Supplementary Materials of the paper

THE TIMING AND MODE OF SOUTHERN ANDEAN HUMAN MIGRATIONS

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Sample Preparation

The samples were processed at Direct AMS (https://www.directams.com/) and CIRAM Lab (https://www.ciram-lab.com/). At CIRAM, the following protocol is utilized. The collagen containing samples are cold etched with hydrochloric acid (HCl, 1 M) for 12 to 24 hours to remove all surface pollutions and to partially damage the mineral part of the bone. That facilitates the following collagen extraction. Thereafter, the collagen containing samples are gelatinized (hot acid extraction). After these pre-treatments, the samples are combusted at 920°C and transformed into gas using an elemental analyzer (Elementar Vario ISOTOPE Select). During this stage, a first check of the C/N ratio is carried out. The EA allows separation of combustion gases and also removal of water. The residual carbon dioxide (CO2) from the EA outlet is absorbed in the zeolite trap of an AGE automated graphitization system (AGE 3, Ion Plus) and then released to the given reactor to be transformed into graphite by catalysis following the method described by (Vogel et al. 1984). Meanwhile, the $^{13}C/^{12}C$ ratio (expressed as $\delta^{13}C$) and $^{15}N/^{14}N$ (expressed as $\delta^{15}N$) were measured using a mass spectrometer dedicated to stable isotopic reports with an error below 0.1‰ (IRMS, Elementar Isoprime precisION).

The different carbon isotopes were separated using a 250 kV accelerator mass spectrometer in joint venture with JSC Barnas (ISO 9001 and ISO 14001). ^{14}C content is determined by comparing the simultaneously collected ^{14}C, ^{13}C and ^{12}C beams with those of control products: Oxalic Acid, CO_2 standard, charcoal. The isotopic compositions were normalized with a calibration straight line made from the measurements of international standards: caffein IAEA 600 ($\delta^{13}C$= -27.771±0.043 ‰ VPDB, $\delta^{15}N$ = +1.0±0.02 ‰ Air (Coplen et al. 2006), glucose BCR 657 ($\delta^{13}C$= -10.76±0.04 ‰ VPDB, European Comission certificate EUR 20064 EN) and ammonium sulfate IAEA N 2 ($\delta^{15}N$= +20.41±0.12 ‰ Air (Gonfiantini 1978; Bohlke et al. 1993).

Conventional radiocarbon age is calculated according to the method described by (Stuiver and Polach 1977). It takes into account the $\delta^{13}C$ correction for isotopic fractionation, based on the comparison between the concentration measurements of $^{13}C/^{12}C$ and $^{14}C/^{12}C$. This factor enables the control of potential pollution and further evaluate the reliability of the measure, it is a good indicator of the quality of the sample. The precision on the analytical measure of pMC is 1σ (1 sigma relative standard deviation). International standards NIST 499C, IAEA-C-7 et IAEA-C-9 were used. $\delta^{13}C$ is expressed per mile (‰) in conformity with international standard VPDB (Vienna Pee Dee Belemnite). $\delta^{15}N$ is expressed per mile (‰) in relation to Air. International standards IAEA-600, IAEA-N-2 and BCR-657 were used. Collagen yield (% weight), C:N, %C and %N values were unreported.

Supplementary Figures

Figure S1. Bayesian model for the migrant phase at Potrero Las Colonias (radiocarbon dates in blue following colouring in Figure 4). Bars underneath each distribution denote 95.4% CI. "CE" denotes Common Era (calibrated). The start of Inka occupation in the region, as calculated in (Marsh et al. 2017), is included at the bottom in red. The start and end estimates are 1175-1275 CE and 1320-1470 CE, respectively.

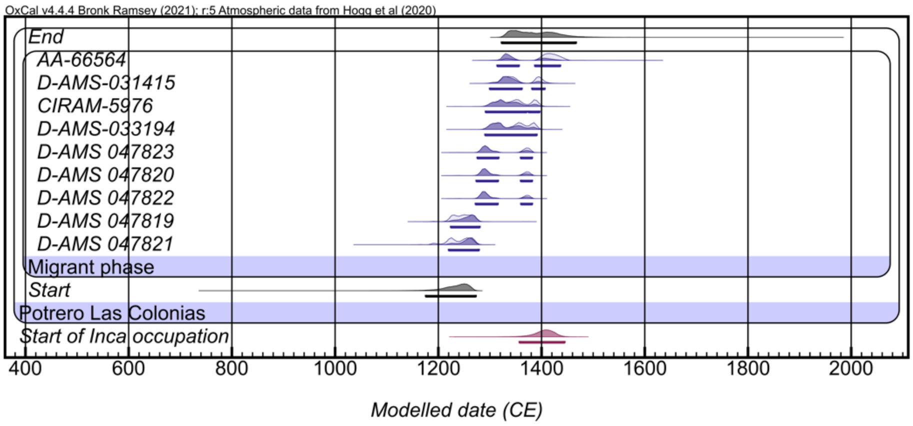


Figure S2. Bayesian model for the migrant phase at Túmulo III (radiocarbon dates in green following colouring in Figure 4). Bars underneath each distribution denote 95.4% CI. "CE" denotes Common Era (calibrated). The start of Inka occupation in the region, as calculated in (Marsh et al. 2017), is included at the bottom in red. The start and end estimates are 1165-1370 CE and 1300-1455 CE, respectively.

