CONTRIBUTION TO THE LATE TRIASSIC GEOCHRONOLOGY BY MAGNETOSTRATIGRAPHIC CORRELATIONS BETWEEN TETHYAN MARINE SECTIONS AND THE NEWARK APTS

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Abstract

Late Triassic chronology is currently a matter of discussion, in particular for the numerical ages of the Carnian/Norian and Norian/Rhaetian boundaries. In the Geological Time Scale 2012 two different options have been proposed: a Long-Tuvalian and a Long-Rhaetian options, based on the magnetostatigraphic correlations between some marine sections and the Newark APTS (Astronomically calibrated geomagnetic Polarity Time Scale). To give a contribution to the Late Triassic chronology, magnetostatigraphic analyses on new Tethyan marine sections have been provided attempting a correlation with the Newark APTS. A preliminary comparison between the Pignola-Abriola section and the Newark APTS suggest a NRB age similar to that proposed in Long-Tuvalian option of GTS 2012. The other sections need further analyses before attempting a similar correlation. Furthermore, analyses on rock magnetism can be used to obtain paleogeographic data and try a reconstruction of the Late Triassic paleogeography.

Introduction

Currently, the Late Triassic chronology is based on magnetostatigraphic correlations between some marine sections and the Newark APTS, which is an upper Carnian (Tuvalian) to Sinemurian lacustrine/alluvial succession characterized by detailed magnetostatigraphy and cyclostratigraphy (e.g. Kent et al., 1995; Olsen et al., 2010). Considered the features of this succession, the Newark APTS can be used for a chronological definition of Late Triassic Stage boundaries. Aware of the difficulties to correlate marine and continental sections based only on biostratigraphy, magnetostatigraphy might be a valid option to perform a strong correlation, even if the recent magnetostatigraphy-based correlations between marine section and the Newark APTS provided different durations of the Late Triassic stages (e.g. Muttoni et al., 2004; Gallet et al., 2007; Hüsing et al., 2011). In fact, in the recent Geological Time Scale 2012, two options have been proposed (Ogg, 2012): a “Long-Tuvalian” and a “Long-Rhaetian”. For example, in the first option Rhaetian is 4.1 My long while in the second one has a duration of 8.2 My. These two options are substantially different, providing an imprecise chronology for Late Triassic.

Aim

The main purpose of this work is to try a correlation between selected marine sections and the Newark APTS, to refine the Late Triassic chronology. The chosen marine sections are well-defined biostratigraphically but not yet investigated for magnetostatigraphic purpose. The numerical definition of stage boundaries could be useful to define the timing of biologic evolution, geodynamic processes and climate changes occurred during the Late Triassic. In addition, data derived from paleomagnetic investigations on these sections can be used for paleogeographic studies of the interested areas.

Methods

Paleomagnetic analyses on sampled oriented cores have been analysed at the Alpine Laboratory of Paleomagnetism (ALP) in Peveragno (CN), in collaboration with Prof. Giovanni Muttoni (Dipartimento di Scienze della Terra, Università degli Studi di Milano). A 2G DC-SQUID Cryogenic Magnetometer has been used for the Natural Remanent Magnetism analyses (NRM). NRM represent the magnetic signal recorded by magnetic minerals during rock genesis. By NRM analysis is possible to observe, for each sample, the recorded direction of the geomagnetic field during the deposition in order to define the sequence of polarity inversions. Furthermore, by trigonometric calculation, it is also possible to define the
position of the paleomagnetic pole for the examined time interval, the paleolatitude and the rotation of the
studied area. The analysis of magnetic susceptibility is performed with the AGICO KLY-3 Susceptibility
Meter to reveal the magnetization capability of the samples. To define the magnetic features of the
samples the Isothermal Remanent Magnetism method (IRM) has been applied, inducing an artificial
magnetization to the cores with a pulse magnetizer. ASC Scientific Thermal Specimen Demagnetizer is
used for stepwise thermal demagnetization, necessary in NRM and three-axial IRM analyses.

First-year activity

During the first year of my PhD, the Pignola 2 section (Potenza, Italy) and part of the Dibona section
(Cortina d’Ampezzo, Italy) has been sampled for paleomagnetic analyses. Moreover, new samples from
Pignola-Abriola section (Potenza, Italy) have been collected to improve the magnetostratigraphic data
already existing. Cores from Mount Messapion (Chalkida, Greece) have been also analyzed.

