Occurrence and possible significance of Cretaceous turbidites in the Western Colombian Andes

Jairo Mojica (1) & Oscar J. Arévalo (2)

(1) Departamento de Geociencias, Universidad Nacional, Bogotá, Colombia; mkindred@gmail.com
(2) Geólogo Consultor; scravlo17@yahoo.com

KEYWORDS: Cretaceous, Turbidites, Western Andes, Central Cordillera, Colombia

OUTCROPS AND STRATIGRAPHY

This work describes the geological characteristics of four Cretaceous sedimentary sequences containing different types of sandstones, interpreted as turbidite deposits. As shown in figure 1, the studied outcrops occur at two regions: 1) The Puente Tabla and La Maizena sections, exposed at the western piedmont of the Central Cordillera, Quindío Department. 2). The Tragedias and the El Naranjo sections cropping out on the western flank of the Western Cordillera, along the Buga-Buenaventura road. Figure 2 shows the corresponding simplified stratigraphic columns.

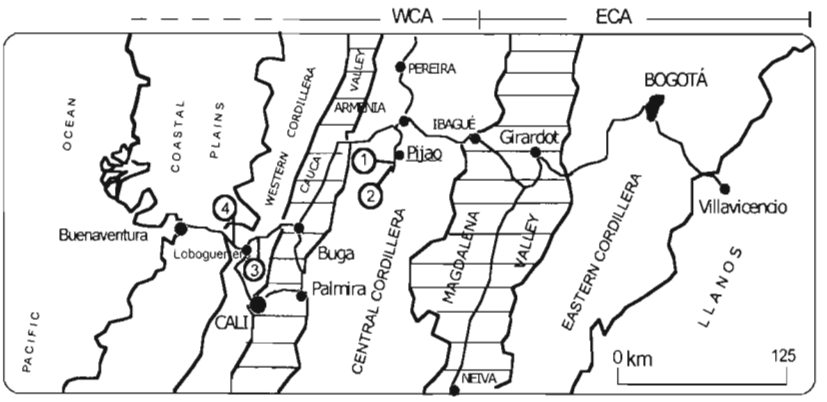

Figure 1. Location of the studied stratigraphic sections. 1: Puente Tabla; 2: La Maizena; 3: Tragedias; 4 El Naranjo. WAC & EAC: Western and Eastern Colombian Andes.

Puente Tabla Section (PTS). It is located 2.5 km SSW of Pijao and is exposed on both sides of the Lejos River. The sandstones are hard, fine-grained, gray colored rocks, with no more sedimentary structures than planar bedding. The sandstones exposed there are composed of mature, fine-grained quartzose sandstones (quartz >90%) with abundant micaceous matrix, sandy claystones and scarce cherty beds. In thin section, besides quartz they show rounded zircon, angular garnet and tourmaline grains, as well as scarce lithics of felsic volcanic rocks and quartz-phyllites. According to their composition the sandstones vary between quartz arenites and litho arenites – subarcoses. Some shale intervals include blocks of quartz-sandstones, pyroclastic rocks, lithoclastic limestones and black micrites. Consequently, they are supposed to represent olistostromes. The uppermost shales yielded ammonites indicating a late Aptian age (Mojica *et al.* 2002).The highest part of the PTS is conformed by *ca.* 55 m of recritallized micrites with subordinated peliodal and lithoclastic limestones.

La Maizena Section (LMS). It is located in the middle portion of the La Maizena creek, 9 km SSW Pijao. There, the sandstones constitute 20% of a 45m thick pelitic sequence. The associated shales contain abundant ammonites and planktonic forams that indicate a late Aptian to early Albian age (details in Arévalo *et al.* 2001 and Mojica *et al.* 2002). The quartz sandstones are fine grained rocks with moderate to poor sorting, composed

by angular to rounded grains of monocrystalline quartz with minor content of plagioclase and metamorphic lithics, as well as accessory minerals as zircon, tourmaline and garnet.

The LMS also contains lithic conglomeratic sandstones composed of medium to pebbly, friable and normal graded litho-arenites made of mono and poly-crystalline quartz, as well as felsitic volcanic lithics. In terms of composition, the conglomeratic sandstones are lithoarenites, the lithoclasts being of felsic vulcanite and plutonites. The QFL and QmFLm ternary diagrams corresponding to PTS and the LMS indicate mixed provenance of a craton or an eroded orogen located eastwards of the sedimentary basin.

