MAGNETO-BIOSTRATIGRAPHY OF THE 'BUCHENSTEIN BEDS' AT FRÖTSCHBACH (WESTERN DOLOMITES, ITALY)

G.Muttoni, D.V. Kent, A. Nicora, H. Rieber and P. Brack

Introduction

In this short contribution we present preliminary results on the magneto-biostratigraphy of the Anisian/Ladinian boundary interval at Frötschbach in the Dolomites of northern Italy. The interdisciplinary research carried out at this and on other coeval sections such as Aghia Triada and Vlichos on Hydra island, Greece (Muttoni et al., in prep.) is aimed at correlating in detail the well-known Tethyan biozonation to a geomagnetic polarity sequence of reversals for the construction of a standard Triassic time scale.

Location of Frötschbach section and lithologies

The Frötschbach section near Seis in the western Dolomites (Fig. 1) was recorded in outcrops close to trail n.1a between Bad Ratzes and Prossliner Schwaige on the way to Seiser Aim. Its trace follows the exposure along the trail (lower part, 0-23 m) and a nearby southern tributary of the Frötschbach creek (upper part, 24 m ff.); both portions are separated by a small fault with a vertical displacement of less than eight metres. As a result of a recent heavy storm water the basal section ('Lower Plattenkalke') is now fully exposed along the Frötschbach creek in the bottom of the main valley.

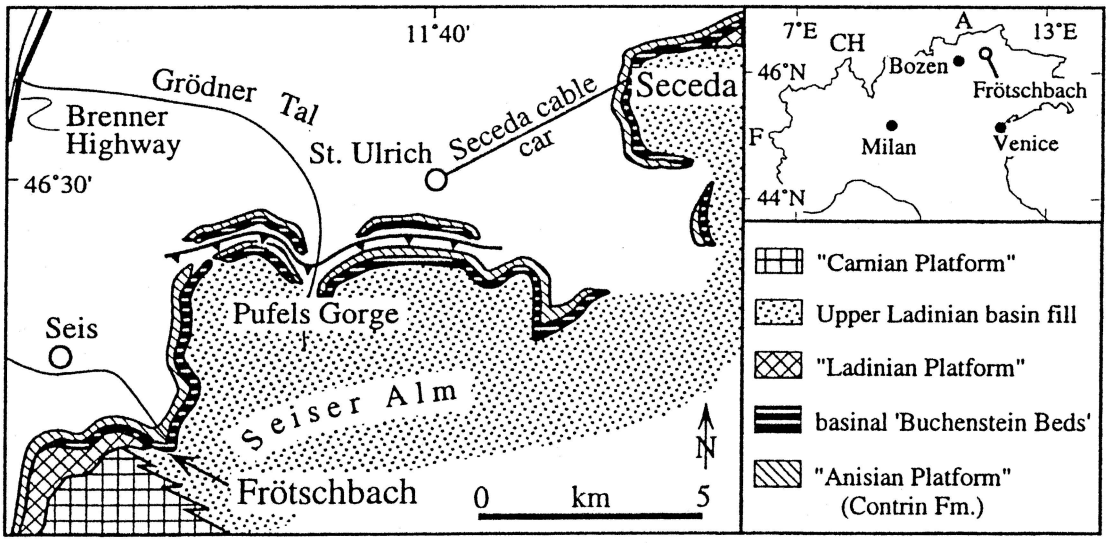


Fig. 1. Simplified geological sketch of Middle Triassic units in the St. Ulrich (Ortisei) area (Dolomites, northern Italy). The Frötschbach section is located to the southeast of the village Seis am Schlern (Siusi allo Sciliar). Other well known and coeval sections in the area are found at Seceda and in the Pufels gorge between these two localities.

The section comprises the 'Buchenstein Beds' (= Livinallongo Fm. in the Italian terminology; for an alternative illustration of the section see Abb. 2 of Brandner, 1982) consisting of two stratigraphically superposed units (Fig. 2): (i) the 'Lower Plattenkalke', which is a 8 to 9 m-thick succession of evenly bedded black siliceous and calcareous mudstones, and (ii) the 'Knollenkalke', consisting of 30 to 35 m of calcareous mudstones arranged in dm-thick wavy to nodular beds with abundant chert. Higher up (i.e., above the 42 m-level in Fig. 2), the 'Knollenkalke' are replaced by more evenly-bedded light dolomitic limestones and dolomites which are in part of a turbiditic origin. Acidic volcaniclastic layers ("Pietra verde") occur throughout the 'Buchenstein Beds' as silty to sandy horizons (e.g., Tc, Td, Te in Fig. 2) between a few centimetres and several decimetres thick.

