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Time and Life in the Silurian: a multidisciplinary approach

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The reference section of the Sardinian Ockerkalk: the Silius Section

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LOCALITY	about 500 m West of Silius, at geographic coordinates 39°31'02"N, 9°17'13"E.
LITHOSTRATIGRAPHIC UNIT	Ockerkalk limestone (informal unit).
AGE	late Silurian (Ludlow-Pridoli); *Oz. hamata* to *Oul. el. detortus* conodont zones.
WHAT TO SEE	typical Ockerkalk limestone; Ludlow/Pridoli boundary.

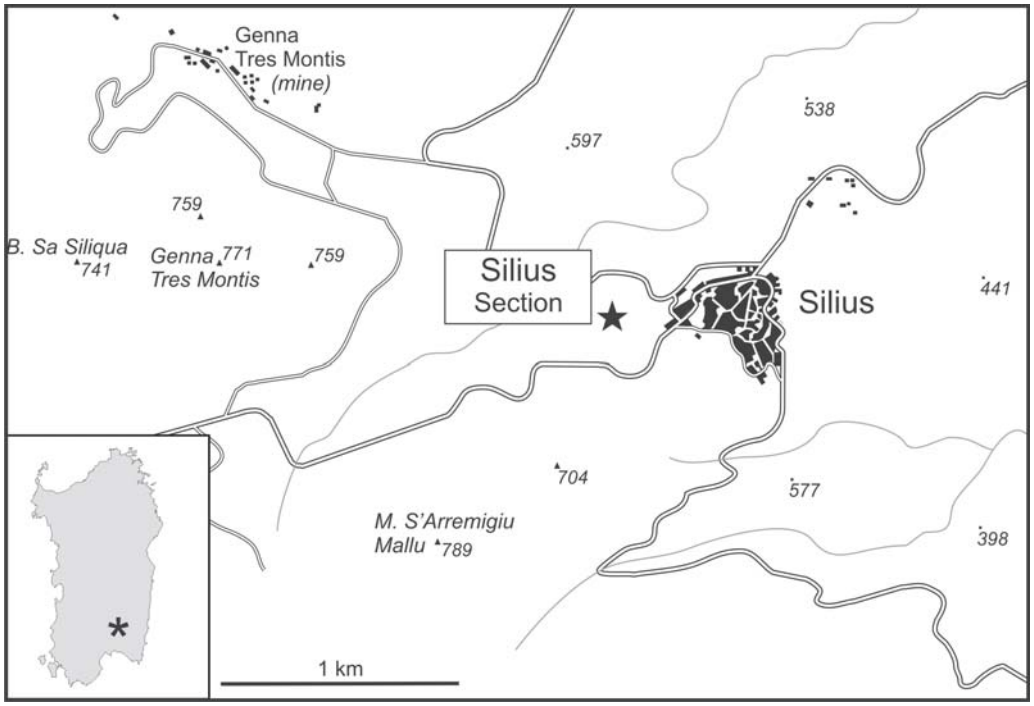


Fig. 1 - Location map of the Silius Section.

