FIELD TRIP GUIDE ON THE SAN ISIDRO – MENDOZA

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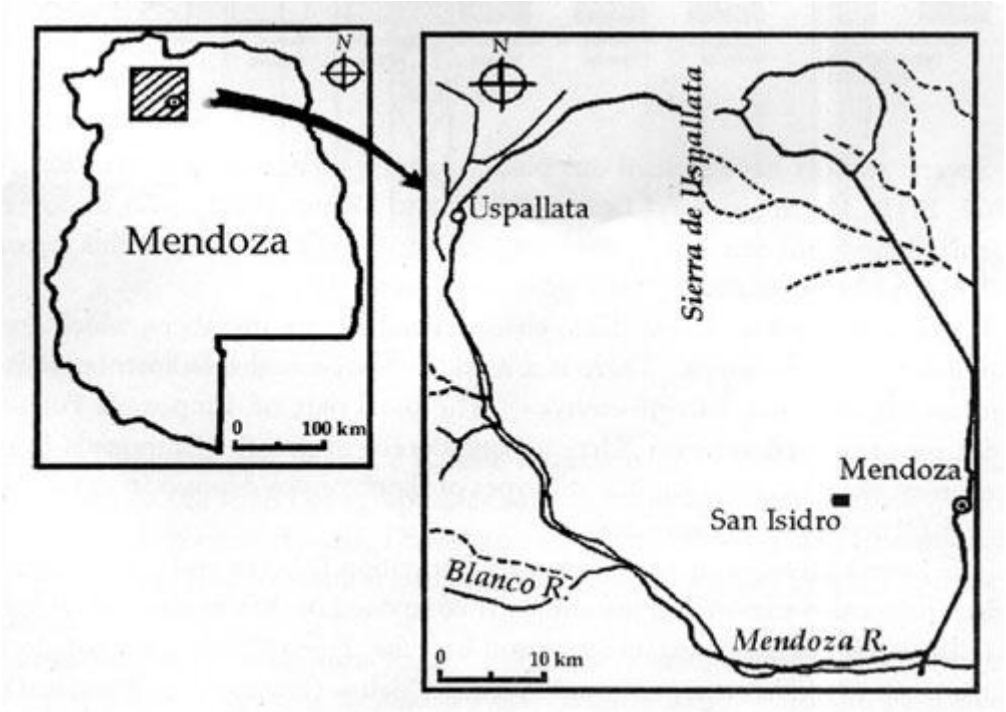
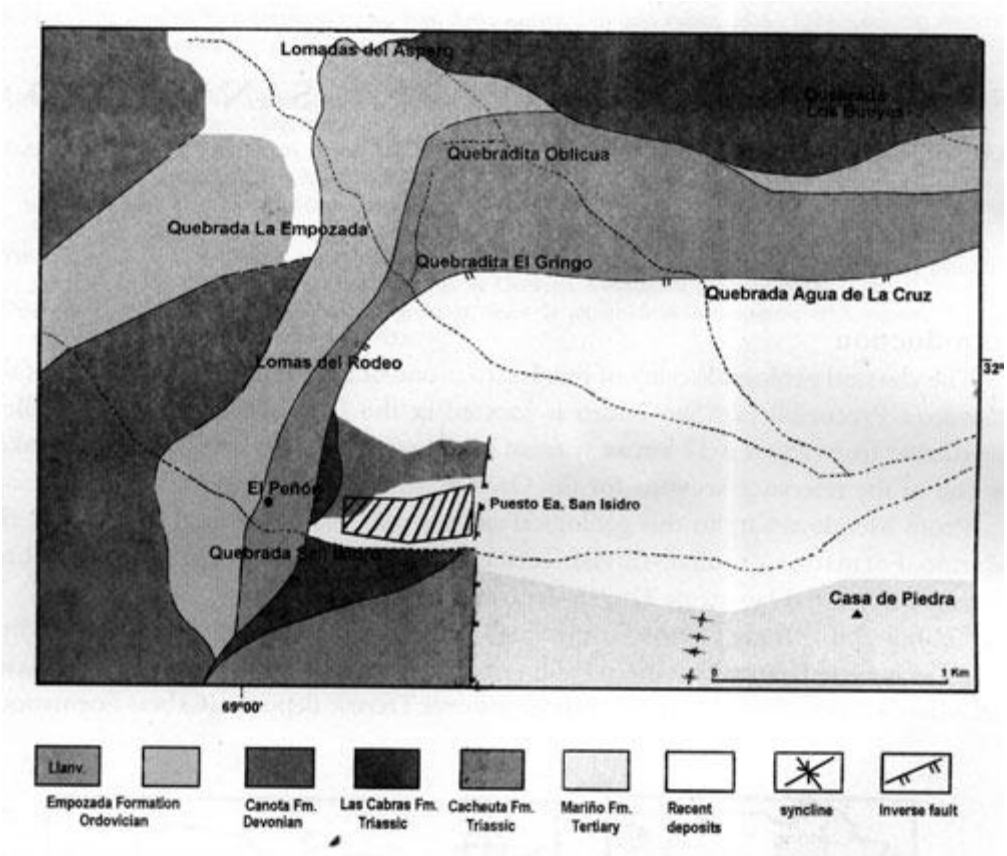
Introduction

The classical geologic locality of San Isidro is one of the first eastern outcrops of the Mendoza Precordillera. San Isidro is located in the foot-hill, on the Precordillera overthrust front and it is 17 km away from Mendoza City. This locality has been taken as one of the reference sections for the Ordovician system of Argentina.

