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Palynological zonation and particulate organic matter of the Middle Triassic of the Southern Alps (Seceda and Val Gola–Margon sections, Northern Italy)

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ABSTRACT

Based on the palynological study of the Seceda core drilled in the north-western Dolomites and of an outcrop section from Val Gola–Margon (Southern Alps, Northern Italy) we propose a new palynostratigraphic subdivision of the Middle Triassic of the Western Tethyan realm. The six new zones (TrS-A–TrS-F) cover the interval between the late Anisian (Illyrian) and the late Ladinian (Longobardian). The zonation is based on the first and last appearances of individual taxa as well as on the quantitative distribution of major groups of sporomorphs. The presented palynological succession is directly correlated with the precise biostratigraphic, magnetostratigraphic and chronostratigraphic framework of the Seceda section, which represents the principal auxiliary global stratotype section and point (GSSP) section of the Ladinian stage. As an additional record we use the data of Van der Eem (1983) newly calibrated using the detailed lithostratigraphic scheme of the Seceda section and the GSSP section from Bagolino. The reassessment of the data from the late Anisian and the Ladinian of Van der Eem (1983) and Brugman (1986) shows earlier occurrences of some of the major pollen groups, and results in more precise correlations with other areas. The overlapping ranges of the palynological phases and subphases proposed by Van der Eem (1983) and Brugman (1986) make some of these phases obsolete.

Within the studied interval the distribution of sporomorphs shows some major changes such as a major reduction of pteridosperms (e.g. taeniate bisaccate pollen), which are abundant in the lower part of the section (zone TrS-A) and are subsequently replaced by conifers (e.g. *Triadispora*, *Ovalipollis* and Circumpolles).

Palynofacies studies show that the relatively high amount of fluorescent amorphous organic matter (AOM) reflects dysoxic conditions in the lowermost part of the section ("*Plattenkalke*"). The change in palynofacies between the "*Plattenkalke*" and the "*Knollenkalke*" corresponds to a marked change in the depositional environment from dysoxic to well oxygenated conditions in the "*Knollenkalke*". In contrast to this, the succession of palynofacies from the "*Knollenkalke*" to the "*Breccias*" suggests a continuity of depositional environments reflecting a slight reduction of the oxic conditions. The light coloured pollen grains show no sign of thermal alteration of the organic matter.

1. Introduction

The Southern Alps (Fig. 1) represent one of the classical areas for the study of Triassic geology. Spectacular outcrops allow an exceptional insight into the genesis of Middle–Upper Triassic carbonate platforms and adjacent basins. Since the late 19th century South Alpine areas have been used to define Triassic stratigraphy (e.g. Richthofen, 1860; Mojsisovics, 1879, 1882; Mojsisovics et al., 1895; Bittner, 1892; Brack et al., 2005; Mietto et al., 2012). Additionally the depositional mode and the timing of rhythmic sedimentation in Middle Triassic platform carbonates at Latemar in the Dolomites have been extensively discussed (e.g. Goldhammer et al., 1990, 1993; Brack et al., 1996; Preto et al., 2001; Zühlke et al., 2003; Kent et al., 2004). The bedding patterns in the coeval basinal Buchenstein (Livinallongo) Formation of the same area have also been evaluated in terms of orbital forcing (Mauer et al., 2004; Spahn et al., 2012). Thus, the stratigraphic resolution and precise correlation of lithologically different Middle Triassic sediments became truly critical issues. The integration of information from numerous well-correlated basinal sections throughout the Southern Alps has resulted in a reliable biostratigraphic framework (ammonoids, bivalves (*Daonella*), and conodonts) especially for the Anisian–Ladinian boundary interval (Brack and Rieber, 1993; Brack and Muttoni, 2000; Muttoni et al., 2004). This framework is tied to radio-isotope age data and to the succession of magnetic reversals (Mundil et al., 1996; Kent et al., 2004; Brack et al., 2007).

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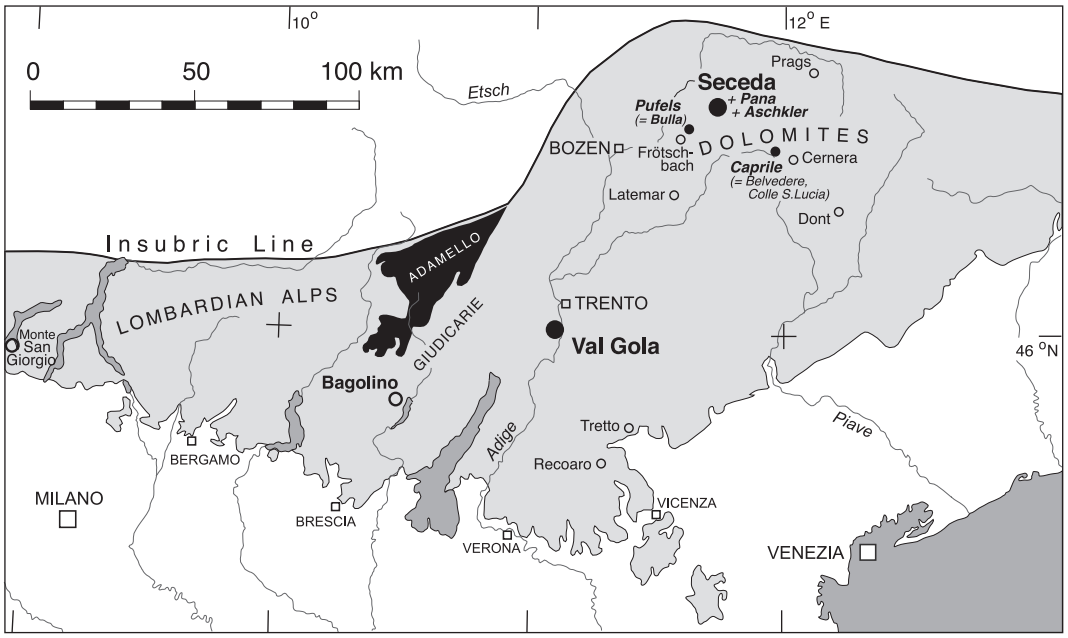

Fig. 1. Location of the studied area and sections mentioned in the text. Seceda and Val Gola (this study); sections studied by Van der Eem (1983) are indicated in italics.