• **Pignola 2:** The Pignola 2 section is a 38 m long basinal succession belonging to the Calcari con
Selce Fm (cherty limestones). A total of 63 paleomagnetic samples have been collected every ca.
50-60 cm from limestones and radiolarites, except for the ca. 2 meter-thick green clayey horizon.
Preliminary analysis on magnetic susceptibility shows high values in correspondence of the green
clay-radiolaritic horizon (Rigo et al., 2007, 2012) and increased values in nearby limestone levels,
mirroring the increasing of the terrigenous component around the green horizon. The sequence of
magnetic polarity inversions derived from NRM analysis consists in 6 magnetozones (MP1-3),
three normal and three reversal, two of which can be correlated with the magnetostratigraphy
recorded at the Pizzo Mondello section (Muttoni et al., 2001b, 2004; Mazza et al., 2012).
Paleogeographic data, derived from site mean direction (Dec: 17,7°, Inc: 34,2°, k: 4,3, α95: 13,6°),
place the paleomagnetic pole position of the Pignola 2 section at 63,5°N/155°E (K: 4,3, A95: 8,9°).
Comparing paleopole parameters with a reference pole (Gondwana reference pole for Late
Triassic/Early Jurassic from Muttoni et al., 2001a), the area results in rotated of about 24,3°
counter-clockwise. Paleolatitude calculated for the examined area is ca. 18,8°N (±6°).

• **Pignola-Abriola:** The Pignola-Abriola section (54 m) consists of limestones/marly limestones,
with clayey intercalations and represents the Norian to Rhaetian portion of the of Calcari con
Selce Fm (e.g. Amodeo, 1999, Rigo et al., 2005; Giordano et al., 2010). A total of 220 samples
have been analysed during the Master and PhD activities, recognizing 22 magnetozones, 11
normal and 11 reversal, resulting coherent with the magnetostratigraphy of the Steinbergkogel
section (Krystyn et al., 2007a, b; Hüsing et al., 2011), GSSP candidate for Rhaetian Stage.
Furthermore, the Pignola-Abriola section have been compared with the Newark APTS, using a
statistical method based on linear regression and t-value test (Muttoni et al., 2004). Preliminary
results suggest a Rhaetian duration similar to the Long-Tuvalian option sensu Ogg (2012). Mean
site direction parameters (Dec: 199,6°, Inc: -33,5°, k: 4,5, α95: 5,7°) results coherent with the data
The area was supposedly subjected to a 26,2°CCW rotation (reference pole from Muttoni et al.,
2001a) and the paleolatitude results as 18,3°N (±2,5°).

• **Dibona:** The stratigraphic portion of the Dibona section sampled for magnetostratigraphic studies
is represented by the upper part of Borca Mb and the Dibona Sandstones Mb of the Heiligkreuz
Fm. Forty-six samples were taken and analysed, recognizing 7 magnetozones (4 normal and 3
reversal) of a time interval never studied for magnetostratigraphic investigation. Preliminary
analyses on magnetic susceptibility show higher values within the Dibona Sandstones,
consequently to the increase of the siliciclastic input.

• **Mount Messapion:** The Messapion section consists in peritidal deposits of a carbonate platform, in
which the Rhaetian/Hettangian boundary (TJB) is well documented (Romano et al., 2008). At
present, 42 cores of the 73 collected samples have been analysed. The magnetic susceptibility data
suggest a scarcity in magnetic minerals in most of the analysed samples and the low NRM signal
confirms this hypothesis. However, about 27 cores of the analysed samples show a good signal
and 5 magnetozones have been identified. A preliminary comparison between Mount Messapion
section and Newark APTS seems to show a good consistency, but further analyses on the remnant samples are necessary.

Next future
The age calibration of the Norian/Rhaetian boundary obtained from Pignola-Abriola section has to be compared with other coeval successions, such as the Mount Volturino (Potenza, Italy) and the Mt. Kobla (Slovenia) sections that will be sampled next year in spring/summer. Since the Pignola-Abriola section represents only the lower part of the Rhaetian stage, magnetostratigraphy of the remnant Rhaetian to Hettangian time interval will be sampled at the Csővár section (Hungary), which is well calibrated with conodont and radiolarian biostratigraphy, in collaboration with prof. József Pálfy (Eötvös Loránd University, Hungary). In addition, the sampling of Dibona section will be extended and completed to the base of the Travenanzes Fm. A request for paleomagnetic analyses on the Norian\Rhaetian portion of the ODP Leg 122 (sites 759-761-764) from Wombat Plateau (NW Australia) will be applied by the end of this year (2013).

References


**SUMMARY OF ACTIVITY IN THIS YEAR**

**Courses:**


E. CALANDRUCCIO: “Corso avanzato di Inglese Parlato”, Department of Geosciences, University of Padua, 2-10 May 2013

L. GULICK: “Corso avanzato di Inglese Scientifico” Department of Geosciences, University of Padua. 13-17 May 2013

V. MASELLI: “Introduzione alla interpretazione sismica” Department of Geosciences, University of Padua. 22-24 May 2013

R. CARNIEL: “Analisi spettrale e dinamica di serie temporali” Department of Geosciences, University of Padua. 11-12 June 2013

R.J. ANGEL: “Scientific Communication” Department of Geosciences, University of Padua. 5 November – 4 December 2013

**Teaching activities:**