From Mendoza City to this geological site we will cross a modern alluvial fan, the Mariño Formation (aeolian-fluvial Tertiary deposits), and Cacheuta and Cabras Formations (fluvial-lacustrine Triassic deposits).

Triassic and Tertiary deposits overlaying Quaternary alluvial sediments produce by a group of inverse faults (Divisadero Fault system). An important inverse fault associated to Divisadero S.F. allows Ordovician outcrops over Triassic deposits (Cabras Formation).





Several authors have studied this place. Among them, we must mention Borrello (1969, 1971), Harrington and Leanza (1957) and Turner (1961) who discovered and organized the Cambrian and Ordovician fossils macro fauna firstly in this region.

Empozada Formation (Harrington and Leanza, 1957)

It is a clastic unit of 430 m thick, characterized by two members, which are clearly distinguished in outcropps. There is a marked change in the sedimentation between both members (major unconformity). The basal part of Empozada Formation is under stratigraphical revision (Heredia and Beresi, in press). Empozada Formation gives an excellent example for different types of allochtonous deposits: rockfalls deposits, canyon-fill deposits and diamictites.

The Lower Member of the Empozada Formation (Middle and Upper Ordovician) is discontinuously exposed in thickness. It composed by 305 m (on San Isidro Creek) of following lithofacies: megabreccias and breccias, green shales, dark conglomerates, mudstones and sandstones, paraconglomerates ("debris flow complex") and black shales.

We can recognize in the Lower Member three different sedimentary events:

The first one is assigned to talus-basin deposits, which includes large olistoliths (see below). The autochthonous paleontological material is mostly composed of graptolites, which enable to define the *Paraglossograptus tentaculatus* Zone (LLanvirn): *Amplexograptus* aff. *A. confertus* Lapworth, *Glossograptus hincksii hincksii* (Hopkinson), *Oelandograptus*

