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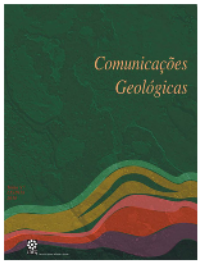
U-Pb detrital ages on tuffaceous and sandstone levels from a Neogene foreland basin of the Central Andes of Argentina

Idades U-Pb em zircões detríticos em níveis tufáceos e areníticos de uma bacia de antepaís neogénica nos Andes Centrais da Argentina



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Artigo Curto
Short Article

Abstract: Six tuffaceous and sandstone levels from an Andean (Mio-Pliocene) synorogenic succession were analyzed using the U-Pb LA-ICP-MS method on detrital zircons, in order to constrain maximum depositional ages and to define the basin provenance and likely connections with the volcanic history of the South-Central Andes. The detrital ages of the different samples were rather similar, ranging from ~2007 to ~5 Ma (Paleoproterozoic to Cenozoic). The pool of ages suggests reworking and detrital contribution for the studied volcaniclastics. The main detrital populations have age mode at 460 and 480 Ma (Ordovician), whereas three main Andean volcanic episodes at ~5, 13 and 21 Ma were identified. From these new data sets, a sedimentation rate of ~0.7mm/yr would characterize the basin fill between ~13 and 5 Ma.

Keywords: Miocene Andean Foreland, Detrital U-Pb ages, Depositional ages, Provenance.

Resumo: Seis níveis de rochas tufáceas e areníticas de uma sucessão sin-orogénica Andina (mio-pliocénica) foram analisados pelo método U-Pb LA-ICP-MS em zircões detríticos, com o intuito de inferir as idades máximas de deposição e a proveniência da bacia, com implicações quanto à história vulcânica do Andes Centro-Sul. As idades em grãos detríticos das diferentes amostras mostraram um padrão similar, variando de ~ 2007 a ~5 Ma (Paleoproterozóico ao Cenozóico). O conjunto de dados sugere retrabalhamento e contaminação detrítica nos níveis vulcanoclásticos estudados. As principais populações detríticas têm moda de idade em 460 e 480 Ma (Ordovícico) enquanto que três principais episódios vulcânicos andinos, datados em ~ 5, 13 e 21 Ma, foram identificados no presente estudo. A partir do conjunto de dados, estima-se uma taxa de sedimentação de ~ 0.7mm/ano para a evolução da bacia no intervalo entre ~ 13 e 5 Ma.

Palavras-chave: Antepaís Andino miocénico, Idades detríticas U-Pb, Idades de deposição, Proveniência.

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The Vinchina basin is a very thick (up to 12 km) Andean (Mio-Pliocene) synorogenic succession formed by alluvial strata, mainly exposed across the Sierra de los Colorados (28°-30° LS), La Rioja province, NW Argentina (Fig. 1). This basin comprises the lower Vinchina and upper Toro Negro Formations (Turner, 1964; Ramos, 1970) that were exhumed during the late Pliocene-Pleistocene. Although the Vinchina basin was studied by diverse methods, its geochronology is still not well known. Magnetostratigraphic studies (Reynolds *et al.*, 1990; Re & Barredo, 1993), zircon fission track ages (Tabbutt, 1986) as well as detrital zircon U-Pb dating (Dávila *et al.*, 2008; Collo *et al.*, 2011; Ciccioli *et al.*, 2012) on tuffaceous levels, allowed constraining the timing of basin sedimentation between ~19 and ~3.4 Ma. K-Ar whole-rock analyses from the same levels suggested, however, a wider range of ages (from Eocene-Oligocene in lower sections, to late Miocene in the upper part of the units, Ciccioli *et al.*, 2005, 2008) which is consistent with the observed recycling. Considering these ages, the sedimentation of the Vinchina basin would have lasted ~16 my and must have been at maximum burial conditions a relatively short time. Three main sedimentation rate stages were recognized in the Sierra de los Colorados: (i) 0.09 mm/yr between 19 and 7.30 myr; (ii) 0.9mm/yr between 7.30 and 4.30 myr; and (iii) 2.2 mm/yr between 4.30 and 3.40 myr (Collo *et al.*, 2011).