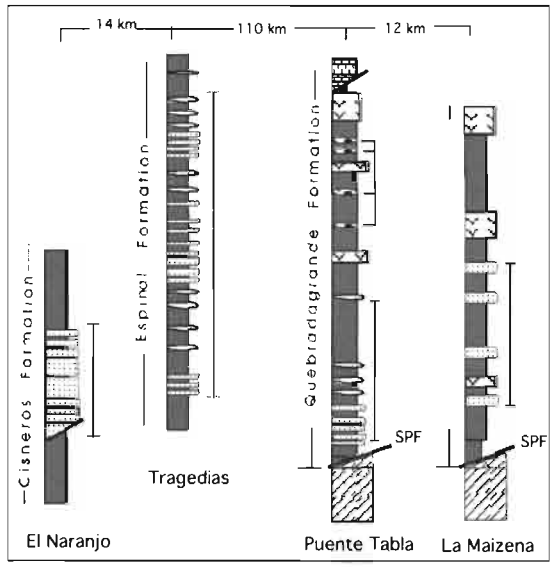

Figure 2. Schematic stratigraphic columns showing the approximately position and frequency of the investigated turbidites layers. Loc.: Fig.1

The PTS and LMS sections are part a major stratigraphic unit that have been previously mapped as the "Quebradagrande Formation", nowadays as a lithodemic unit named Quebradagrande Complex (Maya and González 1997). South of Pijao the "Quebradagrande sediments" are cut by the Silvia-Pijao megafault and appear in contact with the metamorphic rocks of Arquía Complex of possible Paleozoic age (McCourt et al. 1984).

Tragedias Section (TS). It represents a part of the Espinal Formation and is composed of interbedded feldspathic arenites, scarce quartz arenites and black shales with occasional calcareous lenses. The total thickness of the exposed sequence is of about 80 m, 25% of which correspond to sandstones beds. The sedimentary structures (graded bedding, parallel, crossed and convolute lamination, scour and fill marks, borrows and lutitic intraclasts at the undersurface of the sandstone beds) represent isolated divisions or complete series of the Bouma sequences that indicate clearly an overturned sequence. The monotonous alternation of parallel bedded sandstones and shales produces a picture of classical turbidites *sensu* Walker (1984) or, as indicated by Bourgois *et al.* (1989), of a flysch-like succession. From the Espinal Formation Aluja *et al.* (1975) report benthonic forams indicative of a post-Coniacian deposition. The QFL and QFmLt plots of the sandstones of the Espinal Formation suggest provenance from an intrabasinal crystalline source.

El Naranjo Section (ENS). It is a sequence of 25 m thick quartz-sandstones embedded in variegated slates belonging to the "Dagua Group" or Cisneros Formation (Barrero 1979). The sandstone beds show conspicuous shearing and occur in layers of decimeter to meter thickness separated by dark, thin pelitic layers. The only identified structures in the sandstones are parallel and graded bedding indicating normal lying. The overlying slates contain trace fossils, identified by Etayo-Serna (1989) as *Zoophycos sp.*, *Planolites sp.* and *Chondrites sp.*, which he considered as predictors of accumulation in oxygen-poor and quiet- oceanic waters. Thin-section analysis of the sandstones reveals a predominance of monocrystalline quartz grains and small proportion of feldspars and felsitic volcanic clasts. Thus, the ENS contain mineralogycally mature sandstones which, when plotted in the QFL and QFmLt triangles, suggest provenance form a craton or an eroded orogen. The abovementioned characteristics of the quartz-sandstones as well as the environmental incompatibility between

the sandy and pelitic deposits indicate that the sandstones represent turbidites accumulated in distal fans. Nearby the ENS, the Cisneros Formation presents thick volumes of black cherts and thick diabasic flows. Aluja et al. (1975), report *Globogenerinoides sp.* and *Globotruncanella sp.* from the Cisneros Formation that Duque-Caro considers as indicative of an Aptian or younger age.

RESULTS AND CONCLUSIONS

The obtained results allow us to differentiate two main petrographic types at the Tragedias and El Naranjo Sections

The first group is integrated by fine to medium grain quartz feldspathic sandstones (feldspar = plagioclase), present almost exclusively in the Espinal Formation. The plagioclase appears as "fresh" surrounded grains, usually coarser than the quartz ones. They contain fragments of neovolcanic rocks with microlithic texture. Detrital biotite and rounded zircon appear in form of trace minerals. The second group is conformed by the well-sorted and fine-grained quartz-arenites of the Cisneros Formation. The mainframe work components are mono-crystalline quartz grains and paleo-volcanic felsitic fragments; scarce plagioclase and potassium feldspar are also present. One of the samples contains a metamorphic fragment, composed of polycrystalline mica. The accessory components are detrital muscovite, and rounded zircon grains.