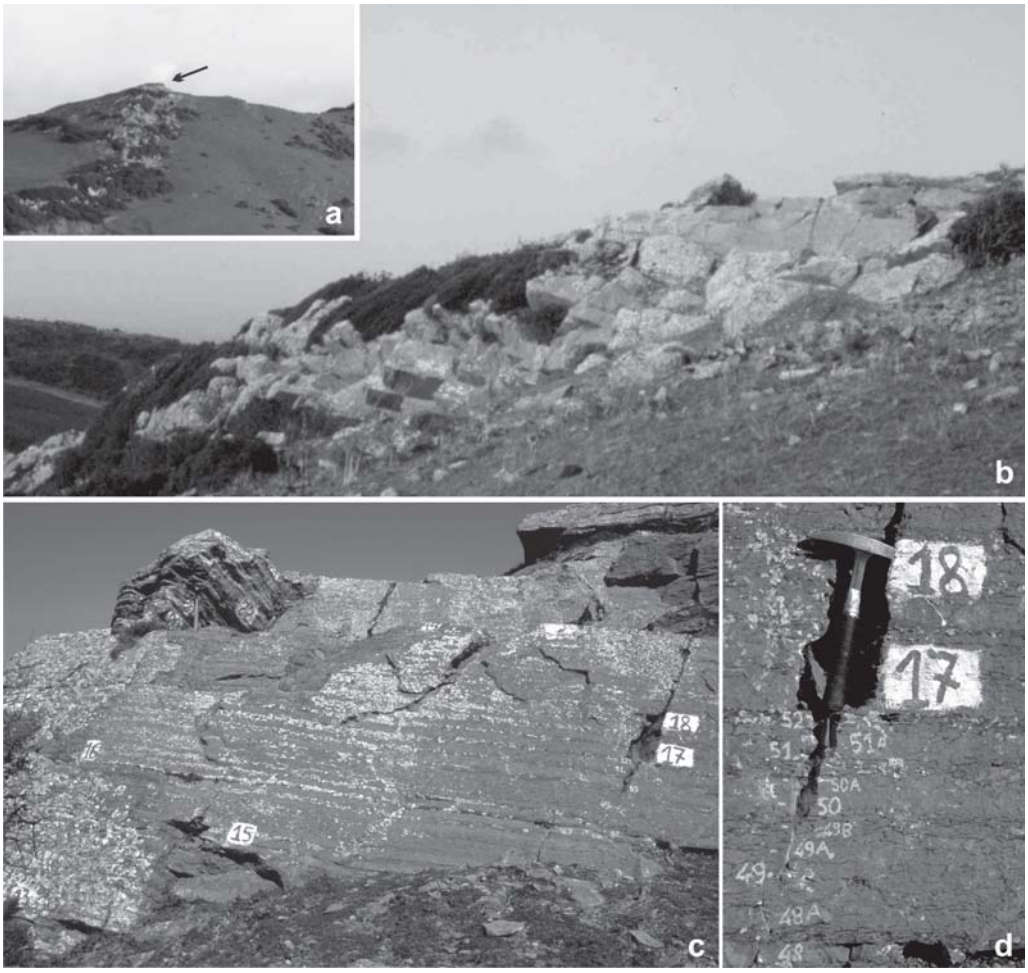


Fig. 2 - a) Panoramic view of the cliff: the Silius Section is measured at the top of the hill (arrow). b) Lower part of the section. c) The part of the section where the Lau Event is documented. d) Close up view of the *siluricus*/*latialata* zonal boundary. Large numbers refer to conodont samples, small numbers to isotope samples.

How to get there

The Silius Section is very close to Silius and can be reached with a short walk from the western part of the village (Fig. 1).

This is the best section available for the Ockerkalk limestone in Sardinia: a continuous and undisturbed sequence expose the whole unit.

Historical Outline

This locality has been stratigraphically studied mostly in the last decade (Barca et al., 1994, 1995; Serpagli et al., 1998). Together with the nearby Genna Ciuerciu Section, the