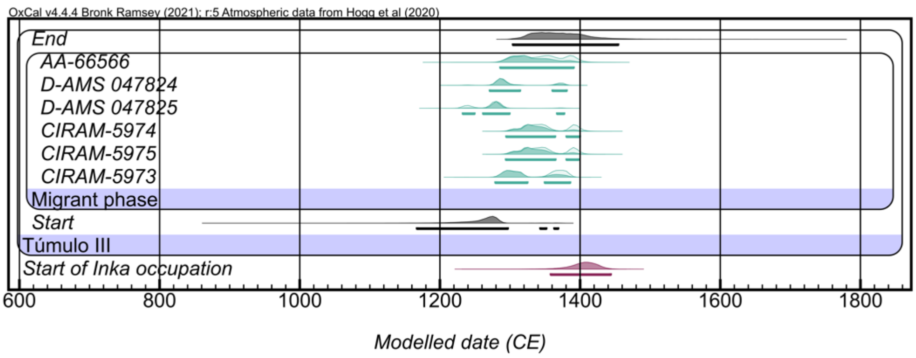
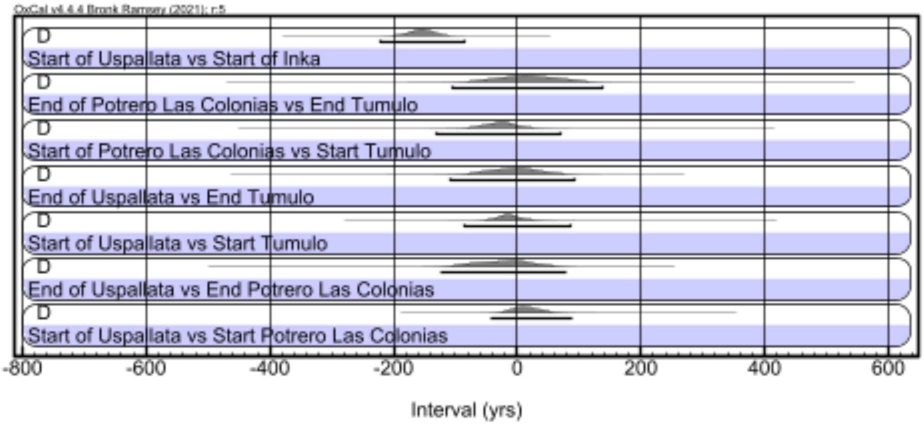


Figure S3. Probability density functions for the difference ("D-") between the start and end boundaries for the three models created (Fig. 4; Fig. S1-2) and the start of the Inka occupation in region, as calculated by (Marsh et al. 2017). Black bars underneath each distribution denote 95.4% CI. Results show that apart from the start of the migrant phase at Uspallata ("Uspallata") and the start of the Inka occupation ("Inka"), there is no significant difference between the modelled outputs as the distributions include zero at 95.4% CI.



References

Bohlke JK, Gwinn, CJ, Coplen TB. 1993. New Reference Materials for Nitrogen-Isotope-Ratio Measurements. Geostandards Newsletter 17(1),159–164.

Coplen TB, Brand WA, Gehre M, Gröning M, Meijer HAJ, Toman B, Verkouteren RM. 2006. New Guidelines for $\delta^{13}C$ Measurements. Analytical Chemistry 78(7):2439–2441.

Gonfiantini R. 1978. Standards for stable isotope measurements in natural compounds. Nature 271(5645):534–536.

Marsh EJ, Kidd R, Ogburn D, Durán V. 2017. Dating the Expansion of the Inca Empire: Bayesian Models from Ecuador and Argentina. Radiocarbon 59:117–140.

Stuiver M, Polach HA. 1977. Discussion Reporting of ^{14}C Data. Radiocarbon 19(3):355–63.

Vogel, JC, Southon JR, Nelson, DE, Brown TE. 1984. Perfomance of catalitically condensed cabon for use in Acelerator Mass Spectrometry. Nuclear Instruments and Methods in Physics Research BS:289–93.

OxCal code

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   Boundary("Start");
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   Boundary("Start");
   Phase("Migrant phase")
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   Boundary("Start");
   Phase("Migrant phase")
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    R_Date("D-AMS 047825",784,19)
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  Difference( "D", "P", "T");
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