Figure 3. QFL ternary diagrams summarizing data form the investigated turbidite sandstones in the WCA

In the first group dominate the intrabasinal volcanic contribution, while the continental contribution is very limited. The opposite happens in the second group, in which the indigenous volcanism lacks. The differences between the two petrographic groups indicate that the arenites of the Espinal and Cisneros Formations were deposited in distinct, maybe non-contemporaneous basins. The petrographic characteristics of the quartz-arenites of El Naranjo result similar to those the La Maizena and Puente Tabla sections, thus indicating a possibly common transport and sediment sources, an idea that would be reinforced if their ages were coincident. The occurrence of immature and mature sand-beds in the Espinal Formation suggests the presence of a near volcanic source providing intrabasinal volcanic detritus (feldspathic arenites) and a far, extrabasinal source providing mineralogycally mature materials. The aforementioned petrographic differences clearly rise into view on the composed QFL ternary diagram shown in figure 3.

Furthermore, the obtained results suggest that during the sedimentation of the here described sandstone sequences, the basinal accumulation areas of the Western Colombian Andes (WCA) must have had channels connecting them with pericratonic source areas located in the Eastern Colombian Andes (ECA), eastwards of the

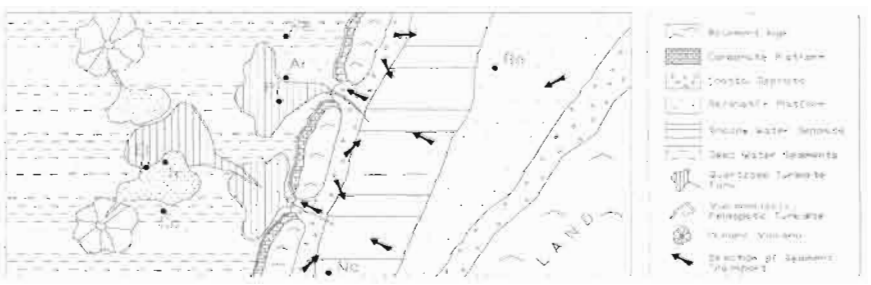

Figure 4. Asummed paleogeographic setting during the sedimentation of the investigated turbidites. Ar: Armenia; Bo: Bogotá; Ca: Cali; El: El Naranjo; Ne: Neiva; Pe: Pereira; Pi: Pijao; Tr: Tragedias.

present day Central Cordillera. Thus, a direct relationship may be expected between the age of the turbidites in the accumulation basins and a somewhat synchronic generation of huge volumes of sand in the source areas. For the ages of the westernmost turbidite sandstones (El Naranjo and Tragedias sections) are not yet well established, it seems obligatory to confront their deposition time-intervals with those Mid- Late Cretaceous stages during which sand deposition was dominant in the supracratonic basin. These result to be the Aptian-Albian transgressive phase during which the Yaví and Caballos Formations were deposited, and the Campanian-Maastrichtian regressive phase during which the Guadalupe Group and Guadalupe-like formations were accumulated. Figure 4 illustrates the hypothetical paleogeographic setting during the two major phases of turbidite deposition in the WCA.

References

Aluja, J., Chaparro, E. & Colmenares, F. (1975): Geología de la sección Buga-Buenventura. Univ. Nacional de Colombia, Bogotá. Trab. Grado, no publicado, Univ. Nal. Bogotà.

Arévalo, O. J., Mojica, J. & Patarroyo, P., (2002): Sedimentitas del Aptiano tardío al sur de Pijao, Q. La Maizena, Flanco occidental de la Cordillera Central, Departamento del Quindío, Colombia. Geología Colombiana No. 26, pp. 29-46.

Bourgois, J., Toussaint, J. F., González, H. et al. 1987: Geological history of the cretaceous ophiolitic complexes of northwestern South America (Colombian Andes). Tectonics vol. 143, p. 307-327.

Etayo-Serna, F. 1986. La icnofacies Zoophycos-Chondrites del Cretácico de la Cordillera Occidental de Colombia y su posible significación paleoambiental. Rev. Caldasia, Vol. Xv, 405-422.

Maya, M. & González, H., 1995: Unidades Litodémicas en la Cordillera Central de Colombia. INGEOMINAS Boletín Geológico, 35 (2-3), p. 43-57.

McCourt, W., Mosquera, D., Nivia, A. & Núñez, A., 1984: Mapa Geológico Preliminar. Plancha 243 – Armenia. Escala 1:100.000. INGEOMINAS.

Mojica, J., Patarroyo, P., Camargo G. & Arévalo O. J., 2001*b*: Sedimentitas del Aptiano tardío en el flanco occi dental de la Cordillera Central, Río Lejos, Pijao, Quindío-Colombia. Mem. VIII Cong. Col. Geol. Manizales.

Walker, R. G. 1984. Turbidites and associated coarse clastic deposits. In Walker, R. G., *ed.*, Facies Models. Geoscience Canada Reprint Series 1.