Correlation with other sections and biostratigraphic constraints

On the basis of the vertical distribution of volcaniclastic layers, distinct lithological marker beds and few macrofossils, the Frötschbach section (Fig. 2) is closely tied to the nearby succession of 'Buchenstein Beds' at Seceda, around 13 km to the northeast (Fig. 1).
Correlation of the lower portions of both sections on a bed-scale is based on the unambiguous recognition of the volcaniclastic markers Tc-e and of distinct nodular limestone beds n.1-6 (corresponding to the 14.7-16.5 m-interval at Seceda). This has been illustrated in Fig. 6 of Brack and Rieber (1993). Probably as a result of closer proximity to coeval carbonate platforms, intervals of 'Knollenkalke' are on the average between 10-20% thicker at Frötschbach than at Seceda. The tuffite-bearing interval above the 34 m-level at Frötschbach most likely corresponds to the lower part of the interval rich in volcaniclastic layers between the 30 m and 40 m-levels at Seceda (see Brack and Rieber, 1993, Fig. 7).
The Seceda section has been correlated in detail with other well-known Anisian/Ladinian boundary sections further afield in the Southern Alps (e.g., Bagolino, Monte San Giorgio; see Brack and Rieber, 1993, 1994).

At Frötschbach the 'Lower Plattenkalke' yielded palynomorphs of the "*vicentinense-scheuringii* Phase" (Brugman pers. comm., in Brack and Rieber, 1993, p.435; see also p. 63 in Gaetani [Ed.], 1993), as well as few ammonoids (*Aplococeras* sp., *Parakellnerites* sp.) and thin-shelled 'pelagic' bivalves of the *Daonella elongata* group (*Daonella angulata*, Fig. 2). The conodont species *Gondolella trammeri, G. fueloepi fueloepi* and *Gladigondolella tethydis* occur from the upper part of the 'Lower Plattenkalke' upwards. *Gondolella trammeri* is considered as a good proxy for the base of the (*Nevadites*) *secedensis* Zone (e.g., Krystyn, 1983; Kovács, 1994; Nicora and Brack, 1995) although at Frötschbach it does occur already somewhat earlier. Other conodont species in this section show an as yet discontinuous distribution and do not provide further biostratigraphic detail. Several specimens of the ammonoid *Chieseiceras chiesense* were collected from a rock slab found at the base of a cliff of the lowermost 15 metres of 'Knollenkalke' (Fig. 2). This non *in-situ* finding is in agreement with data from Seceda where *Chieseiceras chiesense* occurs around three metres above the volcaniclastic Te-level (Brack and Rieber, 1993). According to data from eastern Lombardy and Giudicarie, this ammonoid species marks the very top of the (*Nevadites*) *secedensis* Zone (Brack and Rieber, 1993; Brack et al., 1995). Slightly higher up at Seceda *Eoprotrachyceras* cf. *recubariense* was found around 7.5 metres above the volcaniclastic Te-level; this ammonoid species is attributed to the *curionii* Zone (Brack and Rieber, 1993). Finally, at Frötschbach a specimen of *Arpadites* was collected close to the top of the recorded section. In the Bagolino section ammonoids of the genus *Arpadites* occur in an interval with a few conodonts of the genus *Budurovignathus* (*B. truempyi* slightly below, *B. hungaricus* somewhat higher up; Nicora and Brack, 1995). This association may be referred to the *gredleri* Zone.

Based on these fossil data and correlations, the bottom of the Frötschbach section (i.e., the 'Lower Plattenkalke') is ascribed to the *reitzi* Zone, whereas its top, although less well constrained, presumably represents part of the *gredleri* Zone (Fig. 2). The Frötschbach section therefore straddles two out of the three chief candidates for the ultimate collocation of the Anisian/Ladinian boundary, namely the base of the *secedensis* Zone and the base of the *curionii* Zone. In analogy with Bagolino (Brack et al., 1995), the base of the *secedensis* Zone is drawn immediately below volcaniclastic layer Tc. The base of the *curionii* Zone is constrained by the occurrence of *Chieseiceras chiesense* and *Eoprotrachyceras* at Seceda. At Frötschbach this boundary most probably falls in an interval between four to eight metres above the volcaniclastic Te-layer.

