

# Refining lithostratigraphy, cyclostratigraphy and magnetostratigraphy in Italian reference sections of Hauterivian age (Bosso, Monte Acuto and Frontone) for future comparison of cyclostratigraphic results

S. Wouters\*, S. Satolli, M. Martinez, F. Boulvain, T. Goovaerts, B. Meyvis, X. Devleeschouwer

\*Corresponding author [sebastien.wouters@doct.uliege.be]

## Astrochronology in the Hauterivian

Astrochronology has proven to be a powerful method to constrain the duration of geological periods. However in some geological periods cyclostratigraphic studies give diverging results. For instance the **duration of the Hauterivian Stage** was estimated at **3.5 Myr** in central Italy, and **5.9 ± 0.4 Myr** in South-Eastern France and South-Eastern Spain (Sprovieri et al., 2006; Martinez et al., 2015).

## CRASH: Checking the Reproducibility of Astrochronology in the Hauterivian

The **CRASH** project (Checking the Reproducibility of Astrochronology in the Hauterivian) has for objective to study the reproducibility of astronomical time scales in the problematic Hauterivian stage. Three zones in **Italy**, **Germany** and **Argentina** are being investigated for **cyclostratigraphy** and **magnetostratigraphy**. The identification of magnetic inversions will allow to correlate the sections and to establish a robust framework for the comparison of the astronomical time scales.

## Refining litho-, cyclo- and magnetostratigraphy in Hauterivian Italian reference sections

Well-documented Italian sections of Hauterivian age (**Bosso** and **Monte Acuto**) were sampled for the **CRASH** project. Litho-, cyclo- and magnetostratigraphy are performed based on the observations and samples collected altogether during the CRASH field missions, providing a solid reference framework. A new Italian section was also studied: **Frontone**. Its stratigraphic interval is encompassed by the one that the Bosso sections spans (Fig. 2).

## Centimetre-scale (black) shale levels: markers of regional events ?

High-resolution (1 cm) logging of the Italian sections showed the presence of clustered centimetre-scale shale levels, often of black colour. The most remarkable bundle is known as the Faraoni level (Fig. 1) and is well-documented (e.g. Channell et al., 1995). Other bundles present similar patterns and stratigraphic positions in the Bosso and Frontone sections (Fig. 2). They could therefore be attributed to regional events. Such levels were the only **stratigraphic markers directly observable on the outcrops**. Their identification in new sections could help to define the stratigraphic age of these sections directly in the field.

