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The Wenlockian Graptolitic Shales at Goni, SE Sardinia

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LOCALITY Goni village, Peinconi locality, Gerrei.

STRATIGRAPHIC UNIT Lower Graptolitic Shales; Gerrei Tectonic Unit.

AGE Wenlock, late Sheinwoodian and Homerian.

LOCATION

The graptolite section crops out in the northern side of the Goni village and can be reached by a country road on the right (via dei Graptoliti) from near the town hall. It is mapped in the Geological Sheet Mandas (1:100.000); I.G.M. Tav. 1: 25000 Goni.

HISTORICAL OUTLINE

La Marmora first collected samples of graptolitic black metashales from the Peinconi locality at Goni, where he discovered in the carbon-rich metashales an impressive amount of “silvery“ graptolites “polypieritic plants of the Silurian fauna…” (Itinéraire de l’Île de Sardaigne, 1857, Tome I, pag. 207). Meneghini (1857) described and superbly illustrated that fauna. Later, Gortani (1922) gave important contributions to the knowledge of Goni’s fauna, last author extending the study to the graptolitic black metashales and limestones of the Gerrei and the central Sardinia. From the biostratigraphic viewpoint and the understanding and reconstruction of Silurian and Lower Devonian sequences of eastern Sardinia the most important contributions were provided by German and Italian geologists and paleontologists who worked over the last thirty years in the mining areas of Sarrabus and Gerrei. According to the relevant studies of Schneider (1972), Helmcke (1973), Jaeger (1976, 1977) and Barca & Jaeger (1990), the graptolite associations of Goni and eastern Sardinia, the biozonal sequence and correlations with Thuringia and throughout the world, were precisely assessed. An integrated biostratigraphy by means of conodonts was instead assessed by Barca *et al*. (1994, 1995), Corradini & Olivieri (1997), Corradini & Serpagli (1998), Serpagli *et al.*(1998). Recently, Rickards *et al*. (1995) refined Jaeger’s biozonal concept and discussed the formal principle of the Wenlock-Ludlow boundary. The knowledge on the paleontological content of the Goni succession has been increased by the recent works on chitinozoans (Pittau & Del Rio, 2000) and on “*problematica*“ microfossils (Pittau *et al*., 2002) that copiously are included in some horizons. Lastly, paleoecological researches pointing to the paleontological and geochimical characterization of the *lundgreni* Event in the Goni section, are in progress (Pittau *et al*., 2001 and in prep.)

LITHOLOGY

The N-S section of Goni, about 35 m thick, is composed of alum black metashales almost vertically dipping, with imbricate structure; it crops out between two ockerkalk

