The Cambrian-Ordovician in the Tándilia System, Argentina: sedimentary facies, trace fossils, paleoenvironments and sequence stratigraphy

POIRÉ, SPALLETTI, L.A. AND DEL VALLE, A

The Tandilia System is situated in the Buenos Aires province, between latitude 36° 30´ to 38° 10´ South and longitude 57° 30' to 61° West. Its maximum length is 350 km in the NW SE direction. The hills are composed of an igneous metamorphic basement (Buenos Aires complex, older than 2,000 My) and a Precambrian and Lower Palaeozoic sedimentary cover.

From the lithostratigraphic point of view the Precambrian successions comprise a) the Villa Mónica Formation (conglomerates, sandstones, dolostones and shales) b) the Cerro Largo Formation (chert breccias, shales, siltstones and quartzites), and c) the Loma Negra Formation (limestones), all of these constituents of the Sierras Bayas Group, and d) the Cerro Negro Formation (limestones, fine sandstones and shales). The Lower Palaeozoic succession is known as the Balcarce Formation (quartzites associated with conglomerates and shales). These lithostratigraphic units were grouped into five depositional sequences: the Tofolletti (I), Malegni (II) and Villa Fortabat (111) sequences are Riphean, the La Providencia sequence (IV) is Vendian-Riphean and the Batán sequence (V) is Cambrian-Ordovician. Between the crystalline basement and the sedimentary cover, an arkosic and a quartz-kaolinitic saprolite indicates a palaeowethering surface. A peculiar event is the presence of diamictites between the crystalline basement and the Balcarce Formation reported in the El Volcán Hill.

Being all these units unfossiliferous they carry biogenic sedimentary structures (trace fossils and stromatolites) as the only evidence of biocoenosis in the Precambrian and Lower Palaeozoic seas of this region. Precambrian stromatolites are located in the Villa Mónica Formation, where they are arranged in biostromes and bioherms dated between 800 and 900 My. In the Precambrian units, trace fossils are scarce and show a poor ichnodiversity *Palaeophycus isp.* and *Didymaulichnus isp.* have been described in the Cerro Largo Formation, while *Helminthopsis isp.* and probable medusa resting traces have been found in the Loma Negra Formation. *Skolithos isp.* has recently been registered in the Lower part of the Cerro Negro Formation.

The Lower Palaeozoic Balcarce Formation shows a great quantity of trace fossi1s and a much higher ichnodiversity. After revising the already published material thoroughly and taking into account the recent discoveries made by the authors, the following up-dated list of trace fossi1s is presented:*Ancorichnus anconchnus, Arthrophycus alleghanensis, Arthrophycus isp., Bergaueria isp., Cochlichnus isp., Conostichus isp., Cruziana furcifera, Cruziana isp., Daedalus labeckei, Didymaulichnus lyelli, Didymaulichnus isp., Diplichnites isp., Diplocraterion isp., Herradurichnus sea scgliai, ?Monocreterion isp., Monomorphichnus isp., Palaeophycus alternatus, Palaeophycus tubularis, Palaeophycus isp., Phycodes aff. Pedum, Phycodes isp., Plagiogmus isp., Planolites isp., Rusophycus isp., Scolicia isp.,* and *Teichichnus isp.*

The precise age of the Balcarce Formation is difficult to determine. Through ; radiometric dating (600Ma) and the presence of acritarchs the underlying Cerro Negro Formation has been dated in the Vendian. The upper limit of the Balcarce Formation is sustained by an intrusive diabase body dated between 450-498 My. Consequently the unfossiliferous Balcarce Formation ranges between the Cambrian and the Ordovician. The presence of *Cruziana fureifera* has been one of the most substantial elements to accept an Arenigian age for the Baléarce Formation. Nevertheless the appearance of *Plagiogmus isp.*would strongly indicate a Cambrian affinity.

The Balcarce Formation (100 m thick) is composed of white quartz sandstones and granule sandstones with subordinated levels of mudstones (kaolinitic-rich clays) and quartz conglomerates. The geometry of the sandstone beds is sheet-like; most sedimentary bodies are bounded by convex-upward surfaces, though some wide channel-like features are also present. Planar and tangential cross-stratifications are the dominant structures within sandstone bedsets, and large-scale sigmoidal bodies are frequent in most sections. Sheetlike and lenticular sandstone-mudstone interbeds are commonly intercalated among sandstone storeys. Trace fossils are abundant at the top surface of the sandstone member in sandstone-mudstone interbeds. The quarries all around Batán and Chapadmalal towns allow to depict the stratigraphic architecture of the Balcarce Formation. Based on their contrasting geometry, two main groups of layers can be defined in this siliciclastic succession: one group is characterised by a subhorizontal stacking pattern (aggradational geometry) and the other shows very well developed depositional clinoforms (progradational geometry).

Tidal processes are inferred from the features of cross-bedded sandstone facies (bars) and heterolithic (wavy and lenticular) facies (swales). Large to medium scale laterally persistent bodies of cross-bedded sandstones, exhibit rhythmic lateral variations in the thickness of foresets and in clay content due to spring and neap tide alternation. Clay drapes covering foresets and other sedimentation surfaces, herringbone cross-bedding, opposite palaeocurrent trends in successive sedimentary bodies and reactivation surfaces also suggest tidal deposition. The migration and accretion of bidimensional sand bars seem to be controlled by highly asymmetrical time-velocity tidal currents. High-energy storm episodes are suggested by hummocky cross-bedded sandstones, sheet conglomerates armouring previous tidal sand bodies, and heavy mineral concentrations in the wavy sandstone laminae of heterolithic facies.

An epicontinental shallow marine open shelf is inferred for the CambrianEarly Ordovician in the Tandilia basin. Most sedimentary facies were developed in the nearshore and inner shelf environments of a tide-dominated and storm influenced platform.