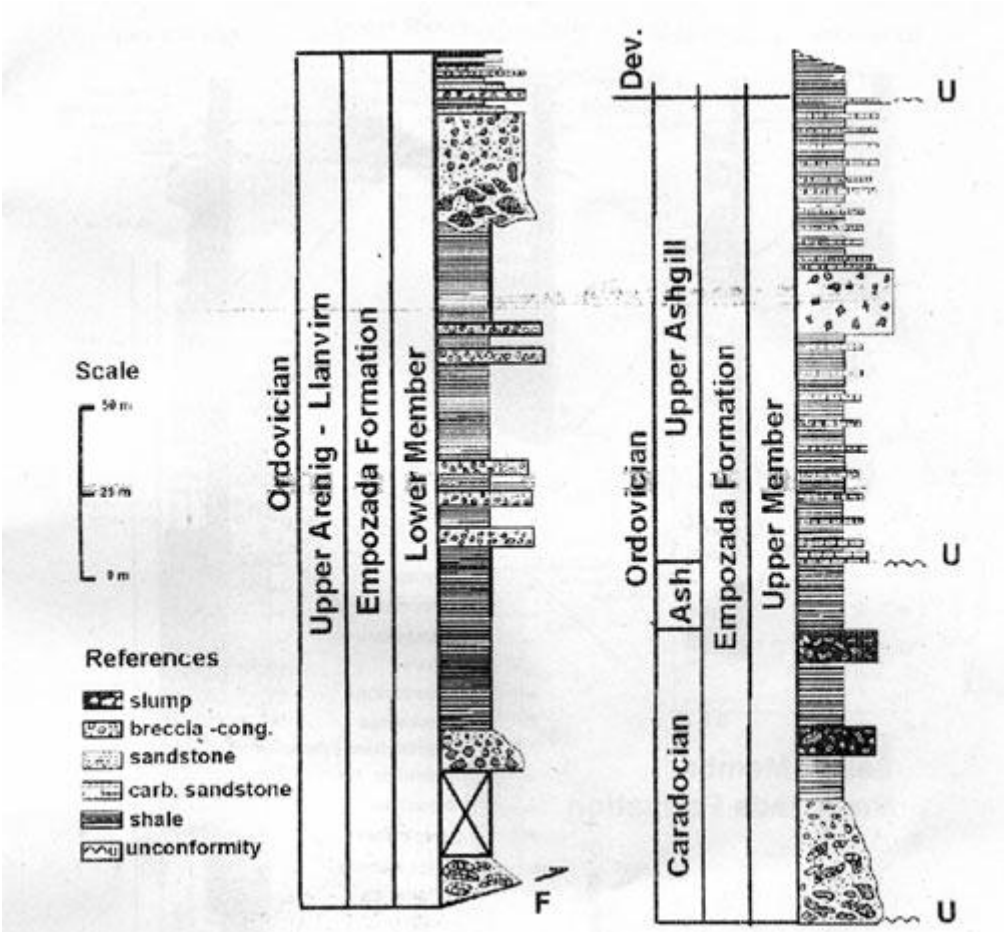


Figure 3: Columnar sketch of Empozada Formation

austrodentatus cf. *austrodentatus* (Harris y Keble), fragments of cf. *Glyptograptus.* Recently, Brussa and Toro (2000) found out graptolites such as *Isograptus caduceus caduceus* (Salter), *Isograptus victoriae* cf. *maximus* Harris*, Dichograptus* cf. *octobrachiatus* (J.Hall), *Pseudisograptus* sp. y *Xiphograptus?* sp. This association indicates isograptids biofacies, which is equivalent to the Arenig.

The second allows us to figure as turbidite deposits (canyon-fill deposits) belonging to *Nemagraptus gracilis*/*Climacograptus bicornis* Zone (Caradocian) (Alfaro and Fernández, 1985).

The last one, the black shales at the top, interpreted as a condensed event (TST) from *Orthograptus quadrimucronatus* Zone (Upper Caradocian- Lower Ashgill) (Alfaro, 1988) and, at the top (unconformity below), *Dicellograptus complanatus* y *D. ornatus* Zones (Ashgill *s.l*) are defined (Mitchell *et al.*1998).