Radiometric age data

High resolution U-Pb ages were obtained by single grain analysis of zircons from selected volcaniclastic layers at Seceda, Bagolino and Monte San Giorgio (Mundil et al., in press; Brack et al., in press). Zircons from a thin crystal-tuff at the base of the volcaniclastic Tc-layer at Seceda have an average radiometric age of 241.2 +0.8/-0.6 Ma (errors given at 95% confidence level). The same layer is also identified at Frötschbach. Zircons from a tuff layer at the 72.5 m-level of the Bagolino section have yielded an age of 238.0 +0.4/-0.8 Ma. This level can be approximately correlated via Seceda to the upper part of the Frötschbach section (35-40 m interval in Fig. 2). These data allow an estimate of the duration of the Frötschbach interval shown in Fig. 2 at about three millions of years.

Magnetostratigraphy

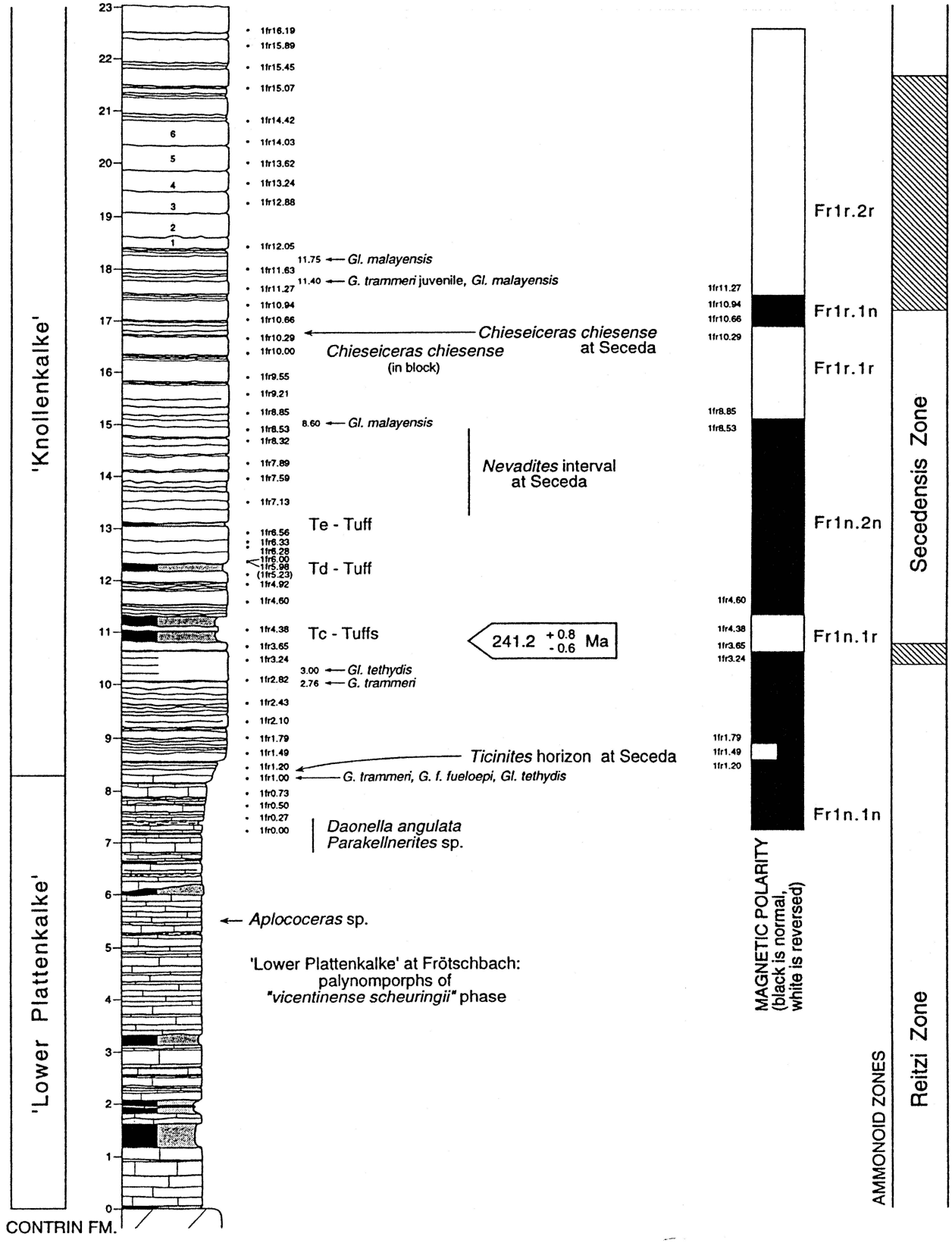
Samples for palaeomagnetic analysis were taken over a stratigraphic interval of 31.6 metres equally subdivided in two complementary sections (Fig. 2). A sampling interval of 2-4 samples per metre was adopted, yielding a total of 101 samples for thermal demagnetization. Samples typically show an initial steeply inclined component which in geographic (i.e., in situ) coordinates is consistent with the present-day field. A bipolar northwest-and-down (southeast-and-up) characteristic component was successively unblocked in 92 samples between about 200°C and 500°C, with a maximum upper limit of 575°C. Magnetic susceptibility is typically low and stable over the heating procedure. We interpret the characteristic directions as carried by a magnetite phase, and assign normal (reversed) polarity to the positive (negative) inclinations after correction for bedding tilt. For each of the characteristic component directions a virtual geomagnetic pole (VGP) was calculated.