We re-analyzed six different levels (four tuffaceous and two sandstones) from the Sierra de los Colorados using the U-Pb LA-ICP-MS method on zircons, not only to constrain the maximum depositional age but also to define the basin provenance and likely connections with the volcanic history of the South-Central Andes. The detrital ages of the different samples were rather similar, ranging from ~2007 to ~5 Ma (Paleoproterozoic to Cenozoic). The pool of ages supports reworking and high detrital contribution of the tuffaceous levels. The main detrital populations have age mode at 460 and 480 Ma (Ordovician) with minor peaks at 258, 283-294, 335, 380, 394-396, 415-426, 442-447, 504, 564, 635-664, 789-876, 915-934 and 1031 Ma. The detrital populations are also similar from the bottom (Vinchina Formation) to top (Toro Negro Formation), showing a recurrent age gap between the Late Triassic and Oligocene.

The lowest tuffaceous level (TRT3 at ~5500 m in depth), at Los Colorados creek, has two main Andean populations

of 12.7 Ma (n=3) and 21 (n=7), with Th/U ratios between 0.30 and 2.2. The tuffaceous level at the top (TRT4 at ~350 m depth), in turn, has an only population of 5.5 Ma (n=13) with Th/U ratios between 0.41 and 0.96. In both levels, the youngest ages were interpreted as sedimentation ages. In the bottom section, at the La Flecha creek, the tuffaceous level (RLT4) shows an Andean population of 13.7 ± 1.5 Ma (Th/U ratios between 0.3 and 1.2), also interpreted as the maximum sedimentation age. From these new data sets, a sedimentation rate of ~0.7mm/yr would characterize the basin fill between ~13 and 5 Ma. This, in turn, would affect the calculated time-temperature conditions given that sedimentation rate controls the basin thermal evolution (see Collo *et al.*, 2011).

Three main Andean volcanic episodes at ~5, 13 and 21 Ma can be interpreted from the U-Pb detrital ages. These are consistent with the Late Oligocene to Recent magmatic pulses reported along the Andes between 28.5 - 32.5 LS (Kay and Mpodozis, 2002). Our detrital ages, concentrated in the Vinchina basin testify the eastward shifting of the magmatic activity from the Early Miocene as evidenced by previous works (Furque, 1963, 1979; Simon, 1985; Jordan *et al.*, 1993; Vergés *et al.*, 2001; Limarino *et al.*, 2001; Kay & Mpodozis, 2002; Dávila *et al.*, 2004). This migration has been associated with the initiation of shallow subduction and changes in plate convergence patterns along the Andean arc at about 18 Ma (Kay & Mpodozis, 2002; Dávila *et al.*, 2004).

Previous paleocurrent and compositional studies proposed a regional sediment supplies for the Vinchina basin from the west and north (Tripaldi *et al.*, 2001; Ciccioli *et al.*, 2014). On the base of this and considering the main features of the Ordovician zircons reported in this work (most important age population, euhedral geometries suggesting the igneous nature of the zircons, with little to no reworking), a close Ordovician source to the north and west might be considered that might match with the Toro Negro Range and High Cordillera, respectively. Moreover, the overlap between the two Ordovician detrital populations and the main magmatic episodes recorded in the Famatinian belt located immediately to the east (Dahlquist *et al.*, 2005) suggests that it could be some contribution from this region. The lack of Late Triassic to Early Tertiary detrital ages suggests that the Jurassic-Cretaceous volcanic arcs as well as the earliest Andean (Paleocene-Eocene) volcanism would not have supplied to the Vinchina basin, and likely, these volcanic sources would have kept along the western flank of the Andes since the Miocene, far from the depositional area of the Vinchina basin. This gap also supports a migration towards the east of the main volcanic arc from the Mesozoic to the Cenozoic (Ramos, 2010).

