A COLLISIONAL MODEL FOR THE STRATIGRAPHIC EVOLUTION OF THE ARGENTINE PRECORDILLERA DURING THE EARLY PALEOZOIC

Juan L. Benedetto (1) and Ricardo A. Astini (1)

(1) CONICET. Cátedra de Estratigrafía y Geología Histórica. Universidad Nacional de Córdoba. Av. Velez Sarsfield 299, 5000 Córdoba, Argentina.

RESUMEN. Se analiza la posible relación existente entre la historia sedimentaria y la evolución geodinámica de la Precordillera a la luz de la hipótesis de su origen como un microcontinente fragmentado de Laurentia y posteriormente acrecionado a Gondwana durante el Paleozoico temprano.

KEY WORDS: Argentina, Precordillera, Early Paleozoic, geodynamics.

On the basis of Dalziel's model (1991), Dalla Salda *et al.* 1992a; 1992b) suggested a Late Ordovician collision between South America and Laurentia in order to explain both, the Taconic orogeny in the Appalachians and the Famatinian orogeny in Western Argentina. According to this model, the carbonate platform of the Precordillera repr e sents the southward continuation of the Appalachian margin. However, several lines of evidence suggest that the precordilleran and eastern North America margins represent a conjugate rift pair, as was proposed by Bond *et al.*(1984). Herrera & Benedetto (1991) demonstrated that the brachiopod faunas of the San Juan Limestone (Early Ordovician) contain a significant proportion of Toquima-Table Head genera associated with several Celtic and Baltic elements. Because the Celtic genera have never been recorded from the North American Ordovician sequences, paleontological evidence do not supports continuity of South America and Laurentian margins. Nevertheless, the faunal affinities of trilobites suggest that both margins were very close during the Cambrian. The increasing amount of Celtic genera from Early Arenig to Early Llanvirn may reflect a gradual expansion of the Southern Iapetus Ocean. Petrologic evidence from the Famatina Range (Aceñolaza & Toselli, 1988; Mainheim & Miller, 1992) are particularly significant in demonstrating the existence of an Ordovician volcanic arc between the Gondwana basement and the Precordillera belt. Deep seismic reflection data across the Sierras Pampeanas and Precordillera boundary seem to be consistent with an allochtonous origin of the Precordillera (Cominguez & Ramos, 1991).

Recently, Benedetto (1993) proposed alternative paleogeographic models consistent with the biogeographic evidence. The hypothesis of Precordillera being a microcontinent which rifted from Laurentia in the Late Proterozoic or Early Cambrian, drifting from low to high latitudes is examined in detail in this paper and summarized in figure 1.

Late Proterozoic-Early Cambrian. The rifting and opening of the Southern Iapetus Ocean, at about 550-570 Ma produced the passive continental margin of Precordillera. A succession of red beds and evaporites which seems to underlie the Early Cambrian limestones in the northern Precordillera may represent a rift related sequence. Paleontological data indicate that a narrow ocean separated both margins. At the Precordillera latitude, the Late Precambrian-Early Cambrian Caucete Group was deposited on the Gondwana margin. This sequence, which could represent passive margin sedimentation, was folded and metamorphosed probably as a result of the development of an east-dipping subduction zone.

Middle-Late Cambrian. Carbonate deposition was continuous throughout the Precordillera platform. The Middle Cambrian successions are mainly subtidal, while the Late Cambrian is composed by intertidal dolostones. A coeval thick succession of rift-related shallow water sandstones and shales (Meson Group) was deposited on the Gondwana margin in northwestern Argentina.

Tremadoc. The Late Cambrian tidal flat carbonates (La Flecha Formation) are followed by a predominantly calcareous mid-shelf sequence (La Silla Formation). The deepening correlates with a global sea level rise which is reflected on the Gondwana margin by a widespread transgressive clastic sequence (Santa Victoria Group). In the Famatina basin, the black shales of the Volcancito Formation were deposited in an ensialic back-arc basin related to the Cambrian east-dipping subduction zone. A similar geodynamic scenary was proposed by Bahlburg and Breitkreuz (1991) to explain the origin of the Puna and Cordillera Oriental basins of northwestern Argentina.