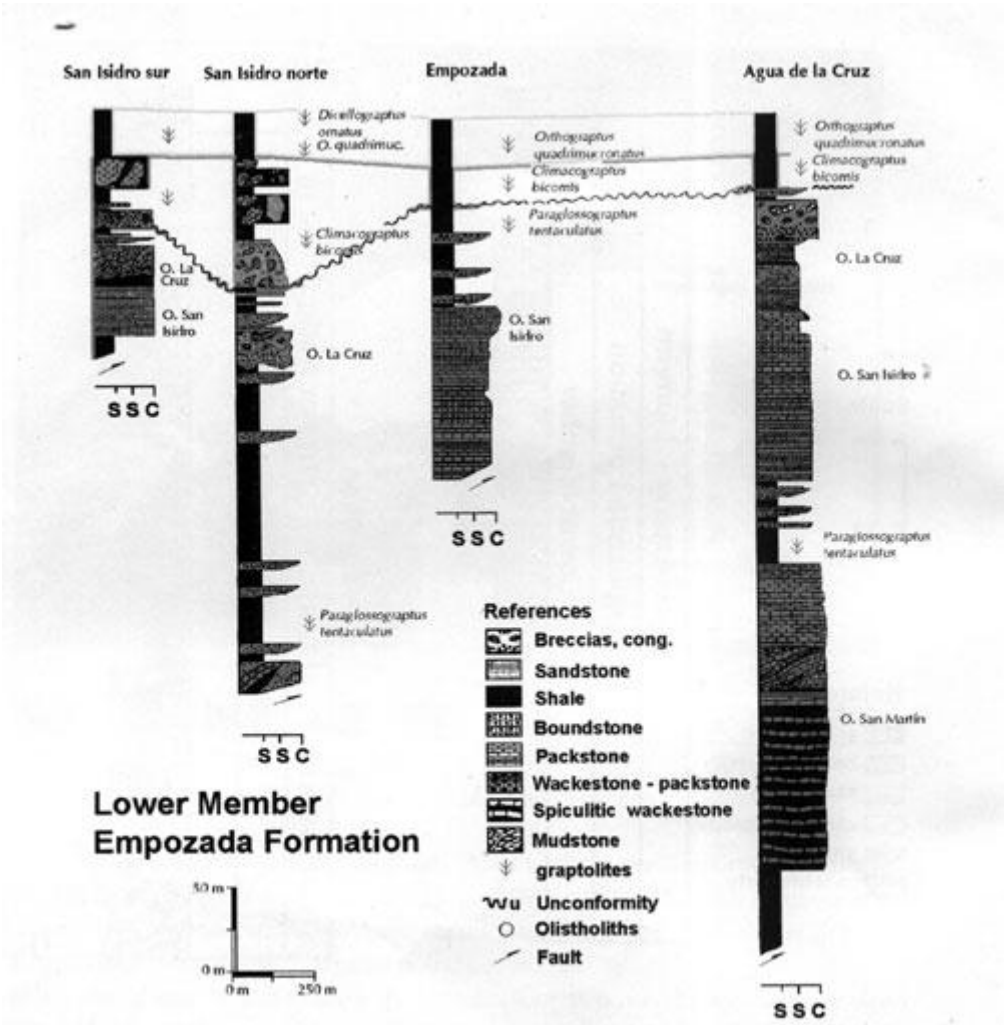
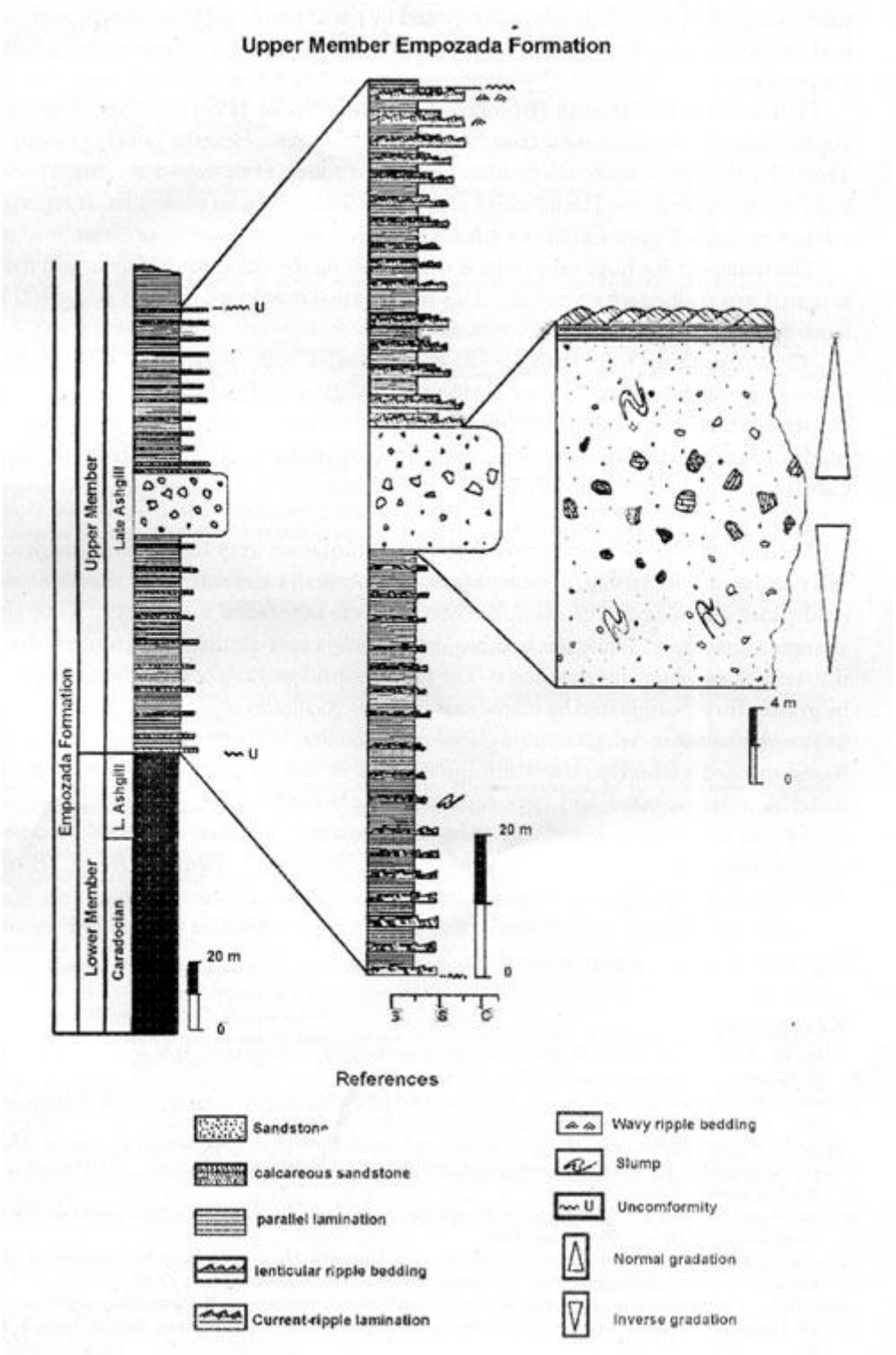


Figure 4. Lower Member of Empozado Formation: mote the different columnar sections arranged for the top of the member

On the other hand, Cambrian and Ordovician fossil material was identified on allochtonous rocks. (1) **San Martin Olistoliths:** trilobites (agnostiths) such as *Glyptagnostus reticulatus* y *Aphelaspis* sp. mentioned by Bordonaro *et al.* (1993), they defined the Upper Cambrian. There are, also, sponge spicules, sponge parts and fragment of shells. Lithology is composed mainly by dark carbonate mudstones and shales.