The latitudes of the VGPs plotted with respect to stratigraphic thickness define a pattern of four main polarity intervals, i.e., Fr1n to Fr2r, with two short polarity intervals within Fr1n and Fr1r (Fig. 2).

Final remarks

The magnetostratigraphic record established so far at Frötschbach indicates the existence of at least one main reversal in the Anisian/Ladinian boundary interval (i.e., between Fr1n and Fr1r in Fig. 2). This event falls in the upper part of the (*Nevadites*) *secedensis* Zone.

Based on its magnetostratigraphic pattern, the Frötschbach section can be successfully correlated to a similar record from the Aghia Triada and Vlichos sections on Hydra island in Greece. The sampling rate and, therefore, the resolution at Aghia Triada has been improved compared to what was reported in Muttoni et al. (1994). These new data and correlations shall be presented in a forthcoming publication by the authors. The main result will be a composite magneto-chrono-biostratigraphic record across a boundary interval of around five million years duration.


'Knollenkalke'
'Lower Plattenkalke'
CONTRIN FM.
1fr16.19
1fr15.89
1fr15.45
1fr15.07
1fr14.42
1fr14.03
1fr13.62
1fr13.24
1fr12.88
1fr12.05
11.75 ← Gl. malayensis
1fr11.63
11.40 ← G. trammeri juvenile, Gl. malayensis
1fr11.27
1fr10.94
1fr10.66
1fr10.29
← Chieseiceras chiesense at Seceda
1fr10.00
Chieseiceras chiesense (in block)
1fr9.55
1fr9.21
1fr8.85
1fr8.53
8.60 ← Gl. malayensis
1fr8.32
Nevadites interval at Seceda
1fr7.89
1fr7.59
1fr7.13
Te - Tuff
1fr6.56
1fr6.33
1fr6.28
1fr6.00
Td - Tuff
1fr5.98
(1fr5.23)
1fr4.92
1fr4.60
1fr4.38
Tc - Tuffs
241.2 +0.8 -0.6 Ma
1fr3.65
1fr3.24
3.00 ← Gl. tethydis
1fr2.82
2.76 ← G. trammeri
1fr2.43
1fr2.10
1fr1.79
1fr1.49
1fr1.20
← Ticinites horizon at Seceda
1fr1.00
← G. trammeri, G. f. fueloepi, Gl. tethydis
1fr0.73
1fr0.50
1fr0.27
1fr0.00
Daonella angulata
Parakellnerites sp.
← Aplococeras sp.
'Lower Plattenkalke' at Frötschbach:
palynomporphs of
"vicentinense scheuringii" phase
MAGNETIC POLARITY
(black is normal,
white is reversed)
Fr1r.2r
Fr1r.1n
Fr1r.1r
Fr1n.2n
Fr1n.1r
Fr1n.1n
AMMONOID ZONES
Secedensis Zone
Reitzi Zone

