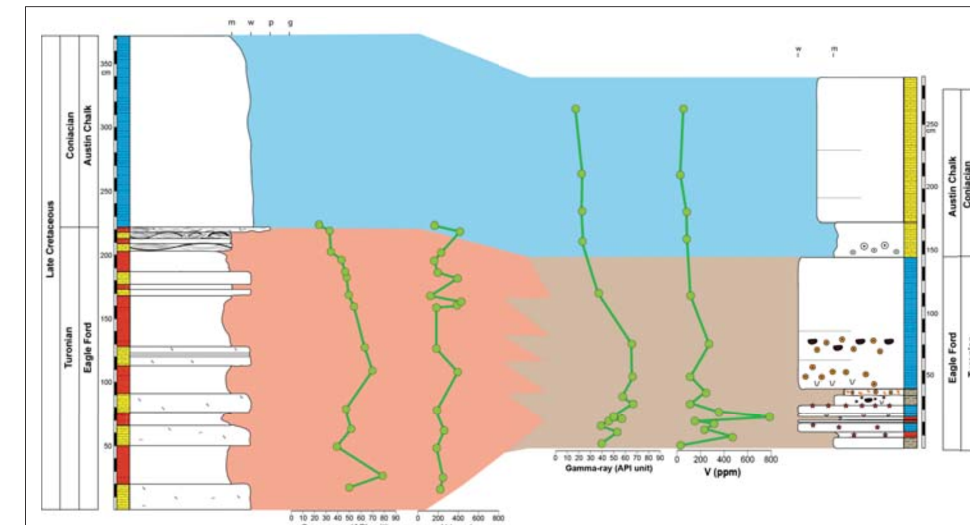

Fig. 10: Gamma ray and lithological correlation of the Target and Olympia Golf Course outcrops (see Fig. 5 for location). Vanadium (V) content serves as a proxy for seawater oxygen level.

The two studied outcrops display different facies and geochemistry. A shallower depositional environment is postulated for the Target outcrop (coarser facies with hummocky cross stratifications), where rather oxic conditions deduced from low vanadium content (Fig. 10) might have hampered the preservation of organic matter (low TOC values; Fig. 8). Conversely, suboxic conditions developed at Olympia Golf Course thanks to a deeper depositional environment where high TOC values were measured (Figs. 8 and 10).

We suggest that faulting created zones of tectonically-enhanced subsidence where reduced oceanographic circulation promoted the developed of suboxic conditions and the preservation of organic matter. Faults development contemporaneous of the Eagle Ford were identified in the Atascosa County (Charlotte Fault Zone; Fig. 11) by Billingsley et al. (2015), thus supporting our interpretation.

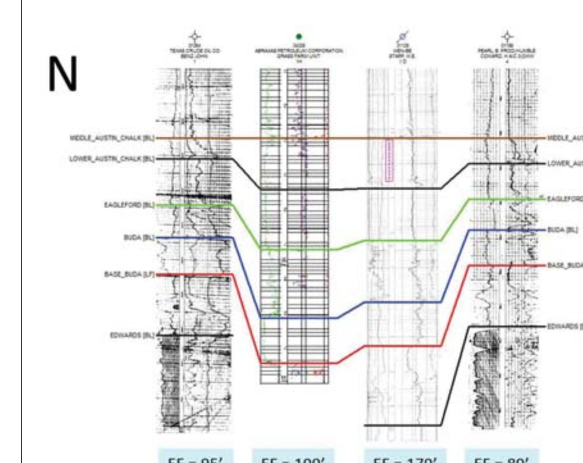

Fig.11: The correlation of well log data from the Atascosa County shows a local thickening of the Eagle Ford deposits induced by syn-sedimentary normal faults (after Billingsley et al., 2015)

References

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Acknowledgements

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