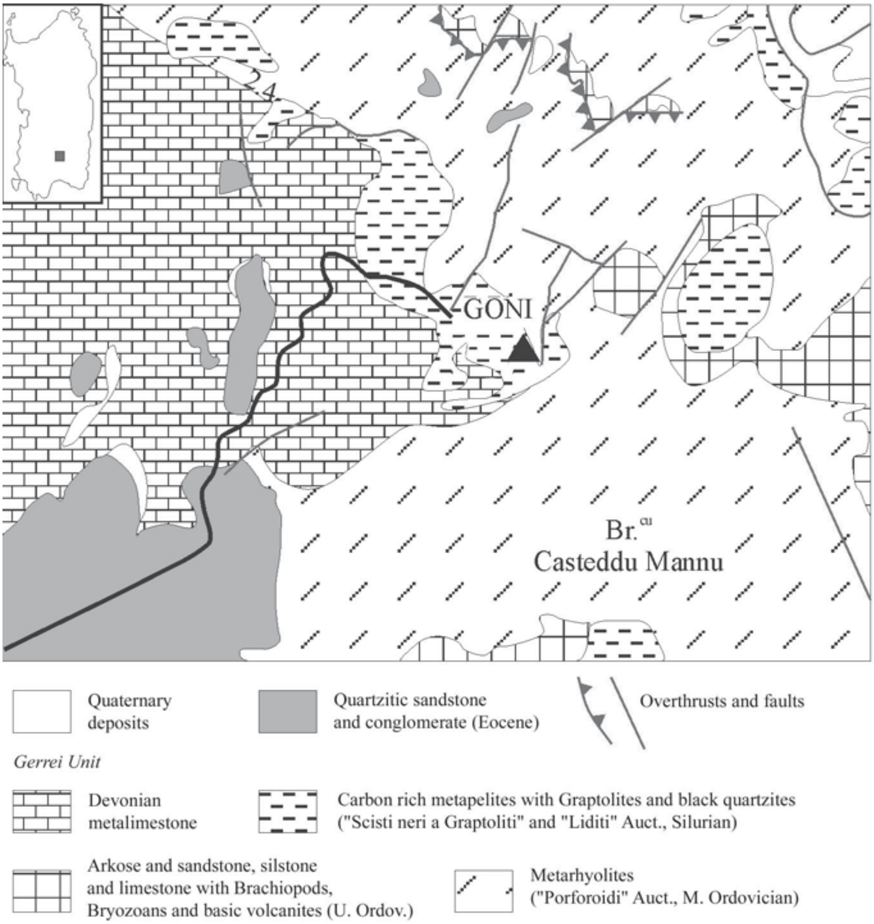

Fig. 1 - Schematic geological map of Goni area (After Carmignani *et al*., 1992).

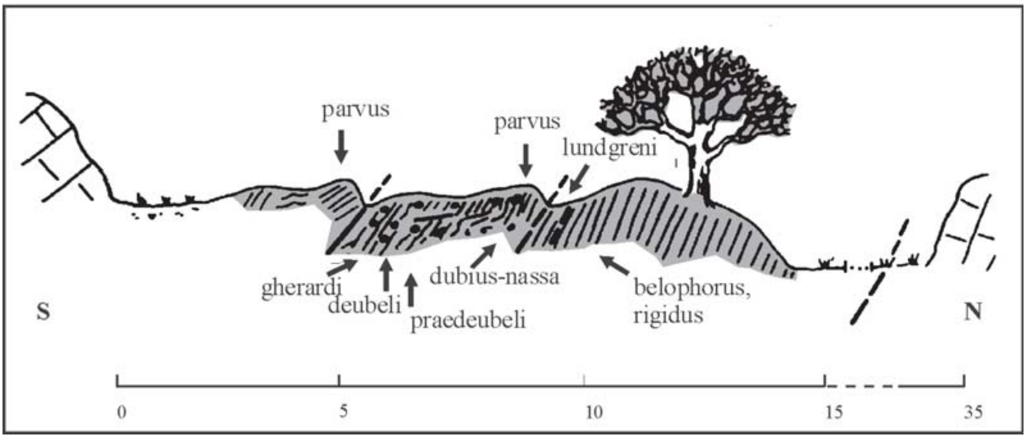

Fig. 2 - Scheme across the Sheinwoodian/Homerian boundary at Goni (After Barca & Jaeger, 1990).

blocks southward deepening. Faults and/or very narrow foldings cause repetition of the stratigraphic sequence (Fig. 2). It's a condensed succession likely deposited in a "deep basin" under strong anoxic conditions. The black metashales are organic carbon rich, dusty, with abundant framboidal pyrite and scattered millimetric nodules of phosphorite. Millimetric layers of phosphorite occur frequently in the interval from the *Cy. lundgreni* to the ?*Col. vulgaris/gerhardi* Biozones.

Paleobiological content and Biostratigraphy

The middle Silurian black metashales are worldwide generally very poor of fossils, with the only exception of abundant graptolites. In this section, the very rich graptolite fauna is associated to chitinozoan assemblages and to "*problematica*" organic walled microfossils; it may be noted that only organic walled fossils have been preserved in the diagenetic environment.

