Detrital zircon typology and U/Pb geochronology for the Miocene Ladrilleros-Juanchaco sedimentary sequence, Equatorial Pacific (Colombia): New constraints on provenance and paleogeography in northwestern South America

E. Osorio-Granada[1], S.A. Restrepo-Moreno[2-3], J.A. Muñoz-Valencia[1], R.A. Trejos- Tamayo[1], A. Pardo-Trujillo[1]
A.A. Barbosa-Espitia[1-3]

[1]Universidad de Caldas, Facultad de Ciencias, Departamento de Ciencias Geológicas, Grupo de Investigaciones en Estratigrafía y Vulcanología, Instituto de Investigaciones en Estratigrafía (IIES), Manizales, Colombia. Pardo-Trujillo; E-mail: andres.pardo@ucaldas.edu.co
[2]Departamento de Geociencias y Medio Ambiente, Universidad Nacional de Colombia; Sede Medellín Restrepo Moreno E-mail: sarestrepom@unal.edu.com
[3]Department of Geological Sciences. University of Florida Gainesville, Florida 32611, USA Barbosa-Espitia E-Mail: angelbarbosa@ufl.edu Restrepo-Moreno E-mail: sergiorm@ufl.edu

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ABSTRACT

Zircon U/Pb dating (LA-ICP-MS) plus typological and internal texture analyses (optical and SEM-CL/BS microscopy) were performed on detrital materials obtained from 12 samples collected from the Miocene sandstones of the Ladrilleros-Juanchaco Sedimentary Sequence (LJSS) located in Colombia's Pacific Coast. Based on 114 zircon grains dated we established a maximum depositional age for the LJSS at ca. 10-13 Ma (Tortonian-Serravallian). We also identified typology-age associations as indicators of sediment provenance. Our results show that zircons with S and P dominant typologies have internal structures/zoning indicative of igneous, and potentially also metamorphic, origins. Morphometric results suggest limited transport from source areas. Both U/Pb age spectra and zircon typology data point to the Western Cordillera as the principal source of detrital materials for the LJSS. A paleogeographic reconstruction shows that, during the Late Miocene, significant portions of the Western Cordillera were uplifted and actively eroding, thereby forming a fluvio-topographic barrier that prevented sediments from the Central Cordillera reaching the Pacific basins. Exhumed Miocene plutons located along the axis of the Western Cordillera may also have played a role as geomorphologically active massifs. Our methodological approach to evaluate provenance in a complex litho-structural regime represents a viable development of the standard methodology, considering the quantity of information provided in provenance studies and paleogeographic reconstruction, and should be systematically used in other sedimentary sequences in the Northern Andes.

LOCATION

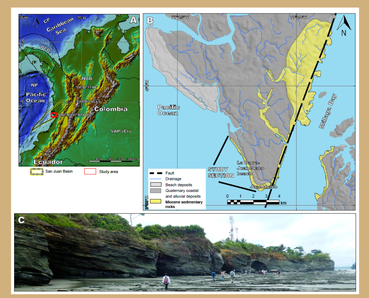

FIGURE 1. A) Location of the Ladrilleros-Juanchaco Sedimentary Sequence (LJSS) on the Colombian and South American context on the Pacific coast. B) Local geological framework of the LJSS (modified from Montoya, 2003). C) General aspect of outcrops for the LJSS in the studied section, NW-SE.

STRATIGRAPHIC COLUMN

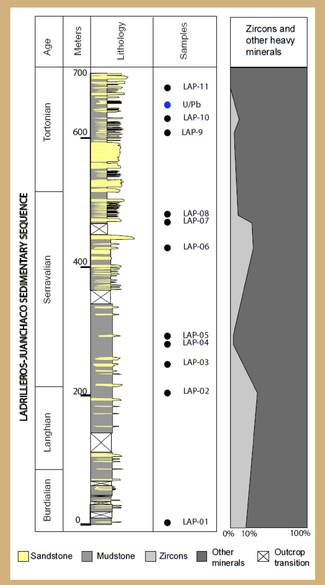

FIGURE 2. Stratigraphic column for the Ladrilleros-Juanchaco sedimentary sequence (adapted from Muñoz and Gómez, 2014). Zircon abundance relative to other heavy minerals is shown. Black dots correspond to the stratigraphic position of samples analyzed. Blue dot marks the position of the sample for detrital zircon U/Pb analysis.