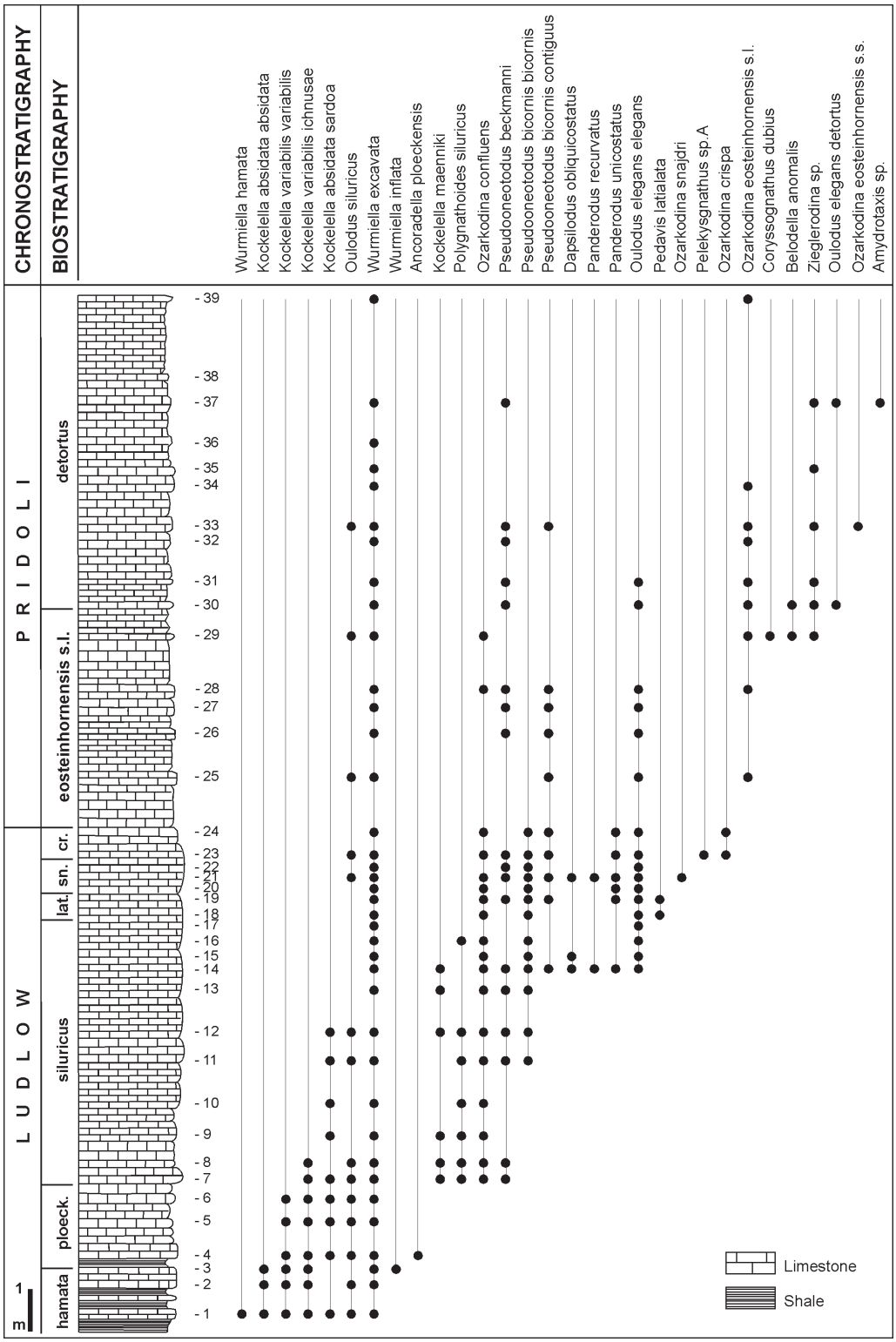


Fig. 3 - Stratigraphical log of the Silius Section and occurrences of conodont taxa. Numbers on the right of the column indicate conodont samples.

Silius Section is a reference section for the Sardinian Ockerkalk, and, being the most complete, it is candidate as stratotype of the unit as soon as it will be formally presented.

This section is the type locality of two conodont taxa: *Kockelella variabilis ichnusae* Serpagli & Corradini and *Pseudooneotodus bicornis contiguus* Corradini. Furthermore it is one of the key-sections for the Silurian Conodont Zonation proposed by Corradini & Serpagli (1998, 1999).

Lithology

About 24 metres of grey-bluish fine grained Ockerkalk limestone is here exposed. Macroscopically it shows a typical irregular nodular structure often masked by rock alteration and lichens. Neither macroscopical, nor thin-section analyses have revealed any variations through the section, even if the rate of sedimentation increased upwards (c. 60% of the Ockerkalk is Pridoli in age).

Plate 1

Fig. 1 - *Ozarkodina confluens* (Branson & Mehl, 1933), Pa element IPUM 25883; sample SIL 11 (*siluricus* Zone); lateral view, x60.

