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The enigmatic Pre-Devonian volcanic and sedimentary rocks at Cerro Chilla, Northern Altiplano, Bolivia – their probable age, regional context and geodynamic significance

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In the central Andes, pre-Devonian magmatic rocks are widespread only in NW Argentina where they are predominantly linked to the Famatinian active margin of Ordovician age. Coeval volcanics occur locally on the Altiplano of southern Peru, and are unknown from Bolivia. Neoproterozoic volcanism is not recorded in Bolivia or Peru. However, zircon age data from Phanerozoic rocks of the area suggest the presence of a hidden Brasiliano-age magmatic arc located most likely east of the Altiplano.

On the Altiplano near La Paz, a pre-Devonian strongly deformed association of mafic volcanic rocks with volcaniclastic sandstones and conglomerates occurs in the isolated Cerro Chilla outcrop (Fig. 1; Paton, 1990; Matos et al., 1995). We present new petrographic and whole rock geochemical data, and U-Pb age and Hf isotope data of detrital zircons in order to determine the age and nature of this magmatism.

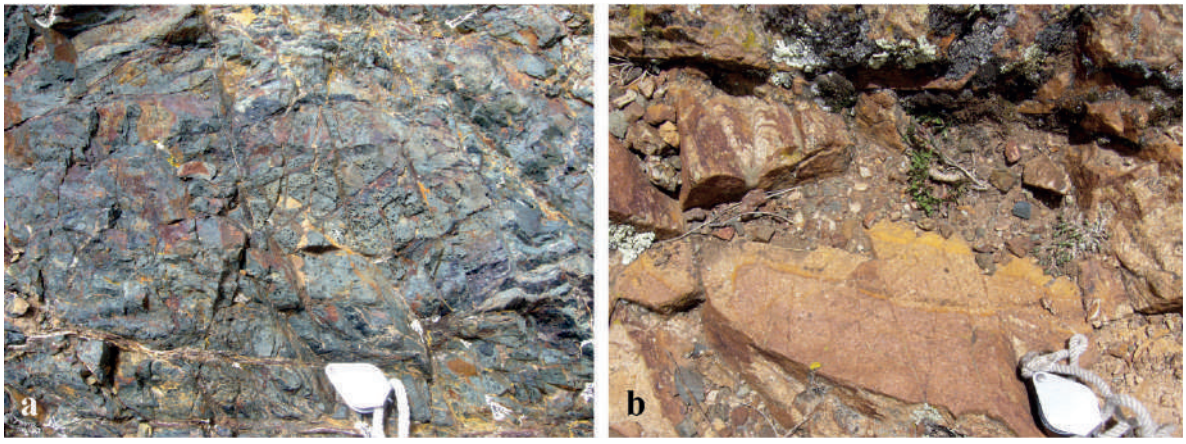

Fig. 1: Mafic lava (a) and volcaniclastic sandstone (b) at Cerro Chilla, Altiplano near La Paz, Bolivia.

The volcaniclastic rocks at Cerro Chilla are quartz-intermediate sensu Crook (1974) and rich in resorption embayed quartz of magmatic origin. Contents of K-feldspar and plagioclase is notable.

Lavas and tuffs are basaltic to andesitic and geochemically transitional between calc-alkaline and tholeiitic (Fig. 2a, b). The compositions show contamination by continental crust with enrichment in incompatible elements compared to MORB, and $La/Yb_{(N)}$ values of 3-5. Trace and REE patterns lack an arc affinity as is

demonstrated by the absence of a Nb-Ta anomaly, and may be representative of continental tholeiites (Fig. 2c, d).

U-Pb ages of detrital zircons (n=124) range between 1750 and 800 Ma with major maxima between 1300 and 1200 Ma (37% of all ages). Ordovician and Brasiliano/Pampean ages typical of Gondwana and the proto-Andean region are absent. Noting that Ediacaran and younger ages are present in virtually all analyzed Phanerozoic sedimentary rocks we conclude that the volcanosedimentary unit at Cerro Chilla most likely is of pre-Ediacaran, probably Cryogenian age, a novelty in the central Andes.

ƐHf isotope values of detrital zircons (n=54) range between -14 and +8. Juvenile values cluster around depleted mantle model ages of 1500 Ma. All data form an array reflecting a continuous isotopic crustal evolution from protoliths juvenile at ca. 1500 Ma, or protracted originally juvenile magmatism between 1500 and 900 Ma contaminated by these increasingly evolved crustal components. However, there is no pronounced vertical data array around 1000 Ma which is present throughout detrital zircon populations from the central Andes and which reflects marked crustal contamination during the Sunsás orogeny.

We conclude that the detrital zircons from the Cryogenian Cerro Chilla unit were derived ultimately from juvenile protoliths formed mainly during the Rondonian-San Ignacio orogeny of SE Amazonia.