RESULTS

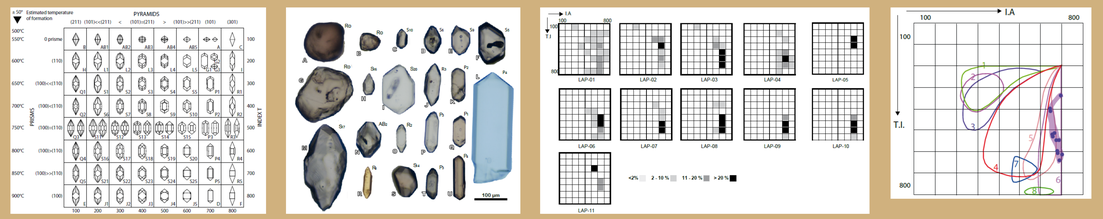

FIGURE 3. A) Zircon typological classification proposed by Pupin (1980). B) Examples of LJSS detrital zircons susceptible to typological analysis. C) Results of the LJSS zircon typology analysis based on the A.I-T.I diagram. D) Distribution of granitic rocks in the typology diagram.

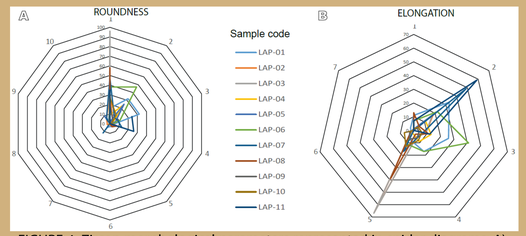

FIGURE 4. Zircon morphological parameters represented in spider diagrams: A) Roundness. B) Elongation. Based on the classification by Gärtner et

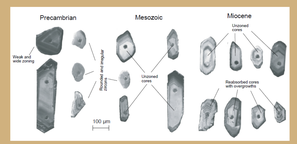

FIGURE 5. Cathodoluminescence (SEM-CL) images of selected LJSS zircons discriminated by age ranges in the Precambrian, Mesozoic and Miocene.

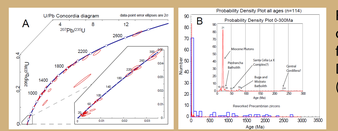

FIGURE 6. U/Pb results for 114 U/Pb dates reported in the detrital zircons for the LJSS sample. A) Concordia Diagram. B) Probability Density Plot (PDP).

DISCUSSION

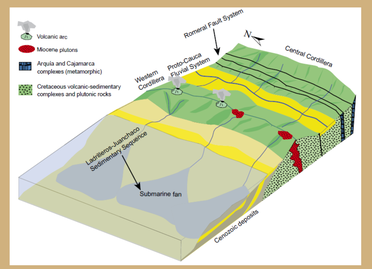

FIGURE 7. Paleogeographic model for the LJSS, Proto-Cauca fluvial system and western cordillera during the Miocene (Burdigalian-Tortonian). Colors are only a reference to differentiate environments and lithologies and do not represent geologic time.

CONCLUSIONS

Integration of techniques such as detrital zircon typology/morphometry, U/Pb dating, and SEM-CL imaging in samples from the LJSS arenites affords improved constraint of the depositional age and provenance of the terrigenous materials deposited in the basin during the Burdigalian-Tortonian. The high affinity of the zircons (typology/age/internal zonation patterns) with Miocene igneous rocks (plutonic and volcanic) potentially implies that an active volcanic-magmatic arc with significant topography existed in the western Cordillera and was the main sediment source. Detrital sources on the central Cordillera were separated from the Pacific realm by wellestablished western Cordillera topographic barriers.
Our methodological approach to evaluate provenance in a complex litho-structural regime represents a viable development of the standard methodology, considering the quantity of information provided in provenance studies and paleogeographic reconstruction, and should be systematically used in other sedimentary sequences in the northern Andes.