Graptolites

The recognized biozonal sequence includes the *Monograptus belophorus* (*flexilis*) – ?*Colonograptus vulgaris gerhardi* interval, equated to part of the Sheinwoodian and the entire Homerian Stages of the Wenlock Series; the graptolite associations identified by Jaeger (1976, and *in* Barca & Jaeger, 1990) and their localisation in the sequence are

Serie	Stage	Graptolite Biozones	Graptolite Faunas	Thickness cm
WENLOCK	Homerian	*?Colonograptus vulgaris gerhardi*	*?Col. gerhardi, ?Col. vulgaris, P. dubius*	+30/+60
		?Colonograptus deubeli	*?Col. deubeli*	0/-30
		?Colonograptus praedeubeli	*?Col. praedeubeli, P. dubius, G. nassa*	-30/-60
		?Colonograptus dubius/ Gothograptus nassa	*P. dubius, G. nassa*	-60/-90
		Pristiograptus dubius parvus	*P. dubius parvus, G. nassa*	-90/-120
				-120/-135
		Cyrtograptus lundgreni	*P. dubius, Cy. lundgreni, Cy.* sp., *M. priodon/flemingii, Cy.* sp. indet.	-135/-160
			Cyrt. lundgreni, Mcl. vomerina group	-160/-180
	Sheinwoodian			-180/-300
		Cyrtograptus rigidus	*M. priodon/flemingii, P. dubius, M. antennularius, Med. retroflexus, M. hemipristis, Cy. rigidus*	-300/-330
		Monograptus belophorus (flexilis)	*M. belophorus*	

Tab.1 – Summary table of the graptolite content in the Goni section as reported by Jaeger (*in* Barca & Jaeger, 1990).

reported below, according to the indications of the aforementioned Author, who fixed the starting level (zero level) at the base of the ?*Colonograptus deubeli* yielding layers (Tab. 1)

Except for *Cyrtograptus ellessae*, never found in Sardinia, the biozonal scheme is striking similar to that one of Thuringia, and also similar to that one recognized in the subsurface sequence of Gotland and Lituania, and in southern Spain (Jaeger, 1991).

To be noticed are the two graptolite extinction levels. The most important one, with extinction of *M. priodon flemingii* and of the giant cyrtograptids line, occurs at the end of the *Cyrtograptus lundgreni* Biozone, in the interval *Cy. lundgreni*-*P. dubius parvus* (Jaeger, 1991); the second, a minor extinction, is little below, within the *Cy. lundgreni* Biozone, when the extinction of the *vomerinus* group occurs.

Chitinozoans

The chitinozoan microfaunulas found in this section are in different state of preservation. Some display graphitized tests, while others are threedimensionally preserved, essentially thanks to the diffuse presence of phosphorite. The concentration ranges from 0,2 to several tens of tests per gram of rock.

With regards to graptolite biostratigraphy, chitinozoans associations have been found in the following biozones: *Cy. rigidus, Cy. rigidus* - *Cy. lundgreni* interval, *Cy. lundgreni and ?Col. vulgaris gerhardi*.

The associations generally display high number of specimens and low to very low specific diversity. They are characterized by the conspicuous presence of a morphogroup with several species or by the dominance of single species. Three biozones have been recognized:

· IG (comprising the *Cy. rigidus* and the stratigraphic interval to *Cy. lundgreni* Biozones). Main taxa is *Conochitina subcyatha*, index taxon of the eponymous biozone of Estonia

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Plate 1
After Barca & Jaeger, 1990