Arenig. 90 Ma after the break-up, the Precordillera was placed approximately 2500 Km to the SE of Laurentia and a narrowing ocean separates it from Gondwana. To the east of the subduction zone an extensive volcanic arc system was active. Shallow marine fossiliferous shales, sandstones and layers of volcaniclastic materials (Suri Formation) filled the Famatina back-arc basin. The presence of brachiopods of Celtic affinities indicates for the first time a faunal connection with the Precordillera carbonate platform. Similar thick successions related to prograding shorelines and storm dominated deltaic complexes (Acoite and Sepulturas formations) were deposited in the Cordillera Oriental in northwest Argentina (Astini & Waisfeld, 1993).

Llanvirn-Llandeilo. Continued eastward subduction resulted in the closure and deformation of the Famatina back-arc basin (early stage of collision) giving rise to the Guandacol orogenic event. The Early Llanvirn is marked by extensive black shale deposition covering the carbonate platform (Astini *et al.*, 1988) in a starved peripheral foreland and accumulation of thick turbidites and olistostromes (i.e.Rinconada Formation) adjacent to the Gondwana basement. The major subsidence to the east could be interpreted as a response of active thrust loading along the eastern border of the Precordillera. The facies changes suggest that a block-faulted structure

accompanied the subsidence of the Precordillera collisional foredeep. Prominent diachronous conglomerates (i.e.La Cantera and Las Vacas Formations) suggest active motion of normal faults during the Llandeilo-Early Caradoc, but these coarse grained sediments also could have been derived from sinistral wrench faulting related to the collision. Along the open sea-faced margin a thick slope-to-basin clastic wedge was being built (Astini, 1988).

Caradoc-Ashgill. Upwarping and erosion of the distal portion of the peripheral foreland gave origin to a regional unconformity developed diachronically during the Late Ordovician in Precordillera (Astini, 1992). Thick carbonate megabreccias (Trapiche and Empozada formations) were shifted from the structural high into local strongly subsident depocenters evidencing active cannibalization of exposed older Ordovician strata. To the western belt, the clastic wedge interfingered with pillow lavas during the Caradoc (i.e.Yerba Loca and Alcaparrosa formations) (Astini, 1988). During the Hirnantian, eastern derived glacial sediments were deposited in the Precordillera.

Silurian-Devonian. Siliciclastic sequences are composed mainly by fine-grained shelf deposits, mostly confined to the east side of the forebuldge. The Early Silurian successions onlap the structural high to the west. On the easternmost border of the Precordillera basin, the influx of flysch-like sediments and olistostromes during the Llandovery and Wenlock (Mogotes Negros Formation) points out the final stages of the collision, although they might be related to a shear zone which displaced the Precordillera with a north-south trend (Ramos *et al.*,1986). The general stacking pattern and the cyclical facies arrange of Silurian and Devonian succcessions was controlled by eustacy or by the lithosphere rheology of the foreland.

REFERENCES

ACEÑOLAZA,G.F. & A.J.TOSELLI,1988. V Congr.Geol.Chileno,I:55-67

ASTINI,R.A.,1988. V Intern.Symp.Ordovician System, Abst.:2

ASTINI,R.A., F.L.CAÑAS & J.L.BENEDETTO, 1988. V Intern. Symp. Ordovician System, Abst.: 3.

ASTINI,R.A., 1992. Paleowathering records and paleosurfaces, 2nd Meeting.Abst.:6-7.

ASTINI,R.A. & B.G.WAISFELD, 1993. XII Congr.Argentino Geología.

BAHLBURG,H. & C.BREITKREUZ, 1991. J. South American Earth Sci., 4:171-188.

BENEDETTO,J.L., 1993. XII Congr. Geológico Argentino, Mendoza.

BOND,G.C., P.A.NICKESON & M.KOMINZ, 1984. Earth & Planet. Sci Letters, 70: 325-345.

COMINGUEZ,A.H. & V.A.RAMOS, 1991. Rev. Geol. Chile, 18: 3-14.

DALLA SALDA,L., C.A.CINGOLANI & R.VARELA, 1992a. Geology, 20: 617-620.

DALLA SALDA,L., I.W.D.DALZIEL, C.A.CINGOLANI & R.VARELA, 1992b. Geology, 20:1059-1062.

DALZIEL,I.W.D.,1991. Geology, 19:598- 601.

HERRERA,Z. & J.L.BENEDETTO, 1991. In:McKinnon,D.I. et al (Eds.), Brachiopods through time. Balkema.pp.283-301.