Fig. 2 - *Oulodus elegans elegans* (Walliser, 1964), Sc element IPUM 25936; sample SIL 26 (*eosteinhornensis* s.l. Zone); lateral view, x90.

Fig. 3 - *Oulodus siluricus* (Branson & Mehl, 1933), Pa element IPUM 25914; sample SIL 5 (*ploeckensis* Zone); lateral view, x60.

Fig. 4 - *Panderodus recurvatus* (Rhodes, 1953), IPUM 25935; sample SIL 19 (*latialata* Zone); lateral view, x90.

Fig. 5 - *Belodella anomalis* (Cooper, 1974), IPUM 25934; sample SIL 29 (*eosteinhornensis* s.l. Zone); lateral view, x100.

Fig. 6 - *Ozarkodina snajdri* (Walliser, 1964); Pa element IPUM 25931 sample SIL 21 (*snajdri* Zone); upper view, x65.

Fig. 7 - *Wurmiella hamata* (Walliser, 1964), Pa element IPUM 25905; sample SIL 1 (*hamata* Zone); upper view, x80.

Fig. 8 - *Polygnathoides siluricus* Branson & Mehl, 1933, Pa element IPUM 25897; sample SIL 12 (*siluricus* Zone); upper-lateral view, x60.

Fig. 9 - *Pelekysgnathus* sp. A Corriga & Corradini, 2009, Pa element IPUM 25933; sample SIL 23 (*crispa* Zone); lateral view, x80.

Fig. 10 - *Ozarkodina crispa* (Walliser, 1964) Pa element α morph. IPUM 25929; sample SIL 23 (*crispa* Zone); upper-lateral view, x80.

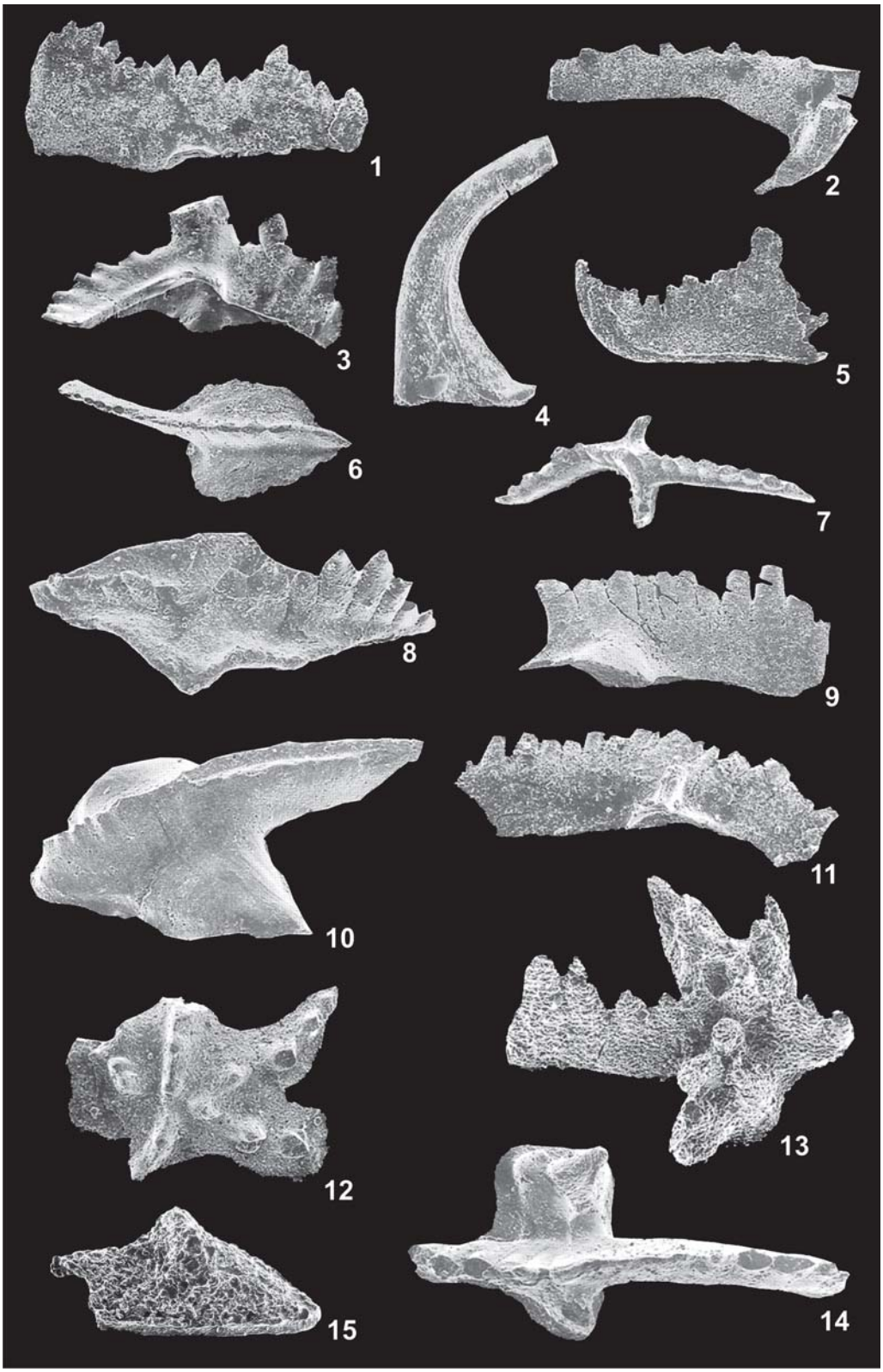
Fig. 11 - *Kockelella absidata sardoa* Serpagli & Corradini, 1999, Pa element IPUM 25858; sample SIL 7 (*siluricus* Zone); lateral view, x80.

