Biostratigraphical data of continental basins of Southern Alps (North Italy) during the Kungurian (Cisuralian, Permian)

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Abstract

The Permian of the Southern Alps is marked by two tectono-sedimentary cycles separated by a marked stratigraphic gap. The lower one is mainly characterised by pull-apart basins with a volcano-siliciclastic infill formed during the Cisuralian (Orobic Basin, Collio Basin and Athesian District). These basins yielded an abundant and diverse fossil content of possible biostratigraphic value from Kungurian nonmarine units, including: tetrapod footprints, fossil plants, fossil sporomorphs, freshwater bivalves and conchostracans. The availability of several radioisotopic dates on volcanic intervals at the base and/or top of the fossiliferous nonmarine units allows a nonpareil correlation to the Global Chronostratigraphic Chart. Tetrapod footprints are known from the Pizzo del Diavolo Formation (Orobic Basin), the Collio Formation and Dosso dei Galli Conglomerate (Collio Basin), the Monte Luco, Tregiovo and Guncina formations (Athesian District). The ichnoassociation is diverse and characterised by reptilian ichnogenera such as *Erpetopus*, *Hyloidichnus*, *Merifontichnus*, cf. *Pachypes* and *Varanopus*. Other ichnogenera are attributed either to reptiles or synapsids (*Dromopus* and *Tambachichnium*). Anamiote tracks include *Amphisauropus*, *Batrachichnus* and *Limnopus* and are generally rare. This ichnoassociation constitutes the local tetrapod footprint biozone called Collio Ichnofaunal Unit (IFU). More importantly, it is a reference for the definition of the *Erpetopus* footprint biochron.
Plant remains are known from the Pizzo del Diavolo Formation (Orobic Basin), the Collio Formation (Collio Basin), the Monte Luco, Tregiovo and Guncina formations (Athesian District). This palaeoflora, dominated by conifers and including also typical Lopingian taxa (*Dolomitia*, *Pseudovoltzia*, and *Ullmannia*), is in agreement with a semi-arid seasonal palaeoclimate and is similar to other upper Cisuralian euroamerican plant assemblages from Southern Europe, North Africa and Western USA.

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Fossil sporomorphs are known from the Collio Formation (Collio Basin), the Tregiovo and Guncina formations (Athesian District). New specimens from the Guncina Formation have been processed, enlarging substantially the association. Microflora mainly consists of bisaccate taeniate pollen such as *Corisaccites alutas*, *Hamiapollenites tractiferinus*, *Protohaploxypinus* spp., *Striatopodocarpites* spp., *Taeniaesporites* sp. with non-taeniates such as *Alisporites* spp., *Gardenasporites heisseli*, *Pteruchipollenites indarraensis* and others. Monosaccate pollen grains were abundantly found as *Crustaesporites globosus*, *Florinites luberae*, *Plicatipollenites malabarensis,* as well as polyplicate pollen such as *Vittatina costabilis* and *V. vittifera*. This association shows close compositional similarities to upper Cisuralian palynofloras from Europe and Kungurian-lower Guadalupian associations from Northern Gondwana and Russia.

Bivalves are known from the Collio Formation (Collio Basin) and the Guncina Formation (Athesian District). The FAD of the genera *Palaeomutela* and *Redikorella* characterises these associations.

Conchostracans are known from the Collio Formation (Collio Basin) and the Tregiovo and Guncina formations (Athesian District) and include two new *Pseudoestheria* morphotypes of possible chronostratigraphic value.

Because of the abundance and diversity of the nonmarine fossil associations and the age constraints provided by radioisotopic dates, the Southern Alps nonmarine fossil association is more and more a reference for continental biostratigraphy and chronostratigraphy at a regional and global level in the Cisuralian. In particular, fossil footprints, plants, and sporomorph associations have the potential to constitute biozones and chronozones. Therefore further research on the biostratigraphy and chronostratigraphy of the Southern Alps is of the outmost importance in the frame of the global nonmarine-marine correlations.

Keywords: Biostratigraphy, Permian, nonmarine, fossil footprints, fossil plants, palynomorphs, invertebrates