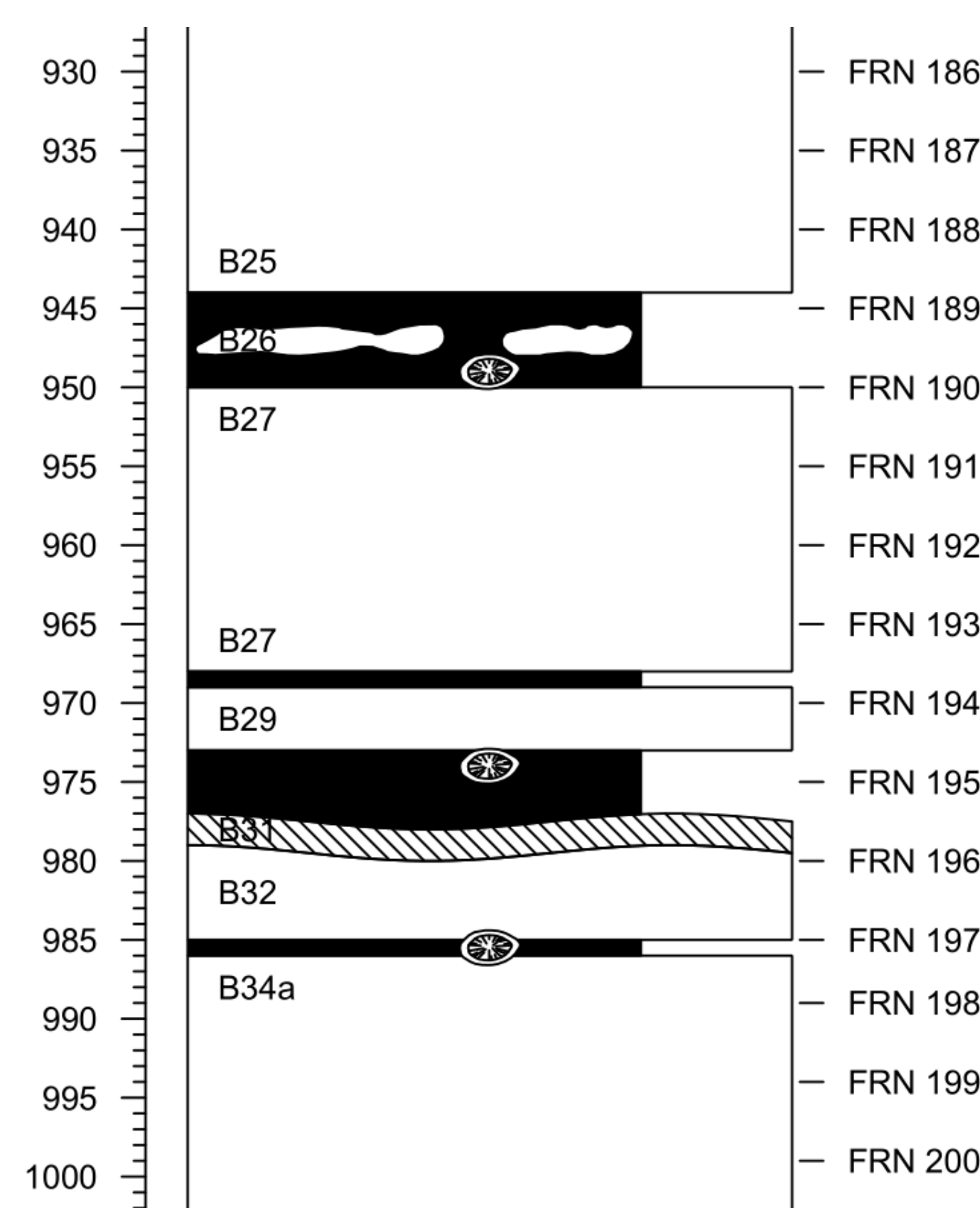
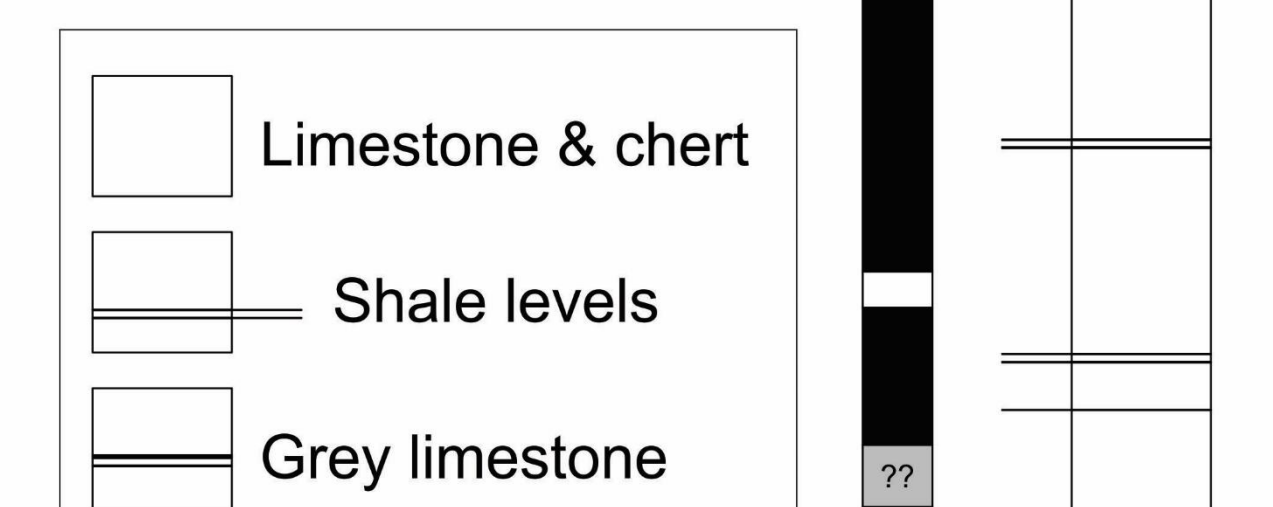
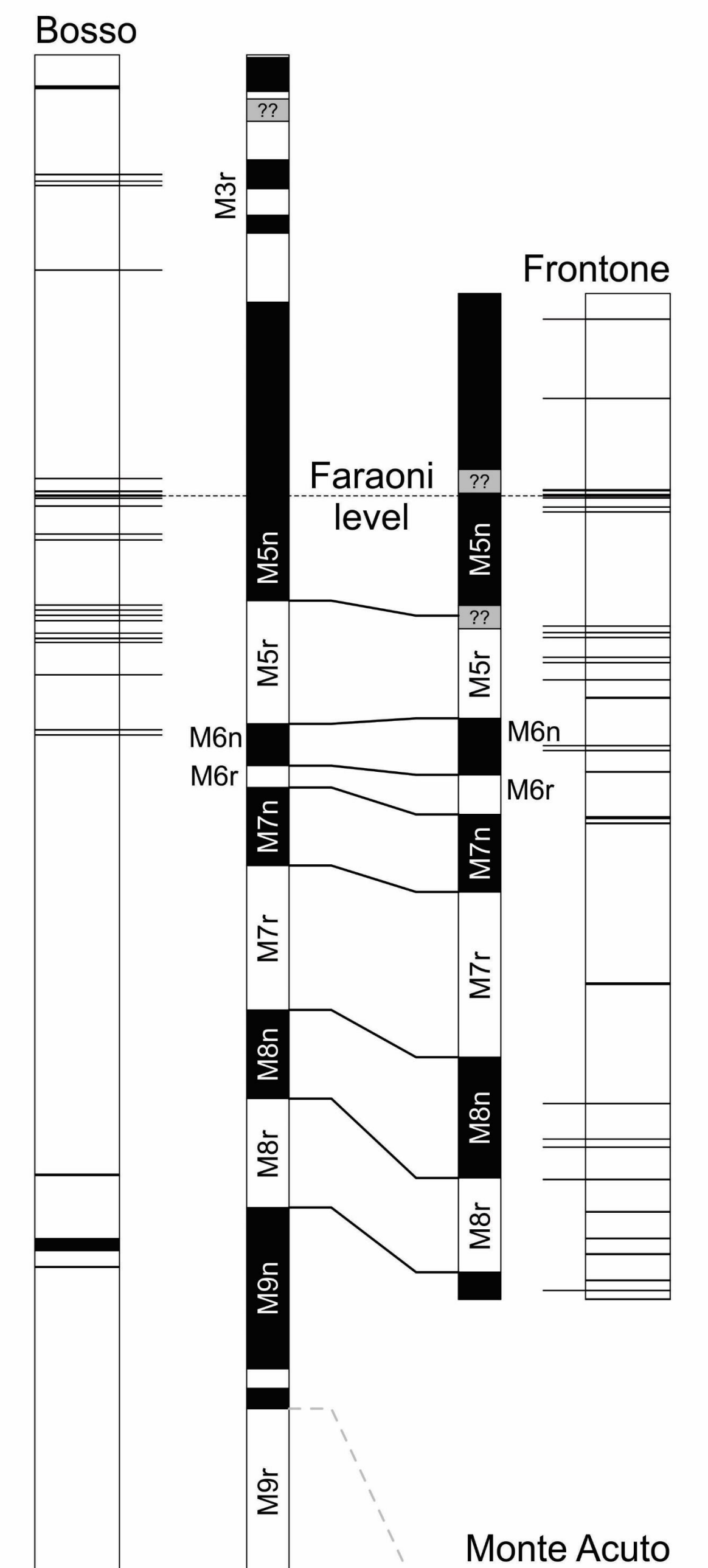