Fig. 12 - *Ancoradella ploeckensis* Walliser, 1964, Pa element IPUM 25923; sample SIL 4 (*ploeckensis* Zone); upper view, x70.

Fig. 13 - *Kockelella variabilis variabilis* Walliser 1957, Pa element IPUM 25854; sample SIL 3 (*hamata* Zone); upper-lateral view, x80.

Fig. 14 - *Kockelella variabilis ichnusae* Serpagli & Corradini, 1998, Pa element IPUM 25836; sample SIL 5 (*ploeckensis* Zone); upper view, x80.

Fig. 15 - *Eurytholia* cf. *bohemica* Ferretti et al., 2006, IPUM 28211; sample SIL 15 (*siluricus* Zone); lateral view, x50.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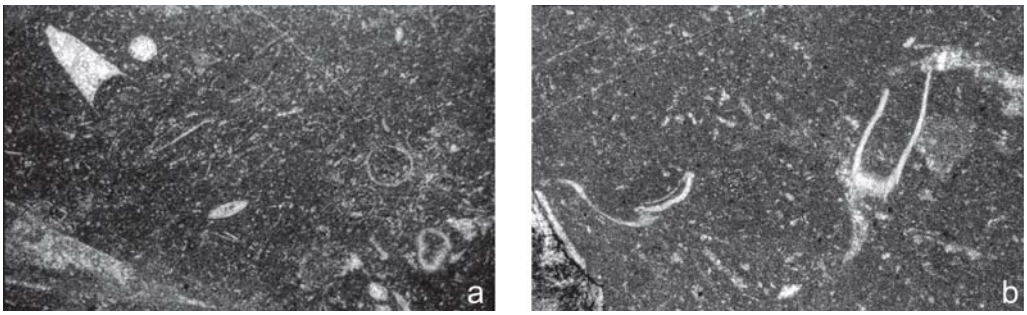

Fig. 4 - Typical Ockerkalk microbiofacies of the Silius Section. a) Bioclastic wackestone with a cephalopod fragment (top); sample SIL 12, x8. b) Trilobite fragments in a bioclastic wackestone; sample SIL 12, x16.

Fossil content

Macrofossils are rare and limited to a few crinoidal stem, parallel to the bedding. A crinoidal enrichment is observable between beds SIL 26 and SIL 28.