Fig. 1 - *Glyptograptus* gr. *tamariscus* (Nicholson); *convolutus* Zone (x 5)
Fig. 2 - *Cephalograptus cometa cometa* (Geinitz); *convolutus* Zone, *cometa* Subzone (x 5)
Figs 3, 5 - *Pristiograptus dubius parvus* (Ulst); *parvus* Zone (x 5)
Fig. 4 - *Pristiograptus dubius* (Suess); *praedeubeli* Zone (x 5)
Fig. 6 - *Pristiograptus dubius* (Suess); *lundgreni* Zone (x 5)
Fig. 7 - *Orthograptus insectiformis* (Nicholson); *convolutus* Zone (x 5)
Fig. 8 - *Monograptus priodon* (Bronn s.l.); *convolutus* Zone (x 3)
Fig. 9 - *Monograptus lobiferus* (Mc Coy); *convolutus* Zone (x 3)
Fig. 10 - *Monograptus limatulus* Törnquist; *convolutus* Zone (x 5)
Figs 11, 12 - *?Colonograptus praedeubeli* Jaeger; *praedeubeli* Zone (x 5)
Fig. 13 - *Monograptus exiguus primulus* (Boucek & Pribyl); *turriculatus* Zone (x 5)
Fig. 14 - *Spirograptus turriculatus* (Barrande); *turriculatus* Zone (x 5)
Fig. 15 - *Rhaphidograptus törnquisti* (Elles & Wood); *vesiculosus* to *gregarius* Zone (x 9)
Fig. 16 - *?Colonograptus gerhardi* Kühne; *vulgaris/gerhardi* Zone (x 3)
Fig. 17 - *Petalograptus minor* Elles; *gregarius* Zone (x 5)
Fig. 18 - *Monograptus triangulatus* (Harkness); *gregarius* Zone (x 5)
Fig. 19 - *?Colonograptus deubeli* Jaeger (x 9)
Fig. 20 - *Monograptus testis* (Barrande); *lundgreni* Zone, *testis* Subzone (x 2)
Fig. 21 - *Coronograptus gregarius* Lapworth; *gregarius* Zone (x 5)
Fig. 22 - *Cyrtograptus rigidus* Tullberg; *rigidus* Zone (x 2)