(2) **San Isidro Olistoliths** (Bordonaro *et al.* 1993) trilobites (*Athabasquia digesta and Glossopleura inexulcata*), hyolites, inarticulate brachiopods (*Obolus*?) y sponge spicules. San Isidro Creek: trilobites such as: *Chilometopus parabolicus, Kistocare mendozanun*, *Alokistocare elongatum*, *Kootenia incerta*, *Zacantoides ferula*,*Agnostus* sp., *Mendogaspis* sp. (*Glossopleura* Zone, Middle Cambrian) (Borrello, 1971). *Tonkinella stephensis* (Middle Cambrian) appering in



minor fragments. Lithologically is composed by packstones and grainstones, glauconite is abundant in some levels, at the top wackestones containing well preserved trilobites are present.

(3) **La Cruz Olistoliths** (Bordonaro, 1992) Borrello (1971) defined 3 trilobites zones *Cedaria*, *Elvinia* y S*aukia* from the Upper Cambrian. Heredia (1995) extended to Tremadoc the age of these olistholiths. Conodont zones: *Proconodontus tenuiserratus* Zone and *Paltodus deltifer* Zone. The lithology is the same for San Martin olistoliths. It represents a fragment of a Upper Cambrian talus.

The transport for huge olistoliths is rockfall along the slope to the basin, and maybe assigned to a major tectonic event. This is a regional event well defined along 400 km, from San Isidro to Jáchal Ordovician outcrops Cambrian and Ordovician Blocks: Black shales with *Tetragraptus aproximatus, T. fruticosus, T. quadribrachiatus* Zones (Bordonaro and Peralta, 1987). Black mudstone*s* with Upper Cambrian conodonts (*Phakelodus tenuis* Miller) In the *"debris flow"* there are mudstones with trilobites (*Trilobagnostus* sp. and *Pseudagnostus idalis idalis*) from the Upper Cambrian (Bordonaro *et al.* 1993), The Upper Member is composed by three lithofacies: very fine grained sandstones and mudstones alternating, carbonate paraconglomerates and carbonate sandstones and mudstones alternating. The interpretation of these lithofacies is complex. They show slumping, load-casts, lenticular bedding, hummocky cross-stratification, and we can use the term "heterolitic" for describe it. They were considered as platform facies, deposited by gravity flows, originated by major storm waves (Gallardo *et al*., 1988). Recently they were assigned at the Ashgill marine glacial event (Keller, 1999; Beresi and Heredia, 2000).

Resedimented carbonate clasts are interpreted as old outer-middle carbonate shelf material re-transported and deposited on the platform. Two conodont zones were found out: *Oepikodus evae* and *Amorphognathus superbus*. The last one with *A. superbus*, *Aphelognathus rhodesi, Drepanoistodus suberectus, Icriodella superba, Plectodina sp.* cf. *P. tenuis, Plectodina sp., Protopanderodus liripipus, Rhodesognathus elegans,* etc.

At the top a hardground is developed. Devonian green shales of Canota Formation Cor Villavicencio Formation overlie it.

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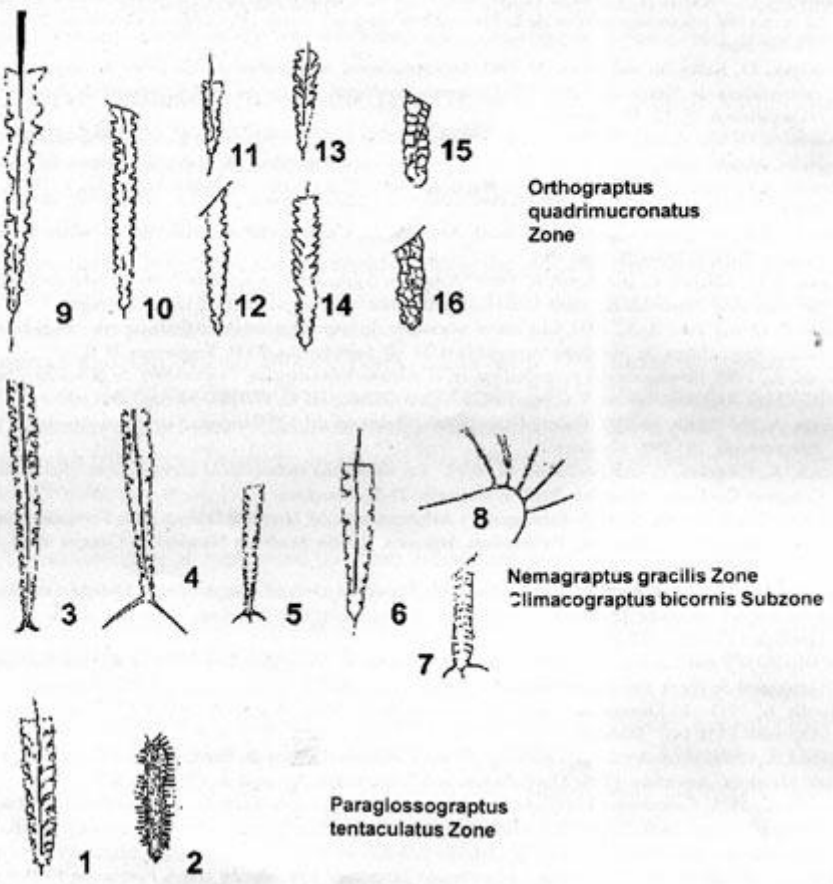