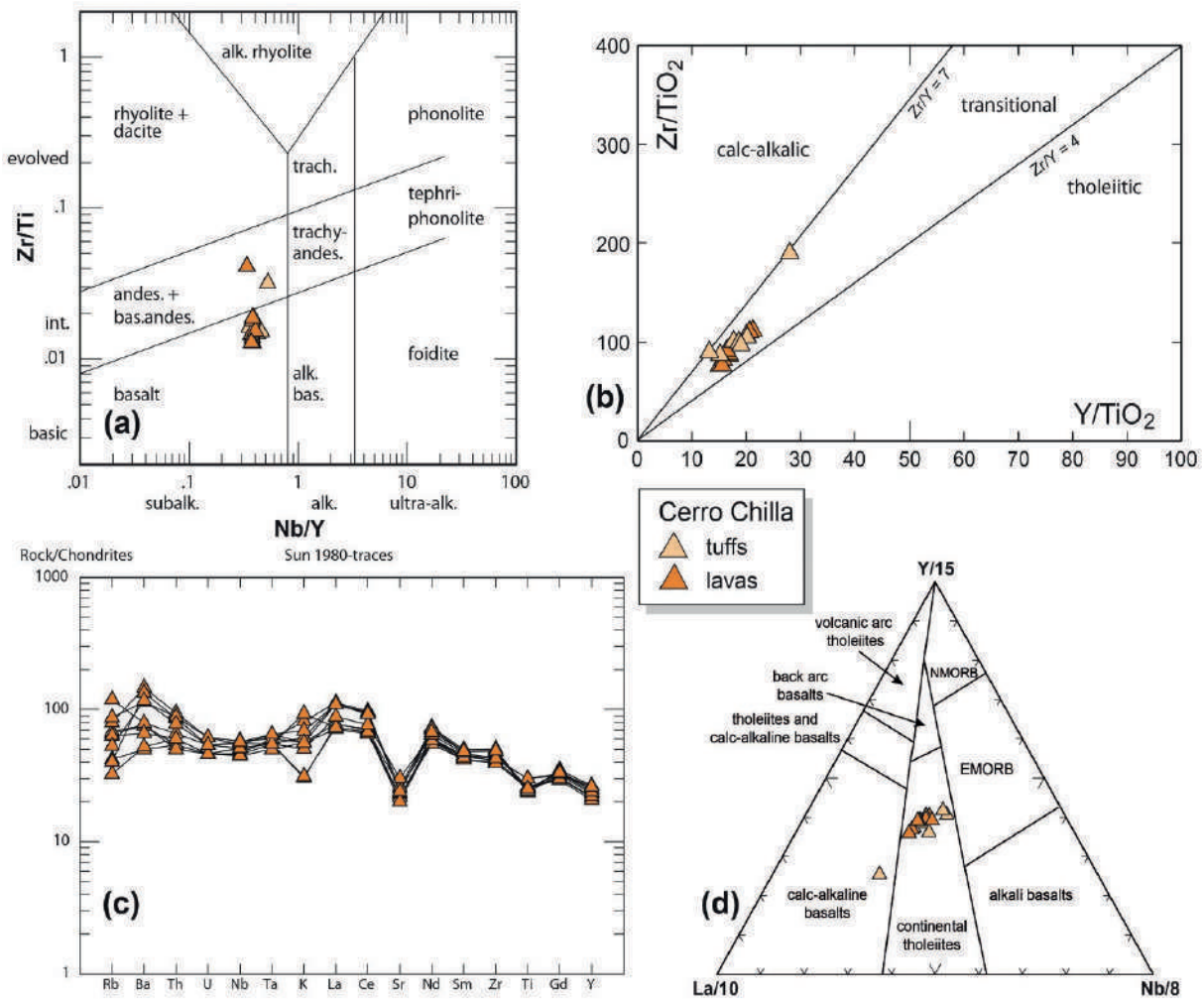

Fig 2: (a) Nb/Y vs Zr/Ti diagram according to Pearce (1996), (b) Y/TiO2 vs Zr/TiO2 diagram of Lentz (1998) and Piercey et al. (2004), (c) La/10-Y/15-Nb/8 diagram of Cabanis and Lecolle (1989), (d) Chondrite-normalized multi-element spectrum of selected major and trace elements and REE (Sun, 1980).

REFERENCES

Cabanis, B., Lecolle, M., 1989. Le diagramme La/10-Y/15-Nb/8 Un outil pour la discrimination des series volcaniques et lamise en evidence des processus de melange et/ou de contamination crustale. Compte Rendus de I'Académie des Sciences Series II, 309, 2023-2029.

Crook, K.A.W., 1974. Lithogenesis and geotectonics: the significance of compositional variation in flysch arenites (greywackes). In: Modern and ancient geosynclinal sedimentation (Ed. by R.H. Dott & R.H. Shaver). SEPM Special Publication 19, 304-310.

Lentz, D.R., 1998. Petrogenetic evolution of felsic volcanic sequences associated with Phanerozoic volcanic-hosted massive sulfide systems: The role of extensional geodynamics. Ore Geology Reviews 12, 289–327.

Matos, R., Aguirre, R., Altamirano, G., et al., 1995. Geologia y mineralizacion del Cerro Chilla, Altiplano de Bolivia. XV Congreso Geológico de Bolivia, resumenes, 6 pp.

Paton, S. McN., 1990. Paleozoic arc related volcanism on the Bolivian Altiplano. Pacific Rim 90 Congress, 565-573.

Piercey, S.J., Murphy, D.C., Mortensen, J.K., Creaser, R.A., 2004. Mid-Paleozoic initiation of the northern Cordilleran marginal backarc basin: Geologic, geochemical, and neodymium isotope evidence from the oldest mafic magmatic rocks in the Yukon-Tanana terrane, Finlayson Lake district, southeast Yukon, Canada. Geological Society of America Bulletin 116, 1087–1106.

Sun, S.-S., 1980. Lead isotopic study of young volcanic rocks from mid-ocean ridges, ocean islands and island arcs. Philosophical Transactions of the Royal Society London A297, 409-445.