Faunal and environmental changes through the Cretaceous-Paleogene boundary (K-Pg) linked with Deccan Volcanism: evidence from the Neo-Tethys, Turkey

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This presentation focuses on the work carried out in the Haymana Basin.
Field pictures showing sedimentation style of Haymana (a), and Mudurnu-Göynük Basins (b,c,d)
Outline of the work on Haymana Basin

- Quantitative analysis: 63-150 µm & >150 µm
- Relative Abundances and Species Richness
- Paleobathymetric Analysis
- Events across the K-Pg boundary
Quantitative analysis
Paleobathymetric Calculation

Planktic/Benthic Ratio

\[
\%P = \left( \frac{P}{P + B} \right) \times 100
\]

Van der Zwaan et al. (1990)

\[
Depth(D) = e^{3.58718 + (0.03534 \times \%P)}
\]

Ave. Depth 381m

De Rijk et al. (1999)

\[
Depth(D) = e^{(\%P + 81.9)/24}
\]

Ave. Depth 490m
A) Paleobathymetric variations (depth in meters) through Maastrichtian are based on formulas of: Van der Zwaan et al. (1990) (upper graph), De Rijk et al. (1999) (lower graph). White bars represent standard errors. Paleobathymetric calculations revealed 400 m paleodepth for our study area corresponding upper bathyal zone.

B) Paleodepth of the study area in the Haymana Basin and its comparison with worldwide K-Pg boundary sections. Image modified after MacLeod and Keller (1994) and Molina et al. (2006 and references therein).
Quantitative Analysis

• 63-150 µm & >150 µm size fractions

• Relative abundance and species richness changes across the K-Pg boundary
Quantitative Analysis

Population at >150 μm fraction

- 394 individual count per sample
- Average 40 species richness
Population at 63-150 µm fraction

- Average 380 individual per sample
- Average 15 species richness
Relative Abundance Analysis

*r-Strategists (Generalists)*

- L. dentata
- H. globulosa
- G. multispinus
- G. cretacea

- Small, unornamented, tolerant to nutrient, temperature, acidity fluctuations in environment
Some K-Strategists (Specialists)

- Large, ornamented, diversified but occupy certain niches and intolerant to environmental fluctuations!
Relative abundance of population >150 µm

K-Pg

r-Strategists (Generalists)

K-Strategists (Specialists)
Population above 63-150 µm fraction

Heterohelicids General

H. globulosa

G. cretacea

Quantitative Analysis

Guembelitria cretacea  Heterohelix globulosa  Heterohelix spp.
Quantitative Analysis

- 50% drop in the species richness before the KPB
- Environmental stress prior to KPB!

Species Richness

9 out of 28 species survived!
Maastrichtian CF1-CF2

Pardo & Keller 2008
Nature of the K-Pg boundary layer

- 2-3 mm thick reddish oxidized layer
- Sharp extinction horizon!
- >63 µm Almost no planktonic foraminifera (only some heterohelicids, guembelitrids, globigerinellids & hedbergellids) & very rare benthics
Findings across the K-Pg boundary
Findings across the K-Pg boundary

- Thoracosphaera acme
- Black and Brown spherules
  Only found within the 2-3mm thick reddish layer!
- Amorphous Grains
  Only found within the 2-3mm thick reddish layer!
- Abrupt increase in pellets
- Euhedral Grains
  Found -2cm & at the K-Pg boundary layer.
  Not above!
Thoracosphaera spp. increase

- Calcareous dinoflagellate-Phytoplankton
- Environmental Stress Marker (Lamolda et al., 2005)

Findings across the K-Pg boundary

Hildebrand-Habel et al., 1999
Our Findings in Haymana Basin

Hildebrand-Habel et al. 1999

Bramlette & Martini 1964
Thoracosphaera opercula
Findings across the K-Pg boundary

Black and Brown spherules
Series 1 - Brownish, amber and yellow ones

Some specimens are pliable!
Series 1 - Black ones

More smooth surface!
Black and Brown Spherules

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<th>Series 1-d</th>
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Findings across the K-Pg boundary

Pellet Surge

A) View of the fecal pellets in reflected light. Samples from E+2, 2 cm above the K-Pg boundary, recovered from >150 mm sieve, X60 magnification

B) Scanning electron microscope (SEM) views of the fecal pellets peak at 2 cm above the K-Pg boundary
Number of fecal pellets rapidly increases right after the K-Pg boundary in the Danian P0 Zone. Notice the abrupt increase right after the K-Pg boundary. Another but much minor increase was detected in the lower Pα Zone.
No solid interpretation is pronounced at this stage about their genesis. Yet, being present only in the 2-3 mm thick layer corresponding the K-Pg boundary may infer the impact origin.

A) Brown grains were found in washed residues of the 2-3 mm thick reddish layer corresponding the K-Pg boundary. Displayed grains were recovered from >150 mm sieve. Left view x40 magnification, right view x60 magnification.

B) SEM images of the brown grains

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Euhedral Grains

Found -2cm & at the K-Pg boundary layer.
Not above!

A) Barite crystals were found only from 2 cm below and right at the K-Pg boundary level (2e3 mm thick reddish layer). View in reflected light. Sample E-2 from >150 mm screen, x100 magnification. B) SEM images of Barite grains.

The increase in the barite grains below and at the K-Pg boundary layer may be a record of paleoproduction enhancement across the K-Pg interval and/or increase in atmospheric sulphur oxides caused by the Chicxulub impact.

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CONCLUSION
Almost complete dominance of *r-Strategists* 
*Heterohelix* ve *Guembelitria* domination

- *r-Strategists (Generalists) > K-Strategists (Specialists)*
- *Heterohelix* domination
- More species richness (Average 40 species)
Events *before* the K-Pg boundary

- **Dominance of *Heterohelix* species**
- **Guembelitria blooms**
- **Decreasing species richness**

**Interpretation:**

- Expanded Oxygen Minimum Zone (OMZ)
- High terrigenous influx (increased weathering) directing augmented nutrient levels/ *eutrophication*. This might have caused by Deccan-induced climate change and enhanced weathering.
- Environmental stress due to Deccan Volcanism
Events at & after the K-Pg boundary

68% of planktonic foraminifera underwent extinction at the K-Pg boundary

Guembelitria cretacea bloom after the KPB

Thoracosphaera acme

Abrupt increase in echinoid pellets

Environmental crisis after the KPB
Thank you...