

## Controversial Triassic chronologies: The Latemar case.

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Almost 20 years ago geologists from Johns Hopkins University, Baltimore attributed the formation of approximately 600 shallow water carbonate cycles of the Middle Triassic Latemar platform in the Italian Dolomites to Milankovitch-type glacio-eustatic sea level oscillations. This interpretation was based on the sedimentological architecture of the basic m-scale cycle (subtidal unit overlain by thin subaerial cap) and the bundling of such cycles into lower frequency megacycles with asymmetric stacking patterns. The allocyclic Milankovitchian interpretation was seriously challenged by biostratigraphic constraints and numeric age data, which later became available for Latemar and adjacent basinal successions: a time span of 10-12 m.y. required for the Milankovitch model contrasts greatly with an interval of 1-2 m.y. indicated by radio-isotope data for the same stratigraphic interval. The disagreement stimulated a fierce debate about the duration of the Latemar-cycles and has become known as the '*Latemar Controversy*'. To date this controversy has produced more than thirty scientific articles and discussions, but years of work on both ways of dating Latemar have failed to resolve the conflict. The American researchers and their coworkers insist on the applicability of the Milankovitch model, mainly on the basis of refined analyses of power spectra of bedding patterns, observations on cycle patterns elsewhere, and using comparative sedimentology as a temporal measuring stick. However, repeated radio-isotope dating efforts on tuff layers and cross-cutting shallow intrusive rocks (Predazzo) consistently point to a shorter duration of the critical interval.

The geological setting at Latemar is outstanding for various reasons: 1) the carbonate platform is of a restricted km-size, spectacularly exposed and the rhythmic interval is fully accessible for detailed sedimentological analysis; 2) the correlation of Latemar and neighbouring platforms (e.g., Rosengarten) with adjacent basinal strata (Buchenstein Fm.) is constrained by clearly identifiable stratigraphic intervals bracketing the platform-basin system. The geometrical correlation is further refined by the updip tracing of basinal layers onto the platform slopes; 3) "pelagic" fossils (ammonoids) occur at numerous levels inside the platform interior succession and provide a detailed comparison with coeval basinal beds which is in agreement with the physical constraints; 4) acidic volcanic tuff layers bearing magmatic zircon are interbedded with both, the platform and the basinal carbonate successions and allow the best currently possible in-situ chronostratigraphic calibration without requiring the step through a geologic time-scale (with inherent uncertainties).

The age constraints and resolution of the platform-basin correlation at Latemar are arguably unique for Mesozoic successions worldwide and the setting is widely acknowledged as suitable for the integration and comparison of a variety of stratigraphic methods. Moreover leading geochronology labs continue to generate U-Pb zircon age data on volcanic materials from layers at Latemar and in coeval basinal sediments. This in turn offers the opportunity for an independent test and assessment of the

reproducibility and accuracy of radio-isotope data. More dating results will likely become available for Latemar and surroundings, and the setting may be designated as a test ground for the *EARTHTIME* program which is an international effort aimed at improving the calibration of Earth history. At Latemar this should also include the application of new methods such as the Re-Os chronometer on organic matter.

*Current state of results:*

- Ammonoid data obtained by different research groups are consistent (though with taxonomic bias) and there is agreement about the age-equivalence of the 450 m thick "cyclic" portion of the platform interior, with 5-15 m of pelagic carbonate strata in adjacent basinal successions.
- The "cyclic" Latemar beds formed close to sea level whose oscillations may have been rapid, with amplitudes in the range of a few metres.
- The interpreted Milankovitch forcings emerging from power spectra of platform cycles and basinal beds are not consistent with the correlation based on fossils and geometrical constraints.
- The platform interior beds at Latemar accumulated on the top of a buildup that was rising between 200-700 metres above the coeval basin floor. Volcaniclastic layers deposited on this topographic feature represent original airborne ash materials.
- U-Pb single-zircon age data from volcaniclastic layers in the platform and in the basinal successions are reproducible and in agreement with Ar-Ar sanidine ages; the U-Pb zircon results of three different geochronology laboratories are consistent with deviations of <1.5 m.y.
- Although the accurate U-Pb zircon ages from the South Alpine Middle Triassic have largely been ignored, even in the most recent time-scales, it now appears that these data are in excellent agreement with new high-resolution age data from the Lower and lower Middle Triassic in China.

The chrono- and biostratigraphic constraints on the duration of the spatially rhythmic beds at Latemar imply that the average duration of the smallest Latemar "cycle" is much shorter than the duration of Earth's precession (i.e., << 20 kyrs). Therefore, the basic beds at Latemar are sub-Milankovitchian but with an as yet unknown control which could have been (quasi)periodic and possibly modulated by Milankovitch frequencies. Alternatively, but less likely, bedding patterns could be non-periodic in time and bed surfaces due to factors unrelated to an oscillating sea level (e.g., autocycles; diagenetic and/or hydrothermal origin). More importantly, the Latemar case clearly shows that without independent age constraints, even high-quality power spectra are insufficient as a stand-alone tool for the evaluation of Milankovitch forcing on rhythmic bedding patterns.

REFERENCES AND FURTHER INFORMATION:

<http://www.latemar-controversy.de>

<http://www.jhu.edu/~eps/faculty/hinnov/hinnovresearch/latemarcontroversy.htm>