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CONSTRAINING THE AGE OF THE MITU GROUP, SOUTH-EAST PERU: U-Pb AGES OF DETRITAL AND IGNEOUS ZIRCONS

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INTRODUCTION

Inverted extensional basins with continental deposits of the Mitu Group straddle the Eastern Cordillera of Peru. The present study investigates the Mitu Group of south-east Peru in the area of Abancay-Cusco-Sicuani, which consists of continental clastic sedimentary rocks and interbedded basaltic to andesitic lavas. There is a paucity of geochemical and geochronological data from the Mitu Group because rocks deemed suitable for geochronological analysis are scarce, and the inverted nature of the rift, which mainly occurred during Andean orogenesis, renders the structure complicated. The Mitu Group is dominated by coarse-grained clastic rocks, hence it is nearly devoid of fossils and its age is only poorly bracketed to be Permo-Triassic based on its stratigraphic relationship to the underlying Copacabana and overlying Pucará groups. The upper levels of the Copacabana Group have been constrained by palynology to the Artinskian (Doubinger and Marocco, 1981). However, a hiatus is observed between the Copacabana and the Mitu groups, rendering the age estimate of the basal Mitu imprecise. The Pucará Group, regarded by Rosas et al. (2007) to represent a thermal sag phase that occurred subsequent to extension and deposition of the Mitu Group, is attributed to the Late Triassic-Early Jurassic on the basis of ammonite fossils and U-Pb zircon ages from ash beds (Schaltegger et al., 2008). Deposition of the carbonates of the Pucará Group started during the Norian (Rosas et al., 2007) in north and central Peru, although equivalent sequences are not found in the Cusco region, implying that deposition may have been diachronous, or the Pucará Group was partly removed by erosion. We aim to generate more accurate and precise age constraints for the age and duration of deposition of the the Mitu Group using U-Pb geochronology applied to zircons extracted from rhyolites and sedimentary rocks. These (maximum) depositional ages will be compared with U-Pb zircon ages of plutons in the region (this study; Miskovic et al., 2009).

U-Pb AGE RESULTS

Laser Ablation - Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS) and Isotope Dilution - Thermal Ionisation Mass Spectrometry (ID-TIMS) U-Pb zircon dating was utilized to delineate age populations in pre- and syn-rift sandstones, and to date the syn-rift volcanic and plutonic activity. Detrital zircon U-Pb age histograms of medium grained sandstones in the pre-rift Ambo and Copacabana groups contain several age populations, which can be linked to major tectonic events identified along the western Gondwanan margin, such as the Sunsas/Grenville (1.2 – 0.94 Ga; Loewy et al., 2004) and Pampean (0.55 – 0.52 Ga; Schwartz et al., 2008) orogenies, as well as the Famatinian magmatic arc (0.47 – 0.44 Ga; Chew et al., 2007). The youngest zircon in the population assigns a maximum depositional age to the rock, which are late Mississippian for the Ambo Group and latest Pennsylvanian for the Copacabana Group. In contrast, the U-Pb age spectrum of detrital zircons extracted from a syn-extensional sandstone of the Mitu Group near the city of Abancay is heavily dominated by one population. This Triassic population (69% of zircons) yields a youngest zircon age of 224 Ma, which we consider to approximate the sedimentation age. The presence of one dominant detrital population suggests erosion of the zircon deprived Copacabana Group at the rift shoulders, combined with hindered sediment input from across the shoulders. Thus, the Triassic detrital zircons were probably derived from syn-rift volcanism. A Middle Triassic age is also found for a rhyolitic lava at the base of the Mitu Group near the city of Sicuani, giving a ID-TIMS U-Pb age of 234 Ma. A rhyolitic tuff with poor stratigraphic control was dated at 226±10 Ma in the same area (Miskovic et al., 2009). However in the Sacred Valley located south-west of Pisac, a red arkose yielded a few zircons (n=42), all of which gave a Lower Jurassic age of 176 Ma, suggesting they were derived from an ash bed that was drained into the depocenter.