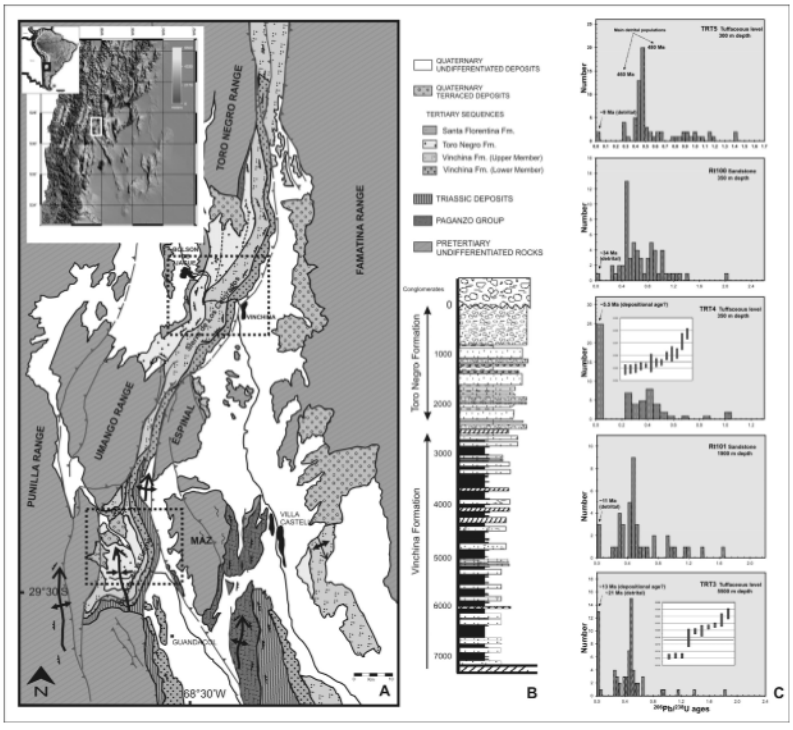

Fig. 1. (A) Geological map from the western region of the La Rioja Province, showing the distribution of the Tertiary deposits within the Vinchina Basin. To the left corner a shaded topographic relief image (U.S. Geological Survey), shows the Central Andean Foreland of Argentina and the location of the basin. (B) Representative stratigraphic column of the basin at Sierra de los Colorados section; the Vinchina and Toro Negro Formations are distinguished. Modifed from Collo *et al.* (2011). (C) U-Pb detrital zircon ages of the analyzed samples.

Fig. 1. (A) Mapa geológico da porção oriental da Província La Rioja, mostrando a distribuição dos depósitos terciários da Bacia Vinchina, Argentina. No canto esquerdo, apresenta-se uma imagem do relevo (Serviço Geológico dos EUA) dos Andes Centrais, Argentina, e a localização da bacia foreland estudada. (B) Coluna estratigráfica da bacia, na seção Sierra de los Colorados na qual as formações Vinchina e Toro Negro estão destacadas. Modificado de Collo *et al.* (2011). (C) Idades U-Pb em zircão detrítico das amostras estudadas. Ver texto para detalhes.

Referências

Ciccioli, P.L., Limarino, C.O., Friedman, R., 2012. La edad de la Formación Vinchina: Su implicancia en la estratigrafía de la cuenca de antepaís del Bermejo. *1st Simposio del Mioceno-Pleistoceno del Centro y Norte de Argentina*. S.M. del Tucumán, Ameghiniana, **49**, 4, 7.

Cicciolli, P.L., Limarino, C., Marenssi, S.A., 2005. Nuevas edades radimétricas para la Formación Toro Negro en la sierra de Los Colorados, Sierras Pampeanas Noroccidentales, provincia de La Rioja. *Revista de la Asociación Geológica Argentina*, **60**, 251-254.

Ciccioli, P.L., Limarino, C.O., Marenssi, S.A., Tedesco, A.M., Tripaldi, A., 2008. Estratigrafía de la cuenca de Vinchina, Sierras Pampeanas noroccidentales, noroeste de la provincia de La Rioja. *Actas del XVII Congreso Geológico Argentino, Asociación Geológica Argentina*, Buenos Aries, 2 p.

Ciccioli P.L., Marenssi, S.A, Limarino, C.O., 2014. Petrology and provenance of the Toro Negro Formation (Neogene) of the Vinchina broken-foreland basin (Central Andes of Argentina). *Journal of South American Earth Sciences*, **49**, 15-38.

Collo, G., Dávila, F.M., Nóbile, J., Astini, R.A., Gehrels, G., 2011. Clay mineralogy and thermal history of the Neogene Vinchina Basin, central Andes of Argentina: Analysis of factors controlling the heating conditions. *Tectonics*, **30**, TC4012, doi:10.1029/2010TC002841.

Dahlquist, J.A., Pankhurst, R.J., Rapela, C.W., Galindo, C., Alasino, P.H., Casquet, C., Fanning, C.M., Saavedra, J., Baldo, E.G., González-Casado, J. 2005. New SHRIMP ages in the Sierra de Famatina, NW Argentina: implications for the Famatinian Orogen. *Actas Gondwana*, **12**, 123.