Microbiofacies analysis has revealed ostracodes, brachiopods, thin-shelled bivalves, trilobites, gastropods, rare small cephalopods and sponge spiculae. All these organisms are scattered in a micritic mudstone, only locally concentrated in thin wackestone-band of disarticulated debris (Barca et al., 1995; Serpagli et al., 1998).

Rare phyllocarids (mainly mandibles) and microbrachiopods were occasionally found in heavy fraction from some samples (i.e. SIL 6). The problematic *Eurytholia bohemica* Ferretti, Serpagli & Storch was found in sample SIL 15 (Pl.1, fig. 15).

Among microfauna, conodonts are abundant throughout the section and allowed a detailed biostratigraphy (see below). However, the occurrence rate is very variable, ranging from 4 elements per kg (sample SIL 16) to 170 elements per kg (sample SIL 7). The preservation is not very good, being many specimens broken and/or texturally altered. Conodonts are black (Colour Alteration Index = 4.5-5).

Thirty conodont apparatuses, belonging to fifteen genera have been recovered from the Silius Section (Fig. 3). Two taxa have their *stratum typicum* in this section: *Kockelella variabilis ichnusae* Serpagli & Corradini in level SIL 5, *Pseudooneotodus bicornis contiguus* Corradini in level SIL 23.

Biostratigraphy

Eight late Silurian conodont zones have been reported from the Silius Section: *hamata* (levels 1-3), *ploeckensis* (levels 4-6), *siluricus* (levels 7-17), *latialata* (level 18-19), *snajdri* (levels 20-22), *crispa* (levels 23-24), *eosteinhornensis* s.l. (levels 25-29) and *detortus* (levels 30-39).

Palaeoenvironment

A quiet pelagic environment below normal wave-base and with bioclastic input variable in time and probably in space, especially in the crinoidal fraction, was suggested by Barca et al. (1995).

The Lau event

The Silius Section was selected as deep water example section within a project on the "Lau Event" led by L. Jeppsson (Jeppsson et al., 2002). The Lau event is one of the main