U-Pb zircon dating of granitoids yields Middle to Upper Triassic ages for plutons exposed in the Cordillera de Carabaya (Figure 1), corroborating the data of Miskovic et al. (2009). The plutons in the Vilcabamba – Quillabamba – Machu Picchu area are considerably older; Ordovician, Carboniferous and Permian ages were identified (Figure 1), with the exception of a single Miocene pluton.
A granite clast extracted from a conglomerate near Calca overlaps in age with the Nevado Chicon pluton (304 Ma) in the Sacred Valley. This has a two-fold geodynamic implication: i) a Pennsylvanian magmatic arc was forming while the Copacabana Group was deposited at the surface, and ii) the Nevado Chicon was at the surface and supplying detritus while the Mitu Group was being deposited.

DISCUSSION

Inception of the Mitu Group near Sicuani during the Middle Triassic, combined with maximum Upper Triassic and Lower Jurassic ages near Abancay and in the Sacred Valley, respectively, suggest that extension commenced in the Triassic in south-east Peru. We have not found any evidence for the previously assumed Permian initiation of the Mitu Group (e.g. Sempere et al., 2002). However, brachiopods of Permian age were reported from calcerous levels of the Mitu Group in the Vilcabamba area (Cárdenas et al., 1997), suggesting a Permian inception in this region.
The Middle Triassic to Lower Jurassic plutons of the Cordillera de Carabaya (this study; Miskovic et al., 2009) strike parallel to exposures of the Mitu Group to the north-east, and overlap with the ages of the Mitu Group presented in this abstract (Figure 1). Therefore, we conclude that the plutons exposed in the Cordillera de Carabaya formed via crustal anatexis associated with Triassic-Jurassic extension.
Fossil evidence clearly shows that the Mitu basins experienced marine conditions during the Norian (Upper Triassic) in north and central Peru, and deposited carbonates of the Pucará Group (Rosas et al., 2007). The Pucará Group is missing in the study area, and hence we can not determine whether or not marine conditions extended throughout Peru, or if extension was diachronous and propagated from north to south. To distinguish between these hypotheses, radioisotopic ages need to be obtained from the top part of the Abancay and Sicuani sections. Such data would also address the question of whether extension during the deposition of the Mitu Group continued from the Middle Triassic to the end of the Lower Jurassic, or if there were two separate extensional events (Middle-Upper Triassic Abancay and Sicuani basins versus a Jurassic age from the Sacred Valley).
Deposition of limestones of the Pucará Group terminated by the end of the Lower Jurassic (Toarcian; Rosas et al., 2007). Therefore, the Jurassic Sacred Valley arkose could either be the time equivalent of the late stage Pucará Group, or of early phases of the continental Sarayaquillo Fm. of north-east Peru (Jaillard et al., 1990). The age approximates the time of emplacement of the Ilo Batholith along the coast of southern Peru (Boekhout et al., 2010), implying that contemporaneous extension in the Cusco area could be related to back-arc tectonism.