Beyond the assessment of stratigraphic cycles these data have provided the framework required for a modern definition of the Anisian–Ladinian boundary. The GSSP of the base of the Ladinian stage is fixed at Bagolino in the western Southern Alps and the Seceda column has been designated as the principal auxiliary section in the Dolomites (Brack et al., 2005).

Three decades ago, the main reference for the Middle Triassic palynological record of the low latitude Tethyan realm was obtained from stratigraphic successions in the Southern Alps (Dolomites and Recoaro), complemented with core data from the Balaton Highland of Hungary (Van der Eem, 1983; Brugman, 1986). In his study of palynomorphs from uppermost Anisian to Carnian sediments, Van der Eem (1983) combined results from rather loosely sampled sections and isolated outcrops in the Dolomites. The correlation of the studied sites relied on published age assignments. Thereafter Brugman (1986) extended this record to cover the entire Anisian and the upper part of the Olenekian. In a range chart for palynomorphs of the late Early Triassic to earliest Carnian of the Alpine (Tethyan) realm Brugman (1986, p. 33) included a "somewhat revised version" of the results of Van der Eem (1983). Up till now this chart has remained the standard for the Alpine Triassic palynomorph record and only portions of it have hitherto been revised (e.g. Ladinian–Carnian boundary interval, see Mietto et al., 2012).

The recent improvements in the stratigraphic framework for the South Alpine Middle Triassic now provide the opportunity for a re-evaluation and new calibration of the results of the pioneering palynological studies of Van der Eem (1983) and Brugman (1986). The combination of macro- and microfossils (conodonts), physical stratigraphy (patterns, tephrastratigraphy) and magnetic reversals (Brack and Muttoni, 2000; Muttoni et al., 2004) allow a reassessment of the stratigraphic succession used by Van der Eem (1983) and indeed results in substantial shifts of the correlated key intervals and outcrops studied by Van der Eem (1983). Moreover, a core drilled for scientific purposes into upper Anisian–Ladinian sediments at Seceda in the north-western Dolomites (Brack et al., 2000) provides the opportunity to assess the palynomorph record in a new and almost undisturbed single succession.

This paper documents the results of a palynological study on samples mainly from the Seceda core. Additional data filling a gap in the Seceda record were gained from samples from an outcrop section at Val Gola (near Trento, Northern Italy). The new information is then compared with the data of the repositioned levels of the samples reported by Van der Eem (1983) and a new scheme of palynological zones is proposed. The combined palynological record represents a long late Anisian–late Ladinian time span of probably slightly over 4 million years. The comparison of our scheme with zonations for the Germanic Basin (Kürschner and Herngreen, 2010; Heunisch, 1999) leads to the recognition of regional differences in the composition of floral assemblages. Such information could be significant for future palaeoenvironmental interpretations and palaeoclimatic analysis of the Middle Triassic.

2. Stratigraphic framework and age calibration

In this paper the chronostratigraphy applied to the Buchenstein interval at Seceda basically follows the scheme of Brack et al. (2005, 2007). Although research on Middle Triassic ammonoids and *Daonella* over the past 25 years resulted in a much improved macrofossil record for the Anisian–Ladinian boundary interval (*R. reitzi* zone to *E. curionii* zone), information on younger Ladinian levels of Buchenstein successions is still fragmentary. Although thin-shelled pelagic bivalves of the genus *Daonella* provide additional constraints for late Ladinian intervals (e.g. Schatz, 2004), relatively large intervals of uncertainty remain between ammonoid zones. These zones also await clear definitions (e.g. "*P. gredleri*" and *P. archelaus* zones). For instance, the term "*P. gredleri*" zone introduced by Krystyn (1983) can be used merely as a label. The index taxon needs revision and the specimens of *Trachyceras gredleri* originally reported by Mojsisovics (1882) were possibly from younger and older levels than the current homonymous zone. The *P. archelaus* zone as used in this study includes the layers containing *Daonella pichleri*. The topmost part of the Seceda column most likely corresponds to a stratigraphic interval with the first occurrences of *Frankites regoledanus* in the lowermost Wengen Fm. at Bagolino (99.5-m level) and Monte Corona in Lombardy and Giudicarie (Brack and Rieber, 1993; Brack et al., 2005).

Following Krystyn (1983), Brugman (1986) assigned the "*P. gredleri*" ammonoid zone to the Longobardian substage. However, its inclusion into the Fassanian more closely matches the original concepts for the substages of the Ladinian as introduced by Mojsisovics et al. (1895, defining: *Fassanisch = Buchensteiner Schichten + Marmolatakalk*; *Longobardisch = Wengener Schichten*). Moreover, the subdivision advocated here results in balanced durations of the early and late Ladinian substages.