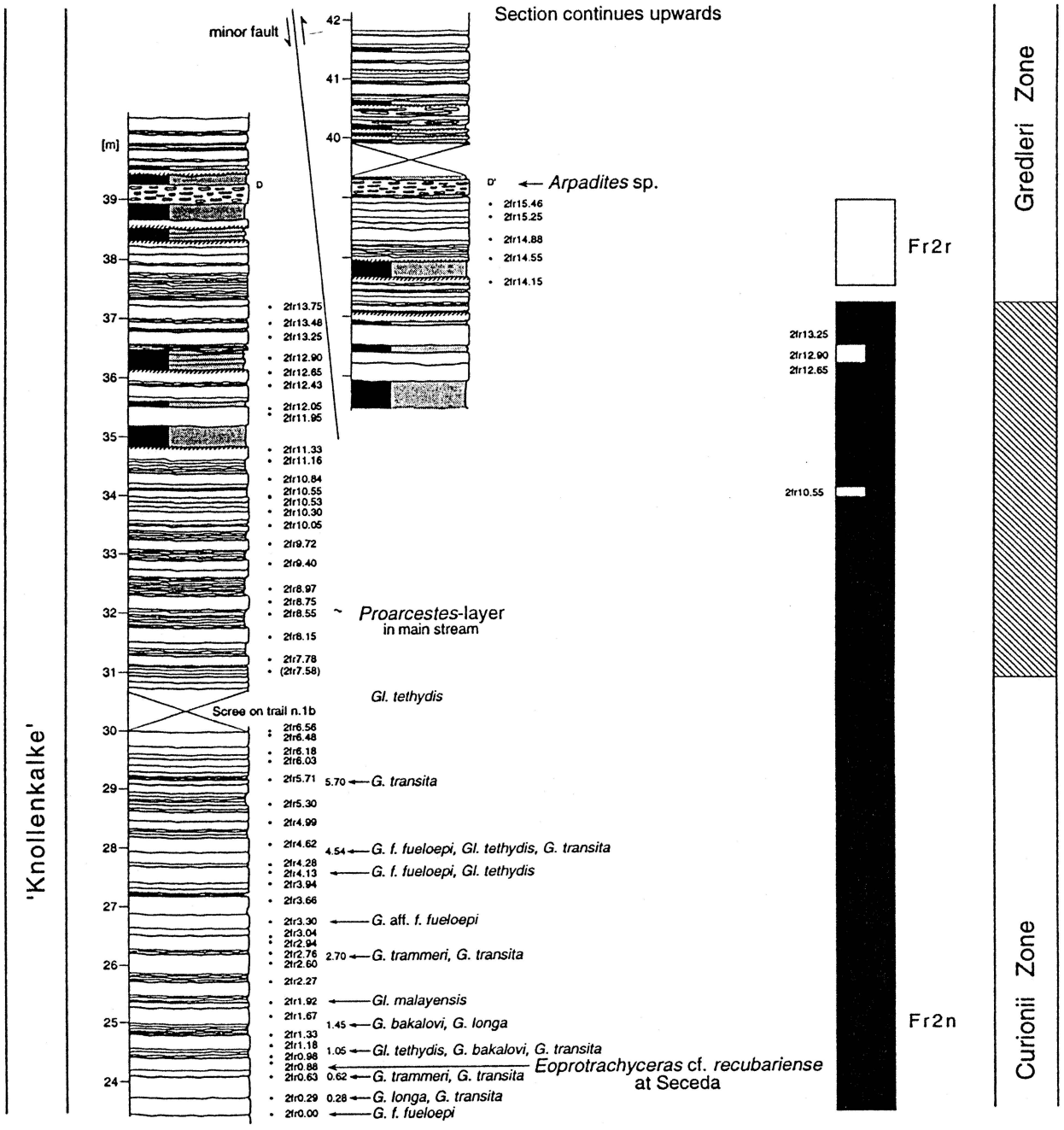


Fig. 2. Section of 'Buchenstein Beds' at Frötschbach: lower part (0-23 m), upper part (24 m ff.) with the position of samples for paleomagnetism (black dots to the right of stratigraphic column labelled 1fr0.00 to 2fr15.46) and the derived magnetic polarity stratigraphy. Volcaniclastic layers are indicated by black bars. Zones are based on ammonoid distribution at Seceda, Bagolino and few fossils from Frötschbach (see text). Conodonts indicated with sample positions are from Frötschbach. See Brack and Rieber (1993) for further information on macrofossils and correlation with other Anisian/Ladinian boundary sections.

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Hans Kerp, WWU - Abt. Paläobotanik
Hindenburgplatz 57-59, W-48143 Münster, Germany
Tel: +49-251-833966; Fax: +49-251-834831
E-mail: kerp@uni-muenster.de