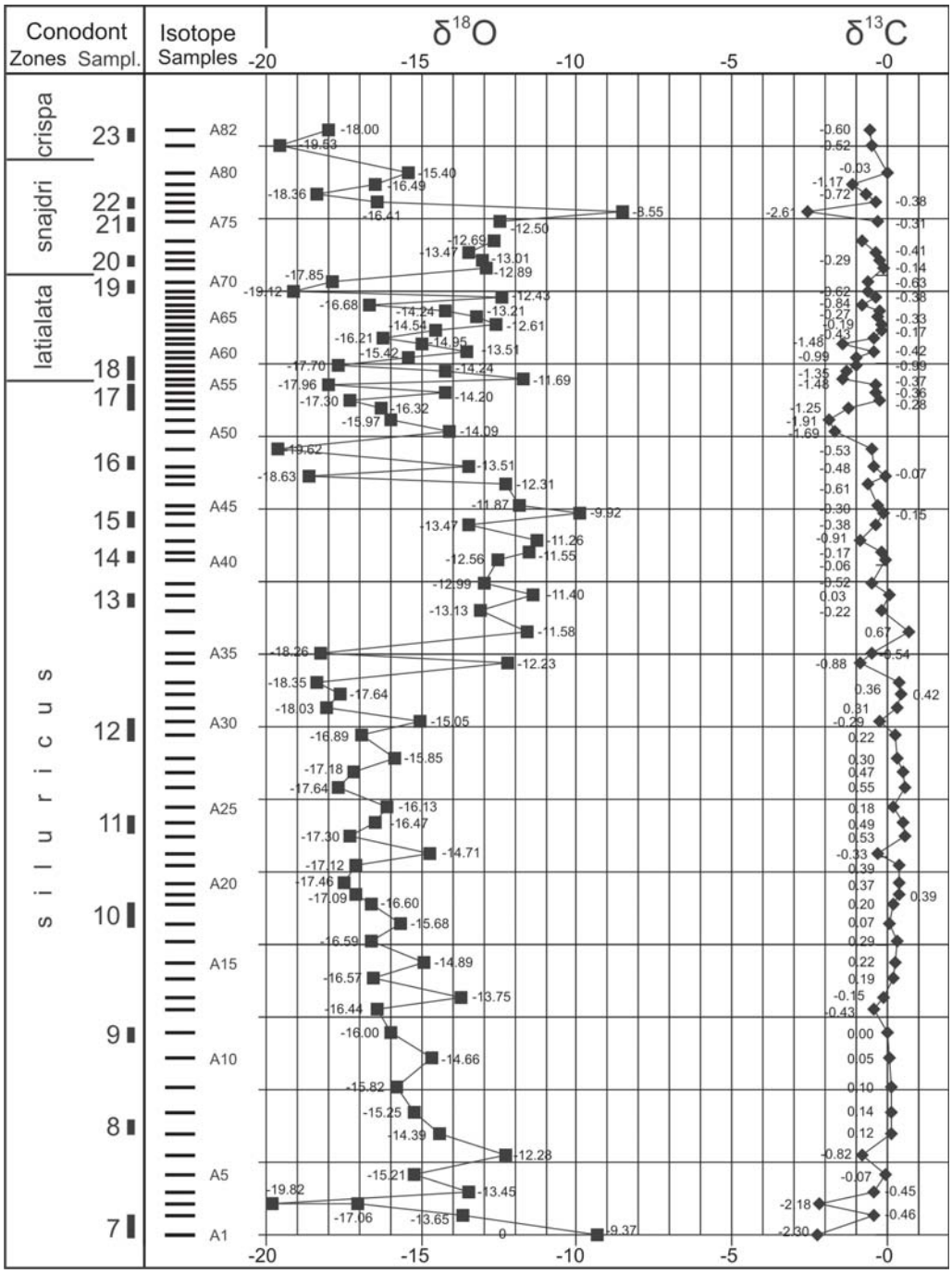

Fig. 5 - $\delta^{13}C$ and $\delta^{18}O$ data from the central part of the Silius Section.

oceanic events in the Silurian, affecting several fossil groups (among others, brachiopods, chitinozoans, ostracods, graptolites, conodonts, trilobites) and has been recognised in Baltica, Gondwana and Laurentia. It corresponds more or less with the *siluricus* conodont Zone (lower Ludfordian).

Oxygen and Carbon isotope data were compared with shallow water regions like Gotland (Sweden) and Broken River (Australia), as conodont data allowed good correlations. The final papers of that project are still in progress and therefore a complete discussion is omitted here.

Eighty-two isotope samples were collected from the base of the *siluricus* Zone (conodont sample SIL 7) to the base of the *crispa* Zone (SIL 23): covering the Lau event interval and the post-event recovery. $\delta^{13}C$ and $\delta^{18}O$ data are available and are reported in Fig. 5. Even if metamorphism could have partly affected the data, a clear shifting towards less negative $\delta^{18}O$ values occurs in the upper part of the *siluricus* Zone, between samples SIL 12 and SIL 13. This can be considered as the beginning of the Lau Event, as marked also by a drop in conodont abundance and the extinction of genus *Kockelella*.

Anomalous conodont elements, mainly ramiforms with extra bars, have been reported from the lower part of the *siluricus* Zone (samples SIL 7-12) (Corradini et al., 1996). The authors referred these occurrences to "pre-event" P-episodes, characterized by abundant and diverse planktonic communities.

Further Notes

The Ludlow-Pridoli boundary should be placed at the top of bed 24, just above the last occurrence of *Ozarkodina crispa*.

The lobolith horizon well exposed in the nearby Genna Ciuerciu Section has not been discovered so far here, probably due to the different kind of exposure. This level is, in fact, well exposed in the latter section, where the bearing-beds are cropping out in an upward attitude. On the basis of conodont biostratigraphy, that horizon should correspond with the base of the *detortus* Zone (sample SIL 30).

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