Dávila, F.M., Astini, R.A., Jordan, T.E., Kay, S.M., 2004. Early Miocene andesite conglomerates in the Sierra de Famatina, broken fore-land region of western Argentina, and documentation of magmatic broadening in the south-central Andes. *Journal of South American Earth Sciences*, **17**, 89-101.

Dávila, F.M., Collo, G., Astini, R.A., Gehrels, G., 2008. U-Pb detrital ages on a tuffaceous sandstone sheet in the Vinchina Formation, La Rioja, Argentina: Deposition and exhumation implications, *Actas del XVII Congreso Geológico Argentino, Asociación Geológica Argentina*, Buenos Aries, 2 p.

Furque, G., 1963. *Descripción geológica de la Hoja 17b, Guandacol*. Dirección Nacional de Geología y Minería, Boletín, Buenos Aires, 105 p.

Furque, G., 1979. *Descripción Geológica de la Hoja 18c, Jáchal*. Dirección Nacional de Geología y Minería, Boletín, Buenos Aires, 79 p.

Jordan, T.E. Allmendinger, R.W., Damanti, J.F., Drake, R.E., 1993. Chronology of motion in a complete thrust belt: The Precordillera, 30°-31°, Andes Mountain. *Journal of Geology*, **101**, 135-156.

Kay, S.M., Mpodozis, C., 2002. Magmatism as a probe to the Neogene shallowing of the Nazca plate beneath the modern Chilean flatslab, *Journal of South American Earth Sciences*, **15**, 39-57.

Limarino, C., Tripaldi, A., Marenssi, S., Net, L., Re, G., Caselli, A., 2001. Tectonic control on the evolution of fluvial systems of the Vinchina Formation (Miocene), northwestern Argentina. *Journal of South American Earth Sciences*, **14**, 751-762.

Ramos, V.A., 1970. Estratigrafía t estructura del Terciario en la sierra de los colorados (Provincia de La Rioja), República Argentina. *Revista de la Asociación Geológica Argentina*, **25(3)**, 359-382.

Ramos, V.A., 2010. The tectonic regime along the Andes: Present settings as a key for the Mesozoic regimes. *Geological Journal*, **45**, 2-25.

Re, G.H., Barredo, S.P., 1993. Esquema de correlaciones de las formaciones terciarias aflorantes en el entorno de las Sierras Pampeanas y la Precordillera Argentina. *12th Congreso Geológico Argentino y 2nd Congreso de Exploración de Hidrocarburos*, **2**, 172-179.

Reynolds, J.H., Jordan, T.E., Johnson, N.M., Damanti, J.F., Tabbutt, K.D., 1990. Neogene deformation of the flat-subduction segment of the Argentine-Chilean Andes: Magnetostratigraphy constraints from Las Juntas, La Rioja Province, Argentina. *Geological Society of America Bulletin,* **102**, 1607-1622.

Simon, W., 1985. Algunos aportes a la geología del distrito minero de Huachi, San Juan. *Primeras Jornadas sobre Geología de Precordillera*. Acta 1, 370–375.

Tabbutt, K.D., 1986. *Fission track chronology of foreland basins, in the eastern Andes: Magmatic and tectonic implications*. Thesis Hannover, New Hampshire, Dartmouth College (unpublished), 100 p.

Tripaldi, A., Net, L., Limarino, C., Marenssi, S., Re, G., Caselli, A., 2001. Paleoambientes sedimentarios y procedencia de la Formación Vinchina, Mioceno, noroeste de la provincia de La Rioja. *Revista de la Asociación Geológica Argentina*, **56(4)**, 443-465.

Turner, J.C.M., 1964. *Descripción geológica de la Hoja 15c Vinchina (Provincia de La Rioja)*. Carta Geológico-Económica de la República Argentina, Escala 1:200 000, Argentina, Dirección Nacional de Geología y Minería, Boletín, Buenos Aires, 100, 81 p.

Vergés, J., Ramos, E., Seward, D., Busquets, P., Colombo, F., 2001. Miocene sedimentary and tectonic evolution of the Andean Precordillera at 318 S, Argentina. *Journal of South American Earth Sciences*, **14**, 735-750.