Graptolites and Conodonts from San Isidro Creek: sketches and outlines (no scale)
Empozada Formation

Figure 1. Autochthonous Graptolites

1.- *Amplexograptus aff. A. confertus*; 2.- *Glossograptus hincksii hincksii*; 3.- *"Climacograptus" bicornis bicornis*; 4.-*"Climacograptus" bicornis bicornis*;5.- *"Climacograptus" bicornis tridentatus*; 6.- *Geniculograptus pygmaeus*; 7.- *Cryptograptus tricornis*; 8.- *Nemagraptus gracilis gracilis*; 9, 10, 12.- *Climacograptus* cf. *C. tubuliferus*; 11.- *Climacograptus pygmaeus*; 13, 14.- *Diplograptus* cf. *D. minutus*; 15, 16.- *Retiograptus sp.*

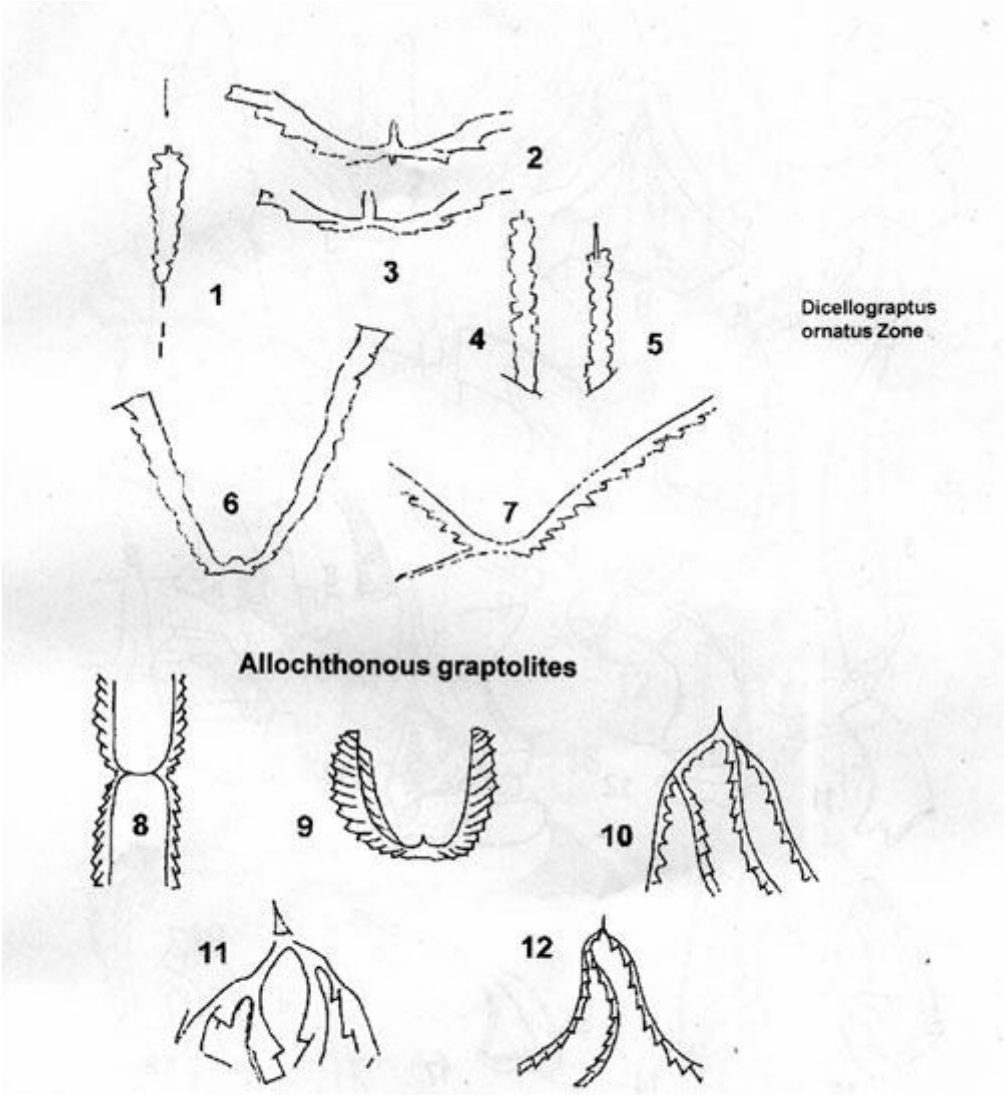

Figure 2. Autochthonous Graptolites
1.- *Climacograptus tubuliferus;* 2, 3.- *Dicellograptus* sp. cf. *D. flexuosus;* 4, 5.- *Normalograptus miserabilis;*6.- *Dicellograptus* sp. cf. *D. complanatus;*7.- *Dicellograptus ornatus.*
Allochthonous Graptolites
8.- *Tetragraptus approximatus approximatus;* 9.- *Tetragraptus* aff. *T. bigsbyi;* 10, 11, 12: *Pendeograptus fruticosus.*

