High-resolution integrated stratigraphy of the Hauterivian in Umbria-Marche (Central Italy)

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STRATI 2019  2nd - 5th July
Introduction

The **CRASH** project:

**Checking the Reproducibility of Astrochronology in the Hauterivian**

<table>
<thead>
<tr>
<th>Mesozoic Cretaceous</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maastrichtian</td>
<td>72.1 ±0.2</td>
</tr>
<tr>
<td></td>
<td>Campanian</td>
<td>83.6 ±0.2</td>
</tr>
<tr>
<td></td>
<td>Santonian</td>
<td>86.3 ±0.5</td>
</tr>
<tr>
<td></td>
<td>Coniacian</td>
<td>89.8 ±0.3</td>
</tr>
<tr>
<td></td>
<td>Turonian</td>
<td>93.9</td>
</tr>
<tr>
<td></td>
<td>Cenomanian</td>
<td>100.5</td>
</tr>
<tr>
<td></td>
<td>Albian</td>
<td>~ 113.0</td>
</tr>
<tr>
<td></td>
<td>Aptian</td>
<td>~ 125.0</td>
</tr>
<tr>
<td></td>
<td>Barremian</td>
<td>~ 129.4</td>
</tr>
<tr>
<td></td>
<td>Hauterivian</td>
<td>~ 132.9</td>
</tr>
<tr>
<td></td>
<td>Valanginian</td>
<td>~ 139.8</td>
</tr>
<tr>
<td></td>
<td>Berriasian</td>
<td>~ 145.0</td>
</tr>
</tbody>
</table>
Introduction

- The CRASH project: Checking the Reproducibility of Astrochronology in the Hauterivian

- Discrepancy of astrochronological duration of the Stage:
  - \(5.9 \pm 0.4\) Myr in Río Argos (Spain)
  - 3.5 Myr in Italian sections (Bosso and Monte Acuto)
Introduction

- The CRASH project:

  Checking the Reproducibility of Astrochronology in the Hauterivian

Examples of cyclo- and magnetostratigraphy in the Hauterivian
(Channell et al., 1995, Martinez et al., 2015)
Temporal correlations of the Valanginian C-isotope shift

(Westermann et al., 2010)
### StratigrapherR

**StratigrapherR: Integrated Stratigraphy**

- **Version:** 0.0.6
- **Depends:** R (≥ 3.5.0)

[https://CRAN.R-project.org/package=StratigrapherR](https://CRAN.R-project.org/package=StratigrapherR)

- R package available on the Comprehensive R Archive Network (CRAN)
- Entirely open source
- Implements R functions for integrated stratigraphy, to be used in combination of base R functions
Stratigrapher: Integrated Stratigraphy

Version: 0.0.6
Depends: R (≥ 3.5.0)

https://CRAN.R-project.org/package=Stratigrapher

Poster: panel n°17 on Thursday and Friday ST2.3-12
Geological setting
New magnetostratigraphic framework

- We refined the magnetostratigraphic framework:
  - Increased resolution at the magnetic inversions (in progress)
  - Palaeomagnetic samples well positioned against high resolution litholog and cyclostratigraphic samples

(Channell et al., 1995)
Chert and limestone in thin sections
Differentiating quartz and calcite
- Limestone:
  - Fine micrite

- Cherts:
  - Microquartz (< 20 µm)
Limestone:
- Fine micrite

Cherts:
- microquartz (< 20 µm)
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- Radiolaria:
  - Silicified or calcified
- **Polarised**

- **Limestone:**
  - Fine micrite

- **Cherts:**
  - microquartz (< 20 µm)

- **Radiolaria:**
  - Silicified or calcified

200 µm
- Limestone:
  - Fine micrite

- Cherts:
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- Radiolaria:
  - Silicified or calcified

Analysed + Gypsum

200 µm
Analysed + Gypsum
Rotation
Chert and limestone in thin sections

Characterization
Limestone:
- Fine micrite
- Calcified radiolaria, badly preserved, visual estimation 5-10%
- Common stylolites
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Well preserved (pyritized) radiolaria parts in palynogical thin sections of black shale for reference.
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Limestone

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- 0.7 to 3.3% SiO₂, well correlated to:
  - Fe₂O₃ (R = 0.84)
  - TiO₂ (R = 0.85)
  - Al₂O₃ (R = 0.90)
Cherts:
- Microquartz (< 20 µm)
- Silicified radiolaria in cherts or neighbouring limestones, well preserved, visual estimation 5-10%
- Limestone/chert interface sometimes sharp, sometimes transitional
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- Purest samples:
  (less than 1% CaO, assumed without contamination, 7 samples on 11)
  - 96 to 98% SiO₂
  - TiO₂ and Al₂O₃ mean values similar to the ones of limestones (but correlations between detrital elements are weak)
  - Fe₂O₃ mean values 40% of that of the limestones, magnetic susceptibility systematically lower than in limestones
Radiolaria rich limestones (3 samples):
- Higher than average radiolaria density (15-20 %)
- Associated with cherts nodules
- Well preserved silicified radiolaria in limestone
- 15% SiO$_2$ (1 sample), probably from small nodules, highest Fe content of limestones
Normal limestone

Radiolaria rich limestones
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Diagenetic effect

- Thorough segregation of mobile Si and Ca between cherts and limestones
- Similar concentrations of radiolaria, Ti and Al in cherts and limestones
- The abundance of cherts in the section (estimated from 5 to 12% based on lithological observation) is coherent with the visual abundance of radiolaria observed in most thin sections (5 to 10% cherts and limestones alike)

- Relatively low Fe concentrations and low magnetic susceptibility in cherts: iron oxides dissolution?

- Intermediary samples of limestone with high radiolaria density and chert nodules
Discussion

- Is there a primary signal preserved in the limestone/chert alternation?

- Is the diagenetic effect reinforcing the alternations or creating them entirely?

“...opal-CT nucleation during chertification is largely heterogeneous on pre-existing opal-CT crystals...” (Maliva and Siever, 1989)

Mechanisms explaining chert formation allow for both possibilities
Using stratigraphy to study diagenesis

- Chert beds and stratified nodules can be correlated as bundles in some parts of the sections, with some only small offsets in relation with black shales and a few differences in number of cherts.

- Beds can be correlated to nodules and vice-versa.

- Some parts of the sections are not correlatable (extending beyond the slump-affected parts in Frontone).
Conclusion

- Strong diagenetic segregation of Si and Ca at the source of nearly pure chert and limestones

- Chert beds and stratified nodules still record a reproducible pattern at a regional scale

- On part strongly inconsistent:
  - Lack of cherts in Bosso
  - Slumps in Frontone, and abundant chert levels outside neighbouring slump intervals
High-resolution stratigraphy at a regional scale is a powerful tool to study diagenesis.

Even with signs of strong diagenesis, diagenetic alternations can still be correlated at a regional scale.  
=> Reinforcement of primary alternations?

However, heterogeneous processes seem to be equally capable of creating alternations from nothing.

The ubiquity and regularity of chert layering make it generally difficult to identify any specific pattern without independent high-resolution stratigraphy.

How do we characterise/quantify discrepancies in pattern matching?
Thank you for your attention