MANNHEIM,R. & H.MILLER, 1992. Conferencia Intern. Paleozoico Inferior de Ibero-América. Abst.:102.

RAMOS,V.A., T.E.JORDAN, R.W.ALLMENDINGER, C.MPODOZIS, S.M.KAY, J.M. CORTES & M.A.PALMA, 1986. Tectonics, 5:855-880.

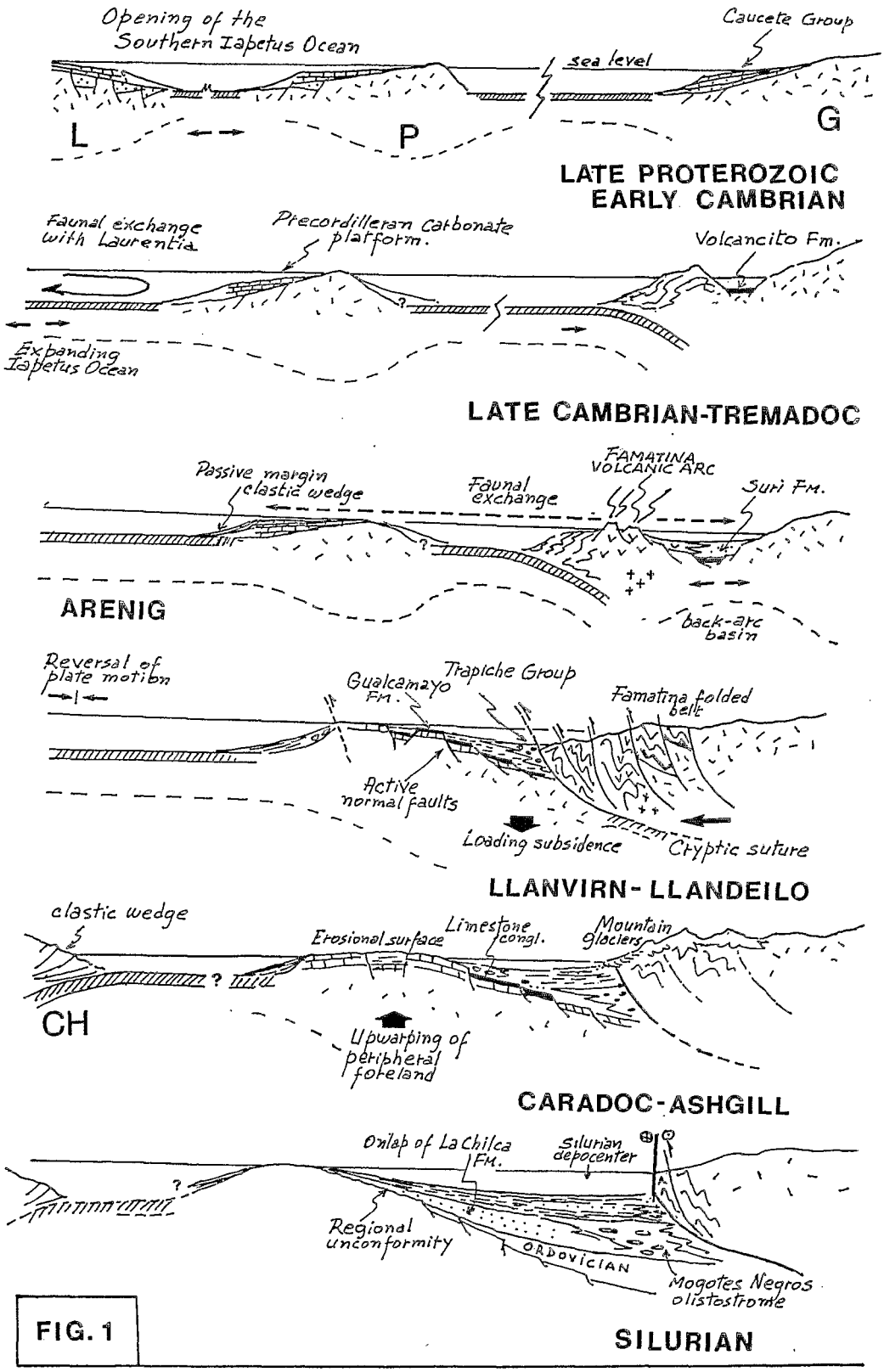

FIG. 1

CH: CHILENIA G: GONDWANA L: LAURENTIA P: PRECORDILLERA