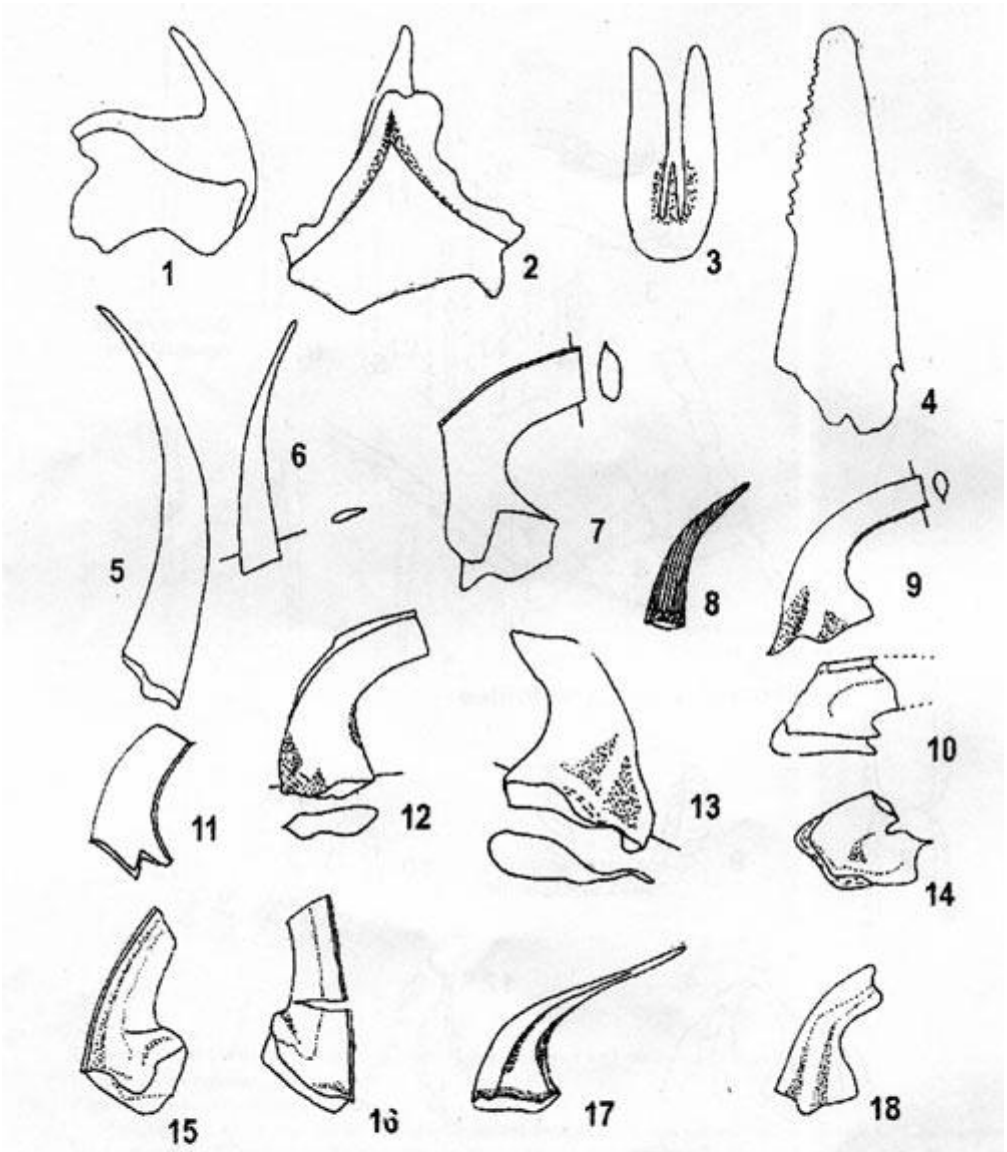

Figure 3. Allochthonous Conodonts.
Upper Cambrian (*Proconodontus tenuiserratus* Zone): 1.- *Furnishina asymetrica*; 2.- *Muellerodus* aff. *M. pomeranensis*; 3.- *Westergaardodina bicuspidata*; 4.- *Proconodontus tenuiserratus*; 5, 6.- *Phakelodus tenuis*;
Lower Ordovician (*Paltodus deltifer* Zone): 7,11,12: *Drepanodus arcuatus*; 13: *Drepanodus* sp.; 9,14: *Drepanoistodus* sp. cf. *D. basiovalis*; 8: *Scolopodus* sp. cf. *S. filosus*; 10: *Paroistodus* ¿ sp.; 15, 16: *Drepanoistodus* sp. cf. *D. suberectus*; 17: *Scolopodus* sp. cf. *S. flowerí*; 18: *Variabiloconus* sp.