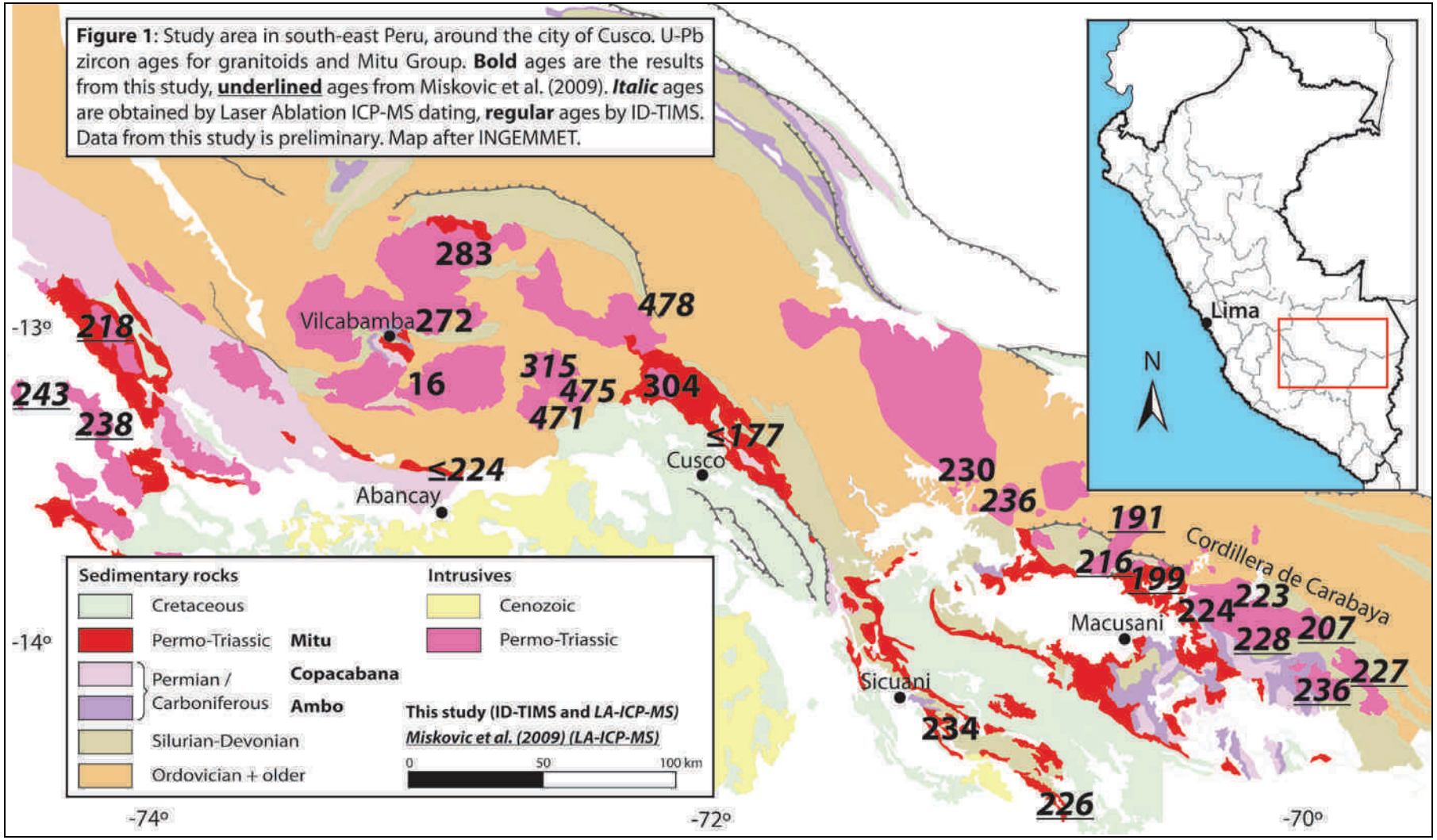
Figure 1: Study area in south-east Peru, around the city of Cusco. U-Pb zircon ages for granitoids and Mitu Group. Bold ages are the results from this study, underlined ages from Miskovic et al. (2009). Italic ages are obtained by Laser Ablation ICP-MS dating, regular ages by ID-TIMS. Data from this study is preliminary. Map after INGEMMET.
283
478
Vilcabamba
272
218
-13º
315
475
304
16
471
243
238
≤177
≤224
Cusco
Abancay
230
236
191
216
199
Cordillera de Carabaya
223
224
228
207
Macusani
227
236
Sicuani
234
226
Lima
N
Sedimentary rocks
Cretaceous
Permo-Triassic
Mitu
Permian / Carboniferous
Copacabana
Ambo
Silurian-Devonian
Ordovician + older
Intrusives
Cenozoic
Permo-Triassic
This study (ID-TIMS and LA-ICP-MS)
Miskovic et al. (2009) (LA-ICP-MS)
0
50
100 km
-14º
-74º
-72º
-70º

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