Fig. 1 Close up of the Faraoni level in the Frontone section litholog. The axis on the left is in cm. Black stands for black shales, white for limestone, shaded for chert. Marcasite nodules are indicated at 984, 976 and 951 cm.

This figure was generated using R, allowing a precise positioning of the beds, samples and other features.

Fig. 2 Litho- and magnetostratigraphy in the sections of Bosso, Frontone and Monte Acuto (Italy). The interpretation of the palaeomagnetic results is based on Channell et al. (1995) and Speranza et al. (2005).

This figure was generated using R, and annotated with a vectorial drawing software.



## References

Channell, J. E. T., F. Cecca, et E. Erba. 1995. « Correlations of Hauterivian and Barremian (Early Cretaceous) stage boundaries to polarity chrons ». *Earth and Planetary Science Letters* 134 (1): 125-40.

Martinez, M., Deconinck, J.F., Pellenard, P., Riquier, L., Company, M., Reboulet, S., & Moiroud, M., 2015. « Astrochronology of the Valanginian–Hauterivian stages (Early Cretaceous): Chronological relationships between the Paraná–Etendeka large igneous province and the Weissert and the Faraoni events ». *Global and Planetary Change* 131: 158-73.

Speranza, F., Satolli, S., Mattioli, E., et Calamita, F., 2005. « Magnetic stratigraphy of Kimmeridgian–Aptian sections from Umbria–Marche (Italy): New details on the M polarity sequence ». *Journal of Geophysical Research: Solid Earth* 110 (B12).

Sprovieri, M., Coccioni, R., Lirer, F., Pelosi, N., et Lozar, F., 2006. « Orbital Tuning of a Lower Cretaceous Composite Record (Maiolica Formation, Central Italy) ». *Paleoceanography* 21 (4).

## Setting new R packages for geological data treatment

New **R** packages are being developed as part of the **CRASH** project. Their purpose is to centralise most of the data treatment with **R**, a free and open-source software environment. These new packages will allow the generation of high-resolution (Fig. 1) and synthetic (Fig. 2) lithologs among others. These packages will be used in combination with pre-existing R packages for astrochronology (e.g. **astrochron**), spherical projection (e.g. **RFOC**; for palaeomagnetism purposes) and signal processing (e.g. **IDPmisc**) among others. Such a data treatment strategy allows an organised use of the big-sized geological datasets required for checking the reproducibility of astrochronology.