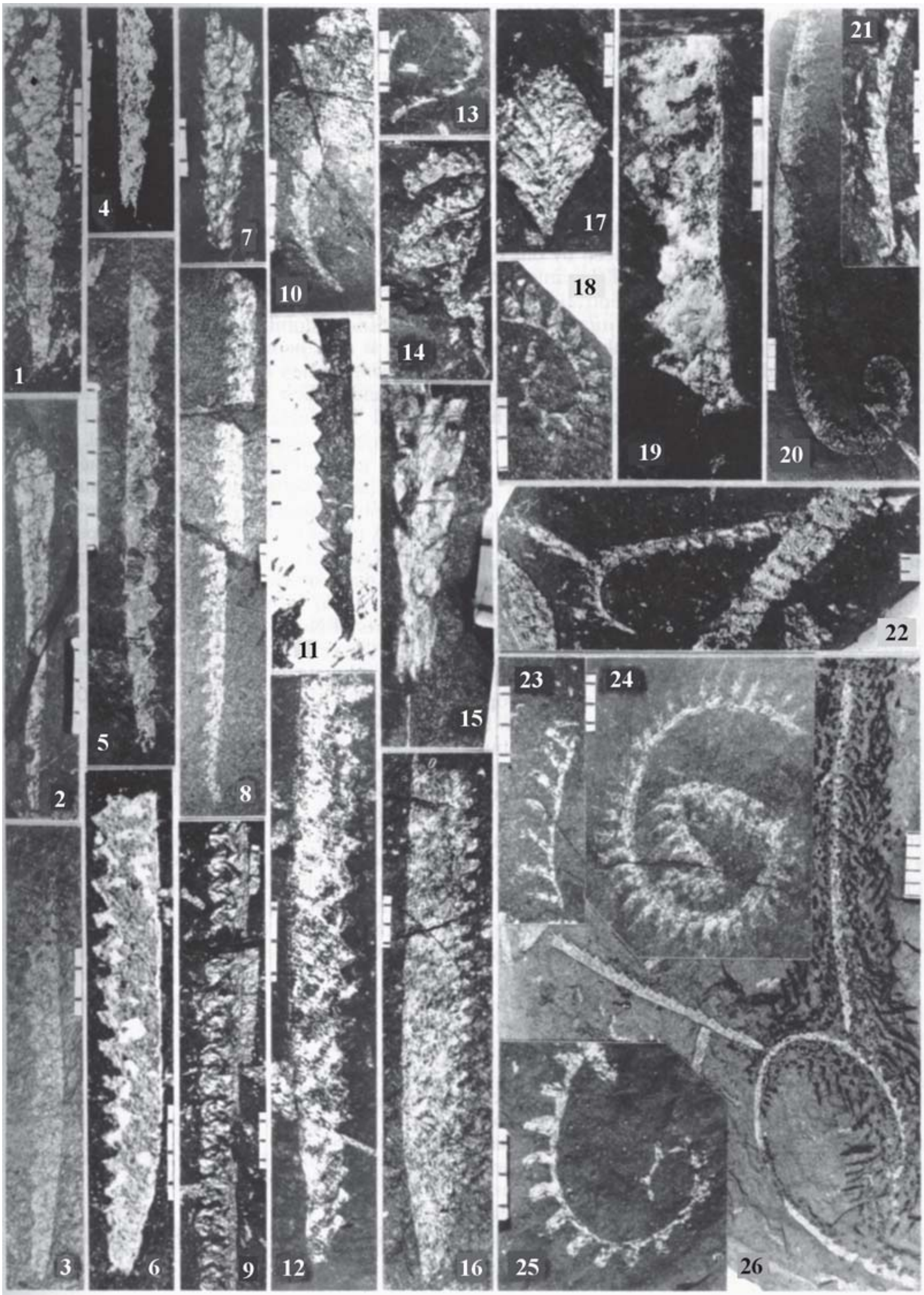

Fig. 23 - *Tetragraptus decipiens* Törnquist?; *convolutus* Zone (x 5)
Fig. 24 - *Monograptus flagellaris* Törnquist; *spiralis* Zone (x 2)
Fig. 25 - *Monograptus denticulatus magnificus* (Pribil & Munch); *convolutus* Zone, *cometa* Subzone (x 5)
Fig. 26 - *Cyrtograptus lundgreni* Tullberg; *lundgreni* Zone (x 2)

in age correlatable rocks (Nestor, 1994). The IG chitinozoan associations is quantitatively represented by long sized conochitinids.

- IIG (lower part of the *Cy. lundgreni* Biozone). Main and dominating taxon is *Conochitina goniensis*. Concurrent taxa are: *C. subcyatha, Sphaerochitina jaegeri, S. ichnussae.*
- IIIG (upper portion of the *Cy. lundgreni* Biozone). Main and dominating taxon is *Sphaerochitina serpaglii*. Concurrent taxa are: *S. ichnussae, Conochitina*. aff. *proboscifera, Rhabdochitina* sp.a, *Tanuchitina* sp.a, *Conochitina* sp.a and *Conochitina goniensis*, ?*Eisenackitina ampulla*.

The successive chitinozoan assemblage is exclusively represented by one species: *Conochitina goniensis*. After an interval lasting four biozones, from *Prist. dubius parvus* to ?*Col. deubeli*, chitinozoans still re-appear with the species *Conochitina pachycephala*.

“Problematica*” microfossils*

A great amount of organic walled hemispheres and spherules (60 to 150 µm of diameter), of presumably different (polyphiletic) biological origin, are present in some horizons.

Lundgreni Event

The extinction of the giant graptolites at the closing of the *Cyrtograptus lundgreni* Chron, recognised in this section and in many parts of the world (Jaeger, 1991; Koren, 1991), has likely been caused by an important environmental change in the mid Homerian: the Mulde Event (Jeppsson 1997, 1998), a state of the ocean that caused extinctions among graptoloid graptolites as well as profound faunal change among conodonts and benthic organisms, such as “Lilliput effects” and low diversity-disaster faunas (Jeppsson 1997). Extinctions in this sections seem to took place into two points: at the end of the *lundgreni* Biozone with extinction of *Conochitina goniensis* and graptolites, and inside it where *Conochitina serpaglii* and *Conochitina ichnussae*, died out. In likely the same horizon or close to it the last presence of the *vomerinus* group, in this section, has been reported (Jaeger, 1991). Conspicuous variations in metal concentration (Pittau *et al*., 2001) in the sedimentary organic matter with respect to total rock have been found; further investigations are necessary to integrate biological and geochemical data.

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