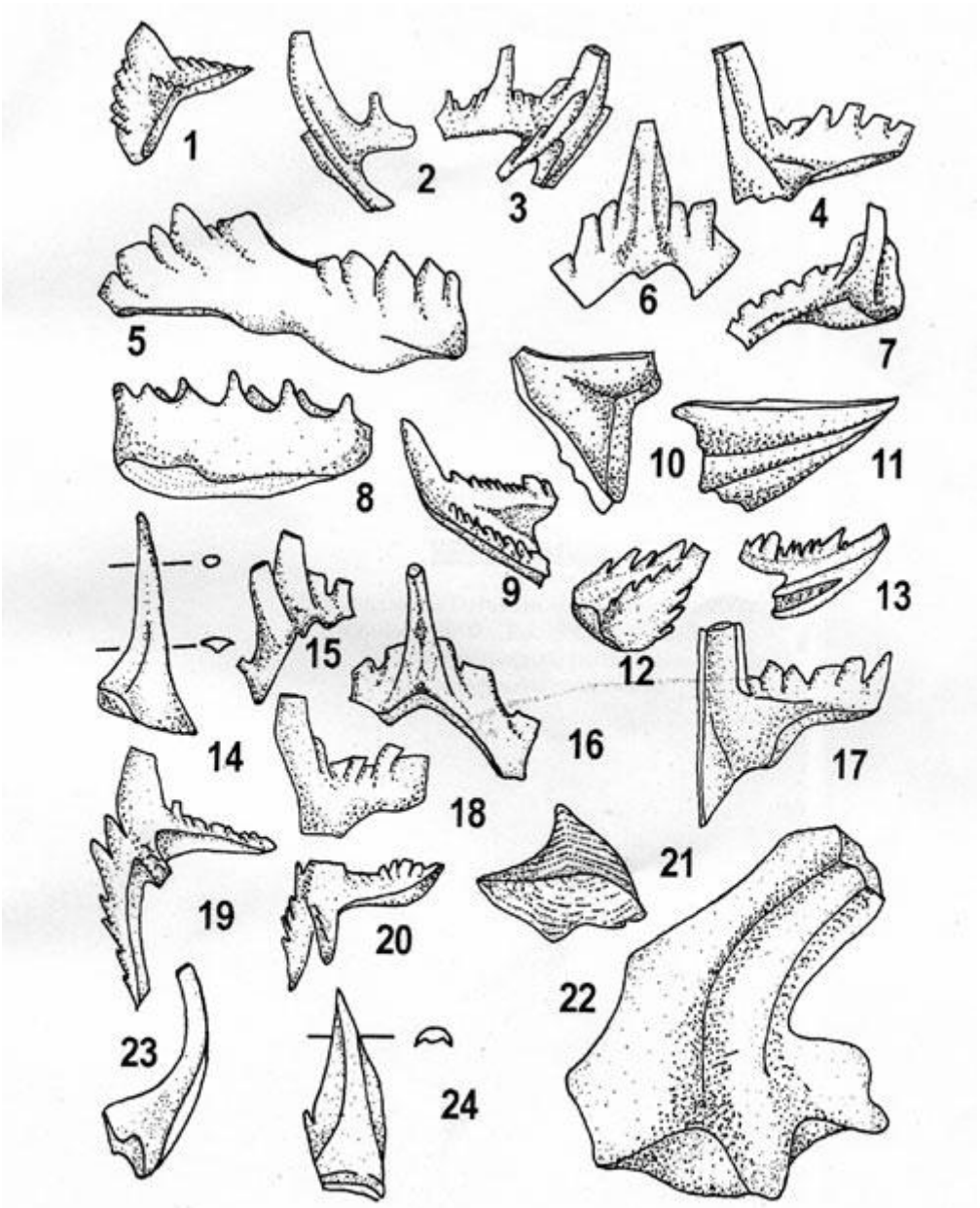

Figure 4: Allochtonous Conodonts
Upper Ordovician (*Amorphognathus superbus* Zone): 1, 2, 3: *Amorphognathus superbus;* 4, 5, 6, 7: *Aphelognathus radhesi;* 8, 9, 10, 11, 12, 13: *Ieriodella superba;* 14: *Drepanoistodus suberectus;* 15: *Plectodina* sp. cf. *P. tenuis;*16, 17, 18: *Plectodina* sp.; 19, 20: *Rhodesognathus elegans;* 21: *Pseudooneotodus* sp.; 22: *Protopanderodus liripipus;* 23, 24: *¿Staufferella* sp.
Drawings, outlines and figures of fossils modified from Cuerda y Alfaro (1993), Alfaro (1988), Brussa et al. (1999), Heredia (1994), Heredia (